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WEAK FORM EFFICIENCY OF THE TURKISH GOLD MARKET

MBA THESIS



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WEAK FORM EFFICIENCY OF THE TURKISH GOLD MARKET

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MASTER OF BUSINESS ADMINISTRATION

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Jamel CHAFRA
June 1996

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

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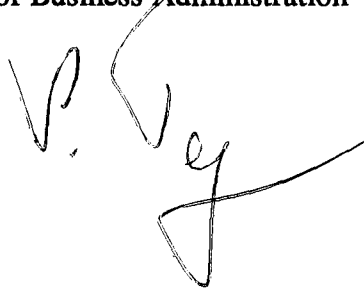
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ABSTRACT

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June 1996

In this study, the Weak Form Efficiency Hypothesis of the Turkish gold market is examined. The period of the study runs from 01/01/1992 to 20/03/1996. This period is divided into four mutually exclusive sub-periods reflecting different stages of the Turkish gold market. Each sub-period's series of gold returns is examined for autocorrelation structure, randomness, and normality. Furthermore, the Weak Form Efficiency hypothesis is conducted on the overall series of gold returns. The result obtained is that the Efficient Market Hypothesis of the Turkish gold market does neither hold for the series of gold returns of the sub-periods nor for that of the overall series. The implications of this result for the current state of the Turkish gold market and the Istanbul Gold Exchange (IGE) are discussed.

Key Words: Weak Form Efficiency, Turkish Gold Market, Istanbul Gold Exchange.

ÖZET

TÜRK ALTIN PAZARININ ZAYIF PAZAR ETKİNLİĞİ

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Bu çalışmada, Türk Altın Pazarının Zayıf Pazar Etkinliği Hipotezi incelenmiştir. Çalışma 01/01/1992 den 20/01/1996 periyodunu kapsamaktadır. Bu periyod, birbirinden bağımsız, Türk Altın Pazarının değişik zamanlarını yansıtan dört alt periyoda bölünmüştür. Her bir alt periyoddaki altın getirileri serisi otokorelasyon, rassengesellik (randomness) ve normallik açısından incelenmiştir. Daha sonra, zayıf pazar etkinliği hipotezi bütünsel altın getirileri serisi için uygulamıştır. Türk Altın Pazarının Etkinliği Hipotezi ne alt periyodda ne de bütünsel periyodda altın getirileri serileri için tutmadığı sonucu elde edilmiştir. Bu sonucun Türk Altın Pazarı ve İstanbul Altın Borsası için etkileri tartışılmıştır.

Anahtar Kelimeler: Zayıf Pazar Etkinliği, Türk Altın Pazarı, İstanbul Altın Borsası

To my Family



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INTRODUCTION

The Efficient Market Hypothesis has attracted, through time, the attention of many researchers who tried to apply this notion, through various studies, on several financial markets. As far as the Turkish financial market is concerned, studies concerning market efficiency were not numerous. Moreover, most of these studies were geared towards testing the Weak Form Efficiency of the Turkish stock market. This study aims to test the Weak Form Efficiency of the Turkish gold market, for 3 main reasons:

1. Studies conducted on the efficiency of gold markets are very few. Moreover, no detailed study has been conducted concerning the Turkish gold market.
2. Investors are usually investigating inefficiencies in financial markets simply because they are looking forward to gaining riskless profits. Hence, this study will give implications of whether such profits are possible in the Turkish gold market.
3. This study tries to find out if the opening of Istanbul Gold Exchange has any effect on the whole Turkish gold market as far as efficiency is concerned.

In the sequel, a brief history of gold and gold markets, along with the demand and supply of gold in Turkey, is presented followed by a literature survey on the Efficient Market Hypothesis. In the methodology section, the set of assumptions under which the study is conducted is listed, the relevant hypotheses tests are conducted. The findings concerning the Weak Form Efficiency of the Turkish gold market are summarized. Finally, in the conclusions section, a summary of the Market Efficiency hypotheses results and their implications is given along with recommendations for further research.

Gold is a rare, shining precious metal, which transfers heat and electricity and can easily be shaped. In addition, it is durable against chemical substances, not subject to corrosion and oxidization¹. That is why people assign gold a very high value. In fact, for centuries, gold has been used not only as an instrument of exchange against other goods and commodities, but also as a way of preserving one's wealth. Troy, ounce and kilogram are the standard measures used in the international gold trade². Carat is a measure of gold purity³ and buyers are willing to pay the highest premium for 24 carat gold, simply because it contains 100 % gold.

In spite of gold's historical monetary significance, an efficient freely functioning world market for gold is contemporary. After World War II, the price of gold was maintained by monetary authorities through central banks at a predetermined level, hence the gold market, at that time, served as a distribution mechanism rather than a price setting device. To illustrate, central banks refrained from dealing with gold on the basis of a free market (i.e. market forces were not, at that time, the determinants of gold prices). Rather, central banks agreed to transact in gold among themselves at a preset official price of \$ 35 a fine ounce. Little by little, then, market forces started taking a driving role in the gold market. However, central banks kept on intervening, as to keep a fine ounce of gold fixed at \$ 35. Yet, such an intervention could not be maintained forever. In fact, the US dollar's convertibility into gold was formally suspended in August 1971⁴. Since then, a global market for physical gold has developed on the basis of a floating price system (i.e. market forces are the "only" determinants of gold prices). This market is, nowadays, open around the clock and use a full range of derivative paper instruments (ex: options, forwards and futures).

¹Appendix A, Table 1.

²Appendix A, Table 2.

³Appendix A, Table 3.

⁴This is mainly due to loss of confidence of other countries, on the US currency \$.

Before 80's, Turkey was well behind the global trend. In fact, at that time, gold was mostly a saving instrument. In addition to the negative real interest rates on deposits at Turkish banks, exchanging local for foreign currency was prohibited. Furthermore, a lack of alternative financial instrument and securities markets were the most important factors that increased the demand for gold.

In the 80's, the most important measure taken to increase foreign exchange reserves was to stop the leakage of foreign currency from the country. This was done through the introduction of stricter market regulations against foreign exchange trade. As a result, the general tendency was towards investing in gold by any means, even through unofficial imports of gold; as a consequence, the need for establishing rules aiding the transaction of gold in legal ways emerged. For this reason, in 1982, legal arrangements were established as to free gold market.

After 1984, the Turkish government initiated rules to control and arrange the domestic gold market. The central bank was given the authority to import and started, hence, importing gold ranging from 50 gr. to 1 kg bullion against TL. The central bank's authority also included the determination of exchange rates and gold prices. Central bank operations, using official rates in gold prices, caused the price of gold to be lower than the world average gold prices which resulted in excess demand. Consequently, the central bank abandoned this method and started determining gold prices on the basis of free market exchange rates. This time, local gold prices were higher than world average gold prices. Again, unofficial gold trade came into the scene. This situation prevailed until April 1989, when the "Gold Exchanged Against Foreign Currency" system was established (Döviz Karsiligi Altin Piyasasi). This had an effect of smoothing gold price differences between Turkey and other countries in the world. Moreover, unofficial

imports of gold were discouraged in the sense that the central bank was able to keep its Kg fixed costs as low as \$ 18, which unofficial importers could not compete with. In this system, the central bank acts as the authorized gold importing agent while the price of standard weight purity bullion is determined by foreign sellers (directly through other central banks or international intermediaries) and Turkish banks demanding an amount of gold at a certain price.

In this kind of transaction, foreign sellers and local banks are entitled, in advance, to open a gold account in the central bank. As soon as a "buy-order" gold price communicated to the central bank coincides with one of the sellers' prices, the central bank executes the offer on behalf of the buyer. Institutions who buy or sell gold can not take short positions.

With the introduction of Istanbul Gold Exchange IGE, it became possible to sell gold to, or buy gold from international markets immediately following gold price changes. IGE's transactions are held, daily, within two sessions: 11:00-13:00 in the morning and 14:00-16:00 in the afternoon⁵.

As mentioned above, today, the gold system in Turkey is one in which prices are determined by market forces. This awakens the necessity for a closer look at the demand and supply of gold in Turkey.

⁵Sener N., Akman V., *Istanbul Borsasi ve Dunya Ornekleri*, pp. 70-71.

Demand for gold in Turkey:

The high growth of gold demand in Turkey, mainly originating from households seeking to hold more gold as a traditional investment instrument, led Turkey to be one of the most important gold importers in the world. In general, the demand for gold in Turkey can be divided into five different categories:

1. Demand arising from savings.
2. Speculative demand.
3. Central bank's demand for gold.
4. Foreign demand.
5. Industrial demand.

Supply for gold in Turkey:

Turkey's supply of gold is limited to 5,000 tons. This supply is partitioned mainly into five different categories:

1. Gold mining supply: According to gold experts, there exists around 6 million tons of raw gold in Turkey. Unfortunately, the non-existence of refineries deprive Turkey from a 42 - 73 tons of pure gold had production in refineries existed. Alternatives to such a potential gold production, is confined to firms such as Rabak, Sarkuysan, Etibank, Karadeniz, Bakir Isletmeleri etc. Such firms, just extract valuable metal blocks, send them to foreign refineries for separation of each valuable metal and receive back only 500 - 600 kg of pure gold from such an operation.
2. Central bank supply (see Appendix A, Table 6).

3. Unofficial gold import ⁶:

Year	85	86	87	88
Official Gold Import (tons)	28	8	8	2
Unofficial Gold Import (tons)	8	50	70	50

As seen from the above table, in the 1985 - 1988 period, unofficial gold imports exceeded official gold imports. This can be explained by the fact that the central bank's gold prices were higher than the world's average gold prices.

4. Gold exchange: This mainly comes from gold traded in Kapalicarsi.

5. Istanbul Gold Exchange (IGE): IGE is a market for gold where unprocessed rod and bullion that meets the necessary standard and purity requirements, and accepted by the London Exchange (see Appendix A, Table 4) is transacted. Moreover, it is a market where buyers and sellers interact in a way as to minimize transaction costs.

⁶ Sener N., Akman V., *Istanbul Borsasi ve Dunya Ornekleri*, pp. 74-75.

LITERATURE REVIEW

The world, nowadays, is living in an era characterized by a trend towards the internationalization of financial institutions. One of the main implications of such a trend is the dominance of security-based financial systems i.e. Capital Markets over credit-based financial systems. That's why, it is believed that capital markets are getting, more and more involved in the development of any country's economy (Barnes, 1986).

One of the approaches in understanding capital markets is through testing their efficiency [Efficient Market Hypothesis (EMH)]. As put by Fama (1970), an efficient market is one in which prices incorporate all the information available in the market. In fact, there are three forms of Market Efficiency (Fabozzi, Modigliani, and Ferri, 1994):

1. Weak Form of Market Efficiency Hypothesis: The Weak Form of Market Efficiency Hypothesis claims that current market prices "fully" reflect public information including past prices, price changes, volume data and other market generated information such as specialist analysis. Hence, no one can earn excess returns solely through developing trading rules based on historical price movements or past market returns. In other words, past prices or returns are neither useful nor relevant in outperforming the market.

2. Semi-strong Form of Market Efficiency Hypothesis: This hypothesis assumes that market prices *adjust rapidly* to the release of *all new public information*. A direct implication of this hypothesis is that no investor can continuously earn excess returns given that all available information is simultaneously disclosed to every investor.

3. Strong Form of Market Efficiency Hypothesis: The Strong Form of Efficient Market Hypothesis asserts that security prices "fully" reflect all information (whether public information or any other form of information). Hence, there is no way for any group of

investors to have " monopolistic" access to information relevant to price formation. This is the highest form of efficiency that may exist in a market. Moreover, the strong form of the efficiency hypothesis does not only require efficient markets (i.e. markets in which prices *adjust rapidly to every new public information release*), but also requires markets in which all information is *immediately* available to every investor *at the same time*. This form of efficient market hypothesis contends that, because all information is immediately available to everyone, no group of investors can have monopolistic access to important new information. Therefore, no one can consistently keep on earning excess returns (*No One Can Beat the Market*).

Many researchers have shown that, in developed countries, Efficient Market Hypothesis EMH holds mostly in the weak form (Fama and Blume, 1966; Lawrance, 1986; Panas, 1990) and in the semi-strong form (Fama, Fisher, Jensen, and Roll, 1969).

This study aims at testing the weak form efficiency of the Turkish Gold Market. The reason behind choosing the Gold Market is that there are very few studies, if any, until this moment, that cover such a subject. Moreover, such a project will, hopefully, give some guides to both existing and potential investors in the Turkish Gold Market in the sense that it will try to highlight whether it is possible for arbitrageurs in the market to earn abnormal riskless profits.

Researchers, who have studied Precious Metal Exchange and in particular Gold Market Efficiency, agree more or less on the fact that Gold Markets are far from being efficient at least in the semi-strong and strong form. Akgiray, Booth, Hatem, and Chowdhury (1991) tested conditional dependence for the London Precious Metal prices and concluded that gold price distribution is peaked and thick tailed. In addition to that, they concluded that gold prices are dependent on time. Such a dependence is present not in first order

properties, rather in two higher order moments. Thus Akgiray, Booth, Hatem, and Chowdhury rejected the Gold Market Efficiency Hypothesis even in its weakest form for the London Precious Metal Market. In fact, they concluded in their study that both precious metal price series i.e. gold and silver are found to exhibit time dependence and pronounced generalized autoregressive conditional heteroscedastic (GARCH) effects.

Goss (1983), on the other hand, tested the Semi-strong Form Efficiency of the London Metal Exchange and concluded that this market is not efficient in the semi-strong form:

"...while the individual tests are predominantly, but not unequivocally, in favor of the non rejection of the hypothesis that the coefficients of the prior forecast errors are zero, the joint test invariably leads to the rejection of the hypothesis that these coefficients are zero. The results therefore, support the view, for all four tested metals (Tin, Zinc, Lead, and Copper) that the market is not efficient in the semi-strong form sense" (Page 693).

Finally, Yin-Wong Cheung and Kon S. Lai (1993), tested the hypothesis of long memory for London gold market returns during the post- Bretton Woods period (weekly data starting July 1973 and ending December 1987). The study lead to the conclusion that long memory behavior for gold returns is rather unstable. Moreover, Yin-Wong Cheung and Kon S. Lai concluded that when only few observations corresponding to major political events in the Middle East, in late 1979⁷, are omitted from the study period, little evidence of long memory can be found.

Turkish Gold Market is a thin market compared, for example, to the London Gold Market in terms of the volume, traded daily, in the gold market. This is mainly due to the fact that it is a rather young market. In fact, it is only after the radical economic reforms that were

⁷Recall the Gulf Crisis between Irak and Iran that started in the late 1979.

conducted in Turkey in the beginning of 80's, that the Turkish Gold Market was believed to have started operating.

Unfortunately, as it was mentioned above, though there were some studies conducted to test Efficient Market Hypothesis for the Turkish Stock Market (Alparslan, 1990; Muradoglu and Oktay, 1992), no study was carried out to accept or reject the Efficient Market Hypothesis as far as the Turkish Gold Market is concerned. This is an important motive behind this study.



METHODOLOGY

1. Sample: This study is based on 1288 daily 24-carat bullion gold price observations covering the period starting from January, 1, 1992 and ending at March, 20, 1996. These observations are all taken from the daily newspaper Hurriyet.

