USING THE ASSET MARKET APPROACH TO ESTIMATE FUTURE EXCHANGE RATES IN A DEVELOPING COUNTRY:THE CASE OF KENYA.

BY

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DECLARATION

This Management Research project is my original work and has not been presented for a degree in any other university.

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This Management Research Project has been submitted for examination with my approval as University Supervisor.

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Barasa, I.O.

DEDICATION

To those who have devoted their lives to the development of Financial Economics.

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ABSTRACT

The study investigates the short term behaviour of exchange rates in Kenya with the aim of making relatively accurate short term forecasts using the asset market approach to exchange rate modelling.

A sample of six different currencies is used to bring out the relationship between the short term movement of exchange rates and the nominal interest rates.

A regression of the current exchange rate against the previous one and the differential interest rates reveals that the time series of exchange rates is predominantly a first order autoregressive process. The inclusion of interest rates does not significantly improve the data fitting performance of the model,though it appears to improve the predictive performance.

To investigate this unexpected finding,the first order difference in exchange rates is regressed against the the interest differential. The result gives poor data fitting and the F-test confirms that the regression is not significant. A close examination of the time series of the first order difference of exchange rates using the autocorrelation function shows that it is very close to white noise,thus suggesting that exchange rate movement in Kenya have closely followed a random walk process with a drift.

1.INTRODUCTION

1.1 Background

The foreign exchange market is a vast industry spanning almost every country in the world due to the importance of international trade.[1] The sheer size of this market and its consequent implications on macroeconomic activity of participating nations has led to intense interest into its detailed functioning as is evident in the number of publications devoted to its study (Meese,1990).

In 1989,the foreign sector accounted for about 25% of Kenya's GDP.[2] Its size,coupled with the volatility of export product prices has made this sector of special interest to economists,policy makers and businessmen alike. Needless to add,the performance of this sector impinges directly on the economic well-being of the country as a whole. One of the powerful tools used by policy makers in its regulation is the exchange rate. While the policy issues relating to the use of the exchange rate as an economic regulation tool are important,this study will focus on an analysis of the short

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[1] The worldwide total of foreign exchange traded in a day exceeds$430 billion (Frenkel and Froot, 1990).

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[2] Source: Central Bank of Kenya: Economic report for the financial year ended 30th June, 1990 PP.43.

term (monthly) movements of mean interbank exchange rates. In developed foreign exchange markets,forward rates provide readily available and reliable estimates for future exchange rates.However, in many developing financial markets, market-driven forward rates are often not available hence the need for reliable estimates of future exchange rates. The behaviour of exchange rates in the short term is the result of a combination of both government economic and exchange rate management policies and global market forces. This study would provide information on the short term behaviour of the Foreign exchange market and the limits of exchange rate forecasting in Kenya.

Towards this end,the study is organised in five distinct chapters. Chapter 1 introduces basic exchange rate terminology including a summarised discussion of existing exchange rate arrangements with special attention to Kenya. This chapter also details the objectives of the study and its importance. Chapter 2 is essentially a condensed review of the asset market approach to exchange rate determination and chapter 3 outlines the methodology and the nature of the data used in this study. In chapter 4 the results of the study are tabulated and finally,chapter 5 discusses these results,pointing out possible limitations of the study and providing suggestions for further research. Appendices of computer print-outs and graphs are provided for the keen reader who might wish to reproduce the study.

1.2 Exchange rate terminology and Exchange rate arrangements.

In this study we adopt the following working definitions;

The Nominal exchange rate is the quoted price of foreign currency in local currency.

The nominal effective exchange rate index represents the ratio (expressed with respect to a base year) of an index of the period average exchange rate of the currency in question to a weighted geometric average of exchange rates for the currencies of selected partner (or competitor) countries. For Kenya, a composite basket of currencies, the Special Drawing Right (SDR)[3] is used.

A real effective exchange rate is defined broadly as a nominal effective exchange rate adjusted for relative movements in national price or cost indicators of the home

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[3]The SDR is a weighted basket of the world's 5 major currencies with the weighting roughly reflecting the relative contributions of these countries to world trade. Its composition and weighting is revised every five years to reflect new developments. Its value as of this writing was(Katsumata, 1991);

1SDR = 0.40$US + 0.21DM + 0.17Y + 0.11ƒ + 0.11FF.

country and its partner (or competitor) countries. In both cases, an increase in the index reflects an appreciation.

Having introduced these concepts, we now outline the various exchange rate management techniques existing in the world (Quirk, 1989).

Governments manage and intervene in foreign exchange systems in essentially two ways; one is by pegging or managing the exchange rate as opposed to allowing it to float (i.e., be set by the market). The other is by imposing restrictions or taxes and subsidies on the use of foreign exchange. Restrictions that limit the openness of the external sector may be aimed at maintaining a pegged or managed exchange rate at a desired level or at influencing the level of a floating exchange rate. Policies for the exchange rate and trade restrictions are therefore two sides of one coin.

The major forms of exchange rate regimes are distinguished from one another by their degree of flexibility, that is, the frequency with which the rate is permitted to adjust.

Currency pegs are exchange arrangements which attempt to stabilise the exchange rate by tying it to a major currency such as the US Dollar, French Franc, or a basket of currencies of which the IMF's SDR is an example.Currency pegs generally have not achieved their purpose of preventing exchange rate variability,first because they must be adjusted from time to time and second because pegged currencies float against currencies outside the peg.

Managed indicator arrangements attempt to formalise the basis on which exchange rate adjustments are made. A common form is the inflation-adjusted "real exchange rate peg",which has the aim of achieving continuous competitiveness against a basket of currencies of major trading partner countries.Another form of indicator arrangement is the pre announced exchange rate or "tablita",by which the exchange rate crawls at a predetermined rate.

In managed-float arrangements the central bank,rather than the market sets the exchange rate ,but varies it frequently. The difference between this and the pegged or indicator arrangements is that broad judgemental factors are used to set the rate,and adjustments are made frequently but not automatically. The rate may be set with regard to many factors,such as the real effective exchange rate ,or developments in the balance of payments,international reserves or parallel markets for foreign exchange. The

Managed indicator arrangement is the foreign exchange management scheme adopted by the Kenya government. In independent floating systems the exchange rate is determined primarily by market forces. The form of government intervention is by participating directly in the foreign exchange market. This form of foreign exchange management is frequently associated with developed economies though a number of developing countries have started adopting it (Quirk,1989). In independent float systems, exchange rate policy and monetary policy collapse into one (Mathieson,1989).

1.3. The Kenyan foreign exchange market: Its operation, organisation, and the effects of government policy.

The breakdown of the Bretton-Woods fixed exchange rate system in 1971 resulted in the de facto adoption of a wide variety of exchange rate systems. Of considerable importance was the trend towards relatively flexible exchange rates, even for the most conservative governments. Perhaps the greatest lesson of this period has been that a government cannot sustain an overvalued exchange rate, at least not in the medium and long term. The balance of payments problems experienced will ultimately force the monetary authorities to adjust the exchange rate. Exchange and trade controls are only useful in the short term,and even then they have not proved to be successful (Quirk,1989). The choice of an appropriate exchange rate system is of great importance to a country as it will have important implications for the conduct of its domestic and international economic policy.

Independent Kenya has had three exchange rate management regimes.[4] Between 1966-1975, the shilling was pegged to the US Dollar in a fixed relationship. Thus variations in the exchange rate in this period was caused purely by external economic & political developments. Between 1975 - 1984 the government adopted the so called "managed float"[5] in which the Kenya Shilling was pegged with the IMF's Special Drawing Right (SDR). The aim was to enhance exchange rate stability by making the Shilling depend on many currencies instead of just one. Fluctuations between the SDR and other currencies caused the reported daily fluctuations in the value of the exchange rates. Since

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[4] For a more detailed discussion dating from colonial times See Kiyingi (1978, 24 - 29) and Njiraini (1983,11 - 18).

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[5] The term "managed float" is a misnomer here since the shilling was really pegged to the SDR apart from occasional devaluations when it was then pegged at a different value to the SDR. According to the IMF, Kenya is a pegger not a floater (Heller, 1978).

these changes were external and did not reflect the country's economic conditions,they led to the Kenya Shilling becoming overvalued with time since its value did not respond to the changing economic conditions in the country. This resulted to the need for frequent adjustments (devaluations) at the instigation of the IMF in order to effectively deal with the chronic balance of payments problems that the country experienced during this period.[6] In addition,massive devaluations of a currency can have devastating political implications and can lead to uncontrolled inflation. Thus the present exchange rate management policy (1984-) was formulated. The current exchange rate management regime is the "Crawling Peg"[7] of the managed indicator variant in which the Kenya shilling is gradually devalued mainly in accordance with trends in the

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[6] As has been observed elsewhere (see, Njiraini, 1983), experience with devaluations seems to suggest that they are not very successful in improving the current account.They may,however,ameliorate the capital account and thus improve the total balance of payments position.

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[7] The crawling peg has a number of advantages. For example, it has fewer political problems as it is hardly noticed. In addition, it not only encourages investors to be export oriented (by watching the devaluation trend), but it also gives them ample time to set up production lines etc (Miguel Urutia,1981).

balance of payments position. This study will concentrate on this last policy regime of the crawling peg. In view of these remarks, it is evident that government policy has a strong influence on the behaviour of exchange rates.

Trading in foreign exchange in Kenya is closely regulated by the government and is limited to authorised dealers only. These are typically institutions licensed as commercial banks and the Central Bank itself. Exchange rate policy is formulated by the treasury and implemented by the Central Bank as the authorised institution.

Very briefly, the Kenyan foreign exchange market works as follows;[8]

First observe that the Kenyan local time is 16 hours ahead of New York time so that in the evening in New York, it is early morning in Nairobi (for example, at 8pm. on monday in New York, it is 4am. on tuesday in Nairobi). At the close of business on a typical business day, closing quotations on the exchange rates between the US Dollar ($US) and the SDR and between the $US and various other currencies are faxed

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[8] Source: central Bank of Kenya.

by the Federal Reserve Bank[9] to the Central Bank of Kenya at which time it is early morning in Kenya. At the opening of the day in Kenya, the Central Bank sets the value of the Kenya Shilling with respect to the SDR as;

$$1SDR = K_t \times 1Ksh.$$

Where K_t is the period t exchange rate coefficient adjusted for the periodic devaluation[10].

Using the triangular arbitrage relation, the Central Bank is now able to compute the exchange rate between the

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[9] There are basically two rates quoted in the foreign exchange market. The first is the interbank rates between the Central Bank and the commercial banks. The second are the rates quoted by the banks to the customers. In addition there is the usual buy - sell spread for each of these rates. Finally, each of these transactions involve commissions, the first being payable to the Central Bank by the commercial banks and the latter is payable to the commercial banks by the customers.

This study will be concerned with the mean interbank rates since these are what are published in historical data.

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[10] The exchange rate between the KShilling and the SDR is closely regulated by the Government. It adjusted using two primary criteria; First, is an effort to maintain the real effective exchange rate and the second criterion is an effort to maintain competitiveness of export products. Hence the need to closely monitor developments in the balance of payments and price indices. Thus each value of K_t lasts for only a few days to several weeks.

This process of gradual adjustment is referred to as the crawling peg.

KSh and the various other currencies in good time to send them to the commercial banks by 9 am. For example,for the Swedish Kroner,we have;

$$Kr/KSh = Kr/\$US \times \$US/SDR \times SDR/kSh$$

The last two items are obtained from the Federal Reserve Bank and the last item is K_t,set by the Central Bank. Before the current policy regime,K_t was essentially a constant for long periods of time.

This relation brings out the strong dependence between the exchange rates in Kenya and the trading activity in the US foreign exchange market. The banks act as retail outlets for the Central Bank and are allowed to charge a commission on foreign exchange transactions.

In summary, the daily exchange rate is set by the official devaluation and external market forces in such a manner that the domestic market forces play an insignificant role. We would therefore expect the behaviour of exchange rates in Kenya to closely resemble that of the US market apart from the official devaluation.

1.4 Statement of the problem

The problem to be investigated in this study is the behaviour of nominal exchange rates in Kenya with a view of assessing whether they are predictable in the short term (less than a year).

Information of this nature is readily available in developed countries where the exchange rates are primarily market driven with little government intervention. These countries operate in the "independent float" policy regime. In this regime the frequent mode of intervention by central banks is by direct participation in the market as any other investor. Pegger systems,on the other hand,usually operate by use of a mesh of restrictive import and export controls, exchange rationing, quotas and tariffs, and a host of other regulations. This is due to the fact that the exchange rates are frequently set above their"true" market values and also because the exchange rates do not respond to domestic economic conditions of the pegging country.

In developed countries the properties of foreign exchange markets are well investigated. Issues such as market efficiency and exchange rate forecasting have been tackled at length though a few areas still remain controversial (Dornbusch,1985).

This study intends to address itself to the problem of exchange rate determination in a typical developing country, where government policy and external market forces play the dominant role. In particular we would like to investigate whether relatively accurate short term forecasts can be made.

1.5. Objectives of the study

The main objectives of this study are as follows;

1) Use a model adapted from the asset market theory of exchange rates to study the time series properties of monthly exchange rates in Kenya and test its accuracy in short term forecasting.

2) Compare the performance of the proposed model with the random walk model with a drift. This is an indirect test of how well the interest rate differentials capture news. The currencies selected are those of six major trading partners. These are the US Dollar,Pound Sterling,Deutsch Mark,the Japanese Yen and the Dutch Guilder.These currencies are selected on the basis of the significance of foreign trade between Kenya and these countries as measured by the level of exports and imports since 1985.

1.6 Importance of Study

In a country without an organised forward exchange rate market[11], the private sector with a significant foreign trade component usually encounters the problem of estimating future exchange rates when contractual payment obligations become due. This frequently gives rise to the problem of current asset management. In situations where a firm has to make payments in foreign exchange, there is only one approach possible; buy foreign exchange now and keep until payment is due. This forces the firm to maintain a higher level of current assets than required thus leading to sub-optimal performance due to the maintenance of unnecessarily high current ratios. If information on exchange rate behaviour is readily available, relatively accurate short term forecasts can be made and on this basis private firms can manage their current assets without having to maintain unnecessarily high levels of current assets. The forecasting error (in the root-mean-square sense) would thus represent the foreign exchange risk that the firm has to shoulder. If this error

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[11] To be precise, Kenya has a forward market for exchange rates restricted to the $US and the pound and for periods of up to 3 months. However, these rates are administered and are set to implement specific policies such as boosting exports, etc. Speculation is strictly forbidden, (source: Central Bank of Kenya.).

is small enough, the risk of the firm encountering serious cash flow problems when payment becomes due is reduced.

Further, information on exchange rate movement would shed light to policy makers as to whether their policy regime is effective or even appropriate. In particular, for example, this information would assist policy makers in computing realistic administered forward rates. Realistic forward rates would form a good basis for hedging against exchange risk. Nonmarket-based "forward cover" or insurance against foreign exchange risk are not successful mainly because they are maintained by government subsidies in an attempt to sustain an overvalued exchange rate. In many countries, this has led to losses that have been absorbed by budgets and subsequently financed by monetary expansion ,fueling inflation and weakening the balance of payments position. Thus the recently proposed foreign exchange deposit fund, like motor insurance pool before it, has very little chances of success (Quirk and Schoofs, 1988).

In addition, the single most important contributor of the serious third world debt is the devaluation of the exchange rate. If this can be anticipated then prudent borrowing would be possible. Finally, this study could be a potentially useful contribution to the theory of exchange rate determination.

2. LITERATURE REVIEW

2.1 Exchange rate modelling in the floating regime

A considerable amount of research has gone into looking for the primary macroeconomic factors (fundamentals) that determine exchange rates. The list is virtually endless. Models have been constructed that use balance of payments (Koray,1990) wage rates (Dixon 1990), consumer utility functions (Stulz,1984), employment levels (Dornbusch, 1990) money supply, relative price levels, relative interest rates, national income (Miller and Weller,1990), (Meese and Rose,1990;Meese 1990) and many others. Conclusion: Exchange rates are affected by such a large number of factors (some economic,emotional,etc) that an approach that attempts to enumerate and use all these factors in exchange rate modelling is not likely to be very successful.

