The efficiency hypothesis and the role of ‘news’ in the Euro/British pound exchange rate market: an empirical analysis using daily data.

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Abstract

In this paper the efficiency for the pound sterling against the euro foreign exchange market has been tested with a `news' exchange rate model using daily data. In the model we use, as proxies of 'news', variables generated by the residuals from a VAR model. Unlike previous researchers we examined the efficiency and the 'news' hypothesis in the exchange rate market over different horizons. Our results are consistent with the hypothesis that the forward exchange rate is not an unbiased predictor of the future spot rate. That is, we reject the hypothesis of efficiency and we show the importance of the 'news' in determining short-run movements in the exchange rate markets.

INTRODUCTION[1]

Markets are interrelated, and a problem in one market can have its source in a different market. This finding is a starting point for macroeconomics. To limit the number of markets they must explore, economists conventionally aggregate the vast number of markets in a modern economy into only four: markets for goods and services, financial assets, money balances, and resources.

Macroeconomists ask two central questions as they examine each: "Is this market a likely source of instability which shows up as inflation or recession," and "Will the adjustment process in this market cause problems for the overall adjustment of the economy." Changes in one part of the economy are rapidly transmitted to other parts through financial markets. The foreign exchange market provides an excellent illustration of how financial markets can transmit disturbances. The market is usually considered to be an efficient one.

Exchange rates, interest rates and inflation rates are linked to one another through a classical set of relationships which have import for the nature of corporate foreign exchange risk. These relationships are: (1) the *purchasing power parity* theory, which describes the linkage between relative inflation rates and exchange rates; (2) the *international Fisher effect*, which ties interest rate differences to exchange rate expectations; and (3) the *unbiased forward rate theory*, which relates the forward exchange rate to exchange rate expectations. We focus our analysis on (2) and (3).

The International Fisher Effect (IFE) states that the interest rate differential will exist only if the exchange rate is expected to change in such a way that the advantage of the higher interest rate is offset by the loss on the foreign exchange transactions. In practical terms the IFE implies that while an investor in a low-interest country can convert his

[1] (i) I am grateful to the ECASS and the ESRC Research Centre staff for the friendly atmosphere I found. I would like to thank John Brice, Kate Taker and Marcia Taylor for helping me in finding the data and, overall, for they kindness. Special thanks go to Professor Giorgio Brunello for helping me in a very critical moment of this research. Needless to say, responsibility for opinion expressed and any remain errors is exclusively mine.

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funds into the currency of the high-interest country and get paid a higher rate, his gain (the interest rate differential) will be offset by his expected loss because of foreign exchange rate changes.

The Unbiased Forward Rate Theory asserts that the forward exchange rate[2] is the best, and an unbiased, estimate of the expected future spot exchange rate. The theory is grounded in the efficient markets theory, and is widely assumed and widely disputed as a precise explanation.

The "expected" rate is only an average but the theory of efficient markets tells us that it is an *unbiased* expectation--that there is an equal probability of the actual rate being above or below the expected value.

In the long run, the exchange rate is influenced by relative inflation, growth and interest rates and trade and investment flows between countries. Foreign exchange dealers therefore closely monitor announcements of new economic statistics on the major world economies. When economic releases are out of line with forecasts, dealers alter the rates they are quoting to reflect the implied change in their assessment of the currency's value.

Since changes within and between different governments often lead to changes in economic and financial policies, political developments can also affect the foreign exchange market. The market may therefore react to changes in public opinion polls or other 'news' items which have implications for future political developments. But expected news, whether economic or political, rarely moves exchange rates – the effect will already have been anticipated or "discounted". Unexpected news, such as a country changing the regime it favours for managing its currency, or unanticipated problems in a nation's economy, however, can lead to sudden and sharp exchange rate movements.

The goal of this study is to investigate the efficiency of the foreign exchange market and, in particular, the role of the news in determining the short-term deviations of the exchange rate from its long run equilibrium. The work is organised as follows. In section two we review the theoretical aspects of the efficiency and 'news' hypothesis. In sections three we present the test for the covered interest parity as pre-condition for the

[2] The forward rate is equivalent to the spot rate plus a premium or minus a discount. The forward premium or discount is determined by means of the following general equation which is adjusted to take account of whether the discount/premium or the bid/offered rate is being calculated: Spot rate x (interest rate differential, i.e. $ interest rate - EUR interest rate) x days/360 1 + (EUR interest rate x days/360).

analysis. In section four we present some econometric issues on testing the efficiency and 'news' hypothesis and the methodology used in this work. In section five we show the empirical results and finally, in section six the conclusion.

2. LITERATURE REVIEW

Under the presence of efficiency in the foreign exchange market, the forward exchange rate should be an unbiased predictor for the future spot rate. There is, however, considerable empirical evidence which rejects the hypothesis of efficiency (e.g. Hakkio, 1981; Hodrick and Srivastava, 1984; Domowitz and Hakkio, 1984; Fama, 1984; Taylor, 1987; Sephton and Larsen, 1991; Corbae *et a*l., 1992). By contrast, other studies have provided evidence in support of the hypothesis of efficiency (Hakkio and Rush, 1989; Baillie and Bollerslev, 1989; Lai and Lai, 1991; Tronzano, 1992; Masih and Masih, 1995). The rejection of the efficiency hypothesis implies the presence of unexploited profit opportunities for those who participate in exchange rate transactions. In other words, the general conclusion emerging from the extensive empirical analysis is that the forward exchange rate could not be an unbiased predictor of the future spot and the presence of a risk premium is apparent (Hodrick and Srivastava, 1984; Domowitz and Hakkio, 1984).

In order that the efficiency hypothesis is valid, two necessary conditions must hold: (i) spot and forward prices must move closely together; departures from equilibrium must be only temporary and (ii) the lagged forward rate must be an unbiased predictor of the present spot rate (Lewis, 1989).

Dornbush (1980) and Frenkel (1982) have suggested that the correct way to model exchange rate movements is to presume that the foreign exchange market is efficient. In this case, movements in exchange rates will be due to the arrival of new information. In doing that, they built two different models for 'news'. Despite these differences, the basic assumption is that any difference between the forward and the future spot rate must be (in an efficient market) due to the 'news'.

Frenkel (1981) considered 'news' on the interest rate differential which is assumed to be a very important variable in determining exchange rate movement from its expected path. In fact, it is generally believed that interest rates are now fully affected by expectations concerning inflation and the currency parity, as well as by changes in interest rates in foreign money and capital markets.

Frenkel used a model in which an artificial variable for 'news' was generated. He took the residuals from an auxiliary regression as a proxy for news and used them as a separate regressor. Pagan (1984) has considered the limiting distribution of such an estimator and shown that the subsequent estimate of the disturbance variance is generally downward biased.

Baillie (1987) proposed a different approach to determine the news. He assume that "when the data generating process can be interpreted as including an equation with an unanticipated or 'surprise' variable, then that equation should be implicit in the unrestricted moving average representation (MAR) of the variables in the system"[3]. "However a potential disadvantage with the technique is that it does require the specification of a complete multivariate time-series model, rather than just being based on single equation estimation"[4].

3. THE COVERED INTEREST RATE PARITY (CIP)

The intuitive appeal of the CIP convention is the same as the visceral appeal of the efficient-markets hypothesis, i.e. that no arbitrage opportunities should remain in an efficient market.

To see this, suppose that the one-year sterling interest rate is 6 per cent, and the comparable Euro interest rate is 4 per cent. On the CIP hypothesis, we only have an equilibrium situation if investors also expect sterling to depreciate by 2 per cent. If instead, they did not expect sterling to depreciate at all, risk neutral investors would borrow a very large amount in euros, and lend it in sterling, which would cause sterling to

[3] Richard Baillie, Patrick Mcmahon, The Foreign Exchange Market, Cambridge University Press, pp. 195-96, 1989.
[4] Richard Baillie, Patrick Mcmahon, op.cit.

appreciate against the euro, and there would also be upward pressure on euro interest rates and downward pressure on sterling interest rates. This process would continue until the interest differential (which would be lower) was equalised with the expected depreciation of sterling (which would presumably now exist as sterling would have risen relative to its prior level).

In the absence of transaction costs, the market is efficient if the CIP is verified. It can be shown as

$$(F_t-S_t)=(i-i^*)/(1-i^*) \qquad [1]$$

or using logarithms, eq.[1] can be transformed in

$$f_t-s_t = i_t-i^*_t \qquad [2]$$

We estimate eq.[2] in the following form:

$$f_t-s_t = \alpha+\beta(i-i^*)_t+u_t \qquad [3]$$

It must be noted that a test for covered interest parity is a necessary condition for efficiency but it is not a sufficient one.

The results of CIP are summarised in table 1.

Table 1	Equation: $f_t-s_t = \alpha+\beta(i-i^*)_t+\mu_t$					
Dep.var. f_t-s_t	**α^**	**β^**	**R^2**	**DW**	**F(1,397)**	**RSS**
	-0.1913	0.9691	0.66	0.074	787.14	0.0885
t-stat	(-28.06)	(81.99)				
No. obs 399						
Sample: 01/02/99 to 11/08/00						

Eq. [3] was estimated under the condition that $\beta\hat{} = 1$ and μ_t is a white noise. The results could suggest that, under the period of investigation (01/02/99 – 11/08/00), the CIP was verified. In fact, the β coefficient is statistically significance at 5% and is not different from 1. According to the above results, in the euro/pound exchange rate market there could not be more opportunities of extra profits from the arbitrage.

Levich, analysing the links between spot, forward and interest variables argue that "the nature of the forward exchange rate - its determinants and relationship to the future spot rate - is an important empirical issue that is currently unresolved. While the forward rate may approximate the market's expectation of the future spot rate, it has been demonstrated clearly that the forward premium is a poor predictor of the future change in the spot exchange rate. However, the unanticipated portion of an exchange rate change does appear to be significantly correlated with "news" concerning fundamental macroeconomic variables" [5].