The study period is divided into 4 mutually exclusive periods reflecting important decisions undertaken by the Turkish government, and concerning the operations in the Turkish gold market. These four periods are as follows:

● Period I: Period I runs from January 1, 1992 till October 3, 1993. This period comes just before the day on which the Istanbul Gold Exchange was opened, upon the decision of deputies in the Turkish Great National Assembly, on October 4 , 1993. This period accounts for 539 daily observations.

● Period II: Period II runs from October, 4 , 1993 till March 15, 1994. This period covers the day from which the law concerning the establishment of Istanbul gold exchange was put into effect till one day before the decided operational opening of Istanbul gold exchange on March 16, 1994. This period covers 139 daily observations.

● Period III: Due to the serious economic crisis faced by Turkey in the beginning of 1994, the operational opening of Istanbul gold exchange was postponed to July 26, 1995. Hence, this period encompasses the period running from the decided effective opening and the day on which Istanbul gold exchange started operating. This period covers 419 daily observations.

● Period IV: This period runs from the operational opening of the Istanbul gold exchange (July 26Th, 1995) until March 20Th, 1996. This period accounts for 191

daily observations. It ends on March 20Th, 1996 due to technical reasons concerning the time constraints put on this analysis finalization. Yet, it may be extended further in the future. Hence, this study may be, hopefully, a guide towards a better analysis of the weak form efficiency hypothesis applied to the Turkish gold market.

For comparison purposes, one more period will be added namely **period T**. It is a consolidated period covering the whole study time horizon.

At this stage, four main points need to be clarified prior to proceeding with the analysis:

1. The reason why data collection starts from January 1, 1992 is to provide a certain symmetry around a crucial decision for the Turkish gold market: the decided effective opening of Istanbul gold exchange on March, 16Th, 1994. That's why, approximately half of the collected data cover the period prior to this above mentioned event (27 months) and the other half covers the period after it (24 months). Moreover, since there are other important events, during the study period, that influenced the Turkish gold market (these events are discussed throughout period I-period IV in the above section), it is desirable to categorize data into four periods.

2. The reason behind choosing TL/Gr. as the measurement for gold prices is that it is the only available and existing data through the whole 1992 - 1995 period. As far as the collection of data is concerned, only one Turkish daily journal was used: **Hurriyet**. The reason behind this was to assert scientificity for the conducted study through recourse to only one source of data. Moreover, different daily journals disclosed slightly different gold prices; therefore, the intended choice of one source is vital here.

3. The reason why a relatively large period of time is chosen in the scope of the study is that the larger is the sample size, the better will be the quality of the parameter estimates.

4. The nature of the statistical tests which will be used to confirm or reject the Efficient Market Hypothesis for the Turkish Gold Market in its weak form (i.e. auto-correlation, run tests, independence tests etc.) necessitates that gold prices should be tabulated into a ranking order, that reflects the continuity of prices. Therefore, days on which gold is not traded in the Turkish Gold Market are omitted (usually on Sundays). Moreover, daily 24-carat gold prices are assumed to reflect closing prices. This is another shortcoming of this study, since such data does not account for price volatility during a given trading day. For convenience, daily gold prices are measured as a weighted average of "bid" and "offer" prices within the same trading day.

5. In order to get rid of the inflationary component in nominal gold prices and to smoothen gold distribution, the logarithmic function will be applied. At this stage, a unit root test will be conducted, in order to clarify whether the logarithmic function of *gold prices* or the logarithmic function of *price returns* would be suitable to be taken as a basis for the Turkish gold market efficiency analysis. Gold return is defined as:

$$\text{Gold Return } R_t = (P_t / P_{t-1})$$

The unit root hypothesis will be depicted in the next section, while a brief understanding of the Augmented Dickey-Fuller unit root test will be introduced in the hypotheses test section.

2. Hypotheses:

As was adopted by most Efficient Market Hypothesis researchers (ex: Lawrance, 1985; Panas, 1990; Butler and Malaikah, 1991), the weak form of Efficient Market Hypothesis can be tested by examining the independence, randomness and normality of gold price series. These tests along with the unit root test would be used for the analysis of the Weak Form Efficiency of the Turkish gold market.

● Unit root hypothesis:

H_0 : Gold return distribution possess a unit root.

H_1 : Gold return distribution is stationary.

● Independence hypothesis:

H_0 : Gold returns are not correlated with each other.

H_1 : Gold returns are autocorrelated.

● Randomness hypothesis:

H_0 : Gold returns depict a random walk through time.

H_1 : Gold returns do not depict a random walk through time.

● Normality hypothesis:

H_0 : Gold returns follow a normal distribution through time.

H_1 : Gold returns distribution is not normal.

3. Hypothesis tests:

● Augmented Dickey-Fuller test (ADF): The ADF test consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms,

and optionally, a constant and time trend. With two lagged difference terms, the regression equation is:

$$\Delta y_t = \beta_1 y_{t-1} + \beta_2 \Delta y_{t-1} + \beta_3 \Delta y_{t-2} + \beta_4 + \beta_5 t$$

where Δy_t is the logarithmic gold return difference between time t and $t-1$, Δy_{t-1} is the logarithmic gold return difference between time $t-1$ and $t-2$, y_{t-1} is the logarithmic gold return at time $t-1$.

There are three choices in running the ADF test regression. One concerns whether to include a constant term in the regression. Another has to do with whether to include a linear time trend or not. The third is how many lagged differences are to be included in the regression.

● Independence tests:

For the Weak Form Efficiency to hold true, gold prices in a time series should be dependent on each other. In fact, if they are somehow correlated with each other, then investors may take, while trading in gold, some positions as to earn riskless profits.

There are several statistical analysis, documented in statistics literature, to test the independence of any price series (e.g. Serial Correlation Analysis, Kolmogorov-Smirnov test, Ljung-Box test...etc.). During this study serial correlation analysis, along with Ljung-Box independence test will be applied to gold return distribution.

Serial correlation analysis: The serial correlation coefficient that will be obtained by conducting the correlation analysis, measures the strength of the relationship between the

value of a random variable (in this case gold returns) at time t and its value in the preceding periods. The population serial correlation coefficient at lag k (ρ_k) is estimated using the sample serial correlation coefficient at lag k (r_k) which is defined by :

$$r_k = \frac{\sum (y_t - \bar{y})(y_{t-k} - \bar{y})}{\sum (y_t - \bar{y})^2} \quad \text{for } k = 1, 2, 3, \dots$$

In this study, y_t denotes the natural logarithm of gold returns R_t , $\bar{y}$ the mean of all logarithmic gold returns, y_{t-k} the natural logarithm of R_{t-k} .

For complete serial independence, $\rho_k = 0$, and complete dependence $\rho_k = \pm 1$. Using the null hypothesis that $\rho_k = 0$, a hypothesis test may be performed to detect whether r_k is significantly different from 0. For the purpose of this study, a two tailed hypothesis test is conducted at the significance level $\alpha = 0.05$. The critical value for a 95 % confidence interval is $1.96 / \sqrt{n}$, where n is the total number of observations in the sample.

A more general approach for testing for serial correlation is to compute the sample autocorrelation and partial autocorrelations of the residuals up to any specified number of lags. This computation can be made using the Ljung-Box Q statistic test. In fact, the Ljung-Box Q statistic tests for serial correlation by summarizing the autocorrelation coefficients. The test statistic is given by:

$$Q_{LB} = n(n+2) \sum (r_k^2) / (n-k)$$

where r_k is the autocorrelation at lag k , and n is the total number of observations in the sample. Q can be used to test the hypothesis that all of the autocorrelations are zero; i.e. the series exhibits white noise. Under the null hypothesis, Q is distributed as χ^2 , with

degrees of freedom equal to the number of autocorrelations in the sum of the above formulae.

● Tests for randomness:

The Weak Form Efficiency hypothesis implies that gold prices follow a random walk through time so that investors won't gain much when analyzing past prices. However, too many or few price change series mean that the market is not efficient even in the weak form. In order to detect, the randomness of a distribution, run test is used. This test shows whether the changes in gold prices follow a systematic pattern. The test is non-parametric and does not require normality and constant variance of the data. A run can be defined as a sequence of price changes of the same sign. For example, a logarithmic return change series as follows:

++++/------/0/++/00/-----

consists of six runs.

The sample proportion of positive, negative, and zero runs of logarithmic return changes are used to estimate the corresponding population proportions; hence under the hypothesis of randomness, the total expected number of runs of all signs for a proportion can be computed as:

$$m = [N (N+1) - \sum (n_i)^2] / N$$

where N is the total number of price changes, and n_i are the total number of runs of logarithmic return changes of each sign, with $i = 1, 2, 3$ representing the total number of positive (+), negative (-) and zero (0) logarithmic return changes. The variance of m is given by:

$$(\delta_m)^2 = [\sum (n_i)^2 [\sum (n_i)^2 + N(N+1)] - 2N \sum (n_i)^3 - N^3] / N^2 (N-1)$$

For large N, the sampling distribution of m is approximately normal. The standardized z-score may be determined by:

$$Z = [(R+0.5) - m] / \delta_m$$

where R is the actual number of runs that exists in the gold return distribution. Two confidence intervals will be used in testing the randomness hypothesis: 95% and 99% confidence intervals.

● Tests for normality

The Weak Form Efficiency hypothesis implies that prices should follow a normal distribution. In fact, if, for example, the distribution is right skewed, it implies that prices show an increasing trend. This leads investors to buy the financial asset, hold it for some time, sell it, and make abnormal profits. From this perspective, tests of normality are very crucial for the Weak Form Efficiency hypothesis.

Tests of normality are used to investigate whether or not the empirical distribution of the successive log price changes conform to the normal distribution. Here, the coefficient of skewness (β_1) and kurtosis (β_2) will be applied.

If the sample of gold logarithmic return series is large, then according to the central limit theory, the function of the square root of the coefficient of skewness is normally distributed, with a mean of 0 and variance of $6/n$ (where n is the number of elements in

the sample). Moreover, the coefficient of kurtosis is also normally distributed with mean **0** and variance **24/n**.

Furthermore, Kolmogorov - Smirnov test will be applied to check the normality of gold logarithmic return distribution in order to support the conclusions concerning the normality of gold return distributions derived from the tests of the coefficients of skewness (β_1), and kurtosis (β_2) respectively. The Kolmogorov - Smirnov test statistic is equal to the absolute value of maximum deviation between the observed cumulative proportion and the theoretical normal cumulative proportion. The confidence interval applied to test the normality hypothesis is a 95 % interval (i.e.: $\alpha = 0.05$). The critical value for a 95 % confidence interval is **1.36 / $\sqrt{n}$** , where n is the total number of observations in the sample.

Last but not least, another normality test will be used, in order to enhance and strengthen the conclusion about the normality of gold logarithmic returns. This test is the Jarque-Bera normality test.

The Jarque-Bera normality test: The Jarque-Bera statistic tests whether a series is normally distributed. The statistic is given by:

$$(n-k/6) [\beta_1^2 + 1/4 (\beta_2 - 3)^2]$$

where n is the number of observations, k is zero for an ordinary series and the number of regressors when examining the normality of residuals resulting from the regression, β_1 is the skewness coefficient and β_2 is the kurtosis coefficient. Under the null hypothesis of normality, the Jarque-Bera statistic is distributed χ^2 with 2 degrees of freedom.

FINDINGS

1. Unit Root test:

Table 1

Augmented Dickey-Fuller Unit Root Test for Logarithmic Function of Gold Prices

Period	Coefficient	Standard Error	t-Statistic
01/01/92-03/10/93 (I)	- 0.012783	0.007275	- 1.757
04/10/93-15/03/94 (II)	- 0.093444	0.043127	- 2.167
16/03/94-25/07/95 (III)	- 0.058259	0.023721	- 2.4560
26/07/95-20/03/96 (IV)	- 0.064711	0.024470	- 2.645
01/01/92-20/03/96 (T)	- 0.004996	0.002625	- 1.904

(**): significant at 0.01.

Table 1 lists the corresponding Augmented Dickey-Fuller coefficients for the each of the periods included in the study. As can be tracked from the table, all the t-statistics obtained, are found not to be significant even at 0.01 level. Hence, the unit root hypothesis conducted on the logarithmic function of gold prices can not be rejected. This arises the question of whether gold prices would be smoothened or not using the logarithmic function of the gold returns.

Table 2**Augmented Dickey-Fuller Unit Root Test for Logarithmic Function of Gold Returns**

Period	Coefficient	Standard Error	t-Statistic
01/01/92-03/10/93 (I)	-1.121385	0.065319	- 17.168**
04/10/93-15/03/94 (II)	- 1.091673	0.125241	- 8.717**
16/03/94-25/07/95 (III)	- 1.158708	0.057363	- 20.200**
26/07/95-20/03/96 (IV)	- 0.858049	0.100503	- 8.538**
01/01/92-20/03/96 (T)	- 1.119651	0.036147	- 30.975**

(**): significant at 0.01.

Table 2 lists the corresponding Augmented Dickey-Fuller coefficients for the each of the periods included in the study. As can be tracked from the table, all the t-statistics obtained, are found to be significant at 0.01 level. This serves to reject the unit root test hypothesis, and leads to the statistical evidence that the logarithmic function of the Turkish return distribution are stationary. Hence, the main outcome from the above results is that the Turkish gold return distribution is smoothened by the logarithm function, in order to get rid of the trends and cycles that it contained. Therefore, during the remaining of the study, all efficiency tests will be conducted on the logarithm function of gold returns.

2. Logarithmic Gold Return Distributions' Statistics

Table 3
Descriptive Statistics

	01/01/92-03/10/93	04/10/93-15/03/94	16/03/94-25/07/95	26/07/95-20/03/96
Mean	0.00163	0.00482	0.01636	0.00229
Median	0	0.00375	0.01636	0.00229
Mode	0	0	0.00561	0.00413
Standard Deviation	0.00863	0.01563	0.01491	0.00400
Variance	$7.45 \cdot 10^{-5}$	0.00024	0.00022	$1.60 \cdot 10^{-5}$
Minimum	- 0.03905	- 0.09378	0.00581	- 0.00053
Maximum	0.04668	0.06076	0.02690	0.00565
Range	0.08573	0.15454	0.02109	0.00565

Table 3 depicts some statistics concerning the logarithmic distribution of gold returns for the four study periods. As can be noticed above, the means of the logarithmic return distributions showed some increase over time, yet for the last period, the mean of the logarithmic gold return distribution decreased significantly (0.00229). This implicitly infers that, during the fourth period, gold price variations, from day to day, are minimized. Actually, this implication can be tracked from the standard deviation and variation columns of table 1. In fact, the standard deviation of the logarithmic function of gold price distributions showed higher variations through time⁸. Yet, as far as the period starting from the operational opening of Istanbul Gold Exchange is concerned, the

⁸ Refer to Period I,II,III, and IV's graphs in the appendix section.

volatility of the logarithmic function of gold returns, translated in the standard deviation, reached its minimum. This implies that gold prices, during the last period, did not show a significant deviation from each other. Hence, the volatility of the gold prices, reached its minimum during the last period.