Perhaps the greatest achievement of these efforts is the realisation that economic fundamentals alone cannot explain short term movements in spot rates. This realisation brought about the recognition of the crucial role played by investor expectations and "news". Thus modern exchange rate models treat foreign currency as any other traded asset whose value is subject to expectations about its future (appreciation or depreciation)[12]. A brief outline of the asset market theory of exchange rates is as follows (Meese,1990);

In general,the current spot exchange rate will be affected by both a set of fundamental economic factors and some conditional expectations of the future spot rate,based on whatever information is available in the present. Thus we could write,

$$S_t = F\left[H_t, E(S_{t+1}/I_t)\right] \quad (1)$$

Where the current spot rate S_t is a function of a set of explanatory variables denoted by H_t and conditional expectation denoted by the symbol $E(S_{t+1} / I_t)$ of the next period spot rate given the information I_t available up to time t.

One specialisation of (1) which has been widely studied in the literature is the linear model (Meese, 1990,

[12]The Asset market theory of money is supported by observations such as the following; As of mid 1989, worldwide foreign exchange trading exceeded US$430 billion/day. The daily worldwide trade in goods and services is in the region of $11 billion. This essentially suggests that people, do in fact, trade in money as an asset(Froot and Thaler, 1990).

Frenkel,1985).[13]

$$LnS_t = H_t + bE\left[(LnS_{t+1} - Ln\ S_t)/I_t\right] \quad (2)$$

Where S_t is the present exchange rate, H_t represents a linear combination of both foreign and domestic contemporaneous explanatory variables (for example a coefficient times money supply plus a coefficient times real income, and so on for both domestic and foreign variables), and b represents the elasticity of the current spot rate to its expected rate of change o<b<1. The composition of H_t and the interpretation of the parameters vary by model.

A nice feature of this general asset market specification is that by solving the equation forward in time, one will find that the current spot rate is the expected discounted sum of all future fundamentals.

$$LnS_t = E(LnS_t) = \frac{1}{1+b}\sum_{k=0}^{\infty}\left(\frac{b}{1+b}\right)^k E(H_{t+k}/I_t) \quad (3)$$

The idea that the current spot rate is the expected discounted sum of future market fundamentals is analogous to the notion that a stock price can be interpreted as the present value of the expectations about the future earnings

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[13] Logarithmic transformations are employed in exchange rate modelling to avoid Siegel's paradox (Miller & Weller, 1990, 174).

of the company.

Rewriting (3) for future expected spot rates, we obtain

$$E(LnS_{t+j}) = \frac{1}{1+b} \sum_{k=0}^{\infty} \left(\frac{b}{1+b}\right)^k E(H_{t+j+k}) \qquad (4)$$

Thus the present exchange rate (j = o) and current expectations of future exchange rates (j>o) are linked because both depend on expectations concerning the future. The strength of the link depends on the magnitude of b which characterises the dependence of the current exchange rate and the expected percentage change thereof. The presumption is that due to profit opportunities arising from arbitrage, this link is strong at least for exchange rates expected in the near future. Hence, the current exchange rate LnS_t $=E(LnS_t)$ should be closely linked to the current expectation of the next period's exchange rate $E(LnS_{t+1})$ which in turn should be closely linked to the exchange rate expected for the following period, $E(LnS_{t+1})$ and so on. Frenkel (1985,130) illustrates this point by showing that the behaviour of the current spot rate S_t is almost identical to that of the forward rate of the previous period F_{t-1}.

The difference between the spot rate and forward rate is accounted for by the "news" that occur in the interim period and is not incorporated in expectations. Thus spot rate behaviour can be modelled as;

$$LnS_t = A + BLn\,F_{t-1} + \text{"News"} + w_t \qquad (5)$$

Where w_t is random error, and A and B are constants.

Since it is quite difficult to observe and quantify the 'news' it is convenient to examine the relation between the exchange rate and a variable whose time series is likely to manifest the "news" promptly.

Assuming that Asset markets clear fast and that the 'news' is immediately reflected in (unexpected) changes in the rates of interest (i), we can write the above equation as

$$LnS_t = \underbrace{A + BLnF_{t-1}}_{\text{EXPECTED EXCHANGE RATE}} + \underbrace{D\left[(i - i^*)_t - E_{t-1}(i - i^*)_t\right]}_{\text{NEWS}} + w_t \qquad (6)$$

where the * represents foreign country and A, B & D are constants.

The news is essentially reflected in the unanticipated interest differential.

2.2 Efficiency of foreign exchange markets and the predictability of Spot exchange rates.

There is considerable controversy as to whether foreign exchange markets are at least weak-form efficient. A number of authors (Frenkel,1985; Levich,1985) believe that on the whole,foreign exchange market behaviour has been broadly consistent with the general implications of the efficient market hypothesis. However tests for market efficiency are difficult to formulate and interpret (Levich,1985). If the foreign exchange market is weak-form efficient,and if the exchange rate is determined in a fashion similar to the determination of other asset prices,we should expect the current price to reflect all information contained in past prices. Expectations concerning future exchange rates should be incorporated in forward exchange rates. Further,in a strong-form efficient market all investors have the same information and hence there should be no room for making arbitrage profits.

Research results to date (confined to the floating regime) can be summarised as follows;

1. Attempts to forecast current changes in exchange rates using past changes in exchange rates has consistently been outperformed by the random walk model. This suggests that past exchange rate behaviour contains virtually no information on current exchange rate behavior. Thus the foreign exchange markets studied appear to be at least weak-form efficient (see, for example Allen and

Taylor,1990;Meese,1990).

2. Some exchange rate models that incorporate economic factors (fundamentals),subjective judgements,and past exchange rate movements (in form of charts) perform better than the forward rate especially in the short term (Allen and Taylor,1990). This suggests that fundamentals and hunches contain information about future exchange rates which is not instantaneously captured by current prices. Thus the market is not semi-strong efficient. As a result,there exists a large number of foreign exchange forecasters that use econometric models tampered with subjective judgements to arrive at better exchange rate predictions than either the forward rate or the random walk and are able to charge substantial fees (See,for example,Chartist M in Allen and Taylor, 1990, 54).

3. Forward rates are weakly biased predictors of future spot rates. This has the implication that the forward rate (F_{t-1})is a biased estimator of $E(S_t)$. This suggests that bandwagon effects exist in the expectations formation process and this causes expectational errors which can lead to speculative "bubbles" (Flood and Hodrick, 1990; Meese, 1990, 31). However the performance of forward rates has been,on the whole,pretty close to that of the random walk

model.

From these remarks we can conclude that market-driven foreign exchange markets may be weak-form efficient but certainly not efficient in the strong and semi-strong form.

2.3 Related work in Kenya

While several studies have been carried out in relation to foreign exchange in Kenya,very few have examined the short term behaviour of exchange rates.

An early paper (Vinnai,1972) discussed the system of the foreign exchange control in Kenya and its effects from the viewpoint of macroeconomic policy formulation. Then later,Kiyingi (1978) in a case study,focused on the Kenyan administered forward rate exchange market bringing out its organisation purpose and limitations.

Subsequently Njiraini (1983) studied the economic and corporate financial reporting implications of devaluations. This study contained a section with some useful background information on exchange rate determination. However empirical issues relating to the behaviour of exchange rates in the Kenyan foreign exchange market were not investigated.

Perhaps,the first study that attempted to model exchange rate behaviour in the Kenyan scene was that by

Jamshed Ali Abubakar (1988). His main concern was on the macro effects of the 1986 coffee boom on kenya's economy. One of the effects,he argued,was the appreciation of the shilling relative to the USDollar as a result of a favourable balance of payment position. He proceeded to model the KSh/$US exchange rate variation using relative prices (Kenya/USA) and coffee price indices in the two countries. He used regression analysis and covered the entire period 1963 - 1986. His model was able to explain 86% of the exchange rate variation using the price indices which indicated a relatively poor fit, possibly due to the use of data from different policy regimes or due to model misspecification or omission of some important explanatory variables. The model was an attempt to explain (not to predict) long term exchange rate behaviour. Such models are useful for economic planning but not for hedging against exchange risk. Further,out-of sample tests of fit were not used,making it difficult to assess its predictive accuracy. This study examined only one foreign currency,the US Dollar.Due to the strong influence of the US Dollar on the KShilling,one would have expected relatively good results.

study uses the treasury bill rate as this is the only short term market rate reported in Kenya. Mean interest rates are reported at about the middle of the month.Since,in practice,this is very close to the monthly average interest rate,this figure is suitable for our study. One problem encountered with IMF data is its accuracy since this data is obtained from IMF member countries some of which do not maintain reliable records. Another limitation of this study is the existence of gaps in the data. However,this is not too serious as to invalidate results as incidents of missing observations are not too many and the statistical package is able to handle data with gaps.

3.2 Modelling and Data analysis Methodology

As explained earlier,the modern theory of exchange rates recognises the crucial role played by market expectations and "news". Thus we may model the spot rates as follows;

$$LnS_t = A + BLnF_{t-1} + D(i-i^*)_t + w_t \tag{7}$$

where the forward rate F_{t-1} reflects market expectations and the interest rate differential is a measure of new information. The constant term takes care of the crawling peg.

Now, since market-driven forward rates do not exist in Kenya, F_{t-1} is not directly observable for either of the currencies under study. However, we can obtain it from the covered interest rate parity relation (CIP)[14] as follows,

$$\frac{F_t}{S_t} = \frac{1 + i_t}{1 + i^*_t} \qquad (8)$$

Taking logs, we obtain;

$$\text{Ln } F_t - \text{LnS}_t = \text{Ln}\left(\frac{1 + i_t}{1 + i^*_t}\right) \qquad (9)$$

When i_t and i^*_t are much smaller than 1 (but greater than zero!), one can expand the logarithm and use only the first terms, to obtain;

$$\text{LnF}_t - \text{LnS}_t = (i - i^*)_t \qquad (10)$$

so that,

$$\text{LnF}_{t-1} - \text{LnS}_{t-1} = (i - i^*)_{t-1} \qquad (11)$$

Using this result in (7) above, we obtain;

$$\text{LnS}_t = A + B\text{LnS}_{t-1} + C\left[i - i^*\right]_{t-1} + D\left[i - i^*\right]_t + w_t \qquad (12)$$

Rewriting this equation in the prediction mode, we obtain,

$$\text{LnS}_{t+1} = A + B\text{LnS}_t + C\left[i - i^*\right]_t + D\left[i - i^*\right]_{t+1} + w_t \qquad (13)$$

Note that the last term in (13) can not be used in

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[14] CIP is an arbitrage relation linking contemporaneous spot and forward exchange rates. There is a general consensus among researchers that the market respects this arbitrage condition (Froot and ,1990,182;Meese,1990,121).

prediction as it is unobservable. This term has been absorbed in w_t in (14) below. Thus the final model we intend to use is the one described in (14).

$$LnS_{t+1} = A + BLnS_t + C\left(i-i^*\right)_t + w_t \qquad (14)$$

Regression analysis will be used to estimate the coefficients A B and C. The data analysis will involve;

1) estimation of the coefficients A,B and C and evaluation of their stability,

2) Performance evaluation of the model, in the root-mean-square-error sense (RMSE), for a nine-month period,

3) analysis of the residuals w_t.

4) comparing the performance of this model with the random walk with a drift.

The random walk with a drift is obtained from (14) by noting that B should be pretty close to 1. Thus, using this observation we may rewrite (14) as;

$$LnS_{t+1} - LnS_t = A + w_t \qquad (15)$$

where the constant A is a measure of the drift rate, consistent with the crawling peg. (15) is called the random walk with a drift.

The computer packages to be used in the data analysis will include Statgraphics and Lotus 123. Lotus 123 is very useful in the evaluation of formulae. It has,however,limited plotting(graphics) capabilities and thus the need for statgraphics. Statgraphics can process a large amount of statistical data and in particular,it is suitable for data with missing observations. A major weakness,however is that it is clumsy to use and is rather slow. It is also frequently unable to handle division with denominators very close to zero. Thus matrix inversion can often be problematic.

4.0.DATA ANALYSIS AND FINDINGS

4.1.Model Fitting results

As stated in the previous chapter, we are interested in estimating the parameters A, B, and C in the regression equation;

$$LnS_t = A + BLnS_{t-1} + C\left[i-i^*\right]_t + w_t \qquad (15)$$

The results of the analysis is given in the Appendices (see page 36) and summarised for each country in the tables below:

Table 1 A : Regression estimates for Ksh/French Franc

variable	Coefficient	t-Statistic	Std.error
Constant	0.0283	1.691	0.0168
LnS_{t-1}	0.9794	62.62	0.0156
$(i-i^*)$	0.0009	0.572	0.0016

coefficient of determination R^2 (Adjusted) = 0.9858

coefficient of skewness = 1.04

coefficient of kurtosis = 2.05

$\text{corr}\left\{(\ln S_t - \ln S_{t-1}), (i - i^*)\right\} = 0.061$

critical $t_{0.05,57}$ = 2.00

Calculated Durbin-Watson statistic = 1.86, D_L =1.44, D_U =1.57.

Table 2 A : Regression estimates for Ksh/Deutsch Mark

variable	Coefficient	t-Statistic	Std.error
Constant	0.07768	1.820	0.0427
LnS_{t-1}	0.9804	70.06	0.0140
$(i-i^*)$	-0.0024	-0.7715	0.0031

coefficient of determination R^2 (Adjusted) = 0.9884

coefficient of skewness = 0.857

coefficient of kurtosis = 1.23

$corr\left\{(\ln S_t - \ln S_{t-1}), (i - i^*)\right\} = -0.0938$

critical $t_{0.05,57} = 2.00$

Calculated Durbin-Watson statistic = 2.00, D_L = 1.44, D_U = 1.57

Table 3 A : Regression estimates for Ksh/Japanese Yen

variable	Coefficient	t-Statistic	Std.error
Constant	0.0660	1.597	0.0413
LnS_{t-1}	0.9597	49.23	0.0195
$(i-i^*)$	0.0051	0.572	0.0016

coefficient of determination R^2 =0.9849

coefficient of skewness = -1.40

coefficient of kurtosis = 9.43

$corr\left\{(\ln S_t - \ln S_{t-1}), (i - i^*)\right\} = -0.0977$

critical $t_{0.05,57} = 2.00$

Calculated Durbin-Watson statistic = 2.40, D_L = 1.44, D_U = 1.57

Table 4 A : Regression estimates for Ksh/Dutch Guilder

variable	Coefficient	t-Statistic	Std.error
Constant	0.0529	1.908	0.277
LnS_{t-1}	0.9814	71.63	0.137
$(i-i^*)$	Not available	Not available	Unavailable

coefficient of determination R^2 (Adjusted) = 0.9886

coefficient of skewness = 0.98

coefficient of kurtosis = 1.48

$\text{corr}\left\{(\ln S_t - \ln S_{t-1}), (i - i^*)\right\}$ = Not available

critical $t_{0.05,57}$ = 2.00

Calculated Durbin-Watson statistic = 1.92, DL = 1.47, DU = 1.54

Table 5 A : Regression estimates for Ksh/Pound Sterling

variable	Coefficient	t-Statistic	Std.error
Constant	0.1252	1.840	0.0681
LnS_{t-1}	0.9652	46.77	0.0206
$(i-i^*)$	Not available	Not available	Unavailable

coefficient of determination R^2 (Adjusted) = 0.9737

coefficient of skewness = 0.93

coefficient of kurtosis = 1.50

$\text{corr}\left\{(\ln S_t - \ln S_{t-1}), (i - i^*)\right\}$ = Not available

critical $t_{0.05,57}$ = 2.00

Calculated Durbin-Watson statistic = 1.86, DL = 1.47, DU = 1.54

Table 6 A : Regression estimates for Ksh/USDollar

variable	Coefficient	t-Statistic	Std.error
Constant	0.1063	1.10	0.0965
LnS_{t-1}	0.9786	32.52	0.0301
$(i-i^*)$	-0.0069	-2.31	0.0030

coefficient of determination R^2 (Adjusted) = 0.9648

coefficient of skewness = 0.60

coefficient of kurtosis = 0.42

$corr\left\{(lnS_t - lnS_{t-1}), (i - i^*)\right\} = -0.2967$

critical $t_{0.05,57} = 2.00$

Calculated Durbin-Watson statistic = 2.28, DL = 1.44, DU = 1.57

These tables bring out several important observations;

First, the data fitting results can described as very good with the coefficient of determination above 0.96 in all the currencies under study. Thus the model is able to explain over 96% of the movements of the exchange rates during the period under study. In the case of the $USDollar, which is the poorest in this study for example, the model explains 96.5% of the exchange rate movement in sharp contrast with the value of 86% reported in the work of Jamshed Ali Abubakar (1986).