4. METHODOLOGY

The assumption of market efficiency implies that the forward exchange rate can be equal to the expected future spot rate (in the absence of risk premium). The general hypothesis is:

$$f_t = E_t (s_{t+1}) \qquad [4]$$

where "f " is the log of the forward exchange rate and "s" is the log of the spot exchange rate.

A general approach for testing Eq. [4] is to estimate the model

$$(s_{t+1} - f_t) = \phi z_{t-j} + u_{t+1} \qquad [5]$$

and to test the hypothesis $H_0 : \phi = 0$ versus $H_1 : \phi \neq 0$

[5] Richard M. Levich , Empirical Studies of Exchange Rates: Price Behavior, Rate Determination and Market Efficiency, Handbook of International Economics Volume 2, Chapter 19.

"Under the null hypothesis, none of the variables included in the z_{t-j} set help to explain s_{t+1}. In other words, the efficient expectations hypothesis holds well. Cornell (1977) and Bilson (1981) were the first to make use of a direct test of the hypothesis and considered that the forward rate is an observable series of expectations. Frenkel (1980) considered a model of the form:

$$s_{t+1} = \alpha + \beta f_t + \mu_{t+1} \qquad [6]$$

The hypothesis of efficiency is accepted if $\alpha = 0$ and $\beta = 1$ hold simultaneously. Many researchers have estimated and assessed the efficiency hypothesis (e.g. Bilson, 1981; Baillie *et a*l., 1983; Bailey *et a*l., 1984; Hsieh, 1984; Baillie, 1989; McCurdy and Morgan, 1991). The method of testing the above model was either OLS or instrumental variable estimations (IVE) (Frenkel, 1981) with lagged forward rates, a time trend and interest rate differentials as the employed instruments. The majority of the results have clearly shown that the forward rate is not an unbiased predictor of the corresponding future spot rate"[6].

For the purposes of this paper the problem of efficiency will be examined in terms of the `news' model proposed by Frenkel (1980, 1981) and modified by Apergis and Eleftheriou (1997)[7].

To test the efficiency hypothesis with a 'news' model we regress the following equation:

$$s_{t+j} - s_t = \alpha + \beta(E_t s_{t+j} - s_t) + \gamma news_{t+j} + \mu_{t+j} \qquad [7]$$

where "...$E_t\ s_{t+l}$ represents the expected spot rate at period t+j given any available information at period t, and *news* represents the difference between a function of some fundamentals at time t+j and their expected value at time t. In most studies $E_t\ s_{t+j}$ is replaced by the forward rate f_t. According to Eq. [7], changes in the spot exchange rate occur because of new information which has not been anticipated in the previous period. News is a function of j -1 innovations that occur in the prediction interval from period t +

[6] Nicholas Apergis and Sophia Eleftheriou, The efficient hypothesis and deregulation: the Greek case, Applied Economics, no. 29, 1997, pp. 111-17.

j to t + 1. In other words, $E(news_{t+j}\ news_{t+j+k}) = 0$ for k >1.... As regards the significance of coefficient γ in Equation [7], a statistically insignificant γ indicates that exchange rate fluctuations do not react to new information, thus indicating that this piece of new information has already been incorporated to exchange rate movements, i.e. the exchange rate market is efficient[8]". In section two we specified that Frenkel (1981) generated news as the residuals from another regression as a proxy for news and to use them as a separate regressor in Equation [7] and we discussed the limit of this approach. In this paper, as proxy for 'news' we use the residuals from a vector autoregressive (VAR) model, the same utilized by Baillie (1987).

A VAR model in a standard form can be written as follow:

$$X_t = A_0 + A_1 X_{t-1} + u_t \qquad [8]$$

or a multivariate generalisation of [8]:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + \ldots + A_p X_{t-p} + u_t \qquad [9]$$

where

X_t = an (n×1) vector containing each of n variables included in the VAR

A_0= an (n×1) vector of intercept terms

A_i= an (n×n) matrices of coefficients

u_t= an (n×1) vector of error terms[9]

"A VAR model is a better technique than any structural equation model, since macroeconometric models are not usually based on sound economic theories and loose models, such as the VAR model, should be employed, which do not impose rigid a priori restrictions on the data generation process (Lutkepohl, 1993). In other words, the user of a VAR model imposes few restrictions and usually employs OLS estimation. A VAR

[7] Nicholas Apergis and Sophia Eleftheriou, op. cit.
[8] Nicholas Apergis and Sophia Eleftheriou, op. cit. pag 112.
[9] For more information about VAR model see Walter Enders, Applied Econometric Time Series, John Wiley & Sons, Inc., 1995

model is largely free of the spurious specification assumptions and errors associated with traditional macroeconometric procedures, so it can capture certain dynamic relationships among any economic variables better than the standard macroeconometric models. Nevertheless, considerable controversy has dealt with certain limitations of the VAR approach (Cooley and Leroy, 1985; Leamer, 1985). This controversy has mainly focused on the specific causal ordering of the variables involved in the VAR model. It is generally believed that, for results to be considered conclusive, they must be robust to ordering"[10].

In order to obtain a relationship between interest rate differential 'news' and exchange rate surprises, it is useful to decompose the general model presented in eq. [9] into a more specific one. We use a simple VAR model with X_t vector containing three variables: s_t (spot exchange rate), Δi_t (interest rate differential) and F_t (forward exchange rate). We focus our attention on a number of different regression relationship that are closely linked to eq. [9]:

$$s_t = a1 + \sum_{i=1}^{v1} b1_i \Delta i_{t-i} + \sum_{i=1}^{v2} c1_i F_{t-i} + \sum_{i=1}^{v3} d1_i s_{t-i} + \varepsilon 1_t \qquad [10]$$

$$\Delta i_t = a2 + \sum_{i=1}^{v4} b2_i \Delta i_{t-i} + \sum_{i=1}^{v5} c2_i F_{t-i} + \sum_{i=1}^{v6} d2_i s_{t-i} + \varepsilon 2_t \qquad [11]$$

$$F_t = a3 + \sum_{i=1}^{v7} b3_i \Delta i_{t-i} + \sum_{i=1}^{v8} c3_i F_{t-i} + \sum_{i=1}^{v9} d3_i s_{t-i} + \varepsilon 3_t \qquad [12]$$

Following Frenkel (1981), we focus on surprises in interest rate differentials as the most important source of unexpected exchange rate movements.

It seems crucial to test the efficiency and 'news' hypothesis using eq. [13], first, in all the period 1999-2000, where the euro market took place; and second in the period from

[10] Nicholas Apergis and Sophia Eleftheriou, op. cit. pag. 112.

January to August 2000, where the euro exchange rate had to face very strong movements apart from its long run equilibrium according to the fundamentals

$$(s_{t+i}-s_t) = \alpha + \beta(F_t-s_t) + \gamma news_{t+i} + \mu_{t+i} \qquad [13]$$

The `news' model therefore seems capable of capturing any revealed information out of the information set process.

5. ECONOMETRIC ANALYSIS

The choice of the sample from January 4th 1999 to August 11 2000 using daily observations was based on the need to analyse the behaviour of the British pound exchange rate against the Euro. Using this exchange rate we assume that the exchange rate value is not strongly influenced by monetary authorities intervention. For the estimation of the equation used in this work, the variables considered were[11]:

1) the closing spot rate sterling/euro (lukeu);
2) one month forward rate sterling/euro (lukeu1f)
3) UK interest rate (ukint);
4) Euro-11 interest rate (euint).

A first step in testing the efficiency hypothesis and 'news' in the exchange rate market is related to the long-run relationship between spot and forward exchange rates, that is, to test if the variables involved in the analysis are cointegrated in the long-run. But, cointegration refers to a stationary relationship between integrated time series. This concept has played an important role in the theories of stochastic process and time series analysis. In fact, nonstationarity in a time series may be due to either a deterministic time trend or to a unit root. As pointed out by Hamilton (1994), for any unit root (i.e. difference -stationary) process there exists a stationary process that will be impossible to distinguish from the unit root representation for any given sample size T. The converse is

[11] In order to avoid Siegel's paradox (which arises because the expectation on an inverse does not, in general, equal over the expectation of the original variable), spot and forward exchange rate are in logarithms, thereby ensuring that results are independent of whether exchange rates are expressed in unit of home or foreign currency.

also true. Interestingly, however, we can arrive at a testable hypothesis if we are willing to restrict further the class of processes to be considered. For example, if we use a first order autoregressive process, i.e. AR(1):

$$X_t = \beta X_{t-1} + \mu_t \qquad [14]$$

where "β" is a real number and μ_t is a sequence of independent normal-zero mean random variable with variance σ^2, so that $\mu_t \sim In(0,\sigma^2)$, then the restriction H_O: β=1 is testable.

To test for stationarity, the unit root test is implemented, the Augmented Dickey-Fuller tests (Dickey and Fuller, 1979). This test is applied to all data we use in this work.

The Augmented Dickey-Fuller test is parametric, and consists of estimating the eq. [14]. To test for stationarity we suppose that the null hypothesis is β=1. The results are shown in Table 2.

Table 2	**ADF Test**		
	τ_u	**Crit.value 5%**	**Crit.value 1%**
lukeu	1.1849	-1.94	-2.57
lukeu1f	1.2719	-1.94	-2.57
ukint	1.4821	-1.94	-2.57
euint	1.3579	-1.94	-2.57
First diff.			
dlukeu	-21.77	-1.94	-2.57
dlukeu 1f	-19.01	-1.94	-2.57
dukint	-18.29	-1.94	-2.57
deuint	-18.29	-1.94	-2.57

In table 2 the null hypothesis of non-stationarity is rejected only when the corresponding statistic is below the critical value. According to the Augmented Dickey-Fuller test[12], the results strongly suggest that all the variables are integrated of order one I(1); that is, we cannot reject the null hypothesis of non stationarity. Since we cannot reject the null hypothesis, then we have to consider the first difference process (DSP). A process is said to be DSP if it is not covariance stationary, but can be transformed into a covariance stationary process by differencing. If the model became stationary after the first difference, we say that it is integrated of order one, $X_t \sim I(1)$. Table 2 shows the ADF test for the first difference of the variables. The results of the ADF test compared with the critical value allow us to reject the null hypothesis. In other words, all the variables are integrated to the same order, that is, they are integrated to order one.