3 Independence test:

Table 4
Autocorrealion Coefficient Statistics

Period	1 Day Lag	2 days Lag	3 Days Lag	4 Days Lag	5 Days Lag	6 Days Lag	7 Days Lag	8 Days Lag	9 Days Lag	10 Days Lag
01/01/92-03/10/93 (I)	- 0.133*	0.028	0.0998*	0.0822	0.0351	- 0.022	- 0.0669	0.0234	- 0.0045	- 0.0087
04/10/93-15/03/94 (II)	- 0.0339	- 0.0412	- 0.174*	- 0.203*	0.1531	0.0024	0.1146	- 0.0639	- 0.1325	0.0051
16/03/94-25/07/95 (III)	0.1811*	- 0.358*	- 0.250*	0.0295	0.0526	- 0.0010	0.0039	0.0236	0.0612	0.05451
26/07/95-20/03/96 (IV)	0.0656	0.0893	0.0000	0.1293	- 0.0725	- 0.0191	- 0.1159	- 0.0896	- 0.0153	0.03586
01/01/92-20/03/96 (T)	0.1059*	- 0.238*	- 0.183*	0.01316	0.0689*	0.01004	0.01888	0.01814	0.03376	0.04128

(*): statistically significant at 0.05.

Table 4 lists all the autocorrelation coefficients at various lags up to the lag of 10 days for different periods' logarithmic gold returns. As far as period I is concerned, 1 day and 3 day lags reveal an autocorrelation coefficient significantly different from 0. For 4 days

lag onwards, all autocorrelation coefficients seem to be in the acceptance region of the independence hypothesis.

On the other hand, during period II, only the gold returns which are two, or three days apart, depict a coefficient of autocorrelation different from 0. Again, for lags of 4 and more, all autocorrelation coefficients are in the acceptance region of the independence hypothesis.

Coming to period III, all autocorrelation coefficients of gold returns which are 1,2, and 3 days apart from each other, are significantly different than 0. Yet, for lags of 4 and more days, autocorrelation coefficients are consistently within the acceptance region of the independence hypothesis.

Finally, there is no significant evidence to reject the independence hypothesis of gold returns during period IV. In fact, the fourth period's autocorrelation coefficients appeared to be consistently in the acceptance region of the independence hypothesis.

As it is all the time better to see the whole image, period T, which is the consolidated form of periods I throughout IV, is incorporated in this study. The autocorrelation coefficient of gold returns, during the whole period, that are 1, 2, 3, and 5 days apart from each other seem to be significantly different than 0.

Table 5
The Ljung-Box Statistics

Period	1 Day	2 days	3 Days	4 Days	5 Days	6 Days	7 Days	8 Days	9 Days	10 Days
	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag
01/01/92-03/10/93 (I)	9.5958*	10.020*	15.430*	19.107*	19.780*	20.066*	22.514*	22.816*	22.827*	22.870*
04/10/93-15/03/94 (II)	0.1623	0.4039	4.739	10.721*	14.126*	14.127*	16.067*	16.675*	19.306*	19.310*
16/03/94-25/07/95 (III)	13.816*	67.943*	94.493*	94.864*	96.044*	96.044*	96.051*	96.291*	97.901*	99.180*
26/07/95-20/03/96 (IV)	0.6310	2.3791	2.3791	5.6582	6.6974	6.7703	9.4519	11.0624	11.1102	11.3709
01/01/92-20/03/96 (T)	14.480*	87.811*	131.15*	131.37*	137.53*	137.66*	138.12*	138.55*	140.03*	142.24*

(*) : statistically significant at 0.05.

Table 5 lists the Ljung-Box statistics for various lags up to 10 days for different periods' logarithmic gold returns. As far as period I is concerned, all gold returns which are separated up to 10 days lag from each other reveal a value of Ljung-Box statistics leading to the rejection of the independence hypothesis.

On the other hand, during period II, gold returns, gold returns which are 1,2, and 3 days apart from each other, depict Ljung-Box statistics, all within the acceptance region of the independence hypothesis. As the lag increases from 4 days onwards, the Ljung-box statistics seemed to be towards the rejection of the independence hypothesis.

Coming to period III, all gold returns that are separated up to 10 days lag appeared to possess Ljung-Box statistics leading to the rejection of the independence hypothesis.

Finally, there is no significant evidence to reject the independence hypothesis of gold returns during period IV. In fact, the fourth period's Ljung-Box statistics appeared to be consistently in the acceptance region of the independence hypothesis.

For comparison purposes, the consolidated period (T), revealed the fact that all gold returns, which are up to 10 days separated from each other, possess Ljung-Box statistics towards the rejection of the independence hypothesis. To recapitulate, periods I, III and T, each show dependency of gold returns on each other, for all lags in the above table. This demonstrates that Turkish gold market is not efficient even in its weakest form. Yet, as far as period IV is concerned, the independence hypothesis can not be rejected and, hence, some sort of dependency seem to be gained with the effective opening of Istanbul Gold Exchange.

4 Randomness Test (Run test):

Table 6

Run test

Period	Actual Runs	Expected Runs	Standard Error	Standard Variable (Z)
01/01/92-03/10/93 (I)	349	463.256	58.7166	- 1.9374**
04/10/93-15/03/94 (II)	76	122.986	29.6203	- 1.5694
16/03/94-25/07/95 (III)	221	375.888	51.289	- 3.0102'***
26/07/95-20/03/96 (IV)	84	175.453	34.4716	- 2.6385'***
01/01/92-20/03/96 (T)	729	1,141.11	90.134	- 4.5667'***

(**): significant at 0.01.

Table 6 depicts the results of the run tests for the 5 study periods in concern. The results will highlight whether gold returns in the Turkish market depict a random walk or not. One main observation from the table is that, throughout all periods, the actual number of runs is smaller than the expected number of runs, for each period, giving a hint to the negative sign that the calculated value of the test statistic takes.

As far as period I is concerned, the random walk hypothesis is rejected at 0.05 significance level. Yet, for period II, the standard variable (Z) is in the acceptance region of the random walk hypothesis both at 0.01 significance levels. Period III, on the other hand, depict a standard variable (-3.0102) which leads to the rejection of the random walk hypothesis both at 0.05 and 0.01 levels of significance. Such a result holds true for periods III, IV, and VI. Hence, the random hypothesis is rejected for all periods of study, except for period II. Therefore, on an aggregate basis, we can conclude that gold returns do not depict a random walk. Based solely on the random walk hypothesis, the Turkish gold market is not efficient in the weak form.

5. Tests for Normality:

Table 7

Coefficient of Skewness

Period	β_1	$\delta\beta_1$	Standard Variable (Z)
01/01/92-03/10/93 (I)	0.6895 ^R	0.1053	6.5479**
04/10/93-15/03/94 (II)	- 0.9321 ^L	0.2063	- 4.518**
16/03/94-25/07/95 (III)	- 0.0503 ^L	0.1194	- 0.042
06/07/95-20/03/96 (IV)	0.193 ^R	0.1793	1 .0947
01/01/92-20/03/96 (T)	- 0.1140 ^L	0.07	- 1.62857

(**): significant at 0.01. (^R): right skewed. (^L): left skewed.

As table 7 reveals, gold price distributions for period I and VI are right skewed, while those of periods II, and III are left skewed. Moreover, the consolidated period (T) depicts gold returns which possess a left skewed distribution.

As far as period I is concerned, the coefficient of skewness of the gold return distribution, turned out to be statistically different from 0 at 0.01 significance levels. The same result is true for period II. On the other hand, periods II and III reveal coefficients of skewness which are significantly within the acceptance range of the normality hypothesis. Last but not least, considering all the aggregated periods' gold return distribution, the normality hypothesis, based only on coefficient of skewness is not rejected.

Table 8

Coefficient of kurtosis

Period	β_2	$\delta\beta_2$	Standard Variable (Z)
01/01/92-03/10/93 (I)	5.2117	0.2102	24.794**
04/10/93-15/03/94 (II)	13.2376	0.4098	32.302**
16/03/94-25/07/95 (III)	39.0404	0.2382	163.89**
06/07/95-20/03/96 (IV)	1.5948	0.3509	4.544**
01/01/92-20/03/96 (T)	60.75	0.14	433.92**

(**): significant at 0.01.

Table 8 depicts the coefficient of kurtosis for various periods of time constituting the study horizon. The major result out of table 8 is that the coefficient of kurtosis, for all periods, turned to be significantly different from 3 (recall that the normal distributions has a coefficient of kurtosis of 3) at 0.01 significance levels. Therefore, based solely on kurtosis test, the normality hypothesis of logarithmic gold returns is rejected.

Table 9
Kolmogorov-Smirnov Goodness of Fit Test

Period	Most Extreme Positive Difference	Most Extreme Negative Difference	Most Extreme Absolute Difference	Kolmogorov-Smirnov Z-statistic
01/01/92-03/10/93 (I)	0.14902	- 0.13118	0.14902	3.456*
04/10/93-15/03/94 (II)	0.12638	- 0.13746	0.13746	1.615*
16/03/94-25/07/95 (III)	0.26760	- 0.23758	0.26760	5.471*
26/07/95-20/03/96 (IV)	0.07392	- 0.06977	0.07392	1.019*
01/01/92-20/03/96 (T)	0.18067	- 0.18976	0.18976	6.808*

(*): significant at 0.05.

Table 9 depicts the Kolmogorov-Smirnov Goodness of Fit test statistics for various periods of time constituting the study horizon. The calculated values of the Kolmogorov-Smirnov Z-statistic, are significantly larger than the critical values, for each of the

periods. Thus, the null hypothesis that the gold returns are normally distributed is rejected.

Table 10
The Jarque-Bera Statistic

Period	Jarque-Bera Statistic
01/01/92-03/10/93 (I)	686.78**
04/10/93-15/03/94 (II)	1,007.65**
16/03/94-25/07/95 (III)	26,548.26**
26/07/95-20/03/96 (IV)	20.54**
01/01/92-20/03/96 (VI)	198,060.2**

(**): significant at 0.01.

Table 10 depicts the Jarque-bera Statistic for various periods of time constituting the study horizon. The major result out of table 10 is that the Jarque-Bera Statistic, for all periods, turned out to reject of the normality of the distribution of gold returns both at 0.05 and 0.01 significance levels. Therefore, based solely on the Jarque-Bera Statistic, the normality hypothesis of gold returns is rejected.

Therefore, based on the above normality tests, the hypothesis on the normality of gold returns is rejected. Thus, based solely on the results of the normality tests, the weak form efficiency of Turkish gold market seems to be far from holding true.

CONCLUSIONS AND RECOMMENDATIONS

Many researchers, in the last years, an increasing interest in testing the market efficiency hypothesis. The importance of such studies emerges from the vital question of whether arbitrage profits still exist in certain markets or not, despite all the talk about globalization, deregulation and the role of market forces in minimizing if not eliminating such opportunities.

Capital markets are expected to be efficient because of three main underlying reasons:

1. In the market place, there are a large number of profit maximizing participants who are concerned with the analysis and valuation of securities, and such participants are independent of each other.
2. New information about securities come to the market in a random fashion.
3. Markets adjust prices rapidly to reflect the effect of new information.

This study is performed to fill the gap arising from the fact that market efficiency studies related to developing countries are very few, let alone the fact that studies testing the weak form efficiency hypothesis on the Turkish gold market are nonexistent. In order to test the above mentioned hypothesis, four mutually exclusive periods were defined reflecting some important decisions undertaken by the Turkish government, and concerning the operations in the Turkish gold market. Moreover, for comparison purposes a fifth period which is nothing but a consolidated form of all above mentioned four periods, was devised. Finally, several tests were conducted on the five periods ranging from independence tests to randomness and normality tests.

Results of these tests reveal, on one hand, that gold returns are rather dependent on each other. Through time, gold return distributions (for the tested five periods) are not normal. Instead, they show a skewness to the left (except for periods I and IV). Furthermore, gold return distributions do not depict a random walk. To sum it up, the Turkish gold market appears to be inefficient even in the weak form. This may be due to the fact that the Turkish gold market is still a thin market where a relatively small number of buyers and sellers interact to trade a small volume of gold. Therefore, such a study may be extended or redesigned to test for such an effect. Hence, it is possible that a redesigned version of this study, accounting for the volume effect, would yield different results.

The major result of this study, is that with the effective opening of Istanbul Gold Exchange (IGE), the market did show some tendency towards becoming a more efficient gold market. In fact, as far as the period starting from the effective opening of IGE is concerned⁹, the independence hypothesis of gold returns is not rejected¹⁰. Moreover, gold return distribution in period IV can be considered as a normal one as far as skewness is concerned¹¹, though, based on all tests for normality applied in this study, gold returns in period IV indicated a non-normal distribution¹². On the other hand, gold return distribution in period IV did not depict a random walk. This fact is stressed by the rejection of the random walk hypothesis for the fourth period ¹³. Hence, in general, even, period IV seemed to strengthen the market inefficiency hypothesis. However, such an inefficiency must not be taken for granted. In fact, due to severe time constraints, this study allowed only for a period of 8 months to be accounted for in the fourth period. Moreover, since the Istanbul Gold Exchange is a newly established market, it is highly

⁹Period running from July 26, 1995 till March 20, 1996.

¹⁰See tables 4 and 5.

¹¹See table 7.

¹²See tables 8, 9 and 10.

¹³See table 6.

probable that it may show some deficiencies . For, as any new financial market, anomalies exist in the sense that financial assets may be under or over priced. This mispricing may be due to the fact that institutional investors, trading in the new market as well as in global market, can get benefit of assets price differences and, hence, develop certain trading rules as to gain abnormal profits. Lastly, throughout history, it is, all the time, the case that the rules and regulations concerning market efficiencies do come to eliminate anomalies. Therefore, existing deficiencies in the Turkish gold market may, very well, be a positive signal to initiate stricter rules and regulations as far as trading in the Turkish Gold Market is concerned.



REFERENCES:

- [1] Akgiray V., Booth G., Hatem J., and Chowdhury M.(1991) "**Conditional Dependence in Precious Metal Prices**", The Financial Review, August, pp. 367-386.
- [2] Alparslan S. M. (1989) "**Tests of Weak Form Efficiency in Istanbul Stock Exchange**", Bilkent University MBA thesis, June, pp. 4-11.
- [3] Balke S. N. (1991) "**Modeling Trends in Macroeconomic Time Series**", Economic Review, May, pp.19-31.
- [4] Butler K.C., Malaikah S.J. (1990) " **Efficiency and inefficiency in thinly traded stock markets: Kuwait and Saudia Arabia** ", Journal of Banking and Finance, pp.197-210.
- [5] Barnes P. (1986) " **Thin trading and stock market efficiency: The case of Kuala Lumpur stock exchange**", Journal of Business Finance and Accounting, March, pp.197-210.
- [6] Cheung Y. W., and Lai K. S. (1993) "**Do Gold Market Returns Have Long Memory ?**", The Financial Review, May, pp.181-202.
- [7] Churchill G. A. Jr., **Marketing Research: Methodological Foundations**, The Dryden Press International Edition (5th Edition), pp.777-784.
- [8] Ekonomik Trend, Dosya, "**Altin'in Turkiye Gulugu-II**", March, 12 1995, pp. 38-40.

[9] Ekonomik Trend, Haber, "**Altin bankaciligi surekli gelir sagliyor**", March, 12 1995, pp. 36-37.