Second for all the exchange rates studied, the constant A is slightly greater than zero representing the general depreciation that the Kenyan shilling has experienced with respect to the currencies under study during this period.

Third, the second coefficient B is very close to unity for all the currencies studied. The value of this coefficient is also relatively stable with low standard errors. This finding strongly suggests that exchange rate movement is a highly retrogressive process of first order.

Finally, the third coefficient C is small and not statistically significant (at 95% confidence level). It would thus appear that the influence of interest rate differentials on exchange rate movement is not obvious. Consistent with the observation of Froot and Thaler (1990), we are able to establish the result that C is reliably less than 1. We have also obtained results for which C < 0.

Results for which C > 0 are reasonable because they indicate positive correlation between exchange rate movement and the interest rate differential. Results for which C < 0 are somewhat disturbing as they point the wrong direction of the movement of exchange rates. In an effort to explain such results Froot and Thaler (1990) advanced the possible explanation that it is the <u>real</u> and not the nominal interest differential that should point to the direction of exchange rate movement.Thus in periods of hyper inflation, the real interest differential may differ considerably from the nominal interest rate differential and thus unrealistic results can be obtained. In Kenya, for example, reliable inflation figures are not usually available, thus the author could not test this assertion.

To investigate the role of the interest differential further, the author regressed exchange rate movement $LnS_t - LnS_{t-1}$ against the interest differential $(i - i^*)$ and found that the model fits the data rather poorly. In all cases the interest differential explained only about 40% of exchange rate variation. From this result alone, it is evident that the nominal interest rate differential does not seem to be a useful explanatory variable of exchange rate movement. The autocorrelation function of the exchange rate movement $(LnS_t - LnS_{t-1})$ was also plotted and it was found that at 95% confidence level, one could not reject the hypothesis that the exchange rate movement is a pure random process with a drift.[15] Another interesting result inferred from the correlation matrix (Appendix 9) is that, while there is

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[15] This result does not rule out the possibility that the interest differential influences the exchange rate movement. It may just be a manifestation of the time series properties of the interest differential itself. (This important point was drawn to my attention by Prof. Morse to whom I am grateful).

little co-movement of exchange rates with interest differentials,there is considerable correlation among the exchange rate and interest rate movements in these countries. This probably reflects coordinated policy efforts and cooperation among these countries.

Further,a look at Appendix 1C to 6C and Appendix 1D to 6D shows that exchange rates,on the whole,have been more volatile than interest rates raising doubts whether movements in the latter could explain movements in the former. The autocorrelation function was also plotted to test for randomness and it was found that,at 95% confidence,the time series of the exchange rate movement i.e.(LnSt-LnSt-1) closely approximates a pure white noise process.

These results taken together, strongly suggest that the time series of exchange rates is predominantly a first order antoregressive process, with a weak dependence on interest differentials. Thus,

$$LnS_t = A + BS_{t-1} + C\ (i - i)_t + w_t \qquad (16)$$

$$\text{with} \qquad B \cong 1,\ A, C \cong 0$$

The case for which B = 1, A,C = 0 represents the pure random walk process i.e.without a drift. The figures below illustrate how closely LnS_{t-1} estimates LnS_t thus furnishing further evidence of strong first order autoregression.Fig.1B to 6B below illustrate this observation.

An analysis of residues,notably the coefficient of skewness and the coefficient of kurtosis indicate that the residues are closely normal (For normal distribution, coefficient of skewness = 0, coefficient of kurtosis = 3). In addition, the computed durbin-Watson statistic,in all cases of this study,falls between Du and 4-Du indicating that at 95% confidence level the residue series is not first-order correlated (Du represents the upper critical value and was obtained tables; Du = 1.57,so that 4-Du=2.43). This confirms that two of the fundamental assumptions of the regression modelling are satisfied.

4.2.Forecasting results.

The predictive performance of (16) was compared with the random walk model (17) using the root mean square error criterion (RMSE). Tables 1C to 6C below provide the results over different time horizons.

Full regression model;

$$LnS_t = A + B\ LnS_{t-1} + C\ (i-i)_t + w_t \quad (16)$$

Random walk; $LnS_t - LnS_{t-1} = A + w_t$ (17)

TABLE 1B: Percentage RMSE Ksh / French Franc

Prediction horizon (months)

	1	3	6	9
Regression	0.109	3.583	1.038	0.646
Random walk	2.333	1.206	1.381	1.958

TABLE 1B: Percentage RMSE Ksh / Deutsch Mark

Prediction horizon (months)

	1	3	6	9
Regression	1.499	2.193	0.143	0.224
Random walk	8.331	4.414	6.905	7.427

TABLE 1B: Percentage RMSE Ksh / Japanese Yen

Prediction horizon (months)

	1	3	6	9
Regression	0.150	0.665	0.220	5.480
Random walk	7.175	8.127	7.526	1.832

TABLE 1B: Percentage RMSE Ksh / USDollar

Prediction horizon (months)

	1	3	6	9
Regression	0.572	3.262	1.151	1.199
Random walk	10.497	7.535	10.685	10.737

From these results, it is evident that the regression model clearly performs considerably better than the random walk model. However, it is evident that interest movements, on the whole, do not have a significant influence on short - term exchange rate movement as is customary assumed.

An important finding is that the size of errors increase fairly gently with the length of the prediction horizon. This is an indication of a stationary process and as a result, it would appear that the model may be useful for periods of up to one year. In a nonstationary series, the coefficients A, B and C are functions of time, and hence not constants.

5.0. DISCUSSION OF RESULTS AND RECOMMENDATIONS FOR FURTHER STUDY.

5.1. Conclusion and discussion

With respect to the objectives set out in chapter 3, this study has established the following;

(1) In the full regression model the coefficients A, B, and C have been computed but the process has been found to be predominantly autoregressive with B being the most significant coefficient. The model fits past data very well.

(2) Out-of-sample model performance of the full regression model indicates that the model is useful for periods of up to 9 months and probably up to one year.

(3) An analysis of the residuals using the computer print outs, shows that, on the whole, the regression model assumptions are valid. Thus the results are valid within the framework of regression analysis.

(4) Predictive performance of the full regression model significantly outperforms the random walk with a drift. This suggests that although the coefficients A and C are, on the whole, only marginally significant, they nevertheless play a role in the model and hence should not be omitted.

The findings of this study seem to suggest that interest rate differentials do not significantly influence exchange rate movements as is presumed in the Uncovered interest rate parity hypothesis. This result is consistent with those discussed in a recent study by Froot and Thaler (1990) who have reported similar inconclusive findings concerning the inference of short term exchange rate movements from differential interest rates.

In retrospect, in developing countries where Capital mobility is low, one might suspect that interest rate differentials may not produce the required levels of capital flows which may influence the exchange rate. It is however surprising that even in developed Countries, inexplicable results are obtained.

5.2 Limitations of the study and recommendations for further research.

The model employed in this study is an adaptation of a general class of models collectively termed monetary models developed in the late 1970's. Recent studies have brought out to the attention of financial economists the fact that exchange rates are not just influenced by purely monetary shocks (e.g. Interest rates, money supply, e.t.c) but also by real shocks (Productivity shocks, price level disturbances, e.t.c). This by itself may explain why purely monetary models may not perform very well in an era dominated by real economic shocks.

Export products from developing countries are particularly susceptible to real shocks in the economy. In particular, the author is of the opinion that the direction of the balance of trade (current account) is perhaps the single most critical factor that influences the exchange rate in a developing Country. Thus future studies in this area would extend the model to factors which affect the current account such as export price indices and the volume of export.

Another important factor not taken into consideration in this study is the issue of capital flight. While capital flows among developed economies can reasonably be assumed to respond to real returns and hence real interest rates, this is frequently not so in developing countries. Capital flow will frequently respond to political risk and hence any future study in exchange rate modelling would attempt to include this critical factor.

Our model has been able to explain over 96% of past exchange rate variation. For prediction purposes, this model can be improved by making it adaptive so that model parameters can be reestimated once new observations are made. This would enhance the model accuracy for nonstationary data.

Finally, nonlinear models tend to outperform linear ones especially where data relationships is inherently nonlinear. While our model may be optimal in the class of linear models, it would be useful to investigate the performance of nonlinear ones. An important class of non - linear models was introduced in exchange rate literature by Paul Krugman (Meese and Rose, 1990). However their performance has yet to be evaluated (Meese,1990).

LIST OF APPENDICES

Notes on the Appendices

1) For some countries, certain computations were not possible due to the nature of the data. The computations involved division by zero and hence results are not available.

2) The data is input in the form of variables F1 to F24. Although an effort has been made to suppress these variables in the final print outs, this was not possible in all cases and in a few print outs, these variables appear. In these cases they are to be interpreted as follows;

F1,F5,F9,F13,F17,and F21, represent the Logarithm of the current exchange rate S_t for the FFranc, Deutsch Mark, Japanese Yen, Netherlands Guilder, Pound sterling and the USDollar respectively.

F2,F6,F10,F14,F18,and F22, represent the Logarithm of the previous exchange rate S_{t-1} for the currencies above and in the same order.

F3,F7,F11,F15,F19,and F23 represent the first order exchange rate movement ($LnS_t - LnS_{t-1}$) for the currencies above and in the same order.

F4,F8,F12,F16,F20,and F24, represent the short term interest differential between Kenya ($i - i^*$) and the countries above and in the same order.

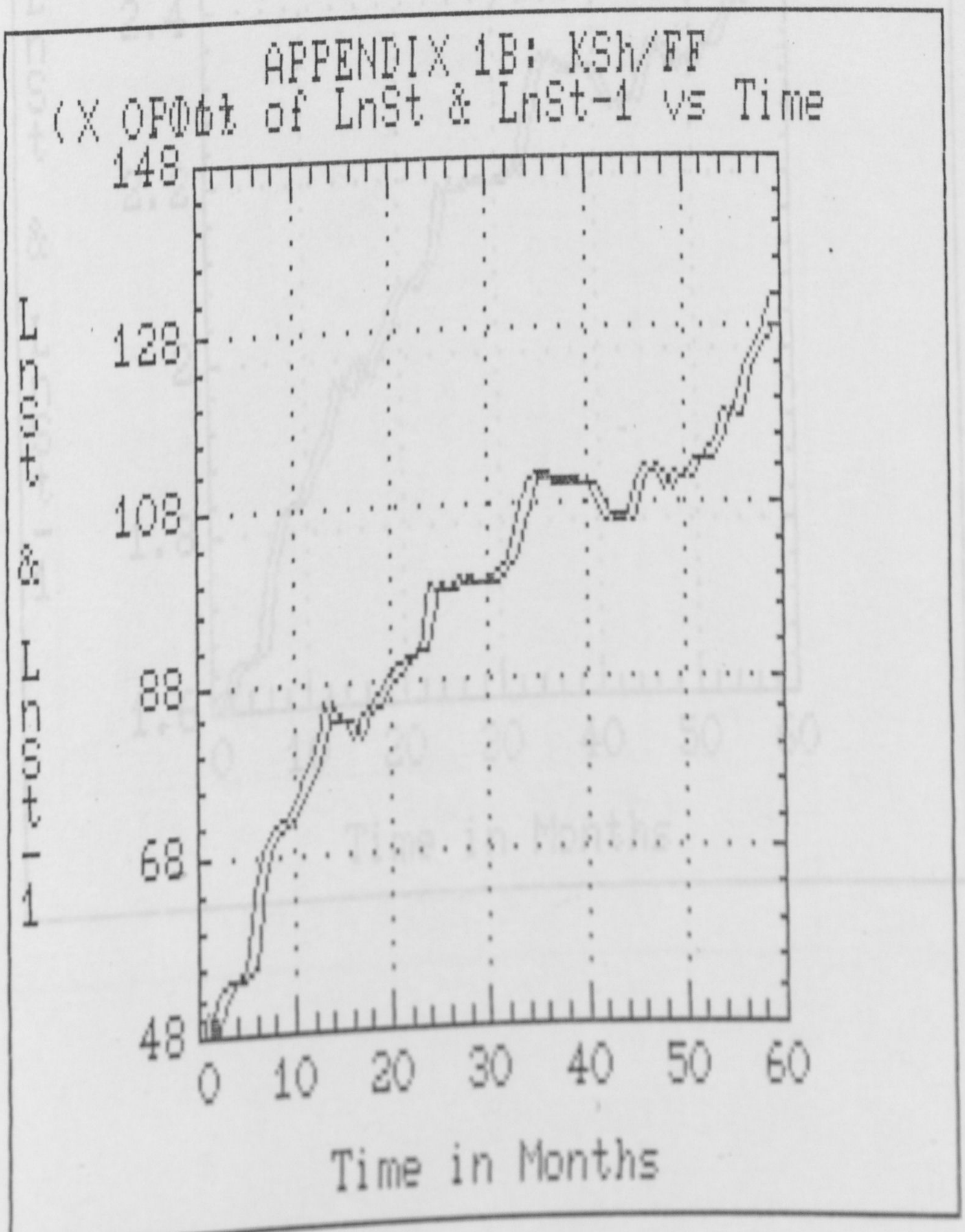
Appendix 1A:Raw Data (continued)

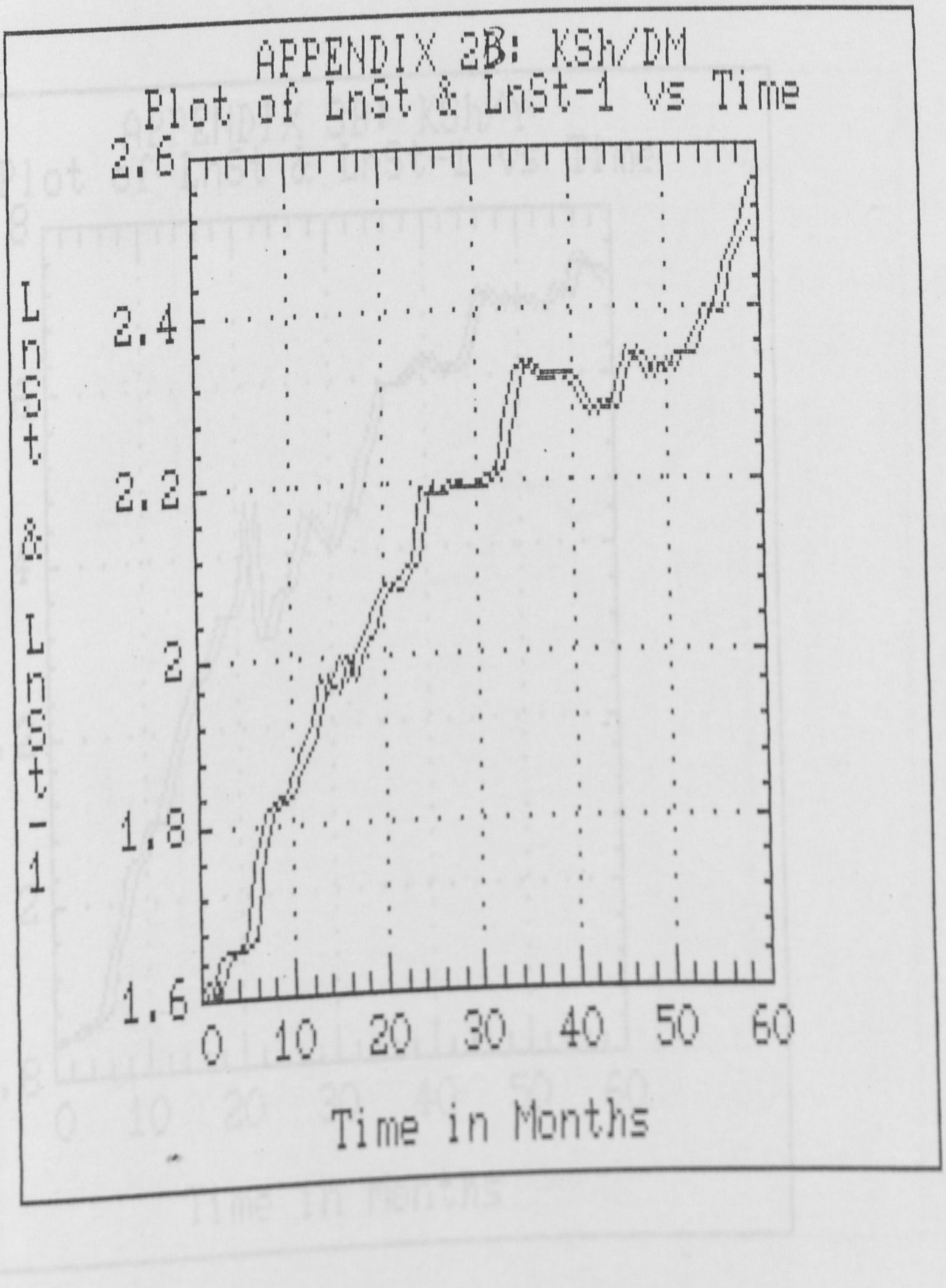
Appendix 1A: Raw Data.