Cointegration analysis

The previous paragraph showed that all the variables relevant to the exchange rate determination can be better described as being non stationary, implying that random shocks to these series will have persistent effects in the distant future. Now, assuming that all the variables are ~I(1), the next step concerns the concept of cointegration. This refers to a stationary relationship between integrated time series. To simplify the discussion, we assume that the long–run relationship between spot, forward and interest rate differential is represented by the following equation:

$$s_t = \alpha + \beta F_{t-1} + \gamma \Delta i_{t-1} + \mu_t \qquad [15]$$

In order for s_t, F_t and Δ_t to be cointegrated, then two condition must be satisfied:

1) the three series have to be cointegrated to the same order;
2) a linear combination of the three series has to exist and it should be integrated to a lower order than the single series. That is, if cointegration is present, then these variables will move together in the long run.

[12] D. A. Dickey and W.A. Fuller, Distribution of the Estimators for Autoregressive Time Series with a Unit Root, Journal of the American Statistical association, vol.74, 1979, pp. 427-431.

In eq. [15], if μ_t is a white noise consequently μ_t is integrated of order zero $\mu_t \sim I(0)$. Perman (1991) affirms that " an equilibrium relationship between two variables implies that, whereas...(they) may have trends, or cyclical or seasonal variations, the movements in one are matched by the movements in the other"[13], then, if the variables are integrated of order one, the equilibrium error will be integrated of order zero. Engle and Granger (1987)[14] in their work, proposed seven tests for cointegration and they recommended in particular the augmented Dickey Fuller test.

The results of cointegration are reported in Table 3.

TABLE 3 Cointegration Test

Equation $s_t = \alpha + \beta F_{t-1} + \gamma \Delta i_{t-1} + \mu_t$

	α	**β**	**γ**	**R2**	**ADF 5%**	**Wald test**
Coefficient	-0.1067	0.778	0.044	0.77	-15.32	1375.2**
t-stat	(-9.78)	(31.48)	(1.901)		crit. val. (-2.57)	
No. obs 399						
Sample: 01/02/99 to 11/08/00						

The results recommend the presence of a cointegrated relationship among the variables concerned in the full sample. Under the null hypothesis of no cointegration, the ADF result from eq. [15] is greater, in absolute value, than the ADF critical value at 5%of significance and we can reject the null hypothesis. Hence, the variables are cointegrated. The implication of the cointegration tests is that the VAR model is estimated in its levels. Once the VAR model was estimated, the residuals from each equation were extracted and they have been used as news proxies for testing the efficiency hypothesis.

The efficiency 'news' model was estimated over the all sample and for two sub-periods:

1) from 01/02/1999 to 31/12/1999;
2) from 03/01/2000 to 11/08/2000.

The results of the estimations of eq. [13] are reported in following tables. They provide mixed support for the efficiency hypothesis using 'news' residuals from a VAR model as

[13] R. Perman, Cointegration: an introduction to the literature, Journal of Economic Studies, vol. 18, 1991.

proxies. "The residuals from the VAR model are considered to be the unanticipated parts of certain macroeconomic variables that seem to play a substantial role in the British pound/euro exchange market"[15]. The results of the estimation of eq. [13] along with the associated restriction, i.e. $H_0 : \alpha = 0$, $\beta = 1$ and $\gamma = 0$, are reported in tables 4, 5 and 6.

Table 4 Efficiency test with a 'news' proxy $(s_{t+i}-s_t) = \alpha + \beta(F_t-s_t) + \gamma news_{t+i} + \mu_{t+i}$

	α	β	γ	R^2	RSS	F-test
newsΔi				**0.09**	**0.016**	**18.667**
coefficient	**-0.0060****	**0.0521***	**0.32****			**[0.00]**
t-stat.	**(-5.615)**	**(2.359)**	**(5.634)**			
newss				**0.06**	**0.17**	**2.724**
coefficient	**-0.0061****	**-0.0556***	**0.0508**			**[0.07]**
t-stat.	**(-5.402)**	**(-2.333)**	**(0.545)**			
newsf				**0.02**	**0.16**	**2.948**
coefficient	**-0.006****	**-0.052**	**0.356**			**[0.05]**
t-stat.	**(-5.408)**	**(-2.272)**	**(0.860)**			
Sample: 15/02/99 to 11/08/00						
No. observations: 374						

The variables 'newss', 'newsΔi' and 'newsf' are the residual of the equations [10], [11] and [12] respectively. The first represents unanticipated changes in exchange rate; the second depicts unanticipated changes in interest rates; the third, represents unanticipated changes in forward exchange market.

Table 4 shows the econometric results from estimating equation [13]. As we have assumed, the 'news' on the interest rate differential is a very important variable in determining exchange rate movement from its expected path. In fact, it is generally believed that interest rates are now fully affected by expectations concerning inflation and the currency parity, as well as by changes in interest rates in foreign money and capital markets. This force us to investigate the efficiency hypothesis with 'news' generated by eq. [11] in two sub-samples. Hence, we tested the model in the period from

[14] R. F. Engle and C. W. J. Granger, Co-integration and error correction: representation, estimation and testing, Econometrica, vol. 55, 1987.
[15] Nicholas Apergis and Sophia Eleftheriou, op. cit. pag. 114.

January to December 1999, where the euro market took place and from January to August 2000 when the euro exchange rate had to face very strong movements apart from its long run equilibrium according to the fundamentals. Tables 5 and 6 show the results of the estimations of eq. [13].

Table 5 Efficiency test with a 'news' proxy $(s_{t+i}-s_t) = \alpha + \beta(F_t-s_t) + \gamma news_{t+i} + \mu_{t+i}$

	α	β	γ	R^2	RSS	F-test
newsΔi coefficient	**-0.0080****	**-0.035**	**0.4870****	**0.06**	**0.039**	**7.63**
t-stat.	**(-8.457)**	**(-2.106)**	**(3.314)**			**[0.00]**
Sample: 15/02/99 to 31/12/99						
No. observations: 215						

Table 6 Efficiency test with a 'news' proxy $(s_{t+i}-s_t) = \alpha + \beta(F_t-s_t) + \gamma news_{t+i} + \mu_{t+i}$

	α	β	γ	R^2	RSS	F-test
newsΔi coefficient	**-0.0031**	**0.559**	**0.861****	**0.11**	**0.022**	**9.29**
t-stat.	**(-1.284)**	**(0.865)**	**(4.311)**			**[0.00]**
Sample: 03/01/00 to 11/08/00						
No. observations: 159						

The empirical does not support the efficient foreign market hypothesis (tables 4,5 and 6) for all the period 1999-2000, and also for the two sub-sample. In fact, since the coefficient γ is significant, the exchange rate fluctuations react to new information so that, the euro exchange rate market is not efficient. In other words, the new information hasn't been incorporated in the exchange rate movements. In particular, the value of the coefficient γ is higher in the second sub-sample (table 6) where the euro was facing with

strong movements apart from its long-run equilibrium. This could confirm, according to Fama (1970) definition[16], that the euro market is not efficient and point out the important role of 'news' in determining short-run movements of the exchange rates.

6. CONCLUSI ONS

In this paper the efficiency for the pound sterling against the euro foreign exchange market has been tested with a `news' exchange rate model using daily data. In the model we use, as proxies of 'news', variables generated by the residuals from a VAR model. Unlike previous researchers, we examined the efficiency and the 'news' hypothesis in the exchange rate market over different horizons. Our results are consistent with the hypothesis that the forward exchange rate is not an unbiased predictor of the future spot rate. That is, we reject the hypothesis of efficiency and we show the importance of the 'news' in determining short-run movements in the exchange rate markets. One interpretation of this systematic expectation failure could be that the unexpected change in the future spot rate is triggered by 'news' which, for expectations between "t" and "t+1", become known only after time "t". These 'news' could take the form of unexpected policy changes, new statistical information or other unknown events which have some exchange rate implication.

