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Forecasting the Return Volatility of the Exchange Rate

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Introduction

Among the most puzzling issues is the behaviour of volatility. While the general properties of volatility remain elusive, perhaps the most intriguing feature revealed by empirical work on volatility is its long persistence. Such behaviour has sparked a search, almost akin to that for the Holy Grail, for the perfect GARCH model, but the underlying question of why such volatility persistence endures remains unanswered. We conjecture that the ability to analyse higher frequency data may be particularly useful in pursuing this issue. (Goodhart and O'Hara (1997)).

A large body of literature assume volatilities and correlations to be constant, but it is widely recognized among both academics and practitioners that they vary importantly over time. Most of what we have learned from this bargaining literature is based on the estimation of parametric ARCH or stochastic volatility models for the underlying returns.

This paper aims to analyse the predictive ability of traditional GARCH models in order to forecast the future movements in exchange rate.

Following the recent research in volatility, we base our analysis on a relatively high frequency (daily) set of data, taking into account that an increase in data observation has as result diminishing the estimation errors. We find that daily volatility models for exchange rate perform well, readily explaining about 0.3 of the variability in the volatility factor[1].

Our contribution to the related literature consists in two major subjects: first, the use of a specific log-range return as volatility proxy to which the empirical study is relied on and second the criteria for moving from one model to another: the marginal significance of the last term in GARCH models.

We do not claim that our contribution is according to the theoretical fundamentals, but the empirical evidence show that the results are satisfactory.

For the first subject, the specific log-range return that we develop is constructed as follows:

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[1] In a related context, Hsieh (1991) and Fung and Hsieh (1991) report R^2's between 34 and 55 per cent when modelling volatility by autoregressions for daily sample standard deviations based on 15-minute equity, currency and bond returns.

$$\text{LRR} = \log \frac{high_t - low_t}{high_{t-1} - low_{t-1}} \quad (1)$$

where *high* and *low* are the extreme values of exchange rate that occur during the day. A similar proxy, the range, was proposed by Alizadeh, Brandt and Diebold[2] (2000), as a simple yet highly efficient estimation method, defined as the difference between the highest and the lowest log-price during a discrete sample interval. Unlike them, we are taking into account the relative change in range because of normal distribution in a very good approximation. The empirical evidence proof that our volatility proxy is not rejected by Jarque-Berra test for normality. Another widely used proxy that we have analysed for proving the efficiency of our proxy, the log-absolute return, with same specification as our proxy failed Jarque-Berra test for normality at zero associated probability, being strongly leptokurtic.

For the second subject, we find that “marginal significance of the last term introduced in GARCH model”, is an efficient criteria in choosing the specific model that fits the real phenomenon.

We have tested for other GARCH models, including the traditional GARCH(1,1), but the results seemed not to be as good as those obtained with selected model by our criteria. ARCH LM test for GARCH(1,1) reveals significant ARCH effects not captured by the model at the higher lags.

Also, a forecast for a random period reveals high Theil inequality coefficient proving that our model fits the real data about 50 per cent. The reported RMSE is about 0.3, which, comparing with those reported by other studies[3] is much smaller.

[2] Gallant, Hsieh and Tauchen (1999) also make use of the log range, albeit with a very different estimator. Altough they are aware of the efficiency of the log range,they are unaware of and do not exploit its normality.

[3] see West and Chow (1994)

Theoretical Background

Over time, the availability of data for increasingly shorter return horizons has allowed the focus to shift from modelling at quarterly and monthly frequencies to the weekly and daily horizons. Along with the incorporation of more data have come definitely improvements in performance, not only because the models now may produce forecasts at the higher frequencies, but also because they typically provide superior forecasts for the longer monthly and quarterly horizons than do the models exploiting only monthly data. Progress in volatility modelling has, however, in some respects slowed over the last decade. First, the availability of truly high-frequency intra-day data has made scant impact on the modelling of, say, daily return volatility. It has become apparent that standard volatility models used for forecasting at the daily level cannot readily accommodate the information in intra-day data, and models specified directly for the intra-day data generally fail to capture the longer inter-daily volatility movements sufficiently well. As a result, standard practice is still to produce forecasts of daily volatility from daily return observations, even when higher-frequency data are available. Second, the focus of volatility modelling continues to be decidedly low dimensional, if not universally univariate. Many multivariate ARCH and stochastic volatility models for time-varying return volatilities and conditional distributions have, of course, been proposed; see, Bollerslev, Engle and Nelson (1994), Ghysels, Harvey and Renault (1996), and Kroner and Ng (1998), but those models generally suffer from a curse-of-dimensionality problem that severely constrains their practical application. Consequently, it is rare to see practical applications of such procedures dealing with more than a few series simultaneously. In view of such difficulties, finance practitioners have largely eschewed formal volatility modelling and forecasting in the higher-dimensional situations of practical relevance, relying instead on simple exponential smoothing methods for construction of volatility forecasts, coupled with an assumption of conditionally normally distributed returns. This approach is exemplified by J.P. Morgan's RiskMetrics. Variances are modelled using an exponential forecast. Formally, the forecast for time *t* is a weighted average of the previous forecasts, using weight λ, and of the latest squared innovation, using weight $(1-\lambda)$

$$\sigma_t = \lambda\sigma_{t-1} + (1-\lambda)r_{t-1}^2 \tag{2}$$

Here, the λ parameter is called the decay factor, and must be less than unity. This model can be viewed as a special case of the GARCH process (the GARCH specification will be mentioned later), where c is set to 0, and α and β sum to unity. The model therefore allows for persistence and it appears to produce results that are very close to those from the GARCH model. The exponential model is particularly easy to implement because it relies on one parameter only. Thus, it is more robust to estimation error than other models. In addition, as was the case for the GARCH model, the estimator is recursive: the forecast is based on the previous forecast and the latest innovation. The whole history is summarized by one number, σ_{t-1}. This is in contrast to the moving average (it will be shown next), for instance, where the last M returns must be used to construct the forecast. The only parameter in this model is the decay factor λ. In theory, this could be found from maximizing the likelihood function. Operationally, this would be daunting task to perform every day for more than 450 series in the RiskMetrics database. An optimisation has other shortcomings. The decay factor may vary not only across series, but also over time, thus losing consistency over different periods. In practice, RiskMetrics uses only one decay factor for all series, which is set at 0.94 for daily data.