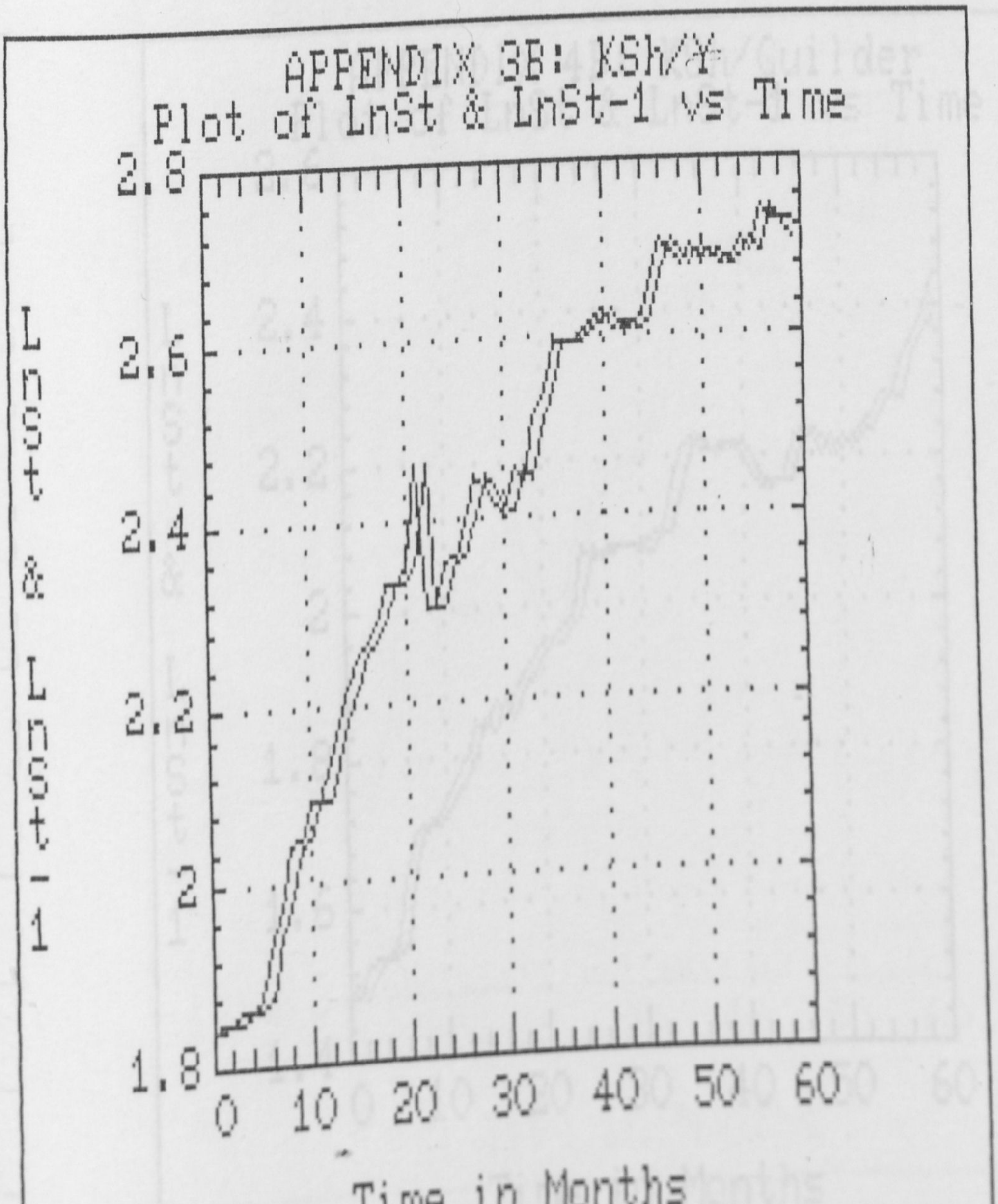
MONTH	KENYA i	FRANCE St	iF	GERMANY St	iG	JAPAN St	iJ	NETHERLANDS St	IN	UK St	iUK	USA St	iUSA
Jan,1985	12.500	1.660	10.560	5.070	5.500	6.310	6.170	4.480	5.770	18.190		16.060	8.350
Feb	12.480	1.620	10.650	4.960	5.800	6.360	6.170	4.400	6.480	17.990	10.960	16.480	8.500
Mar	13.790	1.690	10.670	5.160	5.900	6.360	6.420	4.570	6.900	19.790		16.100	8.580
Apr	14.680	1.720	10.480	5.240	5.700	6.420	6.070	4.640	6.760	20.150		16.180	8.270
May	14.310	1.720	10.170	5.240	5.700	6.420	6.010	4.650	7.120	20.610	10.080	16.150	7.970
Jun	14.810	1.740	10.220	5.300	5.500	6.510	6.130	4.710	6.840	20.970		16.180	7.530
Jul	14.310	1.940	9.880	5.900	5.100	7.000	6.140	5.260	6.610	23.580	11.000	16.580	7.880
Aug	13.980	2.010	9.680	6.160	4.800	7.220	6.170	5.470	5.980	23.940	11.000	17.110	7.900
Sep	13.220	2.050	9.570	6.250	4.600	7.700	6.410	5.550	5.740	23.450	11.750	16.750	7.920
Oct	14.180	2.060	9.340	6.280	4.500	7.780	6.540	5.570	5.870	23.720	10.000	16.540	7.990
Nov	14.410	2.110	8.980	6.440	4.600	8.090	7.230	5.730	5.810	24.060	11.500	16.290	8.050
Dec	14.140	2.160	9.020	6.620	4.600	8.120	8.020	5.880	5.770	23.470	11.000	16.280	8.270
Jan,1986	14.890	2.230		6.850	4.600	8.440	6.840	6.060		23.080	12.380	16.240	8.140
Feb	14.850	2.350		7.220	4.600	8.880	5.780	6.400		23.590	12.000	16.010	7.860
Mar	14.480	2.300	8.520	7.070	4.900	9.170	5.530	6.270	5.710	24.270	12.250	16.490	7.480
Apr	14.930	2.310	8.190	7.360	4.800	9.540	4.700	6.520	5.490	24.720	10.000	16.000	6.990
May	13.240	2.260	7.500	7.180	4.300	9.630	4.210	6.390	6.620	24.620	8.000	16.580	6.850
Jun	14.180	2.330	7.250	7.430	4.400	3.890	4.390	6.590	6.170	25.040		16.340	6.920
Jul	13.250	2.340	7.280	7.600	4.600	10.320	4.500	6.740	6.130	23.970	10.000	16.060	6.560
Aug	12.440	2.390	7.050	7.840	4.500	10.320	4.550	6.950	5.620	23.800	10.000	16.090	6.170
Sep	11.850	2.440	7.090	8.010	4.400	10.530	4.630	7.090	5.310	23.240	10.500	16.170	5.890
Oct	11.220		7.320	7.960	4.400	11.720	4.410	7.050	5.400	22.910	10.980	16.280	5.850
Nov	11.210	2.490	7.290	8.150	4.500	9.970	3.770	7.210	5.650	23.190	10.890	16.220	6.040
Dec	12.150	2.490	7.800	8.240	5.000	10.030	4.180	7.290	6.170	23.570	10.930	16.040	6.910
Jan,1987	12.540	2.690	8.900	8.980	4.200	10.540	4.090	7.970	6.010	24.710	10.800	16.060	6.430
Feb	12.660	2.670	8.360	8.900	3.800	10.610	4.050	7.860	5.300	25.010	10.650	16.230	6.100
Mar	12.630	2.680	7.890	8.930	3.800	10.980	3.850	7.900	5.540	25.790	9.960	16.040	6.130
Apr	12.830	2.710	7.910	9.030	3.700	11.560	3.520	8.000	5.240	26.850	9.780	16.180	6.370
May	12.830	2.700	8.020	8.990	3.700	11.390	3.160	7.930	5.190	26.600	8.790	16.810	6.850
Jun	12.990	2.700	8.010	9.000	3.600	11.220	3.160	7.990	5.190	26.330	8.840	16.450	6.730
Jul	12.930	2.700	7.460	8.960	3.700	11.110	3.170	7.950	5.190	26.490	9.190	16.620	6.580
Aug	12.910	2.730	7.410	9.120	3.800	11.640	3.190	8.100	4.840	26.970	10.030	16.520	6.730
Sep	12.990	2.760	7.360	9.170	3.700	11.530	3.390	8.160	4.880	27.480	10.210	16.880	7.220
Oct	12.980	2.910	7.690	9.820	3.700	12.310	3.370	8.720	5.320	29.220	9.970	17.020	7.290
Nov	12.980	3.020	8.670	10.280	3.600	12.730	3.390	9.140	4.730	30.780	8.940	16.980	6.690
Dec	13.000	3.060	8.030	10.360	3.200	13.390	3.810	9.200	4.500	30.690	8.750	16.520	6.770
Jan,1988	12.990	3.030	7.800	10.230	3.100	13.420	3.540	9.100	4.070	30.370	8.890	17.010	6.830
Feb	13.460	3.000	7.260	10.170	3.300	13.380	3.400	9.060	4.050	30.420	9.270	17.160	6.580
Mar	13.480	3.020	7.540	10.250	3.200	13.650	3.520	9.130	4.030	32.030	8.860	17.030	6.580
Apr	13.440	3.010	7.550	10.250	3.300	13.720	3.340	9.130	4.020	32.020	8.260	17.090	6.870
May	13.490	3.000	7.340	10.070	3.300	13.850	3.240	9.000	4.130	32.090	7.970	17.280	7.090
Jun	13.990	2.950	7.110	9.920	3.700	13.590	3.420	8.800	2.940	30.970	8.950	18.090	7.510
Jul	13.490	2.880	7.190	9.730	4.400	13.700	3.660	8.630	4.560	31.230	10.520	18.110	7.750
Aug	13.490	2.910	7.380	9.860	4.700	13.630	3.790	8.730	4.970	31.070	11.380	18.400	8.010
Sep	13.500	2.890	7.520	9.830	4.700	13.780	3.880	8.730	5.320	31.130	12.100	18.510	8.190
Oct	13.500	3.000	7.570	10.270	4.700	14.500	3.920	9.110	5.070	32.260	12.160	18.200	8.360
Nov	13.380	3.080	7.820	10.500	4.600	14.960	3.700	9.320	5.040	33.600	12.290	18.230	8.750
Dec	13.520	3.050	8.200	10.410	4.900	14.800	4.040	9.220	5.600	33.300	13.120	18.600	8.760
Jan,1989	13.730	2.980	8.460	10.140	5.200	14.580	3.830	8.970	5.560	33.260	13.120	18.860	9.120
Feb	13.710	3.050	8.700	10.370	5.900	14.910	3.890	9.190	6.140	33.870	13.030	18.890	9.360
Mar	13.690	3.030	8.450	10.240	5.600	14.650	4.010	9.090	6.360	32.700	13.020	19.380	9.850
Apr	13.780	3.090	8.310	10.450	5.900	14.840	4.050	9.260	6.270	33.140	13.110	19.600	9.840

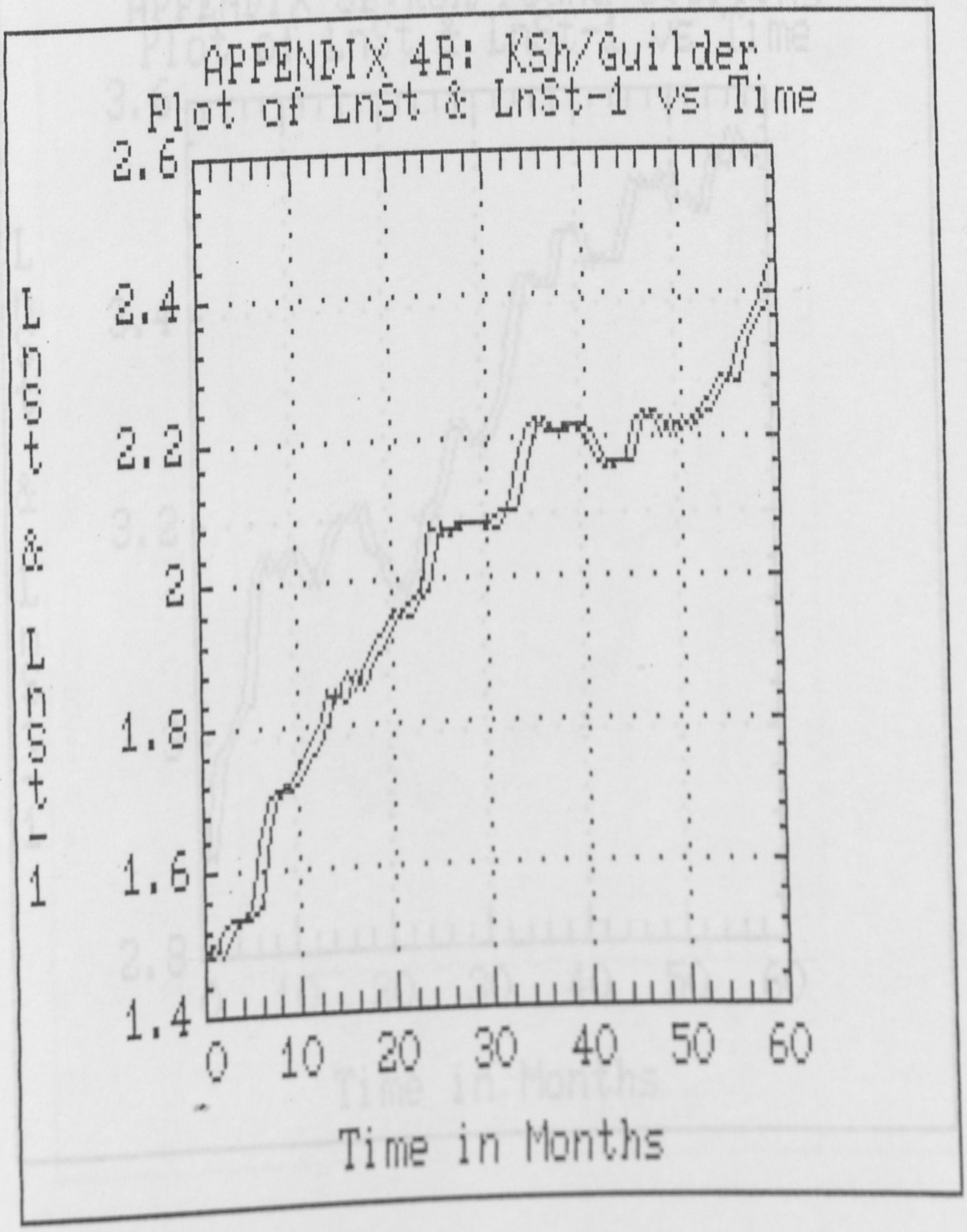
Appendix 1A:Raw Data (continued)