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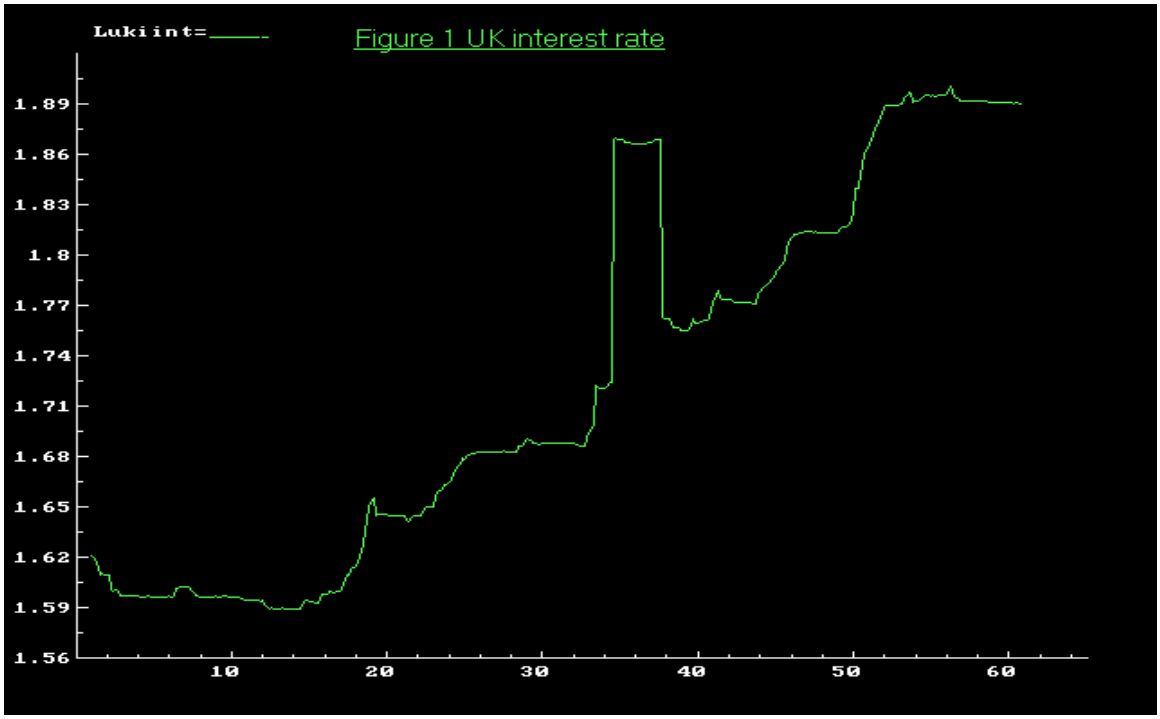
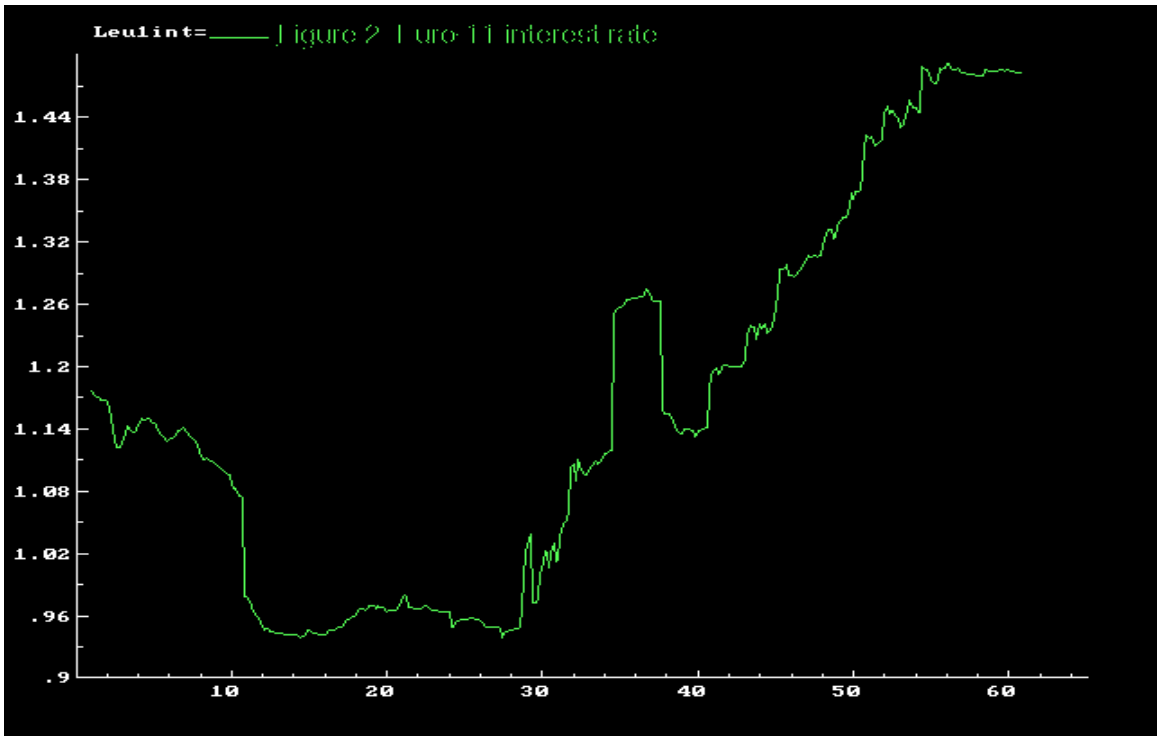
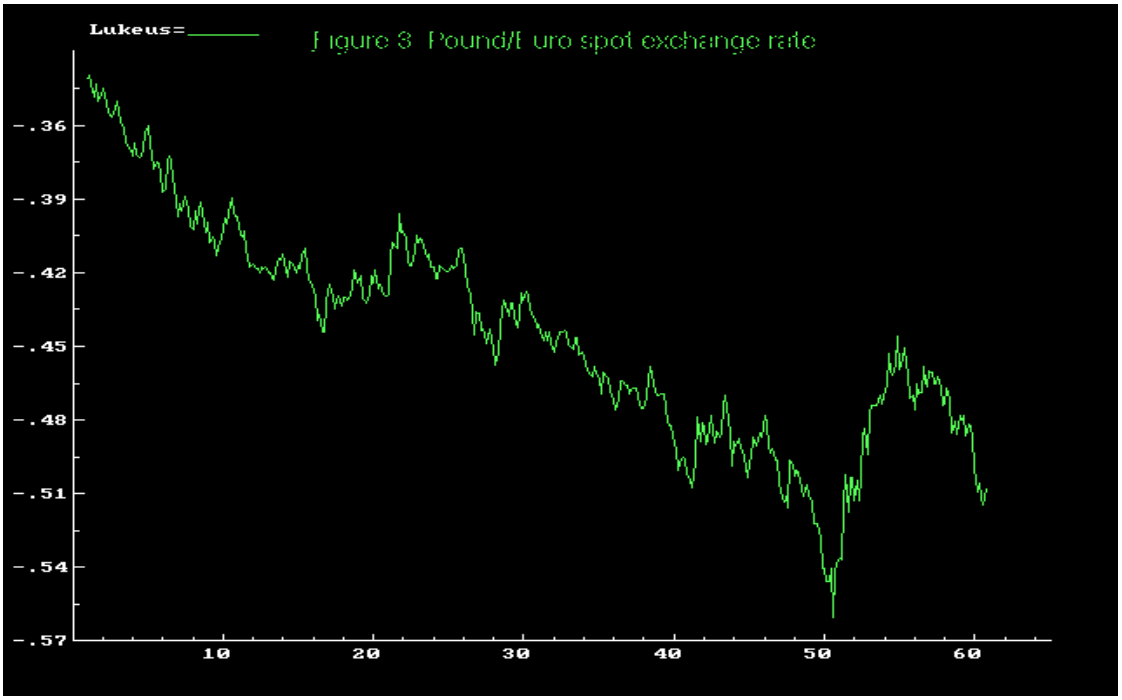
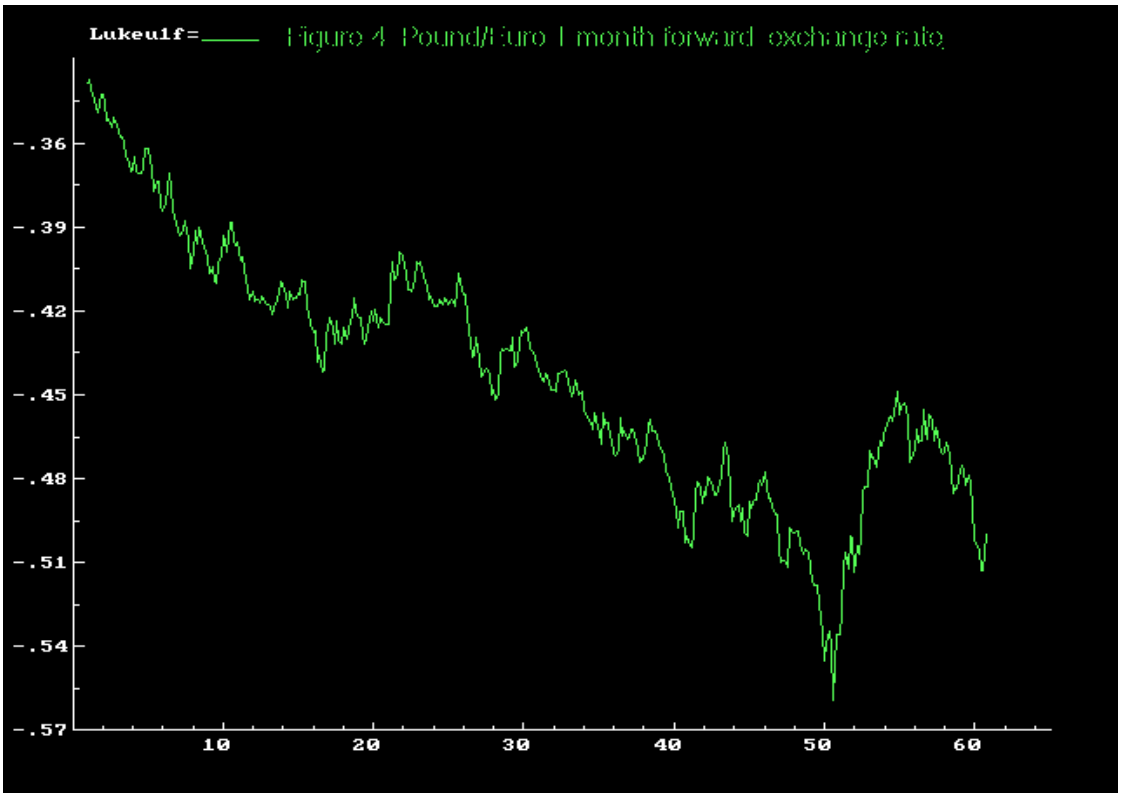
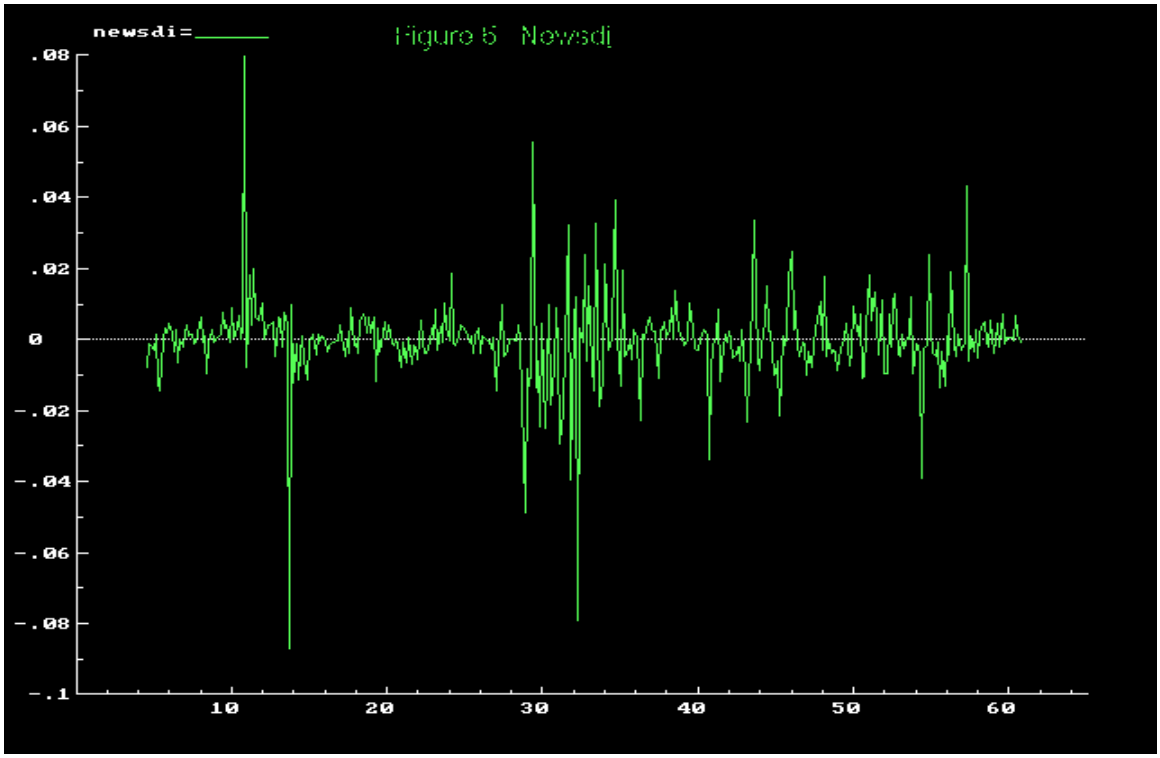
APPENDIX