[10] Ekonomik Trend, Haber, "**Yastik altindan seans salonuna...**", August, 30 1995, pp.20-22.

[11] Fabozzi F. J., Modigliani F., Ferri M. G., **Foundations of Financial Markets and Institutions**, Prentice Hall International Editions (10th Edition), pp.314-315.

[12] Fama, E.F. (1970) " **Efficient capital markets: a review of theory and emperical work** " , Journal of Finance, pp.383-417.

[13] Fama, E.F and Blume, M. (1966) " **Filter rules and stock market trading** ", Journal of Business, pp.226-241.

[14] Fama, E.F., Fisher, L., Jensen, M., and Roll, R. (1969) " **The adjustment of stock prices to new information** " International Economic Review, pp.1-21.

[15] Finans Dunyasi, Dosya, "**Altin artik Borsasi'nda isildiyor...**", September 1995, pp.52-58.

[16] Goss B. A. (1983) " **The Semi-strong Form Efficiency of the London Metal Exchange**", Applied Economics, pp.681-698.

[17] Kirkpatrick G. E., **Introductory Statistics and Probability for Engineering Science, and Technology**, Prentice Hall International Series in Industrial and Systems Engineering (10th Edition), pp.244-246.

[18] Lawrance M. (1986) " **Weak Form Efficiency in the Kuala-Lampur and Singapore Stock Markets**", Journal of Banking and Finance, pp.441-445.

[19] Mc Clave T. J., **Statistics for Business and Economics**, Maxwell Mac Millan (5th Edition), pp.345-388.

[20] Mendenhall W., Reinmuth J. E., Beaver R., **Statistics for Management and Economics**, PWS-KENT Publishing Company (6th Edition), pp. 738-744.

[21] O'Challaghan G. (1993) " **The Structure and Operation of the World Gold Economy**", September, pp.01-34.

[22] Panas E. (1990) " **The behaviour of Athens stock prices**", Applied Economics, pp.1715-1727.

[23] Paramatik, Haber, " **Altin reformu tamamlanmayi bekliyor**", October, 15 1995, pp.08-11.

[24] Sener N., and Akman V., **Istanbul Borsasi ve Dunya Ornekleri**, pp. 64-97.

[25] Sengul M., G. and Oktay, T. (1993) " **Calender anomalies in the Turkish Stock Market** ", paper presented at the International Conference on Business and

Economic Development in Middle Eastern and Mediterranean Countries, Istanbul-Turkey, July 1993.

[26] The Central Bank of the Republic of Turkey (1995) **1994 Annual Report**, April, pp.96-97.



APPENDIX

APPENDIX A

Table 1 Gold Characteristics

Symbol	Au
Melting Point (Co)	1.063
Density (gr / cm ³)	19.3
Atomic Weight	197
Atomic Number	70
Toughness	25
Durability	119
Elasticity	42

Source: Sener Nedim - Akman Vedat. **Istanbul Borsasi Ve Dunya Ornekleri.** p.

10.

Table 2: Conversion Factors for Gold

Measure	Metric Ton	Kilograms	Grams	Troy Ounce	Tolas	Taels
Metric Ton	1.000000	1,000,000	1,000,000 10 ³	32,150.74	85,735.3 5	26,717.25
Kilogram	0.001000	1.000000	1,000.000	32.15074	85.73535	26.71725
Gram	0.000001	0.001000	1.000000	0.032151	0.085735	0.026717
Troy Ounce	0.000031	0.031103	31.10348	1.000000	2.666666	0.830906
Tolas	0.000012	0.011664	11.66380	0.375000	1.000000	0.311624
Taels	0.000037	0.037429	37.42900	1.203370	3.208988	1.000000

Source: O'Challaghan Gary. **The structure and Operation of The World Gold Economy.** September 1993. p.34.

Table 3: Purity Standards for Gold

Carats	Parts per 1,000
24	1,000.000
22	916.667
18	750.000
14	583.333
9	375.000
1	41.667

Source: O'Challaghan Gary. **The structure and Operation of The World Gold Economy.** September 1993. p.34.



Table 4: Refineries whose Gold can be traded in IGE

<u>COUNTRY</u>	<u>COMPANY</u>
Singapore	Degussa (private) Limited
South Africa	Rand Refinery Limited
Spain	Industrias Reunidas Minero Metalurgicas, SA (Indumetal) Sociedad Espanole de Metal Preciocos SA
Sweden	Boliden Mineral AB
Switzerland	Agor-Heraeus SA Cendres & Metaux Precieux SA Metalor Pamp SA Valcambi SA
United Kingdom	Engelhard Limited Johnson Matttey Plc
USA	ASARCO Incorporated Engelhard Corporation (New Jersey Refinery) Handy & Harman Homestake Mining Company Johnson Matthey Incorporated Metalor USA

United States Assay

Offices & Mints

Russia

State Refineries

Zimbabwe

Fidelity Printers & Refineries (Private) Limited

Italy

Metalli Preziosi SpA

Japan

Ishifuku Metal Industry Company Limited

Mitsubishi Meterials Corporation

Mitsui Mining and Smelting Co. Limited

Tanaka Kikinzoku Kogyo KK

Tokuriki Honten & Company Limited

North Korea

Central Bank, DPR of Korea

Mexico

Met - Mex Penoles, S.A.

Netherlands

H. Drijfhout & Zoon's Edelmetaalberidrijven

BV

Shone Edelmetaal BV

Brazil

Banco Riame SA

Cassa de Moeda do Brazil

Degussa SA

Mineraco Morro Veho SA

Canada

Engelhard of Canada Limited

Johnson Matthey Limited

Noranda Minerals Incorporated (Division
CCR)

Royal Canadian Mint

France

Engelhard S.A.

Comptoir Lyon-Alemand

Louyot-Paris

Germany

Degussa

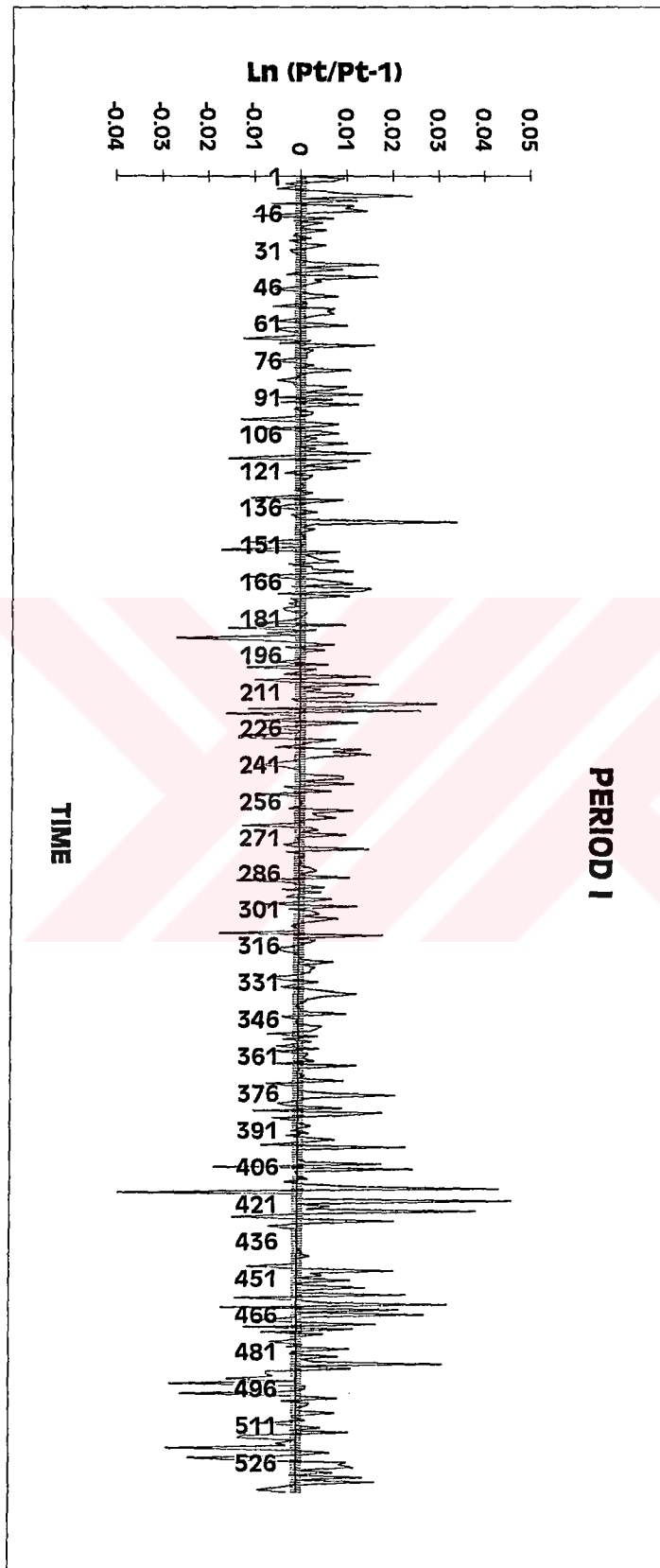
WC Heraeus GmbH

Norddeutsche Affinerie

Aktiengesellschaft



APPENDIX B



PERIOD I

112	73325	0.998978202	-0.001022321
113	73575	1.003409478	0.003403679
114	73575	1	0
115	74700	1.01529052	0.015174798
116	74300	0.994645248	-0.00536914
117	73150	0.984522207	-0.015598824
118	74100	1.012987013	0.012903405
119	74600	1.006747638	0.006724975
120	74600	1	0
121	75350	1.010053619	0.010003418
122	75350	1	0
123	75100	0.99668215	-0.003323366
124	75300	1.002663116	0.002659576
125	75450	1.001992032	0.00199005
126	75450	1	0
127	75450	1	0
128	75500	1.000662691	0.000662471
129	75550	1.000662252	0.000662032
130	75450	0.998676373	-0.001324504
131	75650	1.002650762	0.002647255
132	75650	1	0
133	74850	0.989424983	-0.010631329
134	75550	1.009352037	0.009308578
135	75750	1.002647253	0.002643756
136	75550	0.997359736	-0.002643756
137	75125	0.994374586	-0.005641296
138	75125	1	0
139	75400	1.003660566	0.003653882
140	75250	0.99801061	-0.001991371
141	75225	0.999667774	-0.000332281
142	75250	1.000332336	0.000332281
143	77850	1.034551495	0.033967995
144	78050	1.002569043	0.002565749
145	78050	1	0
146	78300	1.003203075	0.003197956
147	78300	1	0
148	78325	1.000319285	0.000319234
149	78400	1.000957549	0.000957091
150	78450	1.000637755	0.000637552
151	77550	0.988527725	-0.01153859
152	77625	1.000967118	0.000966651
153	77575	0.999355878	-0.00064433
154	76250	0.982919755	-0.017227795
155	76900	1.00852459	0.008488461
156	76950	1.000650195	0.000649984
157	77150	1.00259909	0.002595719
158	77450	1.003888529	0.003880988
159	78100	1.008392511	0.00835749
160	77900	0.997439181	-0.002564104
161	78100	1.002567394	0.002564104
162	78300	1.002560819	0.002557546
163	79200	1.011494253	0.011428696
164	79200	1	0
165	78300	0.988636364	-0.011428696
166	78500	1.002554278	0.002551022
167	79050	1.007006369	0.006981939

PERIOD I

168	79950	1.011385199	0.011320876
169	79800	0.998123827	-0.001877935
170	81050	1.01566416	0.015542744
171	82150	1.013571869	0.013480596
172	81750	0.995130858	-0.004881035
173	82625	1.010703364	0.010646488
174	82450	0.997881997	-0.002120249
175	82450	1	0
176	82250	0.997574287	-0.002428659
177	82250	1	0
178	81950	0.996352584	-0.003654084
179	81700	0.996949359	-0.003055303
180	81825	1.001529988	0.001528819
181	81875	1.00061106	0.000610874
182	81875	1	0
183	81650	0.997251908	-0.002751875
184	80850	0.990202082	-0.009846233
185	81650	1.009894867	0.009846233
186	80375	0.984384568	-0.015738637
187	80650	1.003421462	0.003415622
188	80075	0.992870428	-0.007155109
189	79975	0.998751171	-0.00124961
190	77850	0.973429197	-0.026930188
191	77125	0.990687219	-0.009356416
192	77125	1	0
193	77700	1.007455429	0.007427775
194	77450	0.996782497	-0.003222691
195	77850	1.005164622	0.005151331
196	77850	1	0
197	77850	1	0
198	77850	1	0
199	77775	0.999036609	-0.000963855
200	77375	0.994856959	-0.005156312
201	77850	1.006138934	0.006120167
202	76950	0.988439306	-0.011628038
203	77225	1.003573749	0.003567379
204	77225	1	0
205	76950	0.996438977	-0.003567379
206	78125	1.015269656	0.015154248
207	77350	0.99008	-0.009969531
208	77175	0.997737557	-0.002265007
209	78500	1.017168772	0.017023054
210	78500	1	0
211	78850	1.004458599	0.004448689
212	78950	1.001268231	0.001267427
213	79875	1.011716276	0.011648172
214	80775	1.011267606	0.011204599
215	80625	0.99814299	-0.001858737
216	80625	1	0
217	83050	1.030077519	0.029634061
218	84475	1.017158338	0.017012797
219	83525	0.988754069	-0.011309644
220	85750	1.026638731	0.026290098
221	84375	0.983965015	-0.016164937
222	84375	1	0
223	84350	0.999703704	-0.00029634

PERIOD I

224	83550	0.990515708	-0.009529554
225	84600	1.012567325	0.012489012
226	84750	1.00177305	0.00177148
227	84100	0.992330383	-0.007699179
228	84100	1	0
229	84050	0.99940547	-0.000594707
230	82950	0.986912552	-0.013173843
231	81850	0.986738999	-0.013349713
232	82500	1.007941356	0.00790999
233	82700	1.002424242	0.002421309
234	82700	1	0
235	82250	0.994558646	-0.005456212
236	83350	1.01337386	0.01328522
237	83950	1.00719856	0.007172774
238	85250	1.015485408	0.015366733
239	85650	1.004692082	0.004681109
240	85650	1	0
241	85350	0.996497373	-0.003508776
242	84550	0.990626831	-0.009417374
243	84250	0.996451804	-0.003554506
244	84250	1	0
245	84250	1	0
246	84250	1	0
247	85050	1.009495549	0.00945075
248	85850	1.009406232	0.009362269
249	85750	0.998835178	-0.001165501
250	86750	1.011661808	0.011594333
251	86450	0.996541787	-0.003464207
252	86450	1	0
253	87050	1.006940428	0.006916454
254	86400	0.992533027	-0.00749499
255	86400	1	0
256	86400	1	0
257	86400	1	0
258	86450	1.000578704	0.000578536
259	86450	1	0
260	86250	0.997686524	-0.002316156
261	87250	1.011594203	0.011527505
262	87500	1.00286533	0.002861232
263	87850	1.004	0.003992021
264	88550	1.007968127	0.00793655
265	88550	1	0
266	88650	1.001129305	0.001128668
267	87550	0.987591653	-0.012485974
268	87750	1.002284409	0.002281804
269	88100	1.003988604	0.003980671
270	88100	1	0
271	89000	1.010215664	0.010163837
272	88950	0.999438202	-0.000561956
273	88950	1	0
274	88950	1	0
275	88650	0.996627319	-0.003378382
276	88650	1	0
277	90000	1.015228426	0.015113638
278	89750	0.997222222	-0.002781643
279	89850	1.001114206	0.001113586