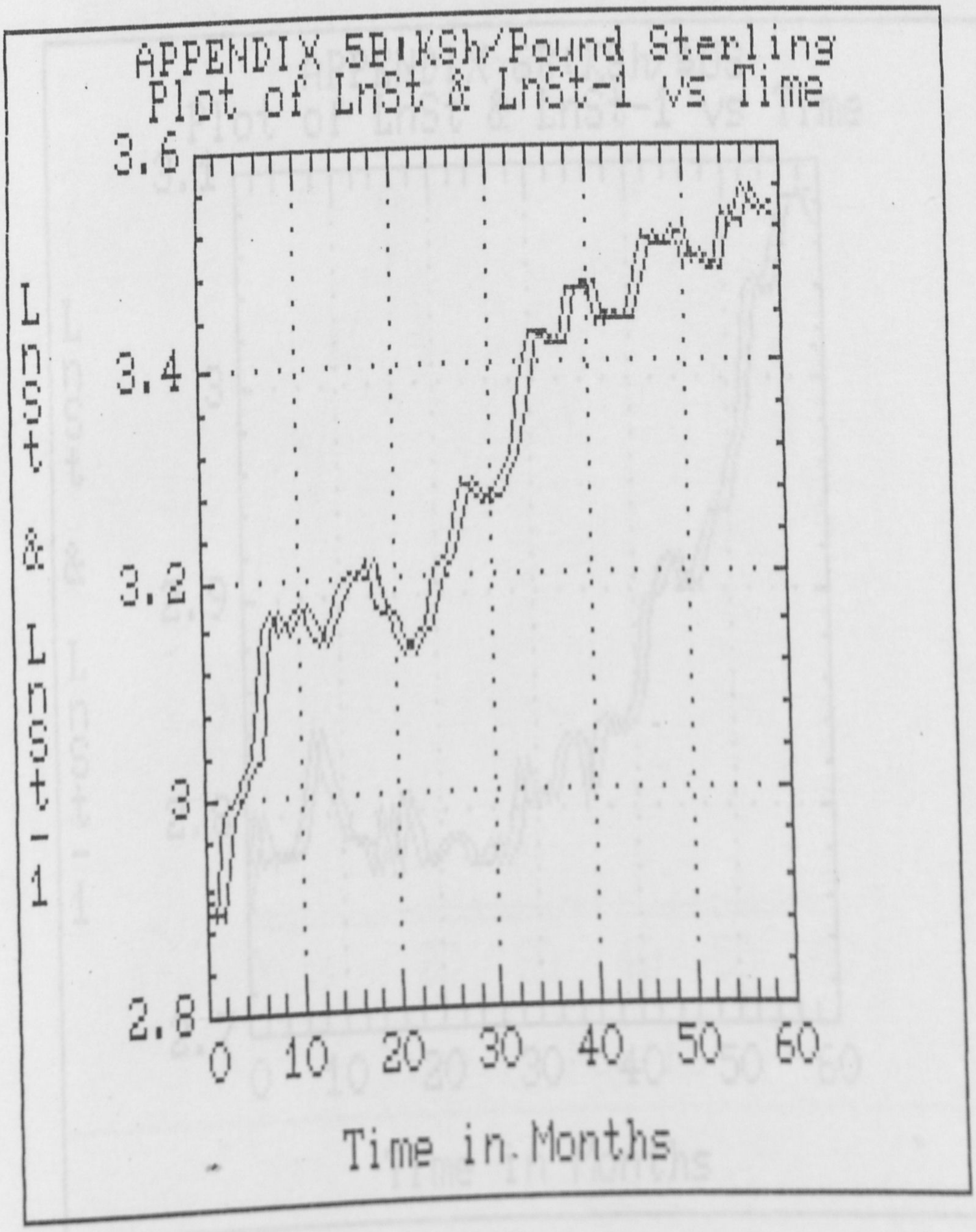
May	13.950	3.090	8.510	10.460	6.300	14.620	4.190	9.280	6.770	32.760	13.130	20.860	9.810
Jun	13.980	3.160	8.930	10.730	6.500	14.660	4.850	9.520	6.760	32.550	14.150	21.070	9.530
Jul	13.980	3.270	9.190	11.080	6.900	14.970	5.050	9.820	6.940	34.460	13.920	20.840	9.240
Aug	13.990	3.250	9.050	10.950	6.800	14.830	5.220	9.720	7.200	33.760	13.850	21.390	8.990
Sep	13.990	3.430	8.940	11.620	6.900	15.560	5.280	10.290	7.230	35.220	14.030	21.850	9.020
Oct	13.990	3.500	9.850	11.890	7.900	15.370	5.840	10.530	8.000	34.510	15.020	21.810	8.840
Nov	14.000	3.590	9.990	12.230	7.500	15.310	5.980	10.840	8.250	34.270	15.090	21.860	8.550
Dec	14.000	3.750	10.480	12.810	7.700	15.030	6.290	11.340	8.430	34.670	15.110	21.600	8.450
Jan,1990	14.000	3.770	10.670	12.780	7.600	14.980	6.430	11.340	8.550	36.250	15.160	21.740	8.230
Feb	14.000	3.870	10.430	13.110	7.800	14.880	6.480	11.640	8.610	37.410	15.110	22.220	8.240
Mar	14.000	4.030	10.190	13.570	7.700	14.700	6.650	12.050	8.240	37.680	15.270	22.980	8.280
Apr	14.000	4.110	9.890	13.810	7.800	14.530	7.000	12.270	8.150	37.810	15.210	23.140	8.260
May	14.940	4.060	9.750	13.680	7.700	15.210	7.100	12.150	8.180	39.020	15.140	23.020	8.180
Jun	14.950	4.120	9.840	13.830	7.800	15.110	7.200	12.280	7.960	40.210	14.790	23.130	8.290
Jul	14.810	4.300	10.060	14.400	8.000	15.630	7.370	12.780	7.790	42.660	14.860	23.130	8.150
Aug	14.970	4.430	9.760	14.860	8.000	16.130	7.380	13.190	8.250	44.680	14.880	23.230	8.130
Sep	14.970	4.470	9.790	14.950	8.000	16.920	7.570	13.260	8.130	43.830	14.830	23.330	8.200


APPENDIX 1B: KSh/FF
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
148
128
108
88
68
48
0
10
20
30
40
50
60
Time in Months

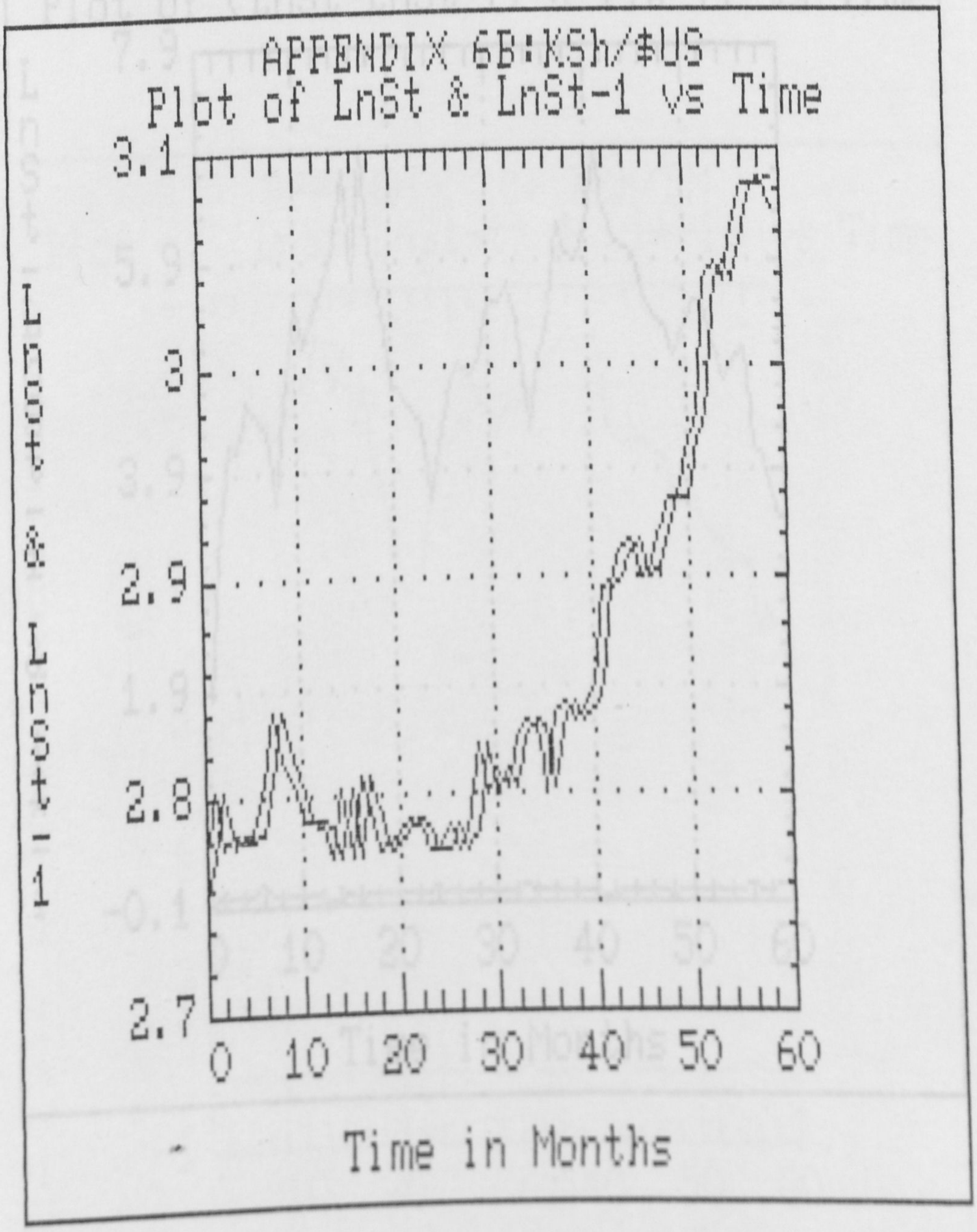

APPENDIX 2B: KSh/DM
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
2.6
2.4
2.2
2
1.8
1.6
0
10
20
30
40
50
60
Time in Months

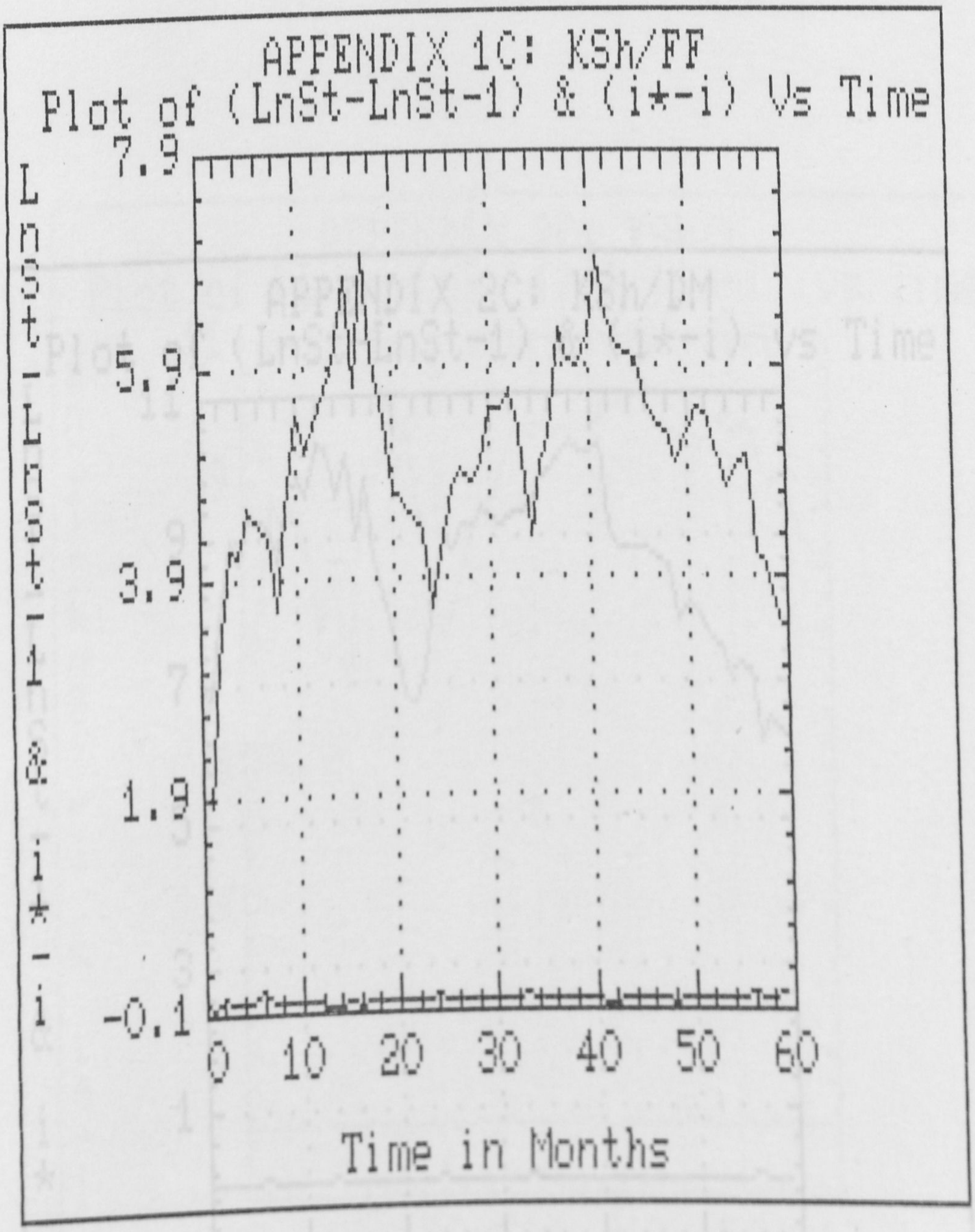

APPENDIX 3B: KSh/Y
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
2.8
2.6
2.4
2.2
2
1.8
0
10
20
30
40
50
60
Time in Months

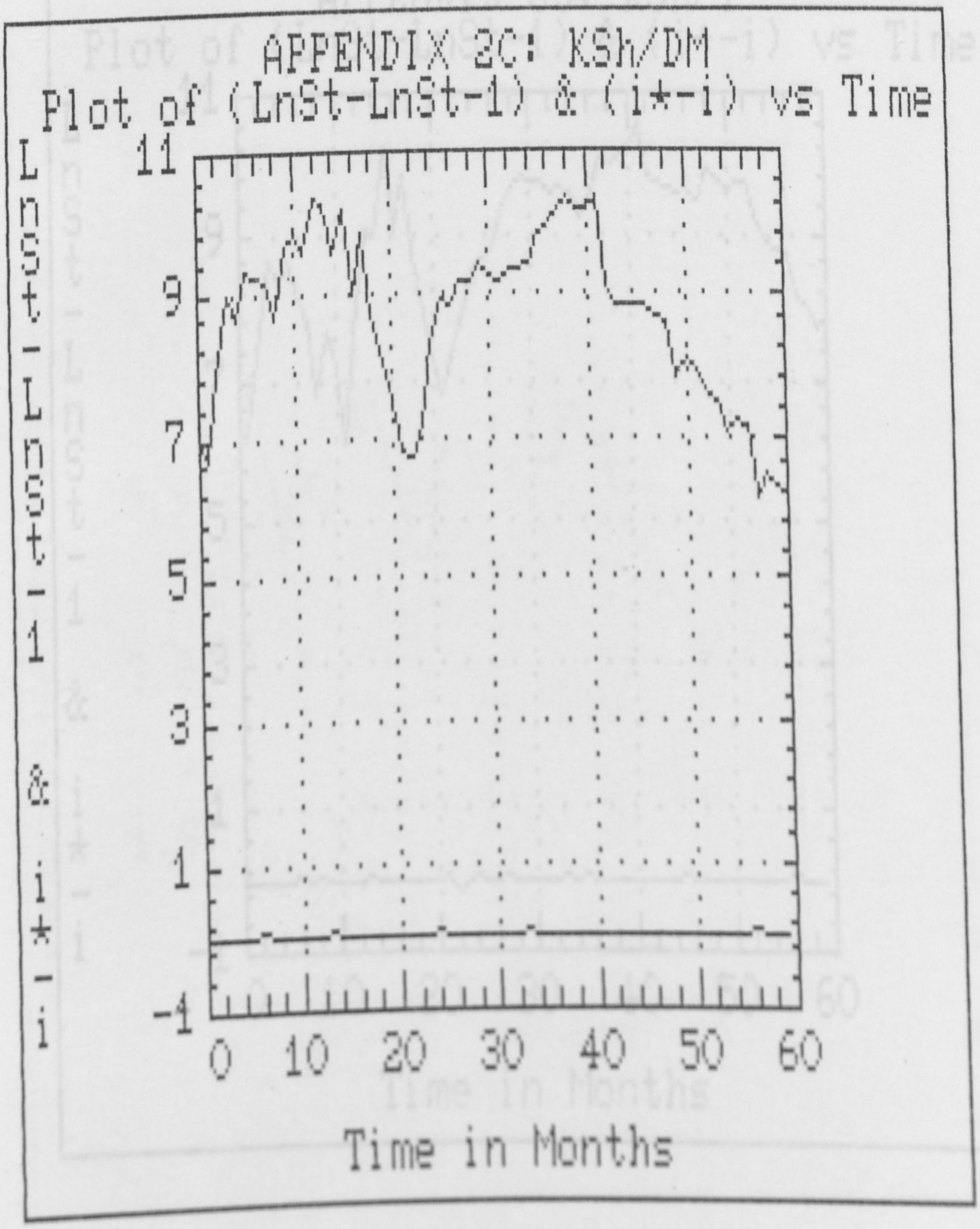

APPENDIX 4B: KSh/Guilder
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
2.6
2.4
2.2
2
1.8
1.6
1.4
0
10
20
30
40
50
60
Time in Months