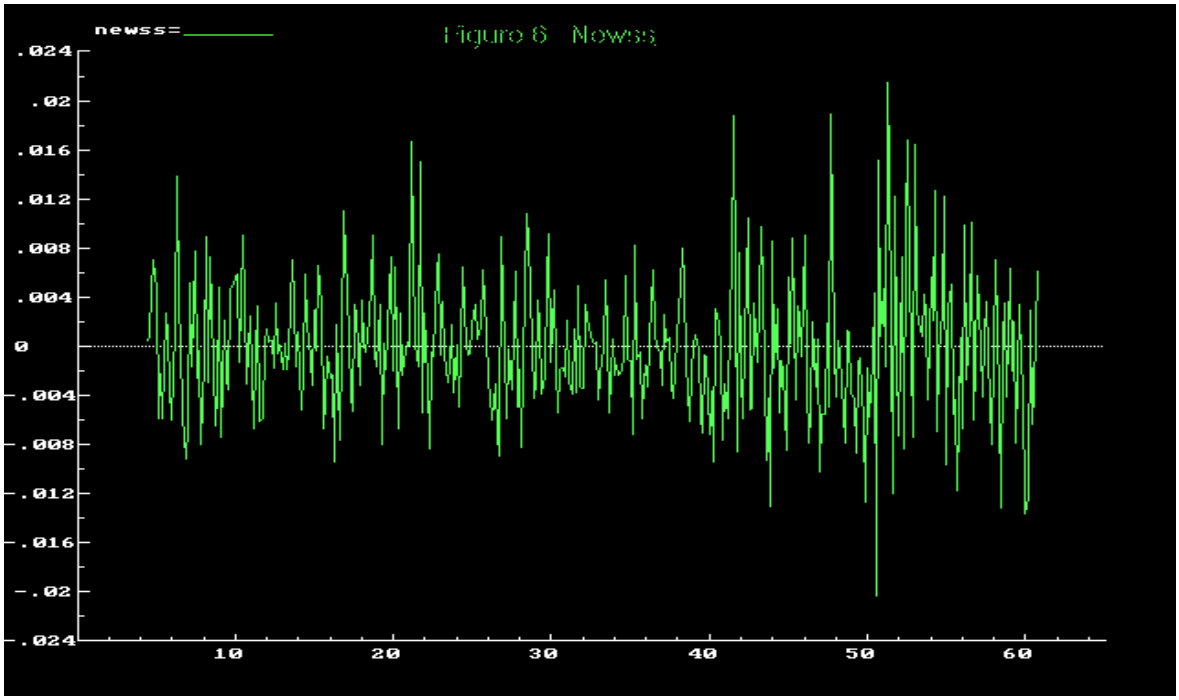

Lukiint=
Figure 1 UK interest rate
1.89
1.86
1.83
1.8
1.77
1.74
1.71
1.68
1.65
1.62
1.59
1.56
10
20
30
40
50
60

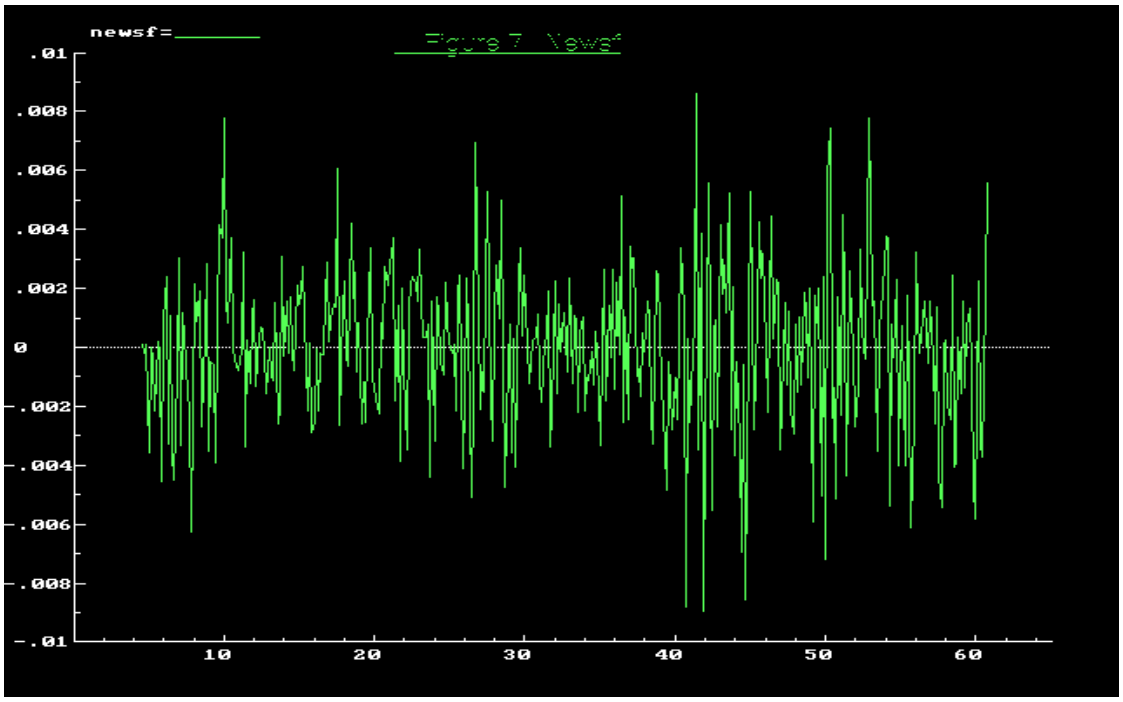

Leulint=
Figure 2 Euro 11 interest rate
1.44
1.38
1.32
1.26
1.2
1.14
1.08
1.02
.96
.9
10
20
30
40
50
60

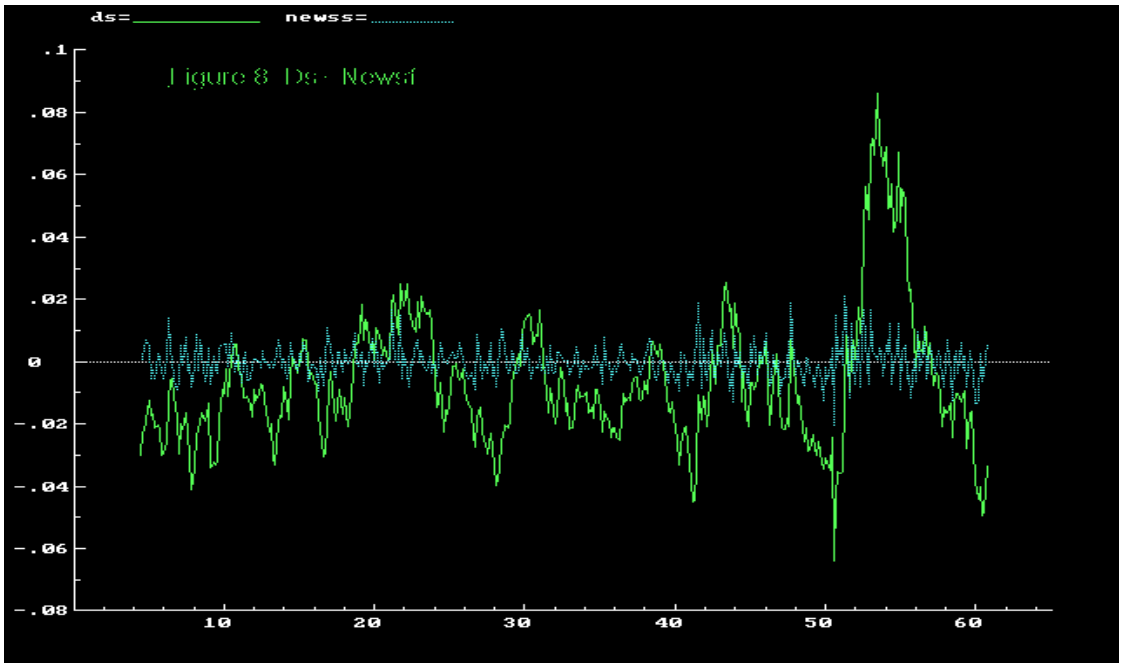

Lukeus=
Figure 3 Pound/Euro spot exchange rate
-.36
-.39
-.42
-.45
-.48
-.51
-.54
-.57
10
20
30
40
50
60