A very crude method, but employed widely is to use a moving window, of fixed length to estimate volatility. For instance, a typical length is 20 trading days (about a calendar month) and 60 trading days (about a calendar quarter). Assuming that we observe returns r_t over M-days, this volatility estimate is constructed from a moving average

$$\sigma_t^2 = \frac{1}{M}\sum_{i=1}^{M} r_{t-i}^2 \tag{3}$$

Here, the focus is on raw returns instead of returns around the mean. This is because, for most financial series, ignoring expected returns makes little difference for volatility estimates. The forecast is updated each day by adding information from the preceding day and dropping information from $(M+1)$ days ago. All weights on past returns are equal and set to $(1/M)$. While simple to implement, this model has serious drawbacks. Most important, it ignores the dynamic ordering of observations. In particular, recent information receives the same weight as older information, but recent data should be more relevant. Also, if there was a large return M days ago, dropping this return as the window moves one day forward will substantially affect the volatility estimate. This is why volatility estimation has moved toward models that put more weight on recent information. The first such model was the autoregressive heteroskedastic (ARCH) model introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). The GARCH model assumes that the variance of returns follows a predictable process. The conditional variance depends on the latest innovation, but also on the previous conditional variance. The simplest such model is the GARCH(1,1) process:

$$\sigma_t = c + \alpha r_{t-1}^2 + \beta\sigma_{t-1} \tag{4}$$

The average, unconditional variance is found by setting $E\left(r_{t-1}^2\right) = \sigma_t = \sigma_{t-1} = \sigma$, which gives

$$\sigma = \frac{c}{1-\alpha-\beta} \tag{5}$$

For this model to be stationary $(\alpha+\beta)$ must be less than unity. This sum is also called the persistence. This indicator shows how fast will decay the volatility shocks. The beauty of this specification is that it provides a parsimonious model with few parameters that seems to fit the data quite well[4].

GARCH models have become a mainstay of time-series analysis of financial markets, which systematically display volatility clustering. Literally, hundred's of papers have applied GARCH models to stock return data, interest rate data and foreign exchange data. Econometricians have also created many variants of the GARCH model, most of them providing only marginal improvement on the original GARCH.

[4] For the theoretical rational behind the success of GARCH models, see Nelson (1990)

The drawback of GARCH models is there non-linearity. The parameters must be estimated by maximization of the likelihood function, which involves a numerical optimisation. Typically, researches assume that the scaled residual $\varepsilon_t = r_t / \sqrt{\sigma_t}$ has a normal distribution. The GARCH model can also be used, and this is one of the reasons that we used it, to compute the volatility over various horizons. Assume that the model is estimated using daily intervals. To compute a monthly volatility, we first decompose the multi-period return into daily returns as:

$$r_{t,T} = \ln(P_{t+T} / P_t) = \ln(P_{t+T} / P_{t+T-1}) + \ln(P_{t+T-1} / P_{t+T-2}) + \ldots + \ln(P_{t+1} / P_t) = r_{t+1} + r_{t+2} + \ldots + r_T \qquad (6)$$

If returns are uncorrelated across days, the long–horizon variance as of t-1 is

$$E_{t-1}(r_{t,T}^2) = E_{t-1}(r_t^2) + E_{t-1}(r_{t+1}^2) + E_{t-1}(r_{t+2}^2) + \ldots + E_{t-1}(r_T^2) \qquad (7)$$

After some manipulation, the forecast of variance τ days ahead is

$$E_{t-1}(r_{t+\tau}^2) = c\frac{1-(\alpha+\beta)^\tau}{1-(\alpha+\beta)} + (\alpha+\beta)^\tau \sigma_t \qquad (8)$$

In theory, GARCH estimation could be extended to a multivariate framework. The problem is that the number of parameters estimate increases exponentially with the number of series. With two series, for instance, we need to estimate nine terms, three c, α and β parameters for each of the three-covariance terms. For larger samples, this number quickly becomes unmanageable. Although such methods must be weighed against considerations of feasibility, simplicity and speed of implementation in high-dimensional environments. The simplicity of the RiskMetrics approach[5] consists in the fact that covariances are estimated, much like variances using an exponential weighting scheme:

$$\sigma_{12,t} = \lambda\sigma_{12,t-1} + (1-\lambda) r_{1,t-1} r_{2,t-1} \qquad (9)$$

As before, the decay factor, λ, is arbitrarily set at 0.94 for daily data. The conditional correlation is then

$$\rho_{12,t} = \frac{\sigma_{12,t}}{\sqrt{\sigma_{1,t}\sigma_{2,t}}} \qquad (10)$$

Note that the reason why JP Morgan decided to set a common factor λ across all series, is to ensure that all estimates of ρ are between –1 and 1.

Otherwise, there is no guarantee that this will always be the case.

The prescriptions of modern financial risk management hinge critically on the associated characterization of the distribution of future returns (Diebold, Gunther and Tay, 1998, and Diebold, Hahn and Tay, 1999). Because volatility persistence renders high-frequency returns temporally dependent (e.g., Bollerslev, Chou and Kroner, 1992), it is the *conditional return distribution*, and not the unconditional distribution, that is of relevance for risk management. This is especially true in high-frequency situations, such as monitoring and managing the risk associated with the day-to-day operations of a trading desk, where volatility clustering is omnipresent.

Exchange rate returns are well known to be unconditionally symmetric but highly leptokurtic. Standardized daily or weekly returns from ARCH and related stochastic volatility models also appear symmetric but leptokurtic; that is, the distributions are not only unconditionally, but also *conditionally* leptokurtic, although less so than unconditionally. A sizable literature explicitly attempts to model the fat-tailed *conditional* distributions, including, for example, Bollerslev (1987), Engle and Gonzalez-Rivera (1991), and Hansen (1994).

To make the discussion more precise, assuming that return dynamics operate only through the conditional variance, a standard decomposition of the time-t return (innovation) is

$$r_t = \sigma_t \varepsilon_t \qquad (11)$$

where σ_t refers to the time-t conditional standard deviation, and $\varepsilon_t iid(0,1)$. Thus, given σ_t it would be straightforward to back out and assess its distributional properties. Of course, σ_t (latent volatility) is not directly observable and evolves in accordance with the particular model entertained. When using an estimate of σ_t the distributions of the resulting standardized returns are typically found to be fat-tailed, or leptokurtic. A common approach for judging the practical relevance of any model is to compare the implied predictions with the subsequent realizations. Unfortunately, as we have mentioned, is not directly observed, so this

[5] RiskMetrics Monitor, JP Morgan, October,1995

approach is not immediately applicable for volatility forecast evaluation. Still, if the model for σ_t^2 is correctly specified, then

$$E_{t-1}\left(r_t^2\right) = E_{t-1}\left(\sigma_t^2 \varepsilon_t^2\right) = \sigma_t^2 \quad (12)$$

which appears to justify the use of squared return innovation over the relevant horizon as a proxy for the ex-post volatility. However, while the squared innovation provides an unbiased estimate for the latent volatility factor, it may yield very noisy measurements due to the error term ε_t^2. This component typically displays a large degree of observation-by-observation variation relative to σ_t^2, rendering the fraction of the squared return variation attributable to the volatility process low. Consequently, the poor predictive power of volatility models, when judged by standard forecast criteria using r_t^2 as a measure for ex-post volatility, is an inevitable consequence of the inherent noise in the return generating process. This motivates a fundamentally different approach. Rather than seeking to perfect the forecast evaluation procedures – taking the noisy observation on volatility provided by fixed-horizon squared return as given – it may prove fruitful to pursue alternative ex-post volatility measures. Specifically, building on the continuous-time stochastic volatility framework developed by Nelson (1990) and Andersen, Bollerslev, Diebold and Labys (1999), high-frequency data allow for the construction of vastly improved ex-post volatility measurements via cumulative squared intraday returns. In theory, as the observations frequency increases from a daily to an infinitesimal interval, this measure converges to genuine measurement of the latent volatility factor. In practice, this is infeasible because of data limitations and a host of market microstructure features, including nonsynchronous trading effects, discrete observations, intra-day periodic volatility patterns and bid-ask spreads. Nonetheless, the proposed volatility measures, based on high frequency returns, provide a dramatic reduction in noise and a radical improvement in temporal stability relative to measures based on daily returns. Theoretically, in a generic continuous time volatility model, the price S of a security (we may consider this price of a security as being the exchange rate) evolves as a diffusion with instantaneous drift μ and volatility σ. Both the drift and volatility depend on a latent state variable υ, which evolves as a diffusion. Formally, this is written as:

$$\begin{aligned} dS &= \mu(S_t,\upsilon_t)dt + \sigma(S_t,\upsilon_t)dW_{St} \\ d\upsilon_t &= \alpha(S_t,\upsilon_t)dt + \beta(S_t,\upsilon_t)dW_{\upsilon t} \end{aligned} \qquad (13)$$

where W_{St} and $W_{\upsilon t}$ are two Wiener processes with correlation $E(dW_{St}, dW_{\upsilon t}) = \theta(S_t,\upsilon_t)$. The functions α and β govern the drift and volatility of the state variable process. The stochastic volatility literature contains numerous variations of this model[6] which can be discretized according to very small intervals resulted by the ability of the market to capture high frequency data.

[6] see the set of "ABDL(2000, 2001)" articles: Andersen, Bollerslev, Diebold and Labys, also Andersen, Bollerslev, Diebold and Ebens

Modelling exchange rate volatility

The data used in this part of the paper, are the daily exchange rate (bid) of the ROL/USD spot rates from Romanian Inter-Banking System, that has been taken from Reuters over the period 03/01/1999 : 06/19/2001, which comprise a number of 602 observations. The methods used to describe daily return are Log - Absolute Return and Log-Range Return[7], which we specify as follows:

Date	Open	High	Low	Close	Log_abs_return	Log_range_return
3/1/1999	A_{11}	A_{12}	A_{13}	A_{14}	0	0
3/2/1999	A_{21}	A_{22}	A_{23}	A_{24}	**$\log(A_{24})-\log(A_{14})$**	**$\log(A_{22}-A_{23})-\log(A_{12}-A_{13})$**
3/3/1999	A_{31}	A_{32}	A_{33}	A_{34}	$\log(A_{34})-\log(A_{24})$	$\log(A_{32}-A_{33})-\log(A_{22}-A_{23})$

The present framework aims to provide a qualitative analysis of the two proxies' for measuring the return of the ROL/USD exchange rate and related on the chosen proxy, to model the volatility of this rate. First, we use the following notations:

LRRDUSD – the daily Log-Range Return sample for ROL/USD exchange rate;

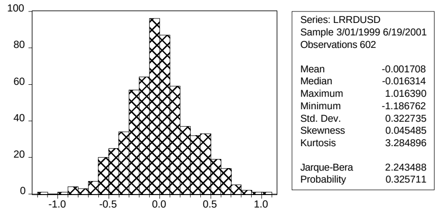
LARDUSD – the daily Log-Absolute Return sample for ROL/USD exchange rate.

Following the histograms for the Log-Absolute Return ("LAR") and Log-Range Return ("LRR") samples, we observe the superiority of LRR estimator because it has a normal distribution, to a very good approximation. The superiority of this estimator has been empirical estimated[8].

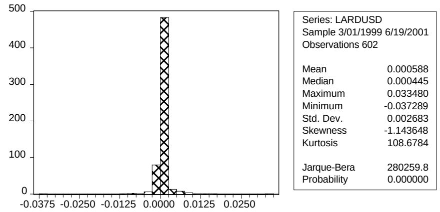
[7] The range is a volatility proxy with a long and colourful history in finance (Garman and Klass, 1980; Parkinson, 1980; Beckers, 1983; Ball and Torous, 1984; Rogers and Satchel, 1991; Anderson and Bollerslev, 1998). Curiously, however, it has been neglected in the recent stochastic volatility literature.

[8] Sassan Alizadeh, Michael W. Brandt & Francis X. Diebold (2000) – *Range-Based Estimation of Stochastic Volatility Models or Exchange Rate Dynamics are More Interesting Than You Think*, Wharton, Financial Institution Centre, worging paper no. 00-28

Graph 1: The histograms of the ROL/USD returns



LRRDUSD



LARDUSD

Synthesizing, we have the following descriptive parameters:

Table 1: The relevant indicators of the data series

Descriptive Statistics for LRRDUSD
Categorized by values of LRRDUSD

Sample: 3/01/1999 6/19/2001
Included observations: 602

LRRDUSD	Mean	Median	Std. Dev.	Skewness	Kurtosis	Obs.
[-1.5, -1)	-1.186762	-1.186762	NA	NA	NA	1
[-1, -0.5)	-0.632944	-0.586587	0.120326	-1.033397	3.112291	35
[-0.5, 0)	-0.188388	-0.160140	0.133768	-0.580547	2.334118	276
[0, 0.5)	0.192486	0.162048	0.147623	0.551030	2.135167	248
[0.5, 1)	0.623258	0.602060	0.103869	1.117956	3.843530	41
[1, 1.5)	1.016390	1.016390	NA	NA	NA	1
All	-0.001708	-0.016314	0.322735	0.045447	3.279440	602

Descriptive Statistics for LARDUSD
Categorized by values of LARDUSD

Sample: 3/01/1999 6/19/2001
Included observations: 602

LARDUSD	Mean	Median	Std. Dev.	Skewness	Kurtosis	Obs.
[-0.04, -0.02)	-0.037289	-0.037289	NA	NA	NA	1
[-0.02, 0)	-0.001227	-0.000561	0.001926	-3.530671	16.52993	89
[0, 0.02)	0.000914	0.000563	0.001493	5.239535	38.02363	511
[0.02, 0.04)	0.033480	0.033480	NA	NA	NA	1
All	0.000588	0.000445	0.002683	-1.142698	108.4978	602