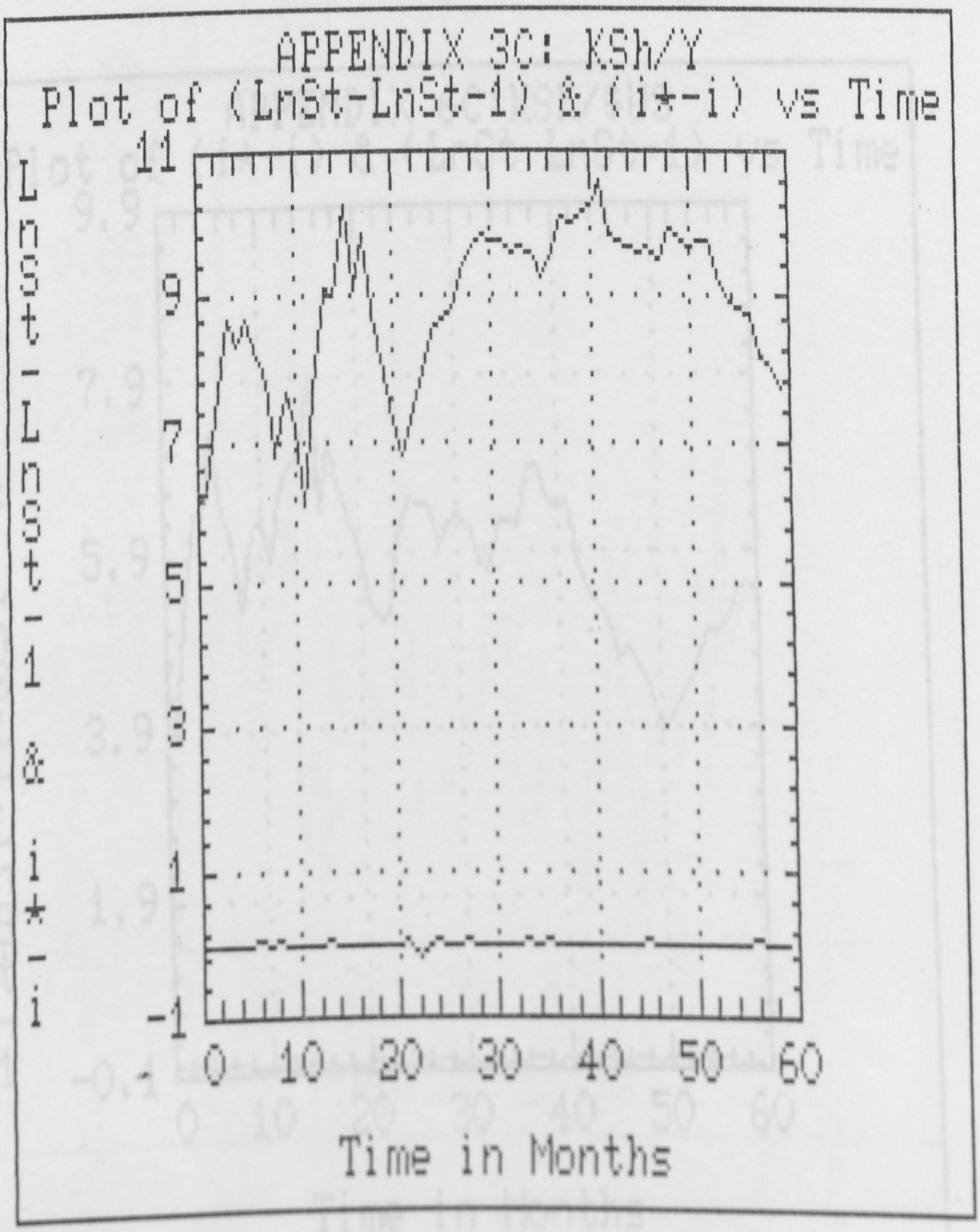


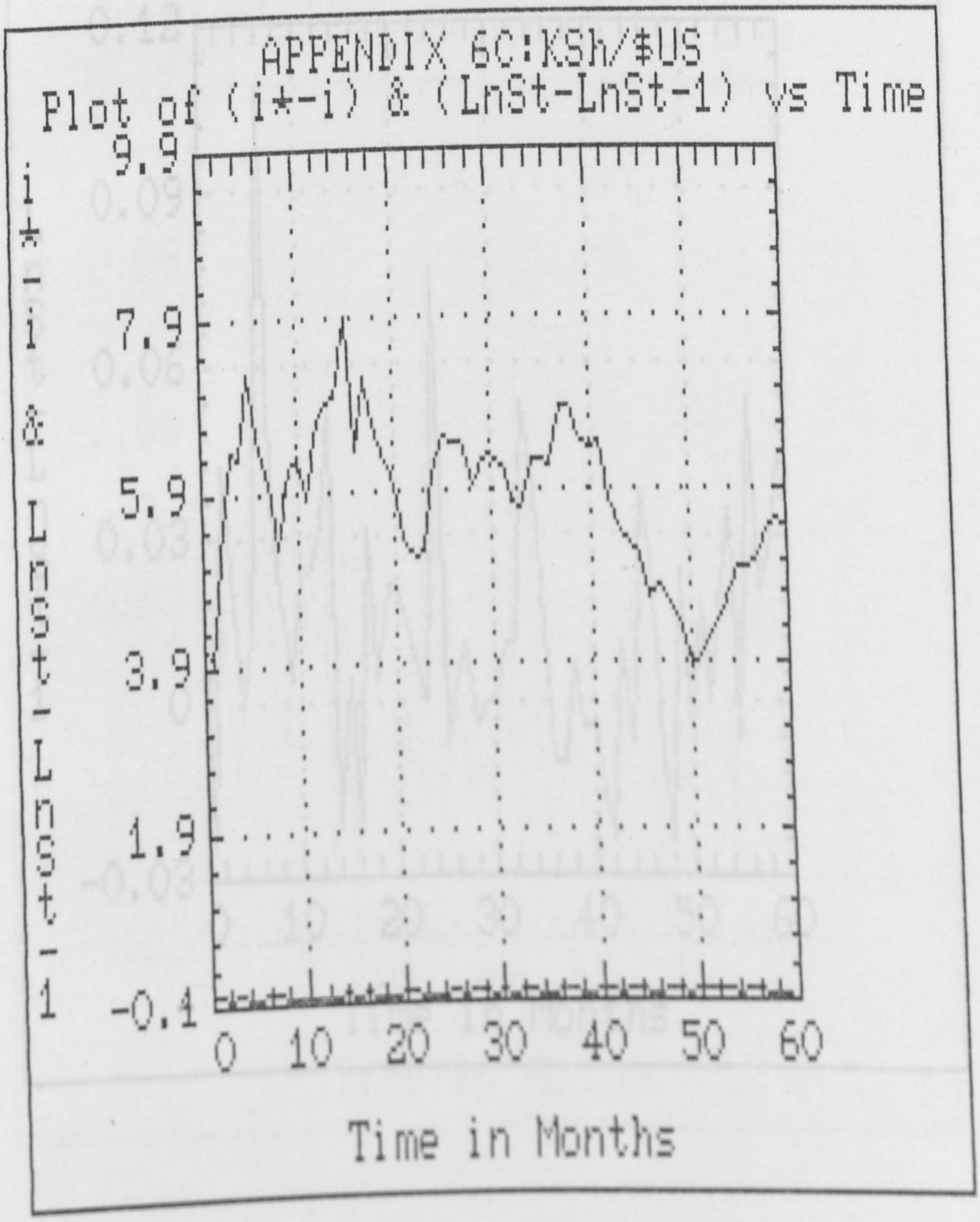
APPENDIX 5B:KSh/Pound Sterling
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
3.6
3.4
3.2
3
2.8
0
10
20
30
40
50
60
Time in Months

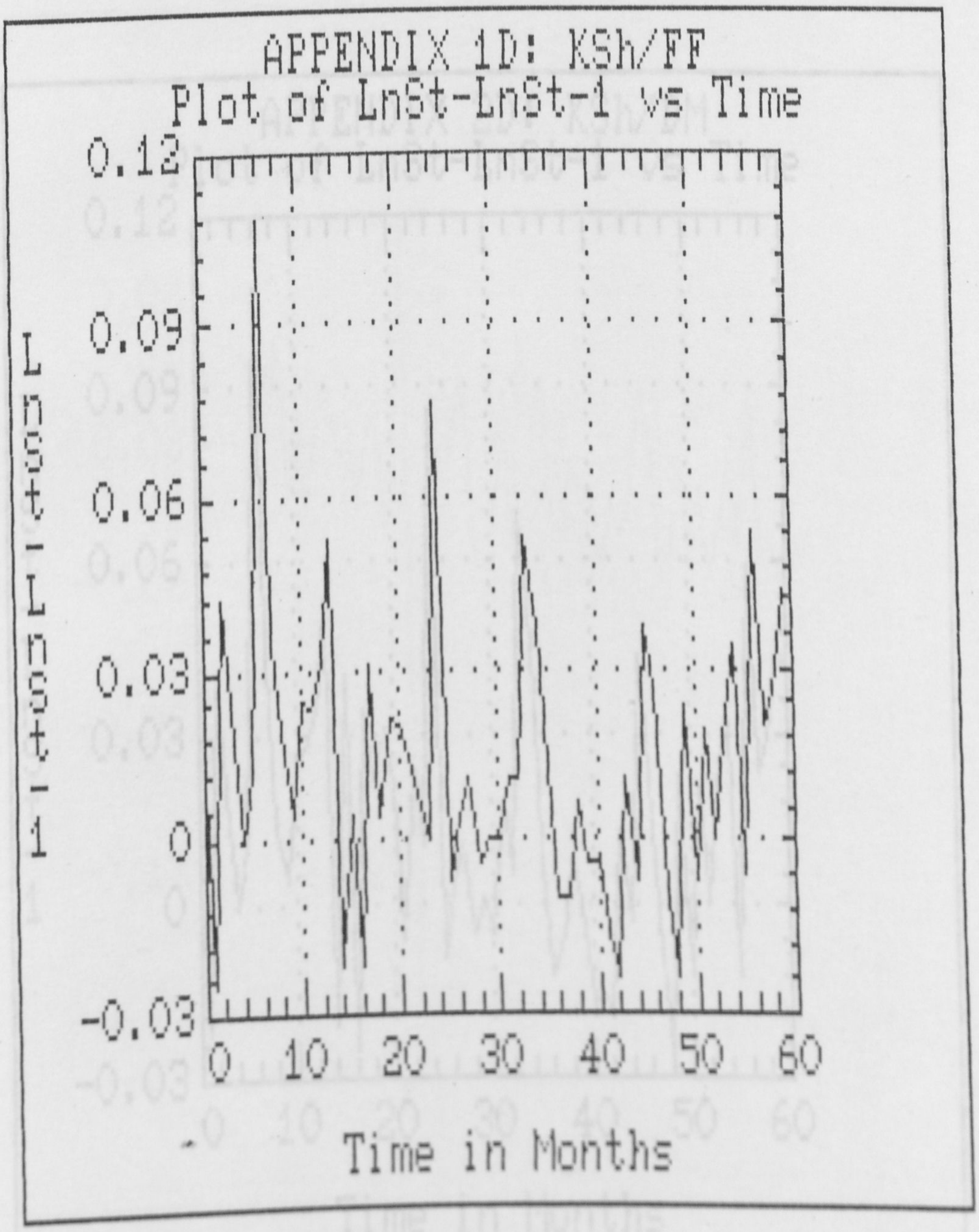

APPENDIX 6B:KSh/$US
Plot of LnSt & LnSt-1 vs Time
LnSt & LnSt-1
3.1
3
2.9
2.8
2.7
0
10
20
30
40
50
60
Time in Months


APPENDIX 1C: KSh/FF
Plot of (LnSt-LnSt-1) & (i*-i) Vs Time
LnSt-LnSt-1 & i*-i
7.9
5.9
3.9
1.9
-0.1
0
10
20
30
40
50
60
Time in Months

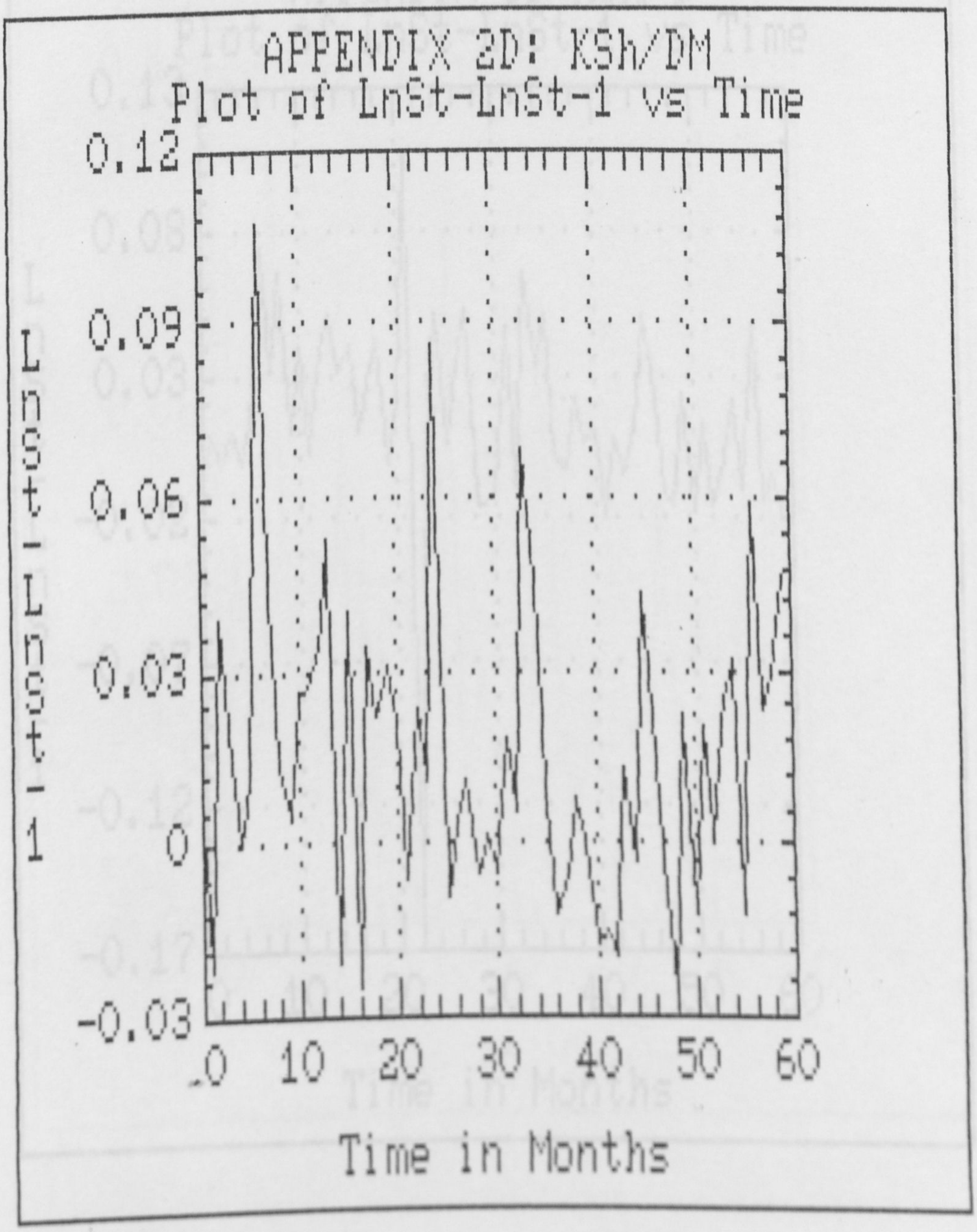

APPENDIX 2C: KSh/DM
Plot of (LnSt-LnSt-1) & (i*-i) vs Time
LnSt-LnSt-1 & i*-i
11
9
7
5
3
1
-1
0
10
20
30
40
50
60
Time in Months