DATE	PRICE	Pt/Pt-1	Ln (Pt/Pt-1)
1	57950		
2	57950	1	0
3	58500	1.00949094	0.009446184
4	58900	1.006837607	0.006814336
5	58700	0.996604414	-0.003401364
6	58700	1	0
7	58400	0.994889267	-0.005123837
8	58650	1.004280822	0.004271685
9	59200	1.009377664	0.009333967
10	60650	1.024493243	0.024198094
11	60650	1	0
12	61400	1.012366035	0.0122902
13	61000	0.993485342	-0.006535971
14	61700	1.01147541	0.011410067
15	62300	1.009724473	0.009677495
16	63200	1.014446228	0.014342875
17	63200	1	0
18	62550	0.98971519	-0.010338064
19	63000	1.007194245	0.007168489
20	62900	0.998412698	-0.001588563
21	63200	1.004769475	0.004758137
22	63250	1.000791139	0.000790826
23	63250	1	0
24	63600	1.005533597	0.005518343
25	63550	0.999213836	-0.000786473
26	63450	0.998426436	-0.001574803
27	63600	1.002364066	0.002361276
28	63450	0.997641509	-0.002361276
29	63450	1	0
30	63800	1.005516154	0.005500996
31	63950	1.002351097	0.002348338
32	63800	0.997654418	-0.002348338
33	63700	0.998432602	-0.001568628
34	63700	1	0
35	63700	1	0
36	63700	1	0
37	63900	1.003139717	0.003134799
38	65000	1.017214397	0.017067909
39	65000	1	0
40	65600	1.009230769	0.009188426
41	65600	1	0
42	65400	0.99695122	-0.003053437
43	66500	1.016819572	0.016679689
44	66700	1.003007519	0.003003005
45	67000	1.004497751	0.004487666
46	67100	1.001492537	0.001491425
47	67100	1	0
48	66700	0.994038748	-0.005979091
49	66700	1	0
50	66850	1.002248876	0.002246351
51	67400	1.008227375	0.008193714
52	67400	1	0
53	67400	1	0
54	67500	1.00148368	0.00148258
55	67100	0.994074074	-0.005943554

PERIOD I

56	67600	1.007451565	0.007423939
57	68000	1.00591716	0.005899722
58	68500	1.007352941	0.00732604
59	68700	1.002919708	0.002915454
60	68700	1	0
61	68300	0.994177584	-0.005839433
62	68500	1.002928258	0.002923979
63	69200	1.010218978	0.010167117
64	68825	0.994580925	-0.005433812
65	68600	0.996730839	-0.003274516
66	68600	1	0
67	68600	1	0
68	67750	0.987609329	-0.012468075
69	67900	1.002214022	0.002211575
70	67600	0.995581738	-0.004428052
71	68700	1.016272189	0.016141216
72	68700	1	0
73	68900	1.002911208	0.002906979
74	69000	1.001451379	0.001450327
75	69100	1.001449275	0.001448226
76	69200	1.001447178	0.001446132
77	68700	0.992774566	-0.007251663
78	68700	1	0
79	68900	1.002911208	0.002906979
80	68800	0.998548621	-0.001452433
81	69550	1.010901163	0.010842173
82	69700	1.002156722	0.002154399
83	69650	0.99928264	-0.000717618
84	69650	1	0
85	69300	0.994974874	-0.005037794
86	69200	0.998556999	-0.001444044
87	69100	0.998554913	-0.001446132
88	69800	1.010130246	0.010079279
89	70250	1.006446991	0.006426298
90	70250	1	0
91	71200	1.013523132	0.01343251
92	70800	0.994382022	-0.005633818
93	71300	1.007062147	0.007037327
94	71000	0.995792426	-0.00421645
95	71900	1.012676056	0.012596388
96	71900	1	0
97	71800	0.998609179	-0.001391789
98	72000	1.002785515	0.002781643
99	72175	1.002430556	0.002427607
100	72125	0.999307239	-0.000693001
101	71200	0.987175043	-0.012907906
102	71200	1	0
103	71800	1.008426966	0.008391658
104	72100	1.004178273	0.004169568
105	71475	0.991331484	-0.008706306
106	71800	1.004547044	0.004536738
107	72400	1.008356546	0.008321823
108	72400	1	0
109	72650	1.003453039	0.003447091
110	72650	1	0
111	73400	1.010323469	0.010270546

PERIOD I

280	89950	1.001112966	0.001112347
281	89950	1	0
282	89950	1	0
283	90000	1.000555864	0.00055571
284	90000	1	0
285	90250	1.002777778	0.002773927
286	90600	1.003878116	0.003870616
287	90750	1.001655629	0.00165426
288	90750	1	0
289	91750	1.011019284	0.010959014
290	90515	0.98653951	-0.013551904
291	90350	0.998177098	-0.001824566
292	90350	1	0
293	90850	1.005534034	0.005518778
294	90515	0.996312603	-0.003694212
295	90950	1.004805833	0.004794322
296	90850	0.998900495	-0.00110011
297	90600	0.997248211	-0.002755582
298	91250	1.007174393	0.007148779
299	91350	1.00109589	0.00109529
300	90600	0.991789819	-0.00824407
301	91750	1.012693157	0.012613274
302	91550	0.997820163	-0.002182216
303	91850	1.003276898	0.003271541
304	92250	1.004354927	0.004345471
305	92350	1.001084011	0.001083424
306	93150	1.008662696	0.00862539
307	93500	1.003757381	0.003750339
308	93500	1	0
309	93350	0.998395722	-0.001605566
310	93350	1	0
311	93350	1	0
312	91750	0.982860204	-0.017288383
313	93450	1.01852861	0.018359047
314	93400	0.999464955	-0.000535189
315	93750	1.003747323	0.00374032
316	93950	1.002133333	0.002131061
317	93950	1	0
318	93600	0.996274614	-0.003732342
319	93200	0.995726496	-0.004282662
320	93100	0.998927039	-0.001073537
321	93100	1	0
322	93100	1	0
323	93200	1.001074114	0.001073537
324	93900	1.00751073	0.007482665
325	94000	1.001064963	0.001064396
326	94350	1.003723404	0.00371649
327	94600	1.002649709	0.002646204
328	94850	1.002642706	0.00263922
329	94850	1	0
330	94250	0.993674222	-0.00634587
331	93900	0.996286472	-0.00372044
332	94300	1.004259851	0.004250803
333	94250	0.999469777	-0.000530363
334	93900	0.996286472	-0.00372044
335	94250	1.00372737	0.00372044

PERIOD I

336	94900	1.006896552	0.006872879
337	96100	1.012644889	0.01256561
338	96600	1.005202914	0.005189425
339	96800	1.002070393	0.002068253
340	96950	1.001549587	0.001548387
341	96950	1	0
342	96900	0.99948427	-0.000515863
343	96950	1.000515996	0.000515863
344	97000	1.00051573	0.000515597
345	98000	1.010309278	0.0102565
346	97650	0.996428571	-0.003577821
347	97650	1	0
348	97600	0.999487967	-0.000512164
349	97600	1	0
350	98100	1.005122951	0.005109873
351	98500	1.004077472	0.004069182
352	98750	1.002538071	0.002534856
353	98100	0.993417722	-0.006604037
354	98525	1.004332314	0.004322957
355	98200	0.996701345	-0.003304108
356	98500	1.00305499	0.003050333
357	98500	1	0
358	98050	0.995431472	-0.004578996
359	98500	1.004589495	0.004578996
360	97950	0.994416244	-0.005599404
361	98175	1.00229709	0.002294456
362	98350	1.001782531	0.001780944
363	98450	1.001016777	0.00101626
364	98800	1.003555104	0.0035488
365	98350	0.995445344	-0.00456506
366	99600	1.01270971	0.01262962
367	99650	1.000502008	0.000501882
368	99650	1	0
369	99650	1	0
370	99800	1.001505268	0.001504137
371	99800	1	0
372	100800	1.01002004	0.009970172
373	100100	0.993055556	-0.006968669
374	100100	1	0
375	100100	1	0
376	100100	1	0
377	100800	1.006993007	0.006968669
378	102950	1.021329365	0.021105078
379	103200	1.002428363	0.00242542
380	103200	1	0
381	102750	0.995639535	-0.00437
382	102600	0.998540146	-0.001460921
383	103600	1.009746589	0.009699397
384	102600	0.99034749	-0.009699397
385	104500	1.018518519	0.018349139
386	105600	1.010526316	0.0104713
387	105000	0.994318182	-0.005698021
388	105000	1	0
389	105000	1	0
390	105300	1.002857143	0.002853069
391	105450	1.001424501	0.001423488

PERIOD I

392	105300	0.998577525	-0.001423488
393	105550	1.002374169	0.002371355
394	105300	0.997631454	-0.002371355
395	105550	1.002374169	0.002371355
396	106400	1.008053055	0.008020803
397	106400	1	0
398	105550	0.992011278	-0.008020803
399	108050	1.023685457	0.023409309
400	108050	1	0
401	108050	1	0
402	108050	1	0
403	108050	1	0
404	108050	1	0
405	108250	1.001850995	0.001849284
406	110250	1.018475751	0.018307147
407	108250	0.98185941	-0.018307147
408	111000	1.025404157	0.025086834
409	110950	0.99954955	-0.000450552
410	110950	1	0
411	110950	1	0
412	111200	1.002253267	0.002250732
413	110900	0.997302158	-0.002701487
414	111100	1.001803427	0.001801802
415	112450	1.012151215	0.012077982
416	117500	1.044908848	0.043929655
417	113000	0.961702128	-0.039050515
418	113000	1	0
419	113000	1	0
420	113000	1	0
421	118400	1.047787611	0.046680904
422	118400	1	0
423	119250	1.007179054	0.007153407
424	119500	1.002096436	0.002094242
425	124250	1.039748954	0.038979294
426	124250	1	0
427	122500	0.985915493	-0.014184635
428	122500	1	0
429	125100	1.02122449	0.021002387
430	125100	1	0
431	124300	0.993605116	-0.006415419
432	124300	1	0
433	124300	1	0
434	124300	1	0
435	124300	1	0
436	124300	1	0
437	124300	1	0
438	124300	1	0
439	124300	1	0
440	124300	1	0
441	124400	1.000804505	0.000804182
442	124500	1.000803859	0.000803536
443	124850	1.002811245	0.002807301
444	124850	1	0
445	124850	1	0
446	124850	1	0
447	123500	0.989187024	-0.010871861

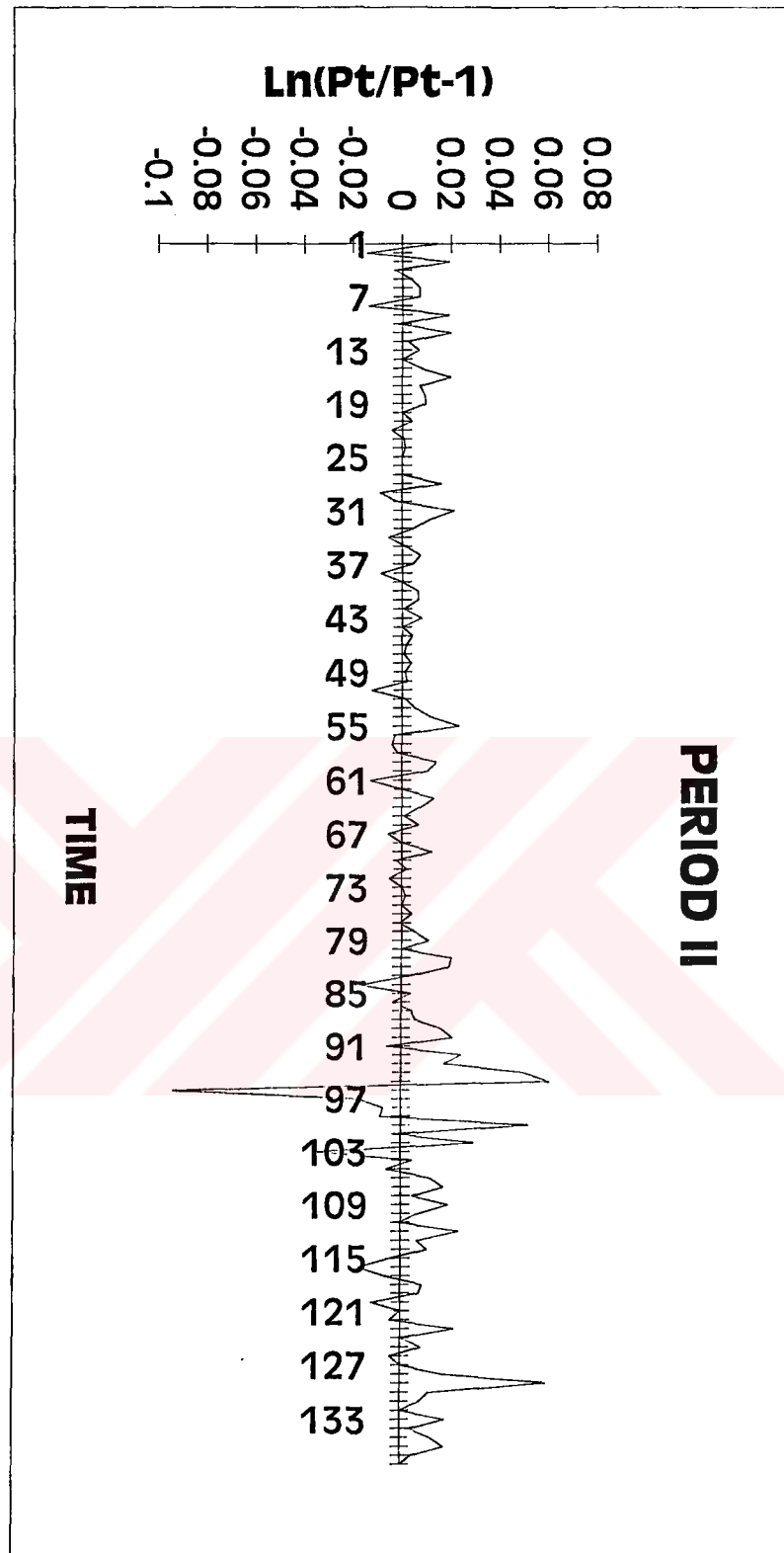
PERIOD I

448	123550	1.000404858	0.000404776
449	126175	1.021246459	0.0210239
450	126550	1.002972063	0.002967655
451	127250	1.005531411	0.005516168
452	127250	1	0
453	128750	1.011787819	0.011718884
454	128700	0.99961165	-0.000388425
455	128950	1.001942502	0.001940618
456	130900	1.01512214	0.015008941
457	130900	1	0
458	130900	1	0
459	134050	1.024064171	0.023779192
460	132250	0.986572175	-0.013518794
461	132300	1.000378072	0.000378
462	133000	1.005291005	0.005277057
463	137450	1.033458647	0.032911086
464	135200	0.983630411	-0.016505051
465	138250	1.022559172	0.022308477
466	138350	1.000723327	0.000723066
467	142250	1.028189375	0.027799367
468	142250	1	0
469	140950	0.99086116	-0.009180855
470	140950	1	0
471	143400	1.01738205	0.017232711
472	141750	0.988493724	-0.011572986
473	143500	1.012345679	0.012270093
474	142400	0.992334495	-0.007695036
475	143250	1.005969101	0.005951357
476	143250	1	0
477	143250	1	0
478	142400	0.994066318	-0.005951357
479	142600	1.001404494	0.001403509
480	142300	0.997896213	-0.002106003
481	143950	1.011595221	0.011528512
482	143950	1	0
483	143750	0.998610629	-0.001390337
484	145050	1.009043478	0.009002831
485	145200	1.001034126	0.001033592
486	145750	1.003787879	0.003780723
487	150450	1.032246998	0.031737978
488	150450	1	0
489	152250	1.011964108	0.011893104
490	151250	0.993431856	-0.00658981
491	150250	0.99338843	-0.006633523
492	149500	0.995008319	-0.005004181
493	147250	0.984949833	-0.01516457
494	147250	1	0
495	143250	0.972835314	-0.027540467
496	143550	1.002094241	0.002092051
497	143850	1.002089864	0.002087683
498	143850	1	0
499	140250	0.974973931	-0.025344546
500	140250	1	0
501	141500	1.008912656	0.008873173
502	141050	0.996819788	-0.00318528
503	141450	1.002835874	0.00283186