Choosing the series based on the estimation model

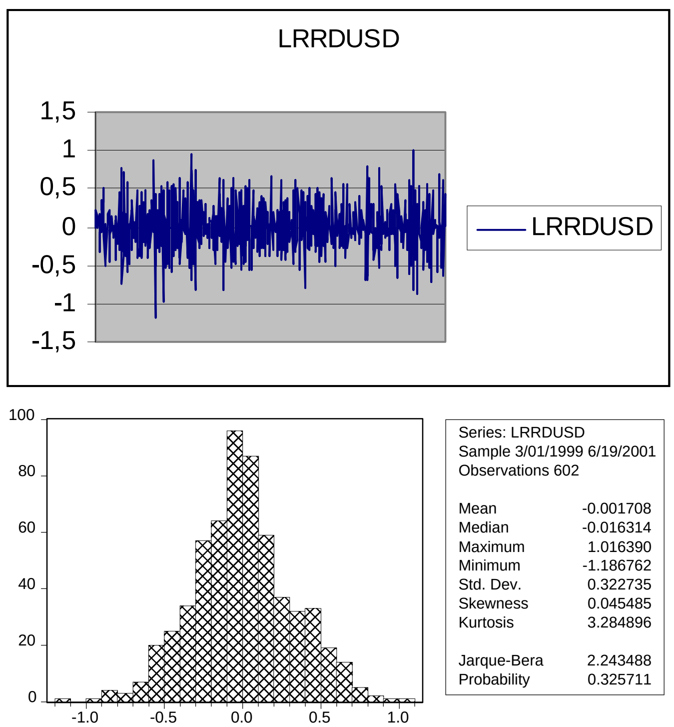
Analysing Graph 1 and Table 1 we might conclude that the best estimation method is “LRR” because it has a normal distribution, to a very good approximation, with a skewness of 0.045485 and a kurtosis of 3.284896, values that are very close to those of the normal distribution: 0 and 3, respectively. The normality hypothesis is confirmed by the higher level of significance of the Jarque-Berra statistic coefficient, with a probability of 0.325711. Accepting a significance level of 10% for this probability, we cannot reject the series normality distribution. From the point of view of the “LAR” estimator, the normality hypothesis is rejected at any level of the critical value. More precisely, this distribution is leptokurtic (fat tails, excess kurtosis: 108.6784).

As a conclusion for our analysis, it is of interest the LRRRDUSD series that we will work with in the following steps.

Data-set analysis

The daily returns of the **ROL/USD** exchange rate are presented in the second graph, that shows a white noise process, the volatility of this process, represented by the variance, being analysed in the following study.

Graph 2: Parameters of the LRRDUSD series



Also, we pointed out that the series is stationary (see Appendix 1), the performed ADF tests rejecting the hypothesis of a unit root at 1% critical value, making valid the subsequent statistical inferences.

Before analysing the issues related to dynamic processes that have been provided by the LRRDUSD series, we aim to study the subsequent correlogram:

The LRRDUSD correlogram

Sample: 3/01/1999 6/19/2001
Included observations: 602

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
***|. |	***|. |	1	-0.437	-0.437	115.57	0.000
.|. |	**|. |	2	-0.007	-0.244	115.60	0.000
.|. |	**|. |	3	-0.053	-0.215	117.29	0.000
.|. |	*|. |	4	0.029	-0.136	117.81	0.000
.|. |	*|. |	5	-0.041	-0.149	118.84	0.000
.|* |	.|. |	6	0.069	-0.043	121.71	0.000
*|. |	*|. |	7	-0.088	-0.122	126.46	0.000
.|. |	*|. |	8	0.045	-0.079	127.68	0.000
.|. |	*|. |	9	-0.008	-0.063	127.73	0.000
.|. |	.|. |	10	0.018	-0.037	127.92	0.000
.|. |	.|. |	11	-0.028	-0.053	128.39	0.000
.|. |	.|. |	12	0.058	0.021	130.49	0.000
*|. |	*|. |	13	-0.113	-0.102	138.31	0.000
.|* |	.|. |	14	0.115	0.014	146.51	0.000
.|. |	.|. |	15	-0.048	-0.004	147.92	0.000
.|. |	.|. |	16	-0.010	-0.036	147.98	0.000
.|. |	.|. |	17	0.010	-0.010	148.05	0.000
.|. |	.|. |	18	-0.011	-0.039	148.13	0.000
.|. |	.|. |	19	0.023	0.012	148.44	0.000
.|. |	.|. |	20	-0.008	-0.014	148.48	0.000
.|. |	.|. |	21	-0.005	-0.003	148.50	0.000
.|. |	.|. |	22	0.008	0.005	148.54	0.000
.|. |	*|. |	23	-0.043	-0.059	149.68	0.000
.|. |	.|. |	24	0.033	-0.030	150.36	0.000

From the correlogram presented above, we may conclude that LRRDUSD follows a moving average process (one lag memory): autocorrelation is obvious for the first lag, and partial correlations gradually become smaller as the number of lags increase[9]. Due to the fact that there is a MA(1) process and because of the rejection of the null hypothesis[10] at any significance level, we stress that series terms are highly autocorrelated, meaning that the bid-spread is influenced by the previous days spread.

ARCH and GARCH Models

1. The mean equation

From the data-set analysis, we will try to estimate the appropriate models focused on the dynamic of the exchange rate return.

In this respect, we will test the existence of AR(p), MA(q) and ARMA(p,q) models that have the following general specifications:

[9] This is the traditional interpretation of autocorrelations and partial autocorrelations by Box and Jenkins method. The configuration corresponds to a MA(1) model.

[10] The null hypothesis is that there are no autocorrelations of an order higher than k, where k denote the number of lags.

AR(p): $u_t = \phi_1 u_{t-1} + \phi_2 u_{t-2} + \phi_3 u_{t-3} + ... + \phi_p u_{t-p} + \delta + \varepsilon_t = \phi(L)u_t + \delta + \varepsilon_t$ (1)

MA(q): $u_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - ... - \theta_q \varepsilon_{t-q} = \mu + \theta(L)\varepsilon_t$ (2)

ARMA(p,q): $u_t = c + \phi(L)u_t + \theta(L)\varepsilon_t$ (3)

in which $\phi(L)$ and $\theta(L)$ are the lag-polynomial functions of order p and q respectively, $\phi(L)$ doesn't contain intercept, because of its existence on the right hand of the AR(p) and ARMA(p,q) model. Analysing the correlogram, we have observed that only the first lag is important. That is why, focused on the OLS (Ordinary Least Squares) method we have tried to estimate the mean equation for AR(1), MA(1) and ARMA (1,1), the results being presented in Appendix 2. All equations show very low values for the intercept term and high values of the associated probability, making the correspondent coefficient not significant.

The Wald tests that have been pursue on the hypothesis c(1)=0, in all the three equations, leads to the conclusion that we cannot reject the hypothesis from which the intercept term is zero. Taking into account the values for R^2 and for the Adjusted R^2, we can observe that models containing intercept have R^2 and Adjusted R^2 closer to one than models without intercept, which means that models with intercept are able to explain better the approaching of the estimated model to the real phenomenon.

Taking this fact into account, we will consider for further analysis those models with intercept term.

The obtained results are presented in the following table:

Table 4: Results for the LRRDUSD mean equation

Models	R-squared	Adjusted R-squared	S.E. of regression	Sum squared resid	Log likelihood	Durbin-Watson stat	Akaike info criterion	Schwarz criterion
AR(1)	0.191021	0.191021	0.290763	50.64131	-109.3969	2.211929	0.370705	0.385343
MA(1)	0.315697	0.314556	0.267198	42.83673	-58.69971	1.823301	0.20166	0.216279
ARMA(1,1)	**0.329304**	**0.32706**	**0.26497**	**41.98497**	**-53.06643**	**2.023901**	**0.186577**	**0.208534**

Taking into consideration the output estimations for all the three models, the best model for the LRRDUSD mean is ARMA(1,1):

- R^2 and adjusted R^2 closer to 1
- The smallest standard error of the regression

- The smallest residuals sum of squares
- The higher Log likelihood
- The Durbin-Watson statistics closer to 2
- The smallest AIC and SBC

From the Wald test performed in ARMA(1,1) on the c(2)+c(3)=0 hypothesis, we have obtained an F-Statistic of 206.0561 (0%) so that we can reject the hypothesis by which the two coefficients are zero or they are jointly not significant.