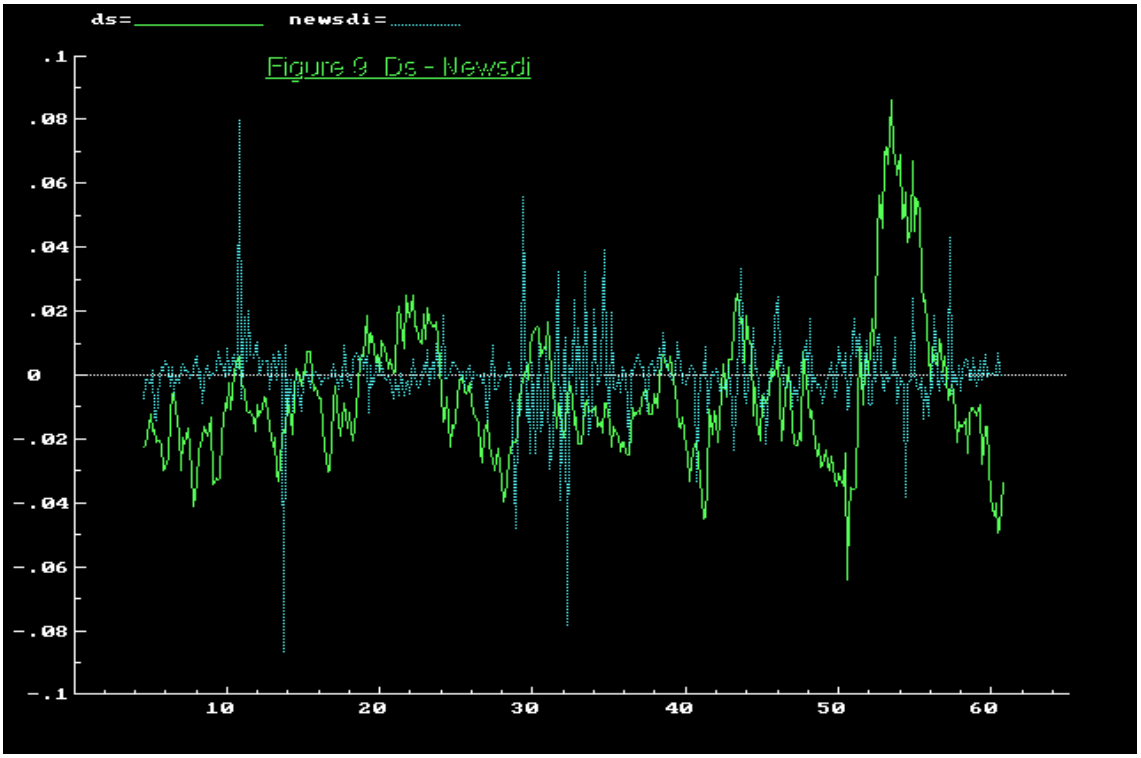

Lukeu1f=
Figure 4 Pound/Euro 1 month forward exchange rate
-.36
-.39
-.42
-.45
-.48
-.51
-.54
-.57
10
20
30
40
50
60

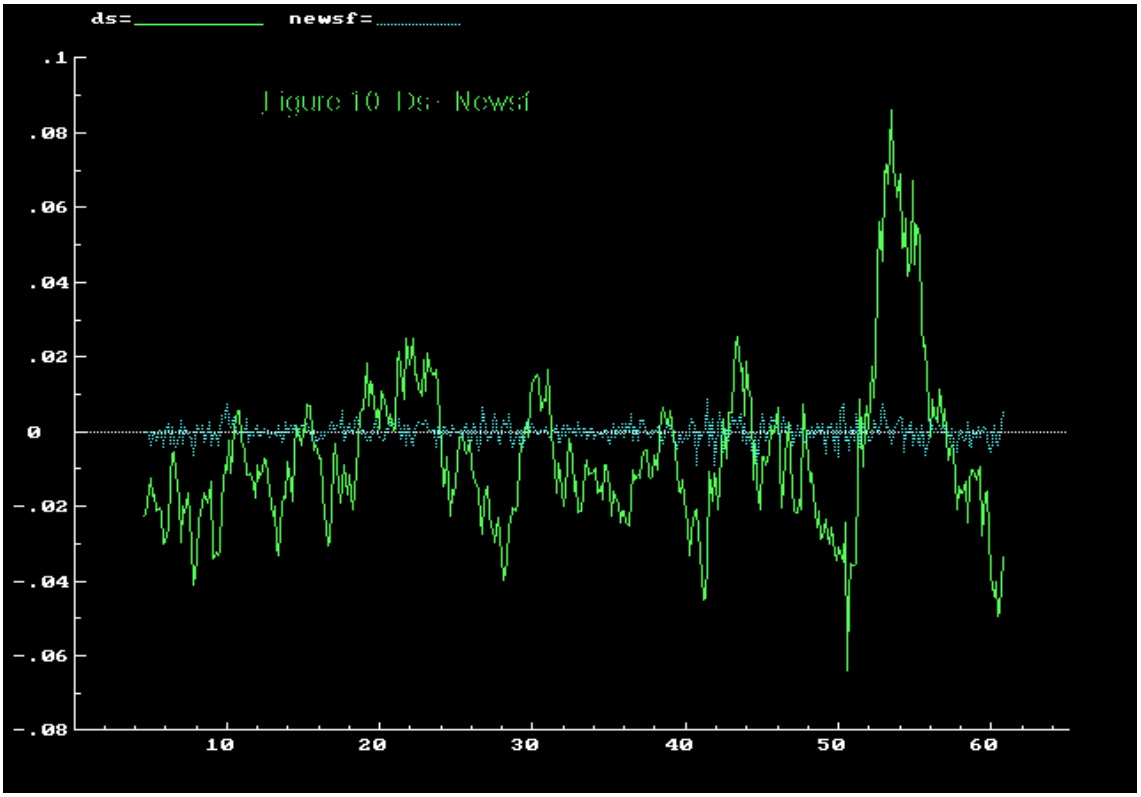

newsdi=
Figure 5 Newsdj
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
-.1
10
20
30
40
50
60

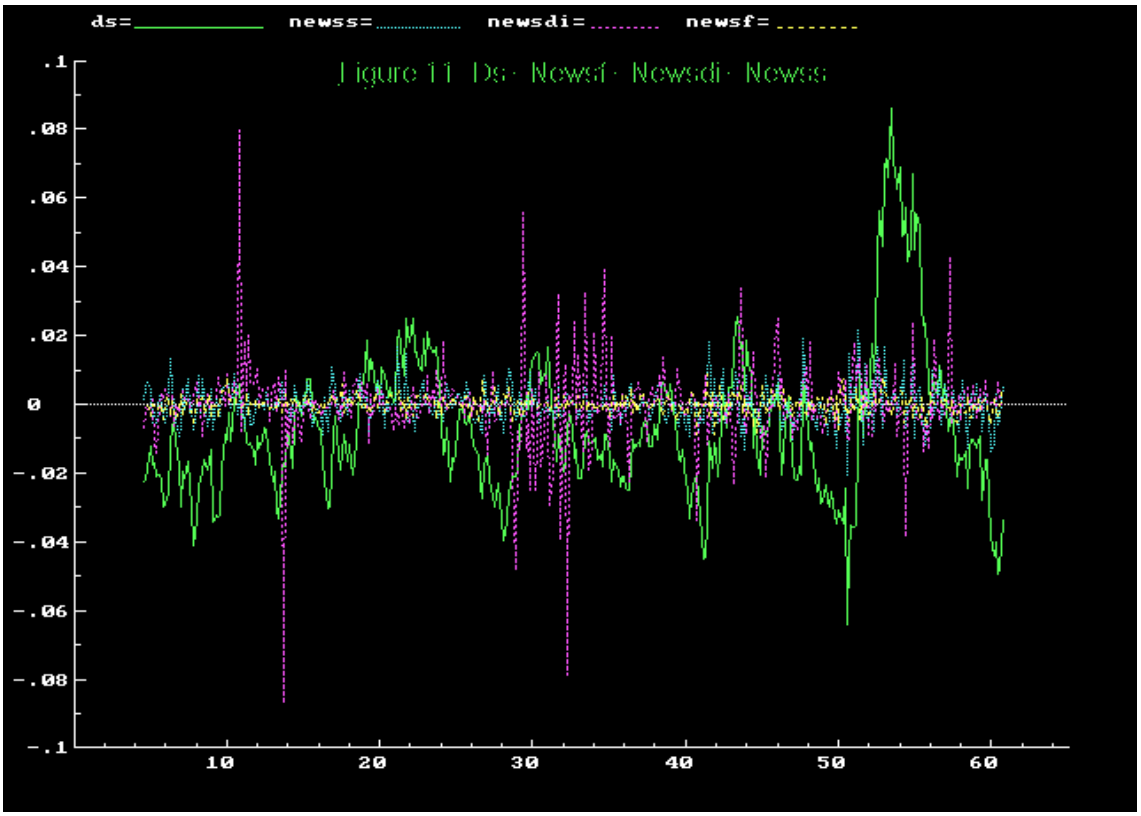

newss=
Figure 6 Newss
.024
.02
.016
.012
.008
.004
0
-.004
-.008
-.012
-.016
-.02
-.024
10
20
30
40
50
60