APPENDIX 3C: KSh/Y
Plot of (LnSt-LnSt-1) & (i*-i) vs Time
LnSt-LnSt-1 & i*-i
11
9
7
5
3
1
-1
0
10
20
30
40
50
60
Time in Months

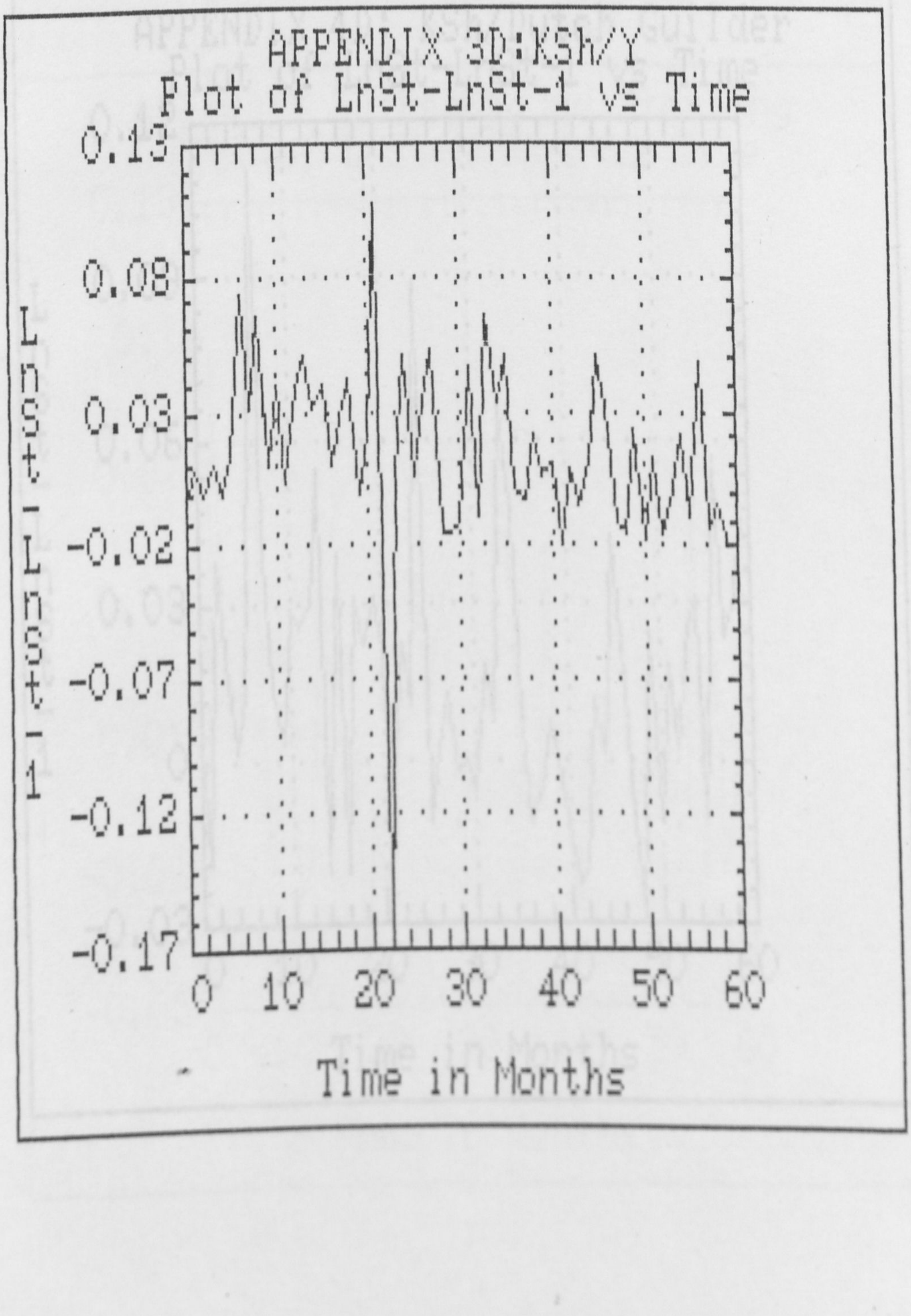

APPENDIX 6C:KSh/$US
Plot of (i*-i) & (LnSt-LnSt-1) vs Time
i*-i & LnSt-LnSt-1
9.9
7.9
5.9
3.9
1.9
-0.1
0
10
20
30
40
50
60
Time in Months

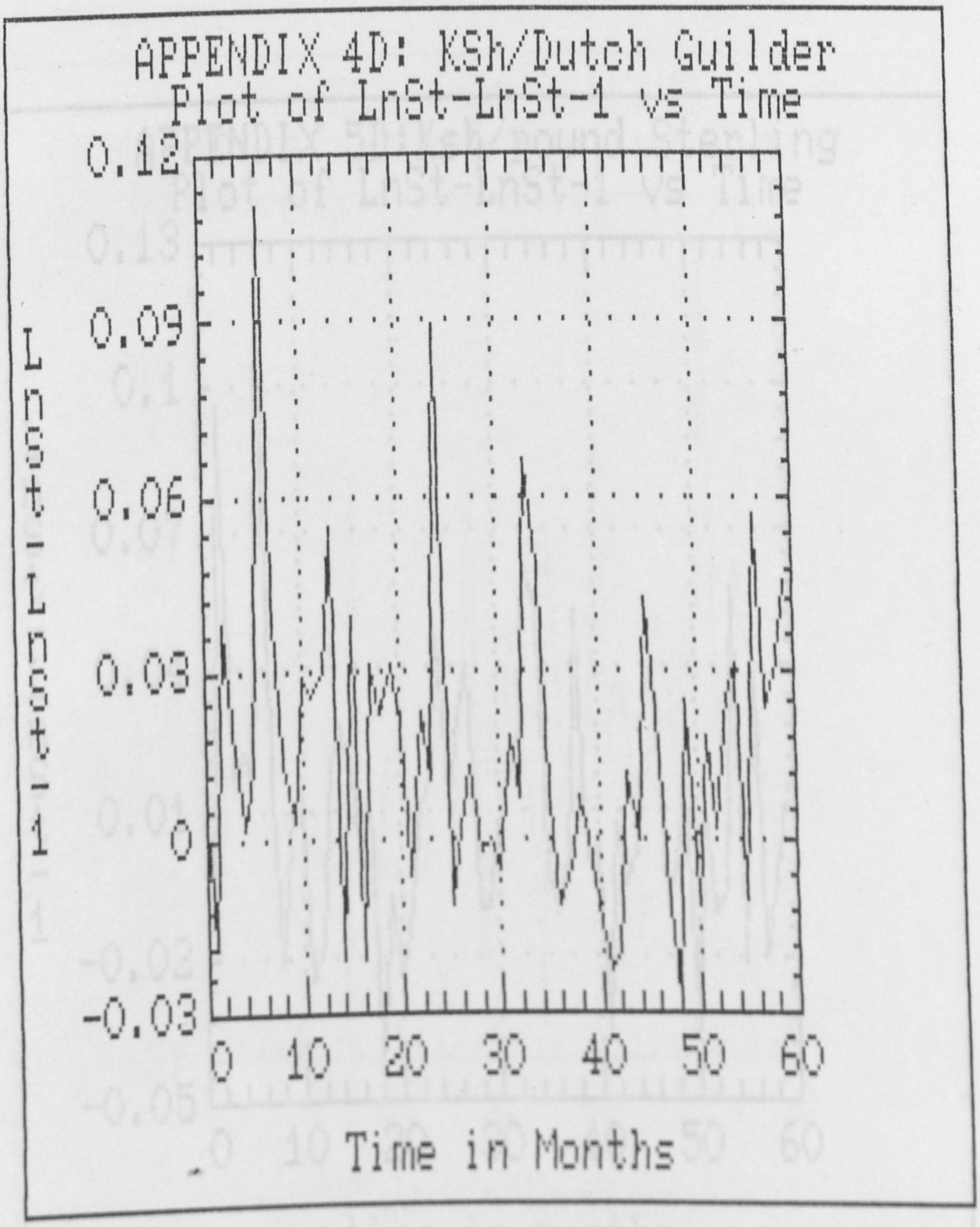


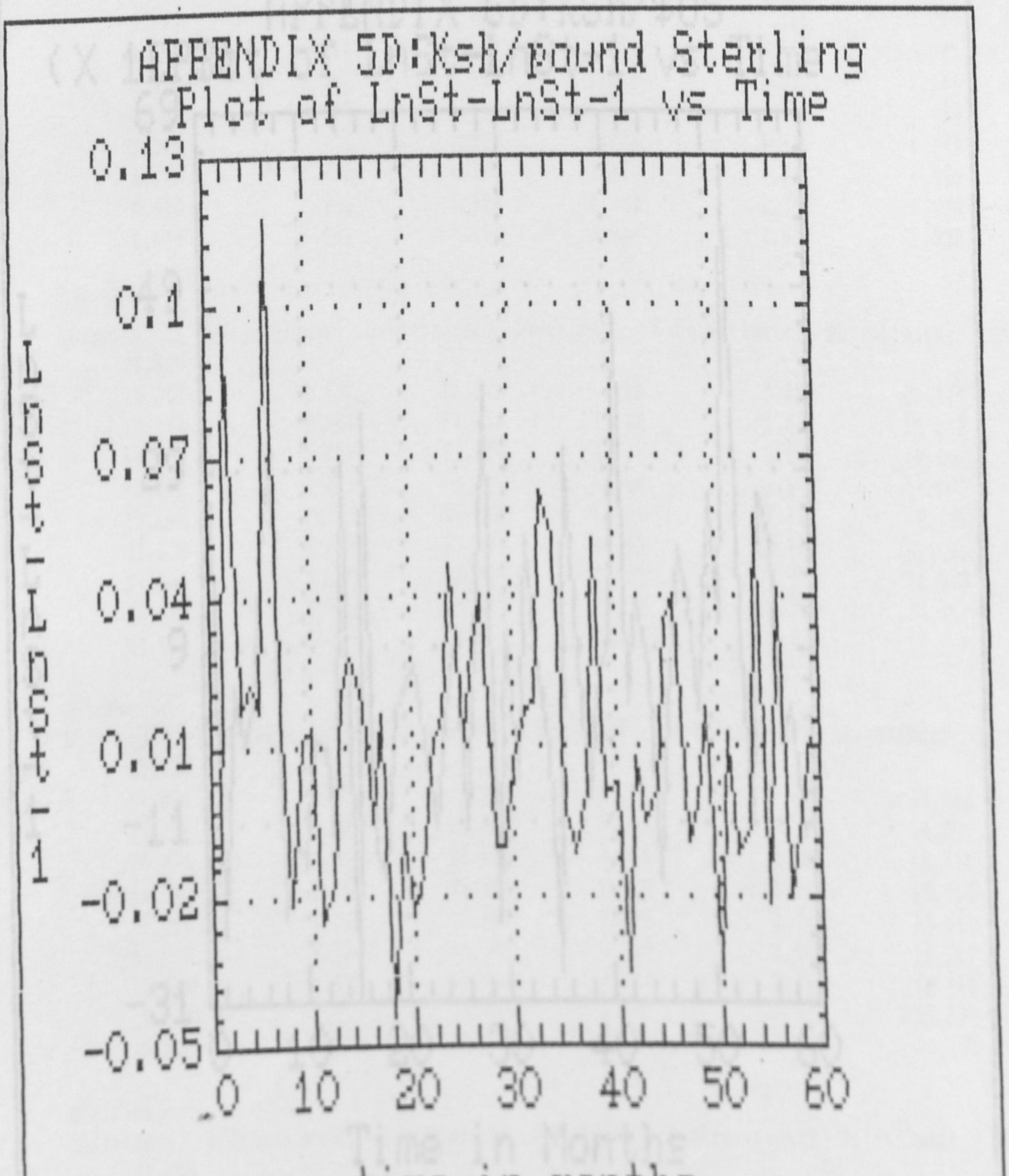
APPENDIX 1D: KSh/FF
Plot of LnSt-LnSt-1 vs Time
0.12
0.09
0.06
0.03
0
-0.03
LnSt-LnSt-1
0
10
20
30
40
50
60
Time in Months

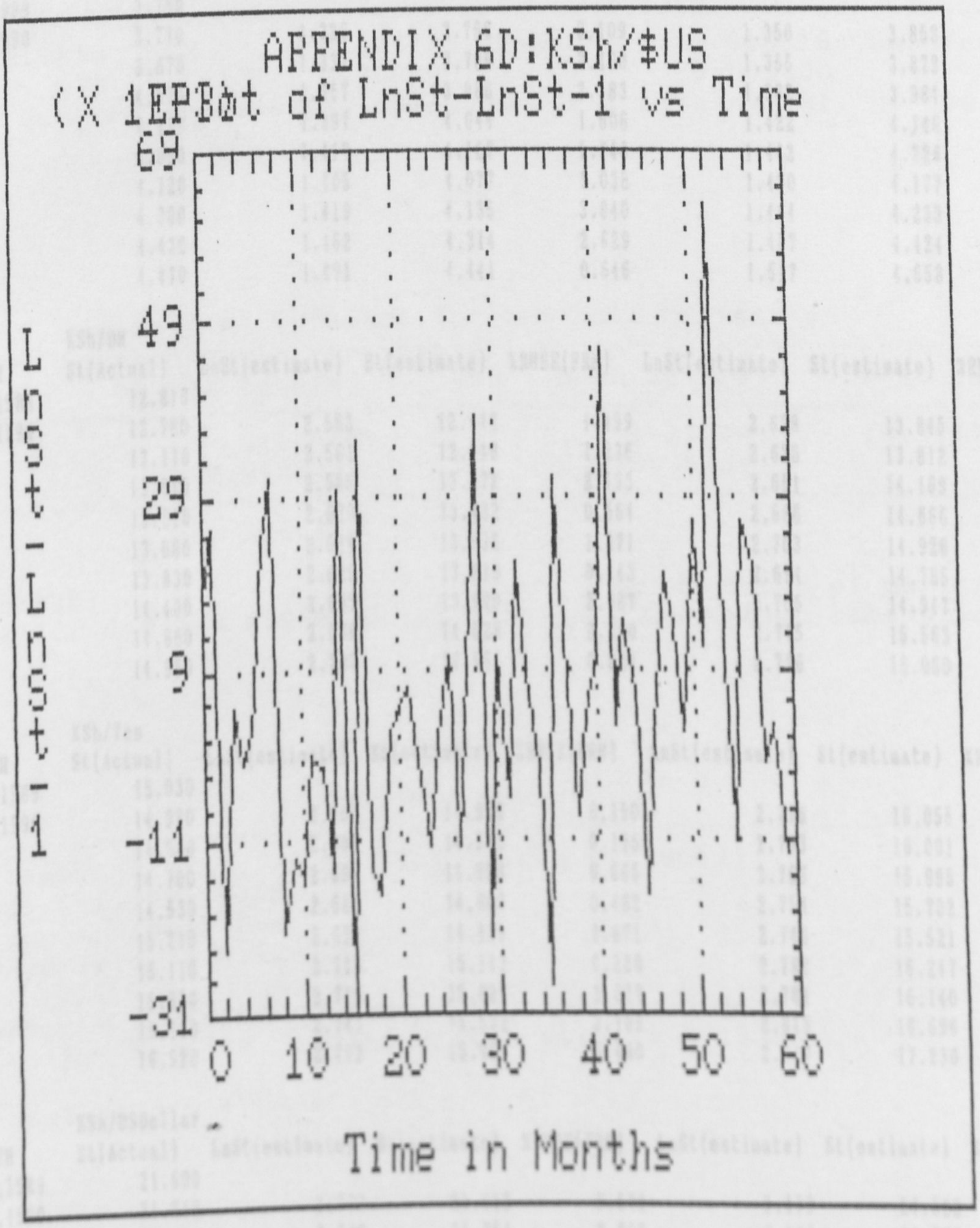


APPENDIX 2D: KSh/DM
Plot of LnSt-LnSt-1 vs Time
0.12
0.09
0.06
0.03
0
-0.03
LnSt-LnSt-1
0
10
20
30
40
50
60
Time in Months