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	C(2)+C(3)=0		
F-statistic	206.0561	Probability	0.000000
Chi-square	206.0561	Probability	0.000000

Thus, we can estimate the LRRDUSD mean equation:

Estimation Command:
=====================
LS(H) LRRDUSD C AR(1) MA(1)

Estimation Equation:
=====================
LRRDUSD = C(1) + [AR(1)=C(2),MA(1)=C(3),BACKCAST=3/02/1999]

Substituted Coefficients:
=====================
LRRDUSD = -0.002566104915 + [AR(1)=0.1769171343,MA(1)=-0.8639695652,BACKCAST=3/02/1999]

For the residuals terms, the tests performed for the mean equation are presented in Appendix 3.

The Breusch-Godfrey test does not reject the null hypothesis that reveals the inexistence of the serial correlation (a conclusion sustained also by the correlogram graph: significant negative autocorrelation on the 5^{th} lag), with a value of F-Statistic of 0.997152 and with a probability of 0.426227. There is also a proof that sustains residuals normality distribution shown by Jarque-Berra test (with a level of the reported probability of 0.168095) and also by the histogram. The ARCH LM test indicates strong ARCH effects on the first 5^{th} lags, results that are also shown by squared residuals correlogram. F-statistic has a value of 4.941050 at a level of the reported probability of 0.000060 and together with previous issue leads to the conclusion that residuals are uncorrelated but not independents. Modelling

ARCH effects helps in predicting continuous volatility periods and/or stability. Also, these issues describe briefly the evolution of the conditional variance. The results from this test help us in choosing the number of the lags for ARCH and GARCH terms in GARCH(p,q) model. The next step consists in explaining the variance using ARCH and GARCH models in which tests performed show us to choose the ARCH term with 5th lags.

2. The conditional variance equation

We have to estimate the model:

$$u_t = c + \phi u_{t-1} + \varepsilon_t \left| \Omega_{t-1} \right. \qquad (4)$$

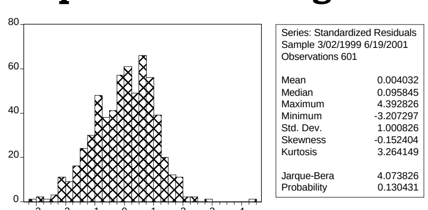
in which the general representation of the conditional variance of the $\varepsilon_t|\Omega_{t-1}$ is GARCH(p,q)[11]:

$$\sigma_t^2 = \varpi + \underbrace{\sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \left| \Omega_{t-1-i} \right.}_{ARCHterm} + \underbrace{\sum_{j=1}^{p} \beta_j \sigma_{t-j}^2}_{GARCHterm} \qquad (5)$$

where q is the order of ARCH terms, p is the order of GARCH terms and Ω_{t-1} represents the information set of $\varepsilon_k, \text{with}\, k \le t$, which also comprise the θ coefficient of ε_{t-1} that has been estimated in ARMA(1,1) equation.

As the ARCH LM test shows us, the first step is the estimation of an ARCH(5,0), because of the weak correlation on the 5th lag. The results are presented in Appendix 4.

Graph 4: The histogram of the residuals ARCH(5,0) – LRRDUSD



The residuals terms are normally distributed. Following the Jarque-Berra test, we cannot reject the normality distribution of the residuals (0.130431).

As we can see in Appendix 4, the coefficients of the ARCH(3) and ARCH(4) are not significant. Because the estimation is based on the residuals errors, we have to rectify the errors that occur taking into consideration ARCH(3) and ARCH(4) terms that are not significant. In this respect, we will use the Bollerslev-Wooldridge correction. This approach improves the results, but the coefficients are still not significant. A range of Wald tests on the ARCH(3) and ARCH(4) coefficients reject the null hypothesis that these coefficients are jointly or separately zero.

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	**C(7)=0**		
F-statistic	1.975682	Probability	0.160371
Chi-square	1.975682	Probability	0.159846

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	**C(8)=0**		
F-statistic	0.388771	Probability	0.533186
Chi-square	0.388771	Probability	0.532946

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	**C(7)+C(8)=0**		
F-statistic	0.822109	Probability	0.364933
Chi-square	0.822109	Probability	0.364564

We will perform an ARCH LM test for ensuring that we have not omitted ARCH effects from the superior lags. The test does not reject the null hypothesis that the coefficients of the squared residuals are jointly zero, indicating an F-statistic of 0.048859 with associated probability of 0.999525.

The next step consists in including the GARCH term and estimation of the model. The first model that we estimate is a GARCH(5,1), the results being presented in Appendix 5. We can observe that GARCH(1), ARCH(2), ARCH(3), ARCH(4) terms does not seem to be significant and the range of Wald tests that we performed are consistent with this issue,

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	**C(10)=0**

[11] Bollerslev, Chou and Kroner (1992) and Bollerslev, Engle and Nelson (1994)

F-statistic	0.278702	Probability	0.597751
Chi-square	0.278702	Probability	0.597553

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	**C(6)+C(7)+C(8)=0**		
F-statistic	0.519876	Probability	0.471180
Chi-square	0.519876	Probability	0.470895

Equation: EQLRRDUSD

Null Hypothesis:	**C(6)+C(7)+C(8)+C(10)=0**		
F-statistic	1.394822	Probability	0.238067
Chi-square	1.394822	Probability	0.237592

but, we should not neglect the marginal significance of the 5th lag. The Wald test rejects the null hypothesis even at 1% confidence level.

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	C(9)=0		
F-statistic	7.143007	Probability	0.007733
Chi-square	7.143007	Probability	0.007526

We will focus on this model, further details about the model being presented in Appendix 5. The ARCH LM test indicates the fact that there are no ARCH effects between the squared residuals, fact that is also confirmed by the correlogram, the residuals being uncorrelated. This issue is very important for the correct estimation of ARCH term from the general GARCH model. Thus, we cannot reduce the ARCH terms because of marginal significance of the 5th lag. Yet, we have to take into consideration that the GARCH(1) coefficient does not seem to be significant. This is the reason why we introduce another GARCH term, passing to GARCH(5,2). We want to test whether, introducing a new term into GARCH model, this perform better than GARCH(5,1), or, putting another way, we have not omitted from the model a significant GARCH term. In this respect, we will perform the tests in Appendix 6. From the very beginning, we can observe the marginal significance of ARCH(5) and ARCH(2) terms: 0.0000 and 0.0008 respectively, and also the significance of the other terms: the ARCH(2) and

ARCH(4) terms are not statistically significant. A Wald test is consistent with this issue:

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	C(6)+C(8)=0		
F-statistic	1.229704	Probability	0.267916
Chi-square	1.229704	Probability	0.267465

Jarque-Berra test (4.048743) does not reject the normality hypothesis (0.132077), and the correlogram does not indicate significant autocorrelations between the squared residuals, these being uncorrelated. Also, ARCH LM test performed at 6 lag levels does not reveal ARCH effects not captured by the model: F-statistic (0.109870) with the associated probability (0.995293). Following the same criteria of the marginal significance of the last term introduced in the model, we will also test for a GARCH(3), but this term is not consistent with the ARCH(5) term significance that we are based on. The estimation output of this model is presented in Appendix 7.