PERIOD I

504	141750	1.002120891	0.002118645
505	141750	1	0
506	141750	1	0
507	142950	1.008465608	0.008429976
508	142850	0.999300455	-0.00069979
509	142750	0.999299965	-0.00070028
510	143050	1.002101576	0.002099371
511	141900	0.991960853	-0.008071635
512	141900	1	0
513	142650	1.005285412	0.005271493
514	142450	0.998597967	-0.001403017
515	144075	1.011407511	0.011342936
516	142450	0.988721152	-0.011342936
517	140650	0.987363987	-0.012716526
518	140650	1	0
519	140050	0.995734092	-0.004275033
520	139750	0.997857908	-0.00214439
521	135850	0.972093023	-0.028303776
522	135750	0.999263894	-0.000736377
523	136750	1.007366483	0.007339482
524	136750	1	0
525	133550	0.976599634	-0.023678502
526	132150	0.989517035	-0.010538299
527	133600	1.01097238	0.01091262
528	134850	1.009356287	0.009312788
529	136550	1.0126066	0.012527798
530	136550	1	0
531	137650	1.008055657	0.008023384
532	137450	0.99854704	-0.001454017
533	139450	1.014550746	0.014445899
534	139450	1	0
535	141850	1.01721047	0.017064047
536	141850	1	0
537	141250	0.99577018	-0.004238791
538	140050	0.991504425	-0.008531868
539	139750	0.997857908	-0.00214439

APPENDIX C



PERIOD II

TIME	PRICE	Pt/Pt-1	Ln (Pt/Pt-1)
1	139250		
2	141250	1.014362657	0.014260491
3	139250	0.985840708	-0.014260491
4	141950	1.019389587	0.019204004
5	141550	0.997182106	-0.002821871
6	142050	1.003532321	0.003526097
7	143050	1.007039775	0.007015111
8	144050	1.006990563	0.006966242
9	142050	0.986115932	-0.013981353
10	144750	1.019007392	0.018829008
11	144550	0.998618307	-0.001382648
12	147450	1.020062262	0.019863667
13	147750	1.002034588	0.002032521
14	148750	1.00676819	0.006745388
15	148750	1	0
16	149850	1.007394958	0.007367749
17	152850	1.02002002	0.019822255
18	153950	1.007196598	0.007170826
19	155350	1.009093862	0.009052761
20	156850	1.009655616	0.009609299
21	156850	1	0
22	157450	1.003825311	0.003818013
23	156750	0.995554144	-0.004455768
24	156850	1.000637959	0.000637755
25	157050	1.001275104	0.001274291
26	157050	1	0
27	157050	1	0
28	157050	1	0
29	159550	1.015918497	0.015793127
30	158150	0.991225321	-0.008813403
31	157850	0.998103067	-0.001898735
32	161250	1.021539436	0.021310741
33	163000	1.010852713	0.010794245
34	163750	1.004601227	0.004590674
35	162850	0.994503817	-0.005511343
36	163050	1.001228124	0.001227371
37	164250	1.007359706	0.007332755
38	164950	1.004261796	0.00425274
39	163500	0.991209457	-0.008829407
40	163500	1	0
41	164550	1.006422018	0.006401485
42	165650	1.006684898	0.006662653
43	165750	1.000603682	0.0006035
44	167050	1.007843137	0.00781254
45	167050	1	0
46	167750	1.004190362	0.004181607
47	168050	1.001788376	0.001786778
48	168150	1.000595061	0.000594884
49	168750	1.003568243	0.003561892
50	168950	1.001185185	0.001184483
51	169250	1.001775673	0.001774099
52	167150	0.987592319	-0.012485299
53	167400	1.001495663	0.001494545
54	168250	1.005077658	0.00506481
55	170250	1.011887073	0.011816977
56	174250	1.02349486	0.023223105
57	173750	0.99713056	-0.002873565
58	173050	0.995971223	-0.004036914
59	172750	0.998266397	-0.001735107

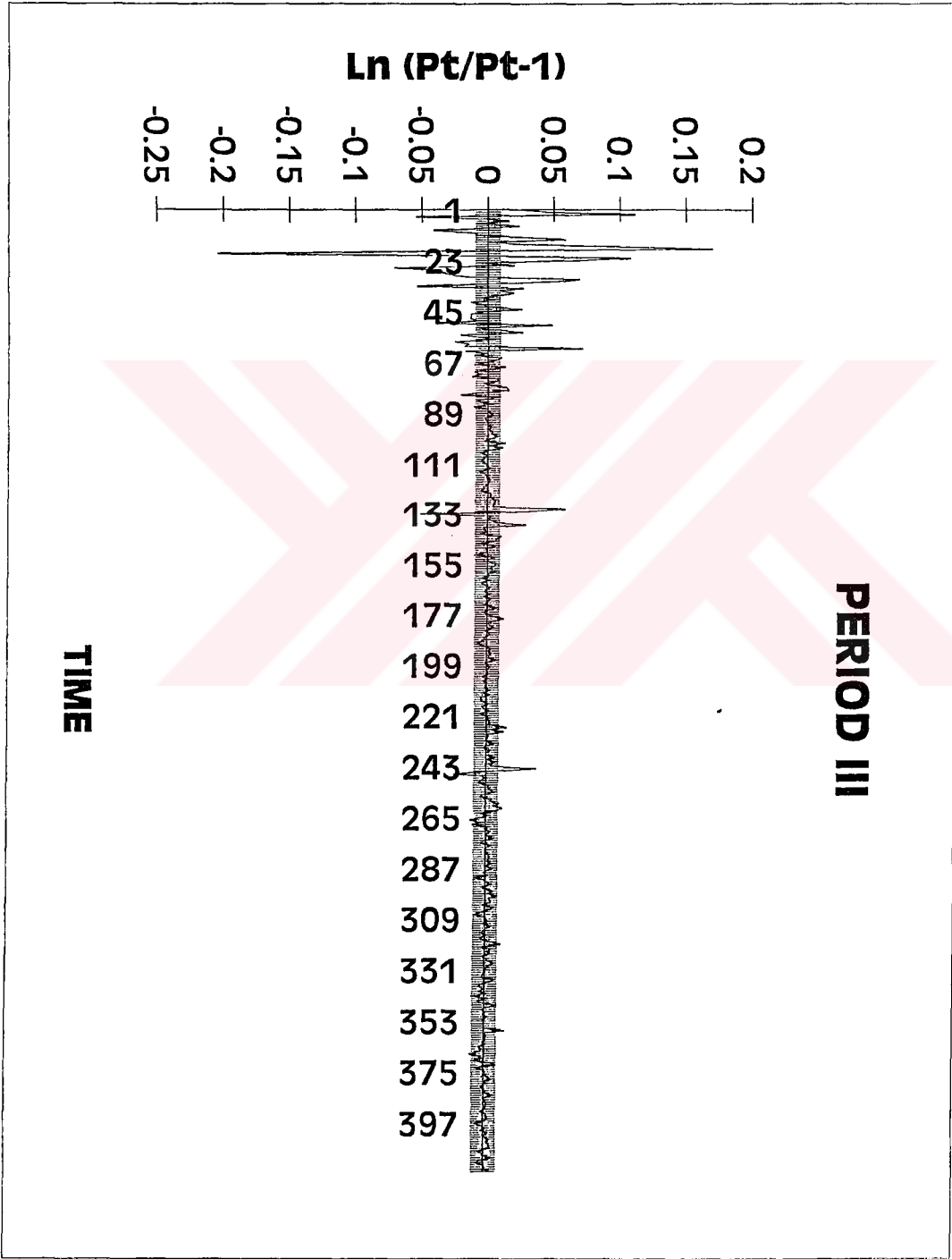
PERIOD II

60	175250	1.01447178	0.014368063
61	177050	1.010271041	0.010218653
62	174750	0.987009319	-0.013075797
63	174750	1	0
64	177050	1.01316166	0.013075797
65	178375	1.007483762	0.007455897
66	178550	1.000981079	0.000980598
67	179750	1.006720806	0.006698323
68	178750	0.994436718	-0.005578815
69	178750	1	0
70	180950	1.012307692	0.012232568
71	180550	0.997789445	-0.002213002
72	180850	1.00166159	0.001660211
73	179950	0.9950235	-0.004988924
74	180000	1.000277855	0.000277816
75	180250	1.001388889	0.001387925
76	180250	1	0
77	181000	1.004160888	0.004152255
78	180850	0.999171271	-0.000829073
79	181750	1.0049765	0.004964158
80	183750	1.011004127	0.010944022
81	183750	1	0
82	187550	1.020680272	0.020469338
83	191250	1.019728073	0.019535996
84	191950	1.003660131	0.003653449
85	188750	0.983328992	-0.016811533
86	189450	1.003708609	0.003701749
87	188750	0.996305094	-0.003701749
88	189500	1.00397351	0.003965636
89	190550	1.005540897	0.005525603
90	193650	1.016268696	0.016137779
91	197750	1.021172218	0.020951201
92	196600	0.994184576	-0.005832399
93	201500	1.024923703	0.024618174
94	205050	1.017617866	0.01746447
95	215500	1.05096318	0.049707058
96	229000	1.062645012	0.060761094
97	208500	0.910480349	-0.093782962
98	205000	0.983213429	-0.016929062
99	203500	0.992682927	-0.007343974
100	201800	0.991646192	-0.008388897
101	212600	1.053518335	0.052135358
102	212000	0.997177799	-0.002826191
103	218500	1.030660377	0.03019974
104	211000	0.965675057	-0.034927881
105	212000	1.004739336	0.004728141
106	210750	0.994103774	-0.005913678
107	213250	1.011862396	0.011792589
108	217000	1.017584994	0.017432167
109	218000	1.004608295	0.004597709
110	222250	1.019495413	0.019307812
111	223750	1.006749156	0.006726483
112	223600	0.999329609	-0.000670616
113	229000	1.024150268	0.023863262
114	230500	1.006550218	0.006528859
115	233000	1.010845987	0.010787591
116	232000	0.995708155	-0.004301082
117	228000	0.982758621	-0.017391743
118	226500	0.993421053	-0.006600684
119	228500	1.008830022	0.008791265

PERIOD II

120	230200	1.007439825	0.007412286
121	227500	0.988271069	-0.011798258
122	227500	1	0
123	226500	0.995604396	-0.004405293
124	231500	1.022075055	0.021834929
125	231500	1	0
126	233500	1.008639309	0.008602204
127	232500	0.995717345	-0.004291852
128	232500	1	0
129	236500	1.017204301	0.017057983
130	251000	1.061310782	0.059504731
131	254000	1.011952191	0.011881328
132	256000	1.007874016	0.007843177
133	256000	1	0
134	260750	1.018554688	0.018384649
135	261750	1.003835091	0.003827756
136	265000	1.012416428	0.012339976
137	269750	1.017924528	0.017765778
138	271000	1.00463392	0.004623217
139	271000	1	0

APPENDIX D



PERIOD III

TIME	PRICE	Pt/Pt-1	LN (Pt/Pt-1)
1	275000		
2	282500	1.027272727	0.026907453
3	295250	1.045132743	0.044143904
4	330000	1.117696867	0.111270199
5	312500	0.946969697	-0.054488185
6	311500	0.9968	-0.003205131
7	316500	1.016051364	0.015923903
8	313500	0.990521327	-0.009523882
9	321000	1.023923445	0.023641763
10	321000	1	0
11	308000	0.959501558	-0.04134134
12	305000	0.99025974	-0.009788006
13	302500	0.991803279	-0.008230499
14	312000	1.031404959	0.03092191
15	331000	1.060897436	0.059115188
16	331000	1	0
17	340000	1.027190332	0.026827242
18	375500	1.104411765	0.099312854
19	445000	1.185086551	0.169815811
20	417500	0.938202247	-0.063789738
21	340500	0.815568862	-0.203869419
22	340500	1	0
23	379500	1.114537445	0.108439471
24	405000	1.067193676	0.06503247
25	401500	0.991358025	-0.008679534
26	409500	1.01992528	0.01972937
27	381500	0.931623932	-0.070826053
28	367500	0.963302752	-0.037387532
29	355000	0.965986395	-0.034605529
30	345000	0.971830986	-0.028573372
31	340500	0.986956522	-0.013129291
32	365000	1.07195301	0.069482228
33	385000	1.054794521	0.053345981
34	385000	1	0
35	365000	0.948051948	-0.053345981
36	375000	1.02739726	0.027028672
37	378000	1.008	0.00796817
38	385500	1.01984127	0.019646997
39	390000	1.011673152	0.011605546
40	387500	0.993589744	-0.00643089
41	390000	1.006451613	0.00643089
42	385000	0.987179487	-0.012903405
43	383500	0.996103896	-0.003903713
44	383500	1	0
45	393500	1.026075619	0.025741447
46	392500	0.997458704	-0.002544531
47	387500	0.987261146	-0.012820688
48	382500	0.987096774	-0.012987196
49	377500	0.986928105	-0.013158085
50	374500	0.99205298	-0.007978766
51	361000	0.963951936	-0.036713845
52	379000	1.049861496	0.048658247
53	375500	0.990765172	-0.009277734
54	377500	1.005326232	0.005312097
55	387500	1.026490066	0.02614528