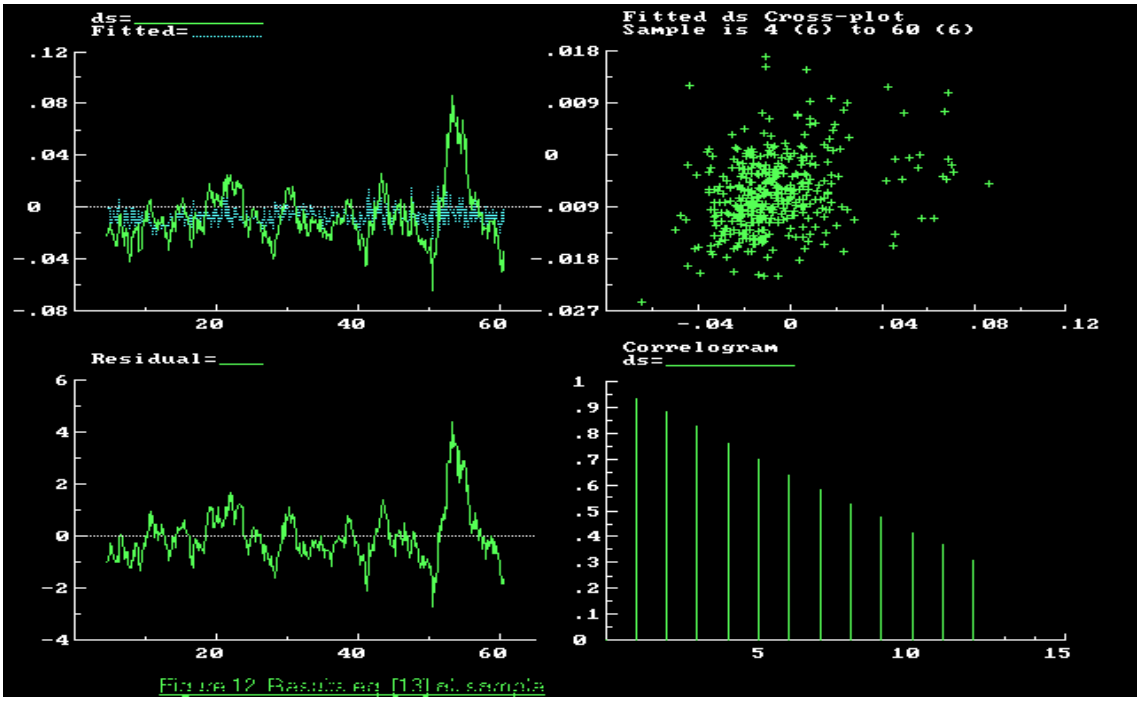

newsf=
.01
.008
.006
.004
.002
0
-.002
-.004
-.006
-.008
-.01
10
20
30
40
50
60

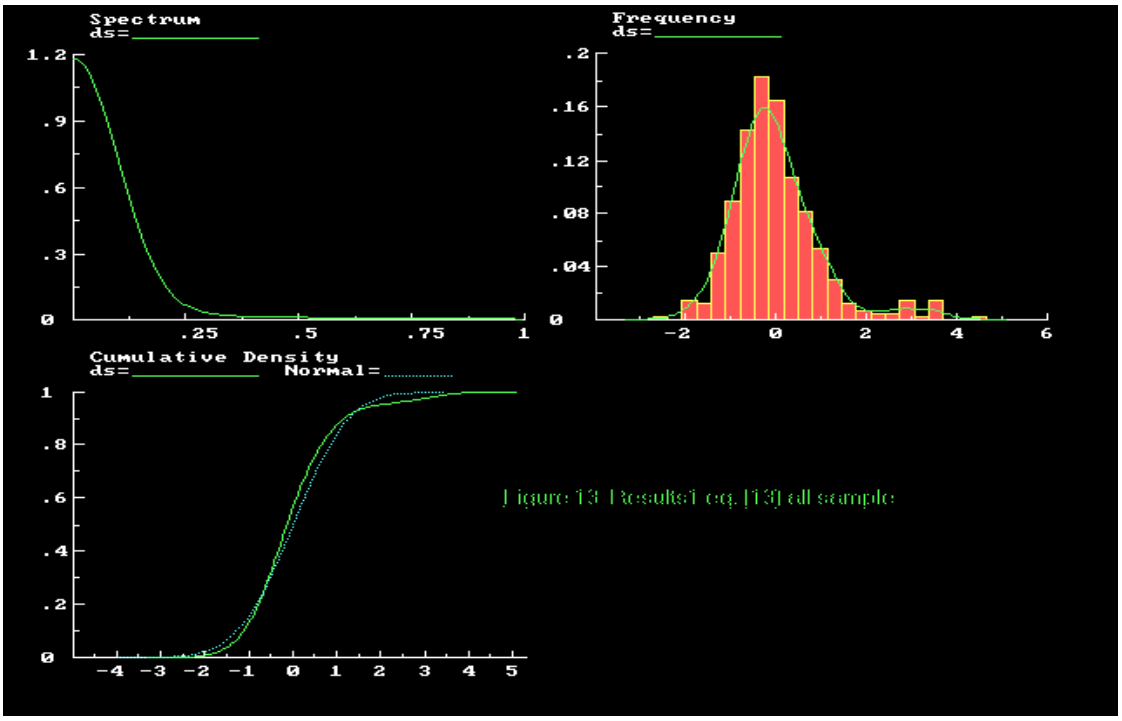

ds=
newss=
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
10
20
30
40
50
60

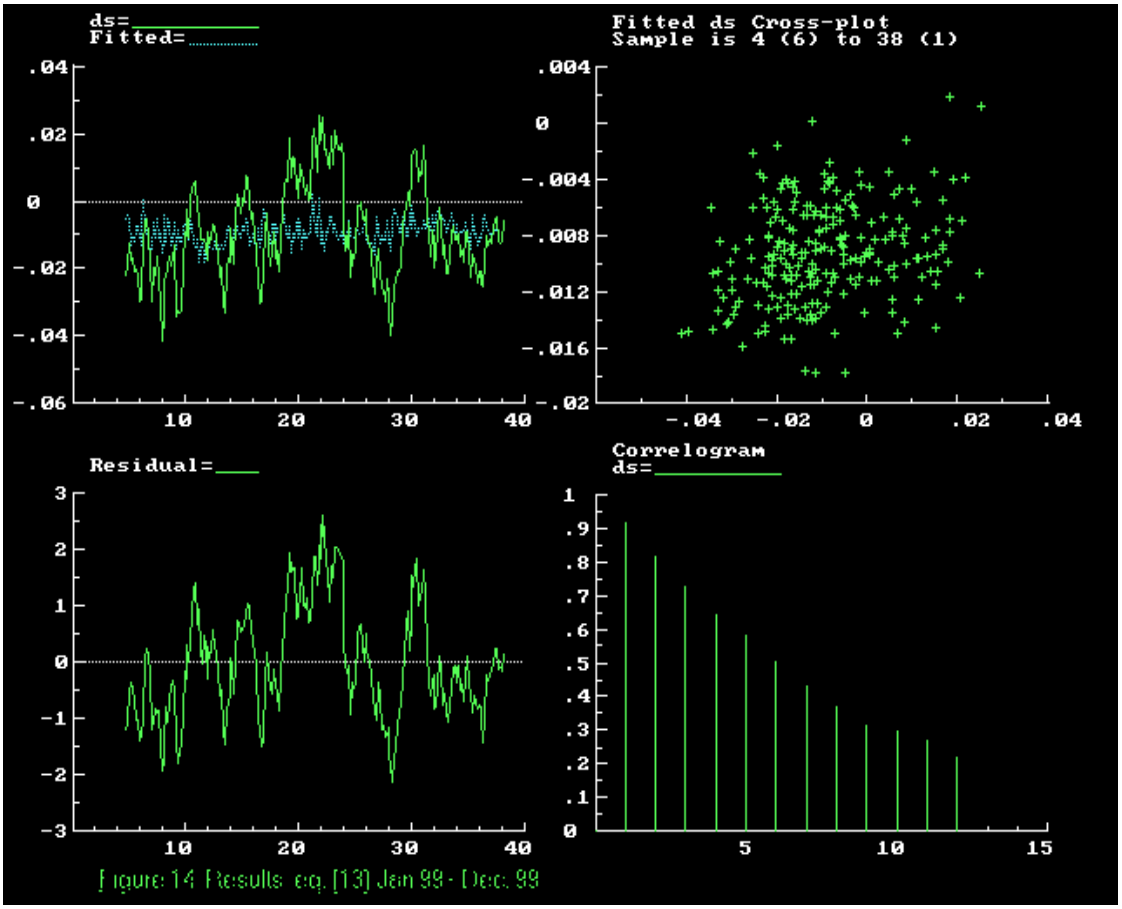

ds=
newsdi=
Figure 9 Ds - Newsdi
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
-.1
10
20
30
40
50
60


ds=
newsf=
Figure 10 Ds - Newsf
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
10
20
30
40
50
60


ds=
newss=
newsdi=
newsf=
Figure 11 Ds: Newsf: Newsdi: Newss:
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
-.1
10
20
30
40
50
60


ds=
Fitted=
.12
.08
.04
0
-.04
-.08
20
40
60
Fitted ds Cross-plot
Sample is 4 (6) to 60 (6)
.018
.009
0
-.009
-.018
.027
-.04
0
.04
.08
.12
Residual=
6
4
2
0
-2
-4
20
40
60
Correlogram
ds=
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
5
10
15