Table 5: Partial estimation output

GARCH(5,2)					GARCH(5,3)				
	Coefficient	Std. Error	z-Statistic	Prob.		Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002834	0.001185	-2.390901	**0.0168**	C	-0.002775	0.001153	-2.407369	**0.0161**
AR(1)	0.144056	0.041490	3.472090	**0.0005**	AR(1)	0.160991	0.040987	3.927807	**0.0001**
MA(1)	-0.893441	0.015036	-59.419080	**0.0000**	MA(1)	-0.900043	0.008525	-105.575100	**0.0000**
	Variance Equation					**Variance Equation**			
C	0.047263	0.009245	5.112064	**0.0000**	C	0.005137	0.001495	3.435775	**0.0006**
ARCH(1)	0.194490	0.067382	2.886360	**0.0039**	ARCH(1)	0.198731	0.062244	3.192769	**0.0014**
ARCH(2)	0.080307	0.062159	1.291967	**0.1964**	ARCH(2)	-0.056013	0.083815	-0.668293	**0.5039**
ARCH(3)	0.135174	0.052509	2.574307	**0.0100**	ARCH(3)	-0.130776	0.074176	-1.763035	**0.0779**
ARCH(4)	0.019411	0.037717	0.514655	**0.6068**	ARCH(4)	-0.008460	0.085469	-0.098983	**0.9212**
ARCH(5)	0.187504	0.043559	4.304556	**0.0000**	ARCH(5)	0.030607	0.054180	0.564916	**0.5721**
GARCH(1)	0.165839	0.092236	1.797987	**0.0722**	GARCH(1)	0.757421	0.085144	8.895801	**0.0000**
GARCH(2)	-0.422584	0.126555	-3.339146	**0.0008**	GARCH(2)	0.857511	0.059132	14.501690	**0.0000**
					GARCH(3)	-0.720560	0.085925	-8.385875	**0.0000**

In terms of model equation indicators (Table 6), moving from one model to another had as result the change in the previous model indicators, so that judging by optimal values that they should have, makes difficult to choose one of the three models.

Table 6: Estimation output indicators

Models	R-squared	Adjusted R-squared	S.E. of regression	Sum squared resid	Log likelihood	Durbin-Watson stat	Akaike info criterion	Schwarz criterion
GARCH(5,1)	0.327002	0.316753	0.266991	42.12906	-36.51488	1.936784	0.154792	0.22798
GARCH(5,2)	0.324486	0.313037	0.267716	42.28652	-35.38857	1.885998	3.654013	3.705643
GARCH(5,3)	0.324407	0.311789	0.267959	42.29151	-31.5019	1.906293	0.144765	0.232591

Reminding that our criterion is the marginal significance of the last lag, we will choose the GARCH(5,2) model for a brief description of the volatility dynamics.

The volatility forecasting

In this section of the paper we will try to emphasize the predictive power of GARCH(5,2) that has resulted from the previous analysis. In this respect we will adopt a comparative perspective between GARCH(5,2) and GARCH(5,1), testing this way whether the chosen criteria (the marginal significance of the last term introduced), is valid or not.

The forecast period that we have chosen is 1/01/2001: 6/19/2001. The results are presented in Appendix 8 (a, b) and Table 7.

Table 7: Forecast indicators

	GARCH(5,1)		GARCH(5,2)	
	Static	Dynamic	Static	Dynamic
Root Mean Squared Error	0.280974	0.337721	0.282048	0.337712
Mean Absolute Error	0.224294	0.247469	0.224843	0.247431
Mean Abs. Percent Error	213.1563	95.976070	216.0078	95.940190
Theil Inequality Coefficient	0.514375	0.962190	0.509613	0.962363
Bias Proportion	0.014536	0.000153	0.015863	0.000145
Variance Proportion	0.208112	0.906441	0.184432	0.906955
Covariance Proportion	0.777353	0.093406	0.799705	0.092900

We find that both models have the forecast indicators close to the optimal values: RMSE (Root Mean Squared Error) and MAE (Mean Absolute Error) have small values and the smaller the error, the better the forecasting ability of that model according to that criterion.

The Theil inequality coefficient always lies between zero and one, where zero indicates a perfect fit.

The bias proportion tells us how far the mean of the forecast is from the mean of the actual series.

The variance proportion tells us how far the variation of the forecast is from the variation of the actual series.

The covariance proportion measures the remaining unsystematic forecasting errors.

If the forecast is “good”, the bias and variance proportions should be small so that most of the bias should be concentrated on the covariance proportions.

Judging the static forecast of our models, GARCH(5,1) performs a little bit better than GARCH(5,2) in terms of RMSE, MAE and MAPE (Mean Abs. Percent Error). But judging by the Theil inequality coefficient, GARCH(5,2) performs better 0.509613 than GARCH(5,1) 0.514375, indicating a good fit with the actual data. For both models the Bias Proportion and Variance Proportion is small indicating that bias is indeed concentrated in Covariance Proportion.

Summing the GARCH model coefficients, we observe that for our model this is equal to 0,5907, indicating that volatility shocks are relatively persistent in the returns of exchange rate, which is not surprising for the chosen high-frequency series. This fact, coupled with the significant parameter estimates is observed almost universally across different speculative returns, suggests that financial market volatility is highly predictable[12].

Further, we test for IGARGH[13] hypothesis:

Wald Test:
Equation: EQLRRDUSD

Null Hypothesis:	C(5)+C(6)+C(7)+C(8)+C(9)+C(10)+C(11)=1		
F-statistic	18.55659	Probability	0.000019
Chi-square	18.55659	Probability	0.000016

and we reject the hypothesis at 1% confidence level, which means that the forecast of conditional variance quickly converges to steady state, as it is shown in Appendix 8b. The process does not explode (reject the hypothesis at 1% confidence level) which is consistent with the rejection of a unit root result (Appendix 1).

---

[12] see for example Andersen and Bollerslev (1998),"Answering the skeptics: yes, standard volatility models do provide accurate forecasts"

[13] IGARCH(1,1) is written as: $\sigma_t^2 = \alpha\varepsilon_t^2 + (1-\alpha)\sigma_{t-1}^2$

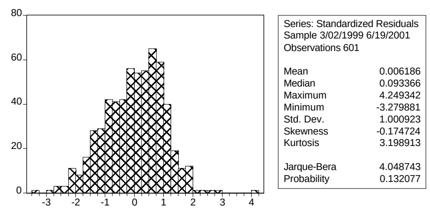
For the chosen model, we perform the residual test, indicating that there is no significant serial correlation between residuals (see Appendix 6).