APPENDIX 3D:KSh/Y
Plot of LnSt-LnSt-1 vs Time
0.13
0.08
0.03
-0.02
-0.07
-0.12
-0.17
LnSt-LnSt-1
0
10
20
30
40
50
60
Time in Months


APPENDIX 4D: KSh/Dutch Guilder
Plot of LnSt-LnSt-1 vs Time
0.12
0.09
0.06
0.03
0
-0.03
LnSt-LnSt-1
0
10
20
30
40
50
60
Time in Months


APPENDIX 5D:Ksh/pound Sterling
Plot of LnSt-LnSt-1 vs Time
LnSt-LnSt-1
0.13
0.1
0.07
0.04
0.01
-0.02
-0.05
0
10
20
30
40
50
60
time in months


APPENDIX 6D:KSh/$US
(X 1EPBot of LnSt-LnSt-1 vs Time
69
49
29
9
-11
-31
LnSt-LnSt-1
0 10 20 30 40 50 60
Time in Months

Appendix 7: %Root Mean Square Error Of Predicted Values

FRM=Full Regression Model
RW=Random Walk Model

MONTH	KSh/FFranc St(Actual)	LnSt(estimate)	St(estimate)	%RMSE(FRM)	LnSt(estimate)	St(estimate)	%RMSE(RW)
Dec,1989	3.750						
Jan,1990	3.770	1.326	3.766	0.109	1.350	3.858	2.333
Feb	3.870	1.331	3.786	2.160	1.355	3.879	0.221
Mar	4.030	1.357	3.886	3.583	1.382	3.981	1.206
Apr	4.110	1.397	4.044	1.606	1.422	4.146	0.876
May	4.060	1.417	4.127	1.643	1.442	4.228	4.146
Jun	4.120	1.405	4.077	1.038	1.430	4.177	1.381
Jul	4.300	1.419	4.135	3.840	1.444	4.239	1.428
Aug	4.430	1.462	4.314	2.629	1.487	4.424	0.140
Sep	4.470	1.491	4.441	0.646	1.517	4.558	1.958

MONTH	KSh/DM St(Actual)	LnSt(estimate)	St(estimate)	%RMSE(FRM)	LnSt(estimate)	St(estimate)	%RMSE(RW)
Dec,1989	12.810						
Jan,1990	12.780	2.563	12.972	1.499	2.628	13.845	8.331
Feb	13.110	2.561	12.948	1.236	2.626	13.812	5.357
Mar	13.570	2.586	13.272	2.193	2.651	14.169	4.414
Apr	13.810	2.620	13.732	0.564	2.686	14.666	6.199
May	13.680	2.634	13.936	1.871	2.703	14.926	9.105
Jun	13.830	2.625	13.810	0.143	2.694	14.785	6.905
Jul	14.400	2.637	13.970	2.987	2.705	14.947	3.799
Aug	14.860	2.676	14.529	2.230	2.745	15.563	4.732
Sep	14.950	2.707	14.984	0.224	2.776	16.060	7.427

MONTH	KSh/Yen St(Actual)	LnSt(estimate)	St(estimate)	%RMSE(FRM)	LnSt(estimate)	St(estimate)	%RMSE(RW)
Dec,1989	15.030						
Jan,1990	14.980	2.705	14.958	0.150	2.776	16.055	7.175
Feb	14.880	2.702	14.906	0.175	2.773	16.001	7.537
Mar	14.700	2.694	14.798	0.665	2.766	15.895	8.127
Apr	14.530	2.681	14.600	0.482	2.754	15.702	8.069
May	15.210	2.674	14.499	4.671	2.742	15.521	2.043
Jun	15.110	2.718	15.143	0.220	2.788	16.247	7.526
Jul	15.630	2.710	15.024	3.877	2.781	16.140	3.265
Aug	16.130	2.743	15.532	3.709	2.815	16.696	3.508
Sep	16.920	2.772	15.993	5.480	2.847	17.230	1.832

MONTH	KSh/USDollar St(Actual)	LnSt(estimate)	St(estimate)	%RMSE(FRM)	LnSt(estimate)	St(estimate)	%RMSE(RW)
Dec,1989	21.600						
Jan,1990	21.740	3.073	21.616	0.572	3.179	24.022	10.497
Feb	22.220	3.080	21.754	2.096	3.185	24.178	8.811
Mar	22.980	3.101	22.230	3.262	3.207	24.712	7.535
Apr	23.140	3.134	22.971	0.730	3.241	25.557	10.444
May	23.020	3.134	22.964	0.241	3.248	25.735	11.793
Jun	23.130	3.130	22.864	1.151	3.243	25.601	10.685
Jul	23.130	3.134	22.971	0.689	3.247	25.724	11.213
Aug	23.230	3.133	22.942	1.240	3.247	25.724	10.735
Sep	23.330	3.138	23.050	1.199	3.252	25.835	10.737

APPENDIX 8A: MODEL FITTING RESULTS FOR THE KSH/FRANCS

Model fitting results for: F1

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.028383	0.016786	1.6908	0.0965
F2	0.979411	0.01564	62.6214	0.0000
F4	0.000923	0.001615	0.5715	0.5700

R-SQ. (ADJ.) = 0.9858 SE= 0.025226 MAE= 0.018816 DurbWat= 1.863
Previously: 0.0000 0.000000 0.000000 0.000
58 observations fitted, forecast(s) computed for 1 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	2.51795	2	1.25898	1978.47	.0000
Error	0.0349987	55	0.000636339		
Total (Corr.)	2.55295	57			

R-squared = 0.986291 Stnd. error of est. = 0.0252258
R-squared (Adj. for d.f.) = 0.985792 Durbin-Watson statistic = 1.86341

Residual Summary

Number of observations = 58 (2 missing values excluded)
Residual average = 1.73233E-16
Residual variance = 6.36339E-4
Residual standard error = 0.0252258

Coeff. of skewness = 1.04366 standardized value = 3.24487
Coeff. of kurtosis = 2.04795 standardized value = 3.18368

Durbin-Watson statistic = 1.86341

Correlation matrix for coefficient estimates

	CONSTANT	F2	F4
CONSTANT	1.0000	-.8347	-.4407
F2	-.8347	1.0000	-.0857
F4	-.4407	-.0857	1.0000

APPENDIX 8B: MODEL FITTING RESULTS FOR THE KSH/ DEUTSCH MARK

Model fitting results for: F5

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.077679	0.042683	1.8199	0.0740
F6	0.980371	0.013994	70.0590	0.0000
F8	-0.002357	0.003055	-0.7715	0.4436

R-SQ. (ADJ.) = 0.9884 SE= 0.026809 MAE= 0.020186 DurbWat= 1.998
Previously: 0.9858 0.025226 0.018816 1.863
60 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	3.61329	2	1.80665	2513.77	.0000
Error	0.0409658	57	0.000718699		
Total (Corr.)	3.65426	59			

R-squared = 0.98879 Stnd. error of est. = 0.0268086
R-squared (Adj. for d.f.) = 0.988396 Durbin-Watson statistic = 1.99828

Residual Summary

Number of observations = 60 (0 missing values excluded)
Residual average = 2.03541E-16
Residual variance = 7.18699E-4
Residual standard error = 0.0268086

Coeff. of skewness = 0.857413 standardized value = 2.71138
Coeff. of kurtosis = 1.2336 standardized value = 1.9505

Durbin-Watson statistic = 1.99828

Correlation matrix for coefficient estimates

	CONSTANT	F6	F8
CONSTANT	1.0000	-.7857	-.7195
F6	-.7857	1.0000	.1433
F8	-.7195	.1433	1.0000

APPENDIX 8C: MODEL FITTING RESULTS FOR THE KSH/JAPANESE YEN

Model fitting results for: F9

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.065965	0.041309	1.5969	0.1158
F10	0.959719	0.019495	49.2295	0.0000
F12	0.005068	0.005069	1.0000	0.3216

R-SQ. (ADJ.) = 0.9849 SE= 0.034683 MAE= 0.023128 DurbWat= 2.396
Previously: 0.9884 0.026809 0.020186 1.998
60 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	4.63069	2	2.31534	1924.82	.0000
Error	0.0685647	57	0.00120289		
Total (Corr.)	4.69925	59			

R-squared = 0.985409
R-squared (Adj. for d.f.) = 0.984897

Stnd. error of est. = 0.0346827
Durbin-Watson statistic = 2.39612

Residual Summary

Number of observations = 60 (0 missing values excluded)
Residual average = 2.55351E-16
Residual variance = 1.20289E-3
Residual standard error = 0.0346827

Coeff. of skewness = -1.39618 standardized value = -4.41511
Coeff. of kurtosis = 9.42691 standardized value = 14.9053

Durbin-Watson statistic = 2.39612

Correlation matrix for coefficient estimates

	CONSTANT	F10	F12
CONSTANT	1.0000	-.4823	-.4108
F10	-.4823	1.0000	-.5958
F12	-.4108	-.5958	1.0000

APPENDIX 8D: MODEL FITTING RESULTS FOR THE KSH/DUTCH GUILDER

Model fitting results for: F13

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.052854	0.027699	1.9081	0.0613
F14	0.981407	0.013701	71.6310	0.0000

R-SQ. (ADJ.) = 0.9886	SE=	0.026551	MAE=	0.020319	DurbWat=	1.919
Previously: 0.0000		0.000000		0.000000		0.000

60 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	3.61708	1	3.61708	5131.00	.0000
Error	0.0408869	58	0.000704946		
Total (Corr.)	3.65797	59			

R-squared = 0.988823
R-squared (Adj. for d.f.) = 0.98863

Stnd. error of est. = 0.0265508
Durbin-Watson statistic = 1.91875

Residual Summary

Number of observations = 60 (0 missing values excluded)
Residual average = 2.40548E-16
Residual variance = 7.04946E-4
Residual standard error = 0.0265508

Coeff. of skewness = 0.984092 standardized value = 3.11197
Coeff. of kurtosis = 1.47973 standardized value = 2.33966

Durbin-Watson statistic = 1.91875

Correlation matrix for coefficient estimates

	CONSTANT	F14
CONSTANT	1.0000	-.9923
F14	-.9923	1.0000

APPENDIX 8E: MODEL FITTING RESULTS FOR THE KSH/POUND STERLING

Model fitting results for: F17

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.125221	0.068063	1.8398	0.0709
F18	0.965179	0.020636	46.7707	0.0000

R-SQ. (ADJ.) = 0.9737	SE=	0.029227	MAE=	0.020932	DurbWat=	1.914
Previously: 0.9886		0.026551		0.020319		1.919

60 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	1.86866	1	1.86866	2187.50	.0000
Error	0.0495461	58	0.000854243		
Total (Corr.)	1.91820	59			

R-squared = 0.974171 Stnd. error of est. = 0.0292274
R-squared (Adj. for d.f.) = 0.973725 Durbin-Watson statistic = 1.91384

Residual Summary

Number of observations = 60 (0 missing values excluded)
Residual average = -2.96059E-17
Residual variance = 8.54243E-4
Residual standard error = 0.0292274

Coeff. of skewness = 0.930516 standardized value = 2.94255
Coeff. of kurtosis = 1.4958 standardized value = 2.36506

Durbin-Watson statistic = 1.91384

Correlation matrix for coefficient estimates

	CONSTANT	F18
CONSTANT	1.0000	-.9985
F18	-.9985	1.0000

APPENDIX 8F: MODEL FITTING RESULTS FOR THE KSH/USDOLLAR

Model fitting results for: F21

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.106281	0.096458	1.1018	0.2752
F22	0.978687	0.030094	32.5208	0.0000
F24	-0.006944	0.003005	-2.3108	0.0245

R-SQ. (ADJ.) = 0.9648 SE= 0.018123 MAE= 0.013458 DurbWat= 2.277
Previously: 0.9849 0.034683 0.023128 2.396
60 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	0.532462	2	0.266231	810.548	.0000
Error	0.0187221	57	0.000328458		
Total (Corr.)	0.551184	59			

R-squared = 0.966033 Stnd. error of est. = 0.0181234
R-squared (Adj. for d.f.) = 0.964841 Durbin-Watson statistic = 2.27679

Residual Summary

Number of observations = 60 (0 missing values excluded)
Residual average = -4.959E-16
Residual variance = 3.28458E-4
Residual standard error = 0.0181234

Coeff. of skewness = 0.597639 standardized value = 1.8899
Coeff. of kurtosis = 0.415684 standardized value = 0.657254

Durbin-Watson statistic = 2.27679

Correlation matrix for coefficient estimates

	CONSTANT	F22	F24
CONSTANT	1.0000	-.9881	-.6632
F22	-.9881	1.0000	.5422
F24	-.6632	.5422	1.0000

APPENDIX 9: CORRELATION MATRIX FOR EXCHANGE RATE MOVEMENT AND DIFFERENTIAL INTEREST RATES

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Sample Correlations

	F3	F4	F7	F8	F11	F12
F3	1.0000	.0610	.9663	-.1163	.5684	-.2562
	(58)	(58)	(58)	(58)	(58)	(58)
	.0000	.6491	.0000	.3848	.0000	.0523
F4	.0610	1.0000	.0807	.5130	.2054	.3108
	(58)	(58)	(58)	(58)	(58)	(58)
	.6491	.0000	.5471	.0000	.1220	.0176
F7	.9663	.0807	1.0000	-.0938	.6027	-.2195
	(58)	(58)	(58)	(58)	(58)	(58)
	.0000	.5471	.0000	.4837	.0000	.0978
F8	-.1163	.5130	-.0938	1.0000	.2764	.4246
	(58)	(58)	(58)	(58)	(58)	(58)
	.3848	.0000	.4837	.0000	.0357	.0009
F11	.5684	.2054	.6027	.2764	1.0000	-.0977
	(58)	(58)	(58)	(58)	(58)	(58)
	.0000	.1220	.0000	.0357	.0000	.4657
F12	-.2562	.3108	-.2195	.4246	-.0977	1.0000
	(58)	(58)	(58)	(58)	(58)	(58)
	:0523	.0176	.0978	.0009	.4657	.0000
F23	-.2659	-.1006	-.3221	-.0983	-.3735	.1590
	(58)	(58)	(58)	(58)	(58)	(58)
	.0436	.4525	.0137	.4629	.0039	.2332
F24	.0307	.3701	.1065	.7059	.2987	.1613
	(58)	(58)	(58)	(58)	(58)	(58)
	.8192	.0042	.4262	.0000	.0227	.2264

Coefficient (sample size) significance level

Fri Jul 5 1991 04:29:19 AM

	F23	F24
F3	-.2659	.0307
	(58)	(58)
	.0436	.8192
F4	-.1006	.3701
	(58)	(58)
	.4525	.0042
F7	-.3221	.1065
	(58)	(58)
	.0137	.4262
F8	-.0983	.7059
	(58)	(58)
	.4629	.0000
F11	-.3735	.2987
	(58)	(58)
	.0039	.0227
F12	.1590	.1613
	(58)	(58)
	.2332	.2264
F23	1.0000	-.2967
	(58)	(58)
	.0000	.0237
F24	-.2967	1.0000
	(58)	(58)
	.0237	.0000

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