Spectrum
ds=
1.2
.9
.6
.3
0
.25
.5
.75
1
Frequency
ds=
.2
.16
.12
.08
.04
0
-2
0
2
4
6
Cumulative Density
ds=
Normal=
1
.8
.6
.4
.2
0
-4 -3 -2 -1 0 1 2 3 4 5
Figure 13 Results: eq. [13] all sample


ds=
Fitted=
.04
.02
0
-.02
-.04
-.06
10
20
30
40
Fitted ds Cross-plot
Sample is 4 (6) to 38 (1)
.004
0
-.004
-.008
-.012
-.016
-.02
-.04
-.02
0
.02
.04
Residual=
3
2
1
0
-1
-2
-3
10
20
30
40
Correlogram
ds=
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
5
10
15
Figure 14 Results: eq. [13] Jan 99 - Dec. 99

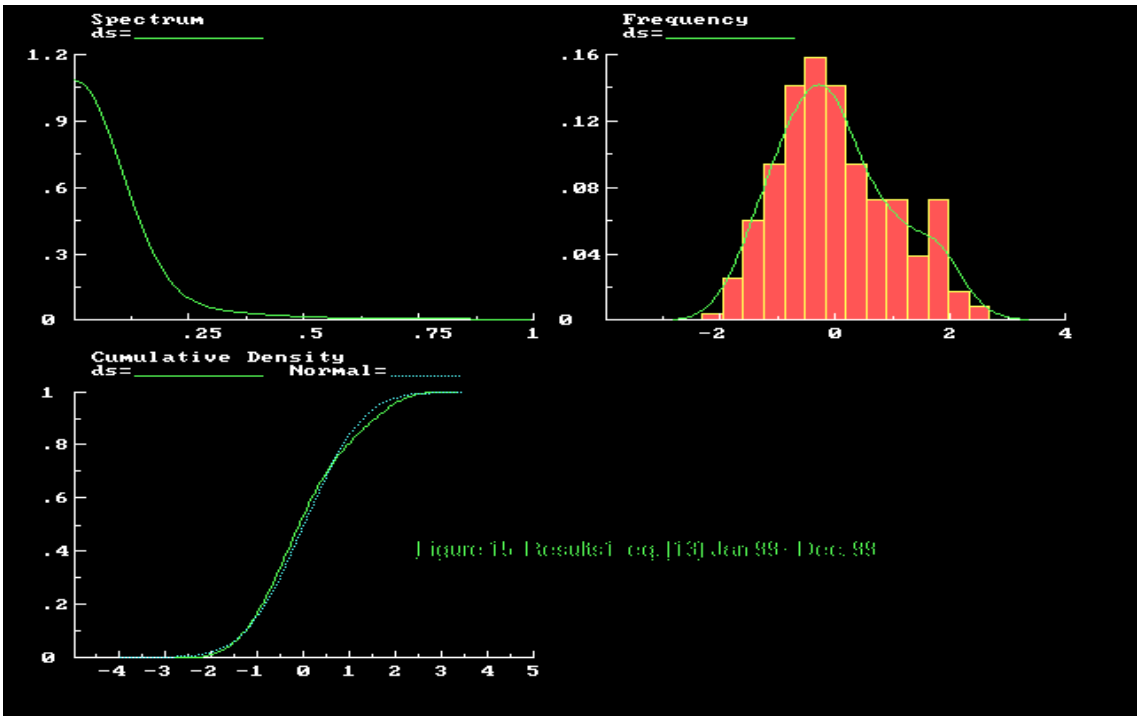


Figure 15 Results1 eq. [13] Jan 99 - Dec. 99

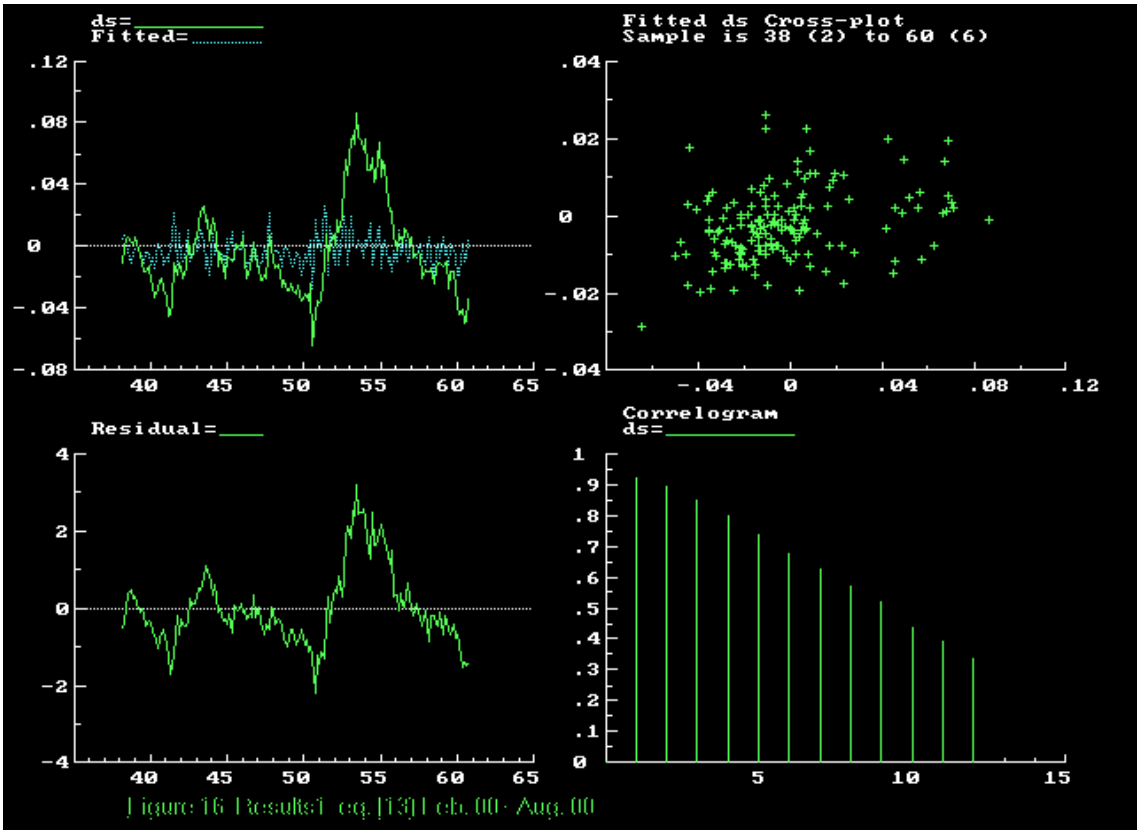


Figure 16 Results1 eq. [13] Feb. 00 - Aug. 00

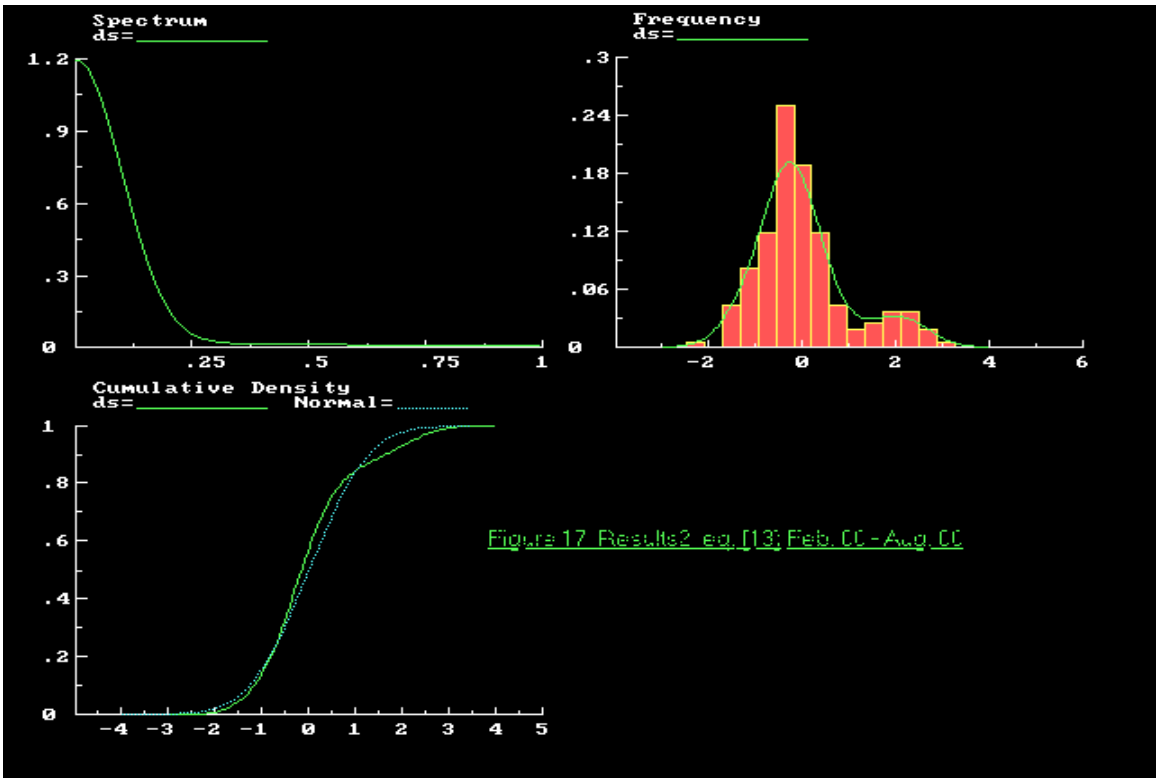


Figure 17 Results2 eq. [13] Feb. 00 - Aug. 00