An ARCH LM test indicates that there are no ARCH effects not captured by the model (also Appendix 6),

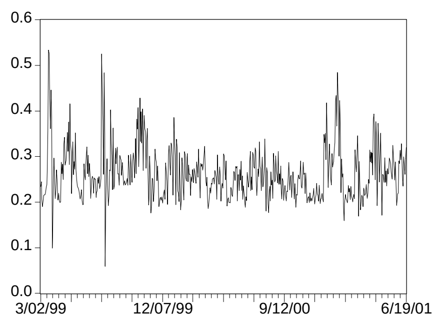
Obs*R-squared	0.666323	Probability	0.995189

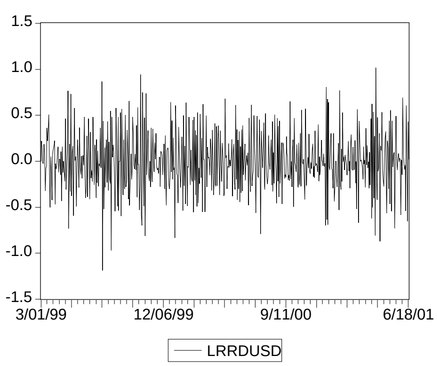
Thus, not rejecting the null hypothesis: “no-further ARCH effects”.

We also obtained the normality of residual distribution, the Jarque-Berra test not rejecting the normality hypothesis as shown below:



We can plot the graph of the one-step ahead conditional standard deviation against returns[14]:





We see that indeed, increases of conditional standard deviation are associated with clustering of large observation in the original series. This is the usual

[14] this is a common procedure when using the mean squared return as volatility proxy

volatility-clustering phenomenon observed in the behaviour of this series and other exchange rates[15].

Conclusions

The GARCH model tested above seems satisfactory in describing exchange rate movements. Forecasting volatility today is very important for options traders, because knowing the volatility trend, they can hedge their positions, and those, minimizing their loss.

The variation in economy-wide risk factors is important for the pricing of financial securities, and return volatility is a key input to option pricing and portfolio allocation problems. As such, accurate measures and good forecasts of volatility are critical for the implementation and evaluation of asset and derivative pricing theories as well as trading and hedging strategies.

[15] ibidem Andersen and Bollerslev (1998)

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Appendix 1: Unit Root Test for LRRDUSD

ADF Test Statistic	**-17.34682**	**1% Critical Value***	**-3.4437**
		5% Critical Value	**-2.8667**
		10% Critical Value	**-2.5695**

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(**LRRDUSD**)
Method: Least Squares
Date: 06/30/01 Time: 15:32
Sample(adjusted): 3/08/1999 6/19/2001
Included observations: 597 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRRDUSD(-1)	-2.849243	0.164252	-17.34682	0.0000
D(LRRDUSD(-1))	1.200097	0.142961	8.394570	0.0000
D(LRRDUSD(-2))	0.741547	0.112151	6.612020	0.0000
D(LRRDUSD(-3))	0.382084	0.077670	4.919315	0.0000
D(LRRDUSD(-4))	0.150909	0.040886	3.690992	0.0002
C	-0.006514	0.011097	-0.587004	0.5574

R-squared	0.758638	Mean dependent var	7.12E-05
Adjusted R-squared	0.756596	S.D. dependent var	0.549306
S.E. of regression	0.271006	Akaike info criterion	0.236645
Sum squared resid	43.40543	Schwarz criterion	0.280785
Log likelihood	-64.63852	F-statistic	371.5212
Durbin-Watson stat	2.012635	Prob(F-statistic)	0.000000

Appendix 2: The models for the Mean Equation

AR(1) with intercept

Dependent Variable: LRRDUSD
Method: Least Squares

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 3 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001720	0.008253	-0.208450	0.8349
AR(1)	-0.437061	0.039791	-10.98393	0.0000

R-squared	0.191021	Mean dependent var	-0.001711
Adjusted R-squared	0.189671	S.D. dependent var	0.323004
S.E. of regression	0.290763	Akaike info criterion	0.370705
Sum squared resid	50.64131	Schwarz criterion	0.385343
Log likelihood	-109.3969	F-statistic	141.4398
Durbin-Watson stat	2.211929	Prob(F-statistic)	0.000000
Inverted AR Roots	-.44		

AR(1) intercept free

Dependent Variable: LRRDUSD
Method: Least Squares

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 2 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.437020	0.039727	-11.00070	0.0000

R-squared	0.190963	Mean dependent var	-0.001711
Adjusted R-squared	0.190963	S.D. dependent var	0.323004
S.E. of regression	0.290531	Akaike info criterion	0.367450
Sum squared resid	50.64498	Schwarz criterion	0.374769
Log likelihood	-109.4187	Durbin-Watson stat	2.211831
Inverted AR Roots	-.44		

MA(1) with intercept

Dependent Variable: LRRDUSD
Method: Least Squares

Sample: 3/01/1999 6/19/2001
Included observations: 602
Convergence achieved after 11 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance
Backcast: 2/26/1999

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002248	0.002486	-0.904268	0.3662
MA(1)	-0.773406	0.031128	-24.84633	0.0000

R-squared	0.315697	Mean dependent var	-0.001708
Adjusted R-squared	0.314556	S.D. dependent var	0.322735
S.E. of regression	0.267198	Akaike info criterion	0.201660
Sum squared resid	42.83673	Schwarz criterion	0.216279
Log likelihood	-58.69971	F-statistic	276.8044
Durbin-Watson stat	1.823301	Prob(F-statistic)	0.000000
Inverted MA Roots	.77		

MA(1) intercept free

Dependent Variable: LRRDUSD
Method: Least Squares

Sample: 3/01/1999 6/19/2001
Included observations: 602
Convergence achieved after 11 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance
Backcast: 2/26/1999

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MA(1)	-0.768855	0.031267	-24.59007	0.0000
R-squared	0.314784	Mean dependent var		-0.001708
Adjusted R-squared	0.314784	S.D. dependent var		0.322735
S.E. of regression	0.267153	Akaike info criterion		0.199671
Sum squared resid	42.89388	Schwarz criterion		0.206980
Log likelihood	-59.10097	Durbin-Watson stat		1.828888
Inverted MA Roots	.77			

ARMA(1,1) with intercept

Dependent Variable: LRRDUSD
Method: Least Squares

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 9 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance
Backcast: 3/01/1999

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002566	0.001803	-1.423536	0.1551
AR(1)	0.176917	0.056586	3.126529	0.0019
MA(1)	-0.863970	0.028228	-30.60722	0.0000
R-squared	0.329304	Mean dependent var		-0.001711
Adjusted R-squared	0.327060	S.D. dependent var		0.323004
S.E. of regression	0.264970	Akaike info criterion		0.186577
Sum squared resid	41.98497	Schwarz criterion		0.208534
Log likelihood	-53.06643	F-statistic		146.8052
Durbin-Watson stat	2.023901	Prob(F-statistic)		0.000000
Inverted AR Roots	.18			
Inverted MA Roots	.86			