PERIOD III

56	379500	0.979354839	-0.020861252
57	376500	0.992094862	-0.00793655
58	379000	1.006640106	0.006618158
59	369500	0.974934037	-0.025385465
60	364000	0.98511502	-0.014996873
61	357500	0.982142857	-0.018018506
62	384000	1.074125874	0.07150719
63	377500	0.983072917	-0.017071984
64	377500	1	0
65	373500	0.989403974	-0.010652564
66	377500	1.010709505	0.010652564
67	380000	1.006622517	0.006600684
68	379500	0.998684211	-0.001316656
69	375500	0.989459816	-0.010596126
70	380500	1.013315579	0.013227706
71	380000	0.99868594	-0.001314925
72	376000	0.989473684	-0.010582109
73	374000	0.994680851	-0.005333346
74	369500	0.987967914	-0.012105057
75	372000	1.0067659	0.006743114
76	375000	1.008064516	0.008032172
77	374000	0.997333333	-0.002670229
78	375000	1.002673797	0.002670229
79	380500	1.014666667	0.014560151
80	386500	1.015768725	0.015645691
81	385000	0.996119017	-0.003888534
82	377000	0.979220779	-0.020998147
83	380500	1.00928382	0.00924099
84	378500	0.994743758	-0.005270104
85	375500	0.992073976	-0.007957602
86	377500	1.005326232	0.005312097
87	373500	0.989403974	-0.010652564
88	373500	1	0
89	373500	1	0
90	374500	1.002677376	0.002673798
91	376000	1.00400534	0.00399734
92	375350	0.998271277	-0.001730219
93	375000	0.999067537	-0.000932898
94	375000	1	0
95	375000	1	0
96	376000	1.002666667	0.002663117
97	376000	1	0
98	377250	1.003324468	0.003318954
99	378375	1.002982107	0.00297767
100	381500	1.008259002	0.008225083
101	382200	1.001834862	0.001833181
102	381000	0.996860283	-0.003144657
103	386000	1.01312336	0.013037994
104	386000	1	0
105	390500	1.011658031	0.0115906
106	391000	1.00128041	0.001279591
107	388500	0.993606138	-0.00641439
108	388500	1	0
109	387750	0.998069498	-0.001932368
110	386325	0.996324952	-0.003681818
111	384500	0.995275998	-0.004735195

PERIOD III

112	384250	0.999349805	-0.000650407
113	384000	0.999349382	-0.00065083
114	385000	1.002604167	0.002600782
115	382500	0.993506494	-0.006514681
116	381000	0.996078431	-0.003929278
117	381000	1	0
118	380800	0.999475066	-0.000525072
119	381500	1.001838235	0.001836548
120	381900	1.001048493	0.001047944
121	382000	1.000261849	0.000261814
122	381000	0.997382199	-0.002621233
123	379750	0.99671916	-0.003286234
124	377850	0.994996708	-0.00501585
125	378500	1.001720259	0.001718781
126	379250	1.001981506	0.001979545
127	380200	1.002504944	0.002501812
128	382600	1.006312467	0.006292627
129	385000	1.00627287	0.006253277
130	387000	1.005194805	0.005181359
131	388700	1.004392765	0.004383145
132	412500	1.06122974	0.059428368
133	426000	1.032727273	0.03220314
134	405000	0.950704225	-0.050552279
135	406500	1.003703704	0.003696862
136	406500	1	0
137	408000	1.003690037	0.003683245
138	411250	1.007965686	0.007934128
139	423500	1.029787234	0.029352212
140	422500	0.997638725	-0.002364067
141	421500	0.997633136	-0.002369669
142	421500	1	0
143	418500	0.992882562	-0.007142888
144	423000	1.010752688	0.010695289
145	426000	1.007092199	0.007067167
146	428625	1.006161972	0.006143065
147	425000	0.991542724	-0.008493242
148	428625	1.008529412	0.008493242
149	428000	0.998541849	-0.001459215
150	428000	1	0
151	427750	0.999415888	-0.000584283
152	423500	0.99006429	-0.009985399
153	426250	1.006493506	0.006472515
154	426500	1.00058651	0.000586338
155	426500	1	0
156	429500	1.007033998	0.007009374
157	431500	1.004656577	0.004645769
158	432300	1.001853998	0.001852281
159	435500	1.007402267	0.007375005
160	435500	1	0
161	436000	1.001148106	0.001147447
162	434250	0.995986239	-0.004021838
163	435500	1.002878526	0.002874391
164	433750	0.99598163	-0.004026465
165	433000	0.998270893	-0.001730603
166	434000	1.002309469	0.002306806
167	434000	1	0

PERIOD III

168	433250	0.998271889	-0.001729606
169	434500	1.00288517	0.002881016
170	433250	0.99712313	-0.002881016
171	434500	1.00288517	0.002881016
172	434750	1.000575374	0.000575209
173	435000	1.000575043	0.000574878
174	433650	0.996896552	-0.003108274
175	437250	1.008301626	0.008267357
176	437500	1.000571755	0.000571592
177	436500	0.997714286	-0.002288331
178	436500	1	0
179	439000	1.005727377	0.005711038
180	444500	1.012528474	0.012450642
181	446500	1.004499438	0.004489345
182	446500	1	0
183	448000	1.003359462	0.003353832
184	450250	1.005022321	0.005009752
185	449500	0.998334259	-0.00166713
186	450000	1.001112347	0.001111729
187	451000	1.002222222	0.002219757
188	450125	0.998059867	-0.001942018
189	449500	0.998611497	-0.001389468
190	447200	0.994883204	-0.005129932
191	444125	0.993123882	-0.006899867
192	444000	0.999718548	-0.000281492
193	445250	1.002815315	0.00281136
194	445750	1.001122965	0.001122335
195	447250	1.003365115	0.003359466
196	448000	1.001676914	0.00167551
197	448750	1.001674107	0.001672707
198	452250	1.007799443	0.007769184
199	451750	0.998894417	-0.001106195
200	451750	1	0
201	453000	1.002767017	0.002763196
202	453000	1	0
203	453250	1.000551876	0.000551724
204	453750	1.001103144	0.001102536
205	452250	0.996694215	-0.003311261
206	452750	1.001105583	0.001104972
207	451750	0.997791276	-0.002211167
208	452000	1.000553403	0.00055325
209	452000	1	0
210	451500	0.998893805	-0.001106807
211	453000	1.003322259	0.003316753
212	451500	0.996688742	-0.003316753
213	452750	1.002768549	0.002764724
214	451100	0.996355605	-0.003651052
215	449100	0.995566393	-0.004443464
216	448000	0.997550657	-0.002452348
217	448750	1.001674107	0.001672707
218	447250	0.996657382	-0.003348217
219	446500	0.998323086	-0.001678322
220	447825	1.002967525	0.002963131
221	445500	0.99480824	-0.005205284
222	445500	1	0
223	446000	1.001122334	0.001121705

PERIOD III

224	446750	1.001681614	0.001680202
225	448000	1.002797985	0.002794078
226	448500	1.001116071	0.001115449
227	455500	1.015607581	0.015487035
228	456500	1.00219539	0.002192983
229	462500	1.013143483	0.013057857
230	463000	1.001081081	0.001080497
231	463500	1.001079914	0.001079331
232	463625	1.000269687	0.000269651
233	463375	0.999460771	-0.000539374
234	466250	1.006204478	0.006185309
235	466500	1.000536193	0.000536049
236	465500	0.997856377	-0.002145924
237	467000	1.003222342	0.003217161
238	467000	1	0
239	467000	1	0
240	470500	1.007494647	0.007466701
241	470500	1	0
242	474000	1.007438895	0.007411363
243	475000	1.002109705	0.002107482
244	478000	1.006315789	0.006295928
245	496500	1.038702929	0.037972751
246	499000	1.005035247	0.005022612
247	486500	0.9749499	-0.025369194
248	484500	0.995889003	-0.00411947
249	484500	1	0
250	482500	0.995872033	-0.004136511
251	479875	0.994559585	-0.005455267
252	481000	1.002344361	0.002341617
253	481750	1.001559252	0.001558037
254	483500	1.00363259	0.003626008
255	487000	1.007238883	0.007212808
256	485750	0.997433265	-0.002570035
257	484000	0.996397324	-0.003609182
258	486000	1.004132231	0.004123717
259	487825	1.003755144	0.003748111
260	493000	1.010608312	0.010552439
261	495750	1.005578093	0.005562593
262	502125	1.012859304	0.012777325
263	506000	1.007717202	0.007687577
264	504000	0.996047431	-0.003960401
265	504750	1.001488095	0.001486989
266	503000	0.996532937	-0.003473087
267	496875	0.987823062	-0.012251685
268	495250	0.99672956	-0.0032758
269	490000	0.989399293	-0.010657294
270	490750	1.001530612	0.001529442
271	490500	0.999490576	-0.000509554
272	492250	1.003567788	0.003561439
273	492750	1.001015744	0.001015229
274	493000	1.000507357	0.000507228
275	496000	1.006085193	0.006066753
276	495750	0.999495968	-0.000504159
277	493750	0.995965709	-0.004042451
278	495750	1.004050633	0.004042451
279	495750	1	0

PERIOD III

280	496250	1.001008573	0.001008065
281	496400	1.000302267	0.000302221
282	497750	1.002719581	0.00271589
283	499050	1.002611753	0.002608348
284	500500	1.00290552	0.002901308
285	501250	1.001498501	0.00149738
286	504000	1.005486284	0.005471289
287	503500	0.999007937	-0.000992556
288	506750	1.006454816	0.006434073
289	507500	1.00148002	0.001478926
290	506750	0.998522167	-0.001478926
291	507750	1.00197336	0.001971415
292	503250	0.991137371	-0.008902136
293	502750	0.999006458	-0.000994036
294	502750	1	0
295	505250	1.00497265	0.004960328
296	504000	0.997525977	-0.002477088
297	504000	1	0
298	507250	1.006448413	0.006427711
299	508250	1.001971414	0.001969474
300	512850	1.009050664	0.009009952
301	514250	1.002729843	0.002726124
302	516250	1.003889159	0.003881616
303	518250	1.003874092	0.003866607
304	517250	0.998070429	-0.001931435
305	520750	1.006766554	0.006743764
306	522750	1.003840614	0.003833258
307	521250	0.99713056	-0.002873565
308	517000	0.991846523	-0.008186899
309	517250	1.000483559	0.000483442
310	517250	1	0
311	518650	1.002706622	0.002702965
312	517750	0.998264726	-0.001736782
313	520250	1.004828585	0.004816965
314	520250	1	0
315	520250	1	0
316	518250	0.996155694	-0.003851714
317	519250	1.001929571	0.001927711
318	517250	0.996148291	-0.003859146
319	516250	0.998066699	-0.001935172
320	518750	1.004842615	0.004830927
321	525000	1.012048193	0.011976191
322	523000	0.996190476	-0.003816799
323	525625	1.00501912	0.005006567
324	526325	1.001331748	0.001330862
325	528750	1.004607419	0.004596838
326	527750	0.998108747	-0.001893044
327	528250	1.000947418	0.00094697
328	529750	1.002839565	0.002835541
329	534000	1.008022652	0.007990642
330	535750	1.003277154	0.003271795
331	536750	1.001866542	0.001864802
332	537000	1.000465766	0.000465658
333	537250	1.000465549	0.000465441
334	536750	0.999069335	-0.000931099
335	535750	0.998136935	-0.001864802

PERIOD III

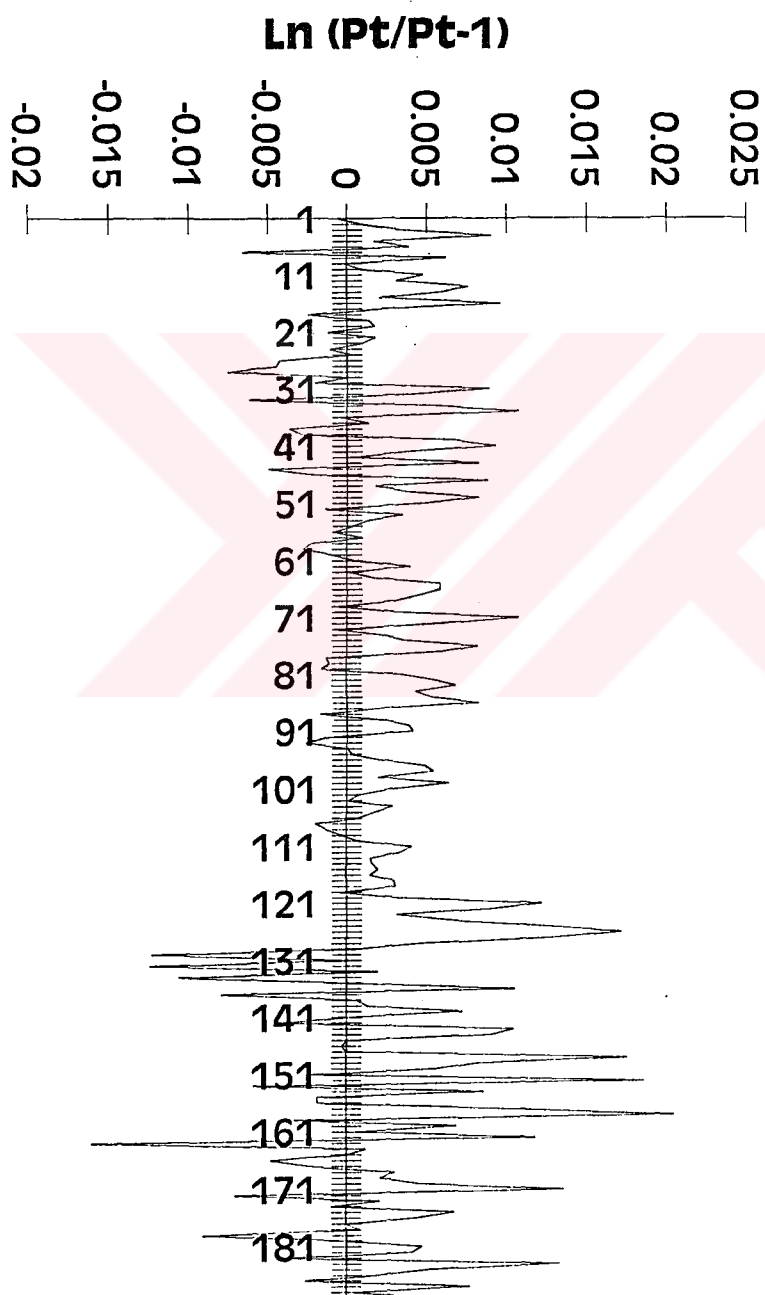
336	539750	1.007466169	0.007438435
337	542000	1.004168597	0.004159932
338	540000	0.996309963	-0.003696862
339	538000	0.996296296	-0.003710579
340	538000	1	0
341	535750	0.995817844	-0.004190926
342	536750	1.001866542	0.001864802
343	531250	0.989753144	-0.010299717
344	532750	1.002823529	0.002819551
345	530000	0.994838104	-0.005175264
346	528750	0.997641509	-0.002361276
347	533750	1.009456265	0.009411834
348	535000	1.00234192	0.002339182
349	534000	0.998130841	-0.001870908
350	534750	1.001404494	0.001403509
351	534500	0.999532492	-0.000467617
352	535750	1.002338634	0.002335904
353	535500	0.999533364	-0.000466744
354	535500	1	0
355	535500	1	0
356	535500	1	0
357	535500	1	0
358	544000	1.015873016	0.015748357
359	544000	1	0
360	545000	1.001838235	0.001836548
361	545250	1.000458716	0.00045861
362	546000	1.001375516	0.001374571
363	545500	0.999084249	-0.00091617
364	546000	1.00091659	0.00091617
365	544000	0.996336996	-0.003669729
366	542750	0.997702206	-0.002300438
367	541250	0.997236297	-0.002767529
368	535250	0.98891455	-0.011147352
369	533000	0.995796357	-0.004212503
370	532250	0.998592871	-0.00140812
371	527500	0.991075622	-0.008964438
372	530500	1.005687204	0.005671093
373	535500	1.009425071	0.009380932
374	532000	0.993464052	-0.006557401
375	532000	1	0
376	532500	1.00093985	0.000939408
377	532750	1.000469484	0.000469373
378	534250	1.00281558	0.002811623
379	537250	1.005615349	0.005599641
380	537250	1	0
381	538750	1.002791996	0.002788106
382	537750	0.998143852	-0.001857873
383	537750	1	0
384	538000	1.0004649	0.000464792
385	539000	1.001858736	0.001857011
386	543000	1.00742115	0.007393749
387	543125	1.000230203	0.000230176
388	543375	1.000460299	0.000460193
389	544250	1.001610306	0.001609011
390	545500	1.002296739	0.002294105
391	546000	1.00091659	0.00091617