ARMA(1,1) intercept free

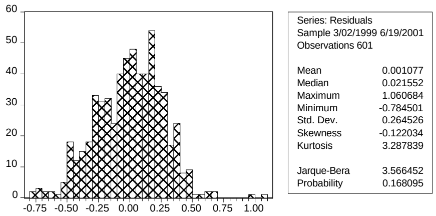
Dependent Variable: LRRDUSD
Method: Least Squares

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 7 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance
Backcast: 3/01/1999

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.167805	0.056702	2.959403	0.0032
MA(1)	-0.853007	0.030181	-28.26303	0.0000
R-squared	0.327209	Mean dependent var		-0.001711
Adjusted R-squared	0.326085	S.D. dependent var		0.323004
S.E. of regression	0.265162	Akaike info criterion		0.186368
Sum squared resid	42.11610	Schwarz criterion		0.201005
Log likelihood	-54.00355	Durbin-Watson stat		2.020517
Inverted AR Roots	.17			
Inverted MA Roots	.85			

Appendix 3: Residual Tests for ARMA(1,1)

Histogram of residuals



The Correlogram of the Squared Residuals

Sample: 3/02/1999 6/19/2001
Included observations: 601
Q-statistic probabilities adjusted for 2 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|* |	.|* |	1	0.155	0.155	14.494	
.|* |	.|* |	2	0.096	0.074	20.125	
.|* |	.|. |	3	0.068	0.044	22.907	0.000
.|. |	.|. |	4	0.006	-0.017	22.930	0.000
.|* |	.|* |	5	0.135	0.132	34.006	0.000
.|. |	.|. |	6	0.020	-0.020	34.259	0.000
.|* |	.|. |	7	0.073	0.056	37.493	0.000
.|. |	.|. |	8	-0.005	-0.039	37.509	0.000
.|. |	.|. |	9	0.009	0.012	37.557	0.000
.|. |	.|. |	10	-0.017	-0.043	37.745	0.000
.|. |	.|. |	11	-0.047	-0.035	39.087	0.000
.|. |	.|. |	12	-0.017	-0.021	39.272	0.000
.|. |	.|. |	13	-0.036	-0.016	40.092	0.000
.|. |	.|. |	14	0.018	0.026	40.302	0.000
.|. |	.|. |	15	0.040	0.051	41.312	0.000
.|. |	.|. |	16	-0.048	-0.056	42.746	0.000
.|. |	.|. |	17	-0.031	-0.018	43.354	0.000
.|. |	.|. |	18	-0.018	0.003	43.562	0.000
.|. |	.|. |	19	0.000	0.009	43.562	0.000
.|. |	*|. |	20	-0.048	-0.061	44.994	0.000
.|. |	.|. |	21	0.035	0.061	45.740	0.001
.|. |	.|. |	22	-0.013	-0.024	45.850	0.001
.|. |	.|. |	23	-0.020	-0.009	46.112	0.001
.|. |	.|. |	24	0.002	-0.003	46.114	0.002

LM Test[16] for Serial Correlations

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.997152	Probability	0.426227
Obs*R-squared	6.003223	Probability	0.422829

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/30/01 Time: 21:52
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.11E-05	0.001796	-0.045148	0.9640
AR(1)	0.653355	0.736617	0.886968	0.3755
MA(1)	-0.063327	0.044618	-1.419333	0.1563
RESID(-1)	-0.603022	0.738191	-0.816891	0.4143
RESID(-2)	-0.009590	0.141484	-0.067783	0.9460
RESID(-3)	0.018135	0.057297	0.316506	0.7517

[16] The null hypothesis of LM test is that there is no serial correlation up to order k

RESID(-4)	0.053355	0.049846	1.070393	0.2849
RESID(-5)	0.014520	0.048237	0.301008	0.7635
RESID(-6)	0.064736	0.046645	1.387849	0.1657

R-squared	0.009989	Mean dependent var	0.001077
Adjusted R-squared	-0.003390	S.D. dependent var	0.264526
S.E. of regression	0.264974	Akaike info criterion	0.196488
Sum squared resid	41.56490	Schwarz criterion	0.262357
Log likelihood	-50.04474	F-statistic	0.746623
Durbin-Watson stat	1.995832	Prob(F-statistic)	0.650245

ARCH Test [17]

F-statistic	4.941050	Probability	0.000060
Obs*R-squared	28.55930	Probability	0.000074

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 07/01/01 Time: 21:47
Sample(adjusted): 3/10/1999 6/19/2001
Included observations: 595 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.047736	0.006249	7.638844	0.0000
RESID^2(-1)	0.144100	0.054886	2.625432	0.0089
RESID^2(-2)	0.061520	0.048890	1.258346	0.2088
RESID^2(-3)	0.036824	0.037473	0.982666	0.3262
RESID^2(-4)	-0.035266	0.030914	-1.140750	0.2544
RESID^2(-5)	0.135715	0.045724	2.968150	0.0031
RESID^2(-6)	-0.020089	0.037033	-0.542446	0.5877

R-squared	0.047999	Mean dependent var	0.070437
Adjusted R-squared	0.038285	S.D. dependent var	0.106070
S.E. of regression	0.104020	Akaike info criterion	-1.676768
Sum squared resid	6.362280	Schwarz criterion	-1.625138
Log likelihood	505.8385	F-statistic	4.941050
Durbin-Watson stat	1.996337	Prob(F-statistic)	0.000060

[17] The null hypothesis of ARCH test is that there is no ARCH effect between residuals at a higher than q lag

Appendix 4: The ARCH Models – Estimation Output

ARCH(5,0)

Dependent Variable: LRRDUSD
Method: ML - ARCH

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 26 iterations
Backcast: 3/01/1999

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002744	0.001358	-2.021037	0.0433
AR(1)	0.159828	0.053038	3.013491	0.0026
MA(1)	-0.888972	0.020339	-43.70731	0.0000
	Variance Equation			
C	0.039071	0.005075	7.699000	0.0000
ARCH(1)	0.167892	0.062288	2.695421	0.0070
ARCH(2)	0.105180	0.058509	1.797662	0.0722
ARCH(3)	0.062782	0.060122	1.044235	0.2964
ARCH(4)	-0.016949	0.051473	-0.329276	0.7419
ARCH(5)	0.131163	0.063860	2.053905	0.0400

R-squared	0.326741	Mean dependent var	-0.001711
Adjusted R-squared	0.317643	S.D. dependent var	0.323004
S.E. of regression	0.266817	Akaike info criterion	0.152181
Sum squared resid	42.14535	Schwarz criterion	0.218051
Log likelihood	-36.73050	F-statistic	35.91320
Durbin-Watson stat	1.931813	Prob(F-statistic)	0.000000
Inverted AR Roots	.16		
Inverted MA Roots	.89		

ARCH(5,0) with Corrected Standard Errors

Dependent Variable: LRRDUSD
Method: ML - ARCH

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 26 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Backcast: 3/01/1999

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002744	0.001329	-2.065259	0.0389
AR(1)	0.159828	0.042954	3.720930	0.0002
MA(1)	-0.888972	0.018077	-49.17762	0.0000
	Variance Equation			
C	0.039071	0.006039	6.470084	0.0000
ARCH(