PERIOD III

392	546750	1.001373626	0.001372684
393	545600	0.997896662	-0.002105553
394	547000	1.002565982	0.002562696
395	548250	1.002285192	0.002282585
396	550250	1.003647971	0.003641333
397	550250	1	0
398	546750	0.993639255	-0.006381061
399	546000	0.998628258	-0.001372684
400	547250	1.002289377	0.002286761
401	546250	0.998172682	-0.00182899
402	548250	1.003661327	0.003654641
403	548750	1.000911993	0.000911577
404	549250	1.000911162	0.000910747
405	551750	1.004551661	0.004541334
406	553025	1.002310829	0.002308163
407	555300	1.004113738	0.0041053
408	557750	1.00441203	0.004402325
409	560500	1.004930524	0.004918409
410	558000	0.995539697	-0.00447028
411	557750	0.999551971	-0.000448129
412	557250	0.999103541	-0.000896861
413	561250	1.007178107	0.007152467
414	560000	0.997772829	-0.002229655
415	556750	0.994196429	-0.005820478
416	556750	1	0
417	557000	1.000449035	0.000448934
418	557250	1.000448833	0.000448732
419	560500	1.005832212	0.00581527

APPENDIX E

TIME



PERIOD IV

PERIOD IV

TIME	PRICE	Pt/Pt-1	LN (Pt/Pt-1)
1	560950		
2	560650	0.999465193	-0.00053495
3	561150	1.000891822	0.000891425
4	563000	1.003296801	0.003291379
5	568100	1.009058615	0.009017831
6	569050	1.001672241	0.001670844
7	571250	1.003866093	0.003858638
8	567500	0.993435449	-0.006586193
9	571050	1.006255507	0.006236022
10	571000	0.999912442	-8.75618E-05
11	571500	1.000875657	0.000875274
12	574225	1.004768154	0.004756822
13	576000	1.003091123	0.003086355
14	580375	1.007595486	0.007566786
15	583850	1.005987508	0.005969654
16	585050	1.002055322	0.002053213
17	590700	1.009657294	0.009610961
18	591975	1.002158456	0.00215613
19	590525	0.997550572	-0.002452433
20	591325	1.001354727	0.00135381
21	592325	1.001691117	0.001689689
22	591600	0.99877601	-0.00122474
23	592625	1.00173259	0.00173109
24	593150	1.000885889	0.000885497
25	592500	0.998904156	-0.001096445
26	592675	1.000295359	0.000295315
27	590150	0.995739655	-0.004269446
28	587525	0.995551978	-0.004457944
29	583125	0.992510957	-0.007517227
30	583150	1.000042872	4.28715E-05
31	581950	0.99794221	-0.00205991
32	587150	1.008935476	0.00889579
33	589600	1.004172699	0.004164017
34	585950	0.993809362	-0.006209879
35	589200	1.005546548	0.005531223
36	595575	1.010819756	0.010761641
37	595425	0.999748143	-0.000251889
38	596225	1.001343578	0.001342676
39	594050	0.996352048	-0.003654622
40	592400	0.997222456	-0.002781409
41	596350	1.006667792	0.006645661
42	601925	1.009348537	0.00930511
43	604125	1.00365494	0.003648277
44	604450	1.000537968	0.000537823
45	609450	1.008271983	0.008237957
46	606450	0.995077529	-0.004934626
47	605125	0.997815154	-0.002187236
48	610475	1.008841149	0.008802294
49	611550	1.001760924	0.001759375
50	613800	1.003679176	0.003672424
51	618875	1.008268166	0.008234171
52	621925	1.004928297	0.004916193
53	621075	0.998633276	-0.001367659
54	623225	1.00346174	0.003455762
55	624000	1.001243532	0.001242759

PERIOD IV

56	624200	1.000320513	0.000320461
57	623700	0.999198975	-0.000801346
58	624325	1.001002084	0.001001583
59	622925	0.997757578	-0.00224494
60	621200	0.997230806	-0.002773035
61	620675	0.999154862	-0.000845496
62	621000	1.000523623	0.000523486
63	623475	1.003985507	0.003977586
64	623600	1.000200489	0.000200469
65	624650	1.001683772	0.001682356
66	628300	1.005843272	0.005826267
67	632000	1.005888907	0.005871635
68	634875	1.004549051	0.004538735
69	636800	1.003032093	0.003027505
70	636525	0.999568153	-0.00043194
71	638500	1.003102785	0.003097981
72	645400	1.010806578	0.010748604
73	649175	1.005849086	0.005832046
74	648800	0.999422344	-0.000577823
75	650175	1.002119297	0.002117055
76	652500	1.00357596	0.003569582
77	657875	1.008237548	0.008203804
78	661725	1.005852176	0.005835118
79	660875	0.998715478	-0.001285347
80	660150	0.99890297	-0.001097633
81	659100	0.998409452	-0.001591814
82	661325	1.003375816	0.00337013
83	664950	1.00548142	0.005466452
84	669500	1.00684262	0.006819315
85	672400	1.004331591	0.004322236
86	675975	1.005316776	0.005302692
87	681575	1.00828433	0.008250203
88	682775	1.001760628	0.00175908
89	681625	0.998315697	-0.001685723
90	683150	1.002237301	0.002234802
91	685800	1.00387909	0.003871585
92	688625	1.004119277	0.004110816
93	687825	0.998838265	-0.001162411
94	686050	0.997419402	-0.002583934
95	686100	1.000072881	7.28783E-05
96	686325	1.000327941	0.000327887
97	687750	1.002076276	0.002074123
98	691125	1.004907306	0.004895305
99	694875	1.005425936	0.005411269
100	696225	1.001942795	0.001940911
101	700675	1.006391612	0.006371272
102	702600	1.002747351	0.002743584
103	703100	1.000711642	0.000711389
104	703150	1.000071114	7.11111E-05
105	705150	1.002844343	0.002840306
106	706325	1.001666312	0.001664925
107	706825	1.000707889	0.000707639
108	705425	0.998019312	-0.001982652
109	704550	0.998759613	-0.001241157
110	704350	0.999716131	-0.000283909
111	704875	1.000745368	0.00074509

PERIOD IV

112	707750	1.004078737	0.004070442
113	710125	1.003355705	0.003350087
114	711175	1.001478613	0.001477521
115	712300	1.001581889	0.001580639
116	713725	1.002000562	0.001998563
117	714775	1.001471155	0.001470074
118	716900	1.002972964	0.002968553
119	719075	1.003033896	0.003029303
120	718800	0.999617564	-0.000382509
121	721100	1.003199777	0.003194669
122	729975	1.012307586	0.012232463
123	736625	1.009109901	0.009068656
124	738925	1.003122349	0.003117484
125	743725	1.006495923	0.006474916
126	752975	1.012437393	0.012360684
127	766050	1.017364454	0.017215415
128	775950	1.012923438	0.012840643
129	779500	1.004575037	0.004564603
130	780000	1.000641437	0.000641231
131	770500	0.987820513	-0.012254265
132	770500	1	0
133	761000	0.987670344	-0.012406297
134	762500	1.001971091	0.001969151
135	754500	0.989508197	-0.01054723
136	754500	1	0
137	762500	1.010603048	0.01054723
138	756500	0.992131148	-0.007899975
139	757000	1.000660939	0.00066072
140	758000	1.001321004	0.001320132
141	763500	1.007255937	0.007229739
142	763500	1	0
143	760500	0.996070727	-0.003937013
144	768500	1.010519395	0.010464451
145	775500	1.009108653	0.00906742
146	775500	1	0
147	775250	0.999677627	-0.000322425
148	775250	1	0
149	789000	1.017736214	0.017580763
150	795500	1.008238276	0.008204527
151	800000	1.00565682	0.00564088
152	798250	0.9978125	-0.002189896
153	813250	1.018791106	0.018616734
154	808500	0.994159238	-0.005857886
155	815500	1.008658009	0.008620743
156	814000	0.998160638	-0.001841056
157	812500	0.998157248	-0.001844452
158	820500	1.009846154	0.009797996
159	837500	1.020719074	0.020507353
160	834750	0.996716418	-0.003288985
161	840500	1.00688829	0.006864674
162	841000	1.000594884	0.000594707
163	851000	1.011890606	0.011820469
164	837500	0.98413631	-0.015990865
165	838500	1.00119403	0.001193318
166	838500	1	0
167	834500	0.995229577	-0.004781838

PERIOD IV

168	832500	0.997603355	-0.002399521
169	835000	1.003003003	0.002998503
170	836750	1.002095808	0.002093615
171	840500	1.004481625	0.004471613
172	852000	1.013682332	0.013589574
173	846000	0.992957746	-0.007067167
174	847750	1.002068558	0.002066421
175	847000	0.999115305	-0.000885086
176	852750	1.006788666	0.006765727
177	856500	1.004397537	0.004387896
178	856500	1	0
179	857225	1.000846468	0.00084611
180	849500	0.990988364	-0.009052487
181	849500	1	0
182	853500	1.004708652	0.004697601
183	857000	1.004100762	0.004092376
184	853500	0.995915986	-0.004092376
185	865000	1.013473931	0.013383965
186	869500	1.005202312	0.005188827
187	871000	1.001725129	0.001723643
188	868750	0.997416762	-0.00258658
189	875500	1.007769784	0.007739755
190	876000	1.000571102	0.000570939
191	880500	1.005136986	0.005123837



APPENDIX F

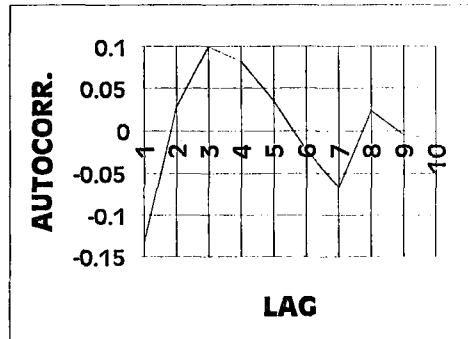
INDEPENDENCE TESTS

PERIOD 1

Critical Value

0.086

Lag	r	QLB
1	-0.13318	9.5958
2	0.028	10.0207
3	0.09981	15.4304
4	0.082213	19.1076
5	0.035165	19.7803
6	-0.02282	20.0660
7	-0.0669	22.5146
8	0.02346	22.8163
9	-0.00453	22.8276
10	-0.00878	22.8700

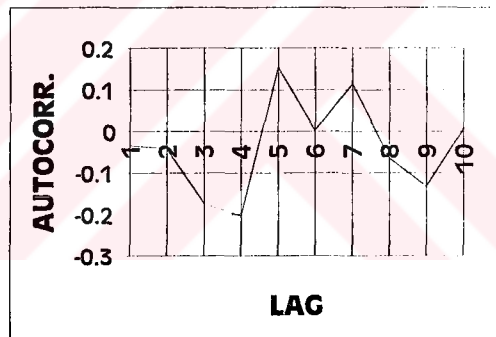


PERIOD 2

Critical Value

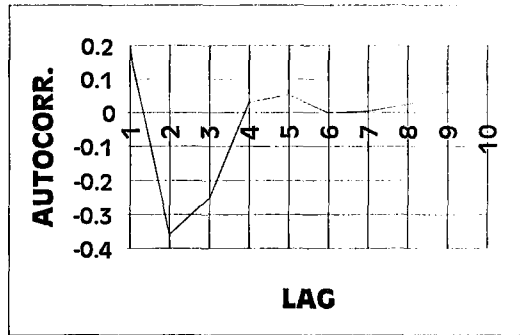
0.17025

Lag	r	QLB
1	-0.033927	0.1623
2	-0.041236	0.4039
3	-0.174045	4.7390
4	-0.2037	10.7215
5	0.153108	14.1267
6	0.002416	14.1276
7	0.114676	16.0671
8	-0.063976	16.6753
9	-0.132539	19.3062
10	0.0051	19.3102

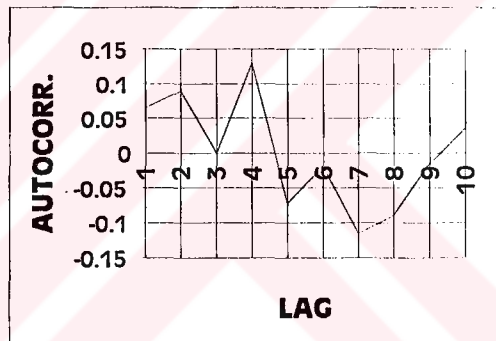


PERIOD 3**Critical Value** **0.0978231**

Lag	r	QLB
1	0.181157	13.8166
2	-0.35813	67.9435
3	-0.25052	94.4934
4	0.029579	94.8644
5	0.052686	96.0444
6	-0.00108	96.0448
7	0.003926	96.0514
8	0.023695	96.2919
9	0.061228	97.9010
10	0.054519	99.1800

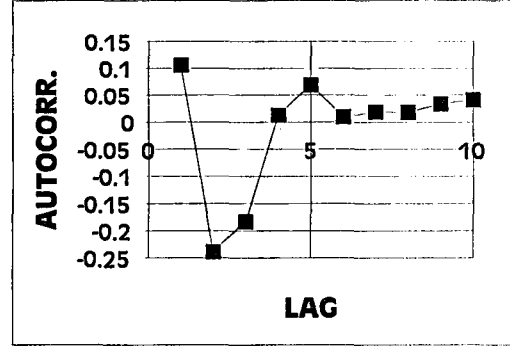
**PERIOD 4****Critical Value** **0.1450952**

Lag	r	QLB
1	0.0656151	0.8310
2	0.0893197	2.3791
3	0.00005176	2.3791
4	0.129303	5.6582
5	-0.0725965	6.6974
6	-0.0191636	6.7703
7	-0.1159835	9.4519
8	-0.0896384	11.0624
9	-0.0153956	11.1102
10	0.0358691	11.3709



PERIOD T**Critical Value****0.0557278**

Lag	r	QLB
1	0.10594844	14.4804
2	-0.23833	87.8111
3	-0.183155	131.1526
4	0.013164	131.3766
5	0.0689892	137.5356
6	0.010042	137.6662
7	0.0188821	138.1282
8	0.0181413	138.5551
9	0.0337661	140.0351
10	0.0412878	142.2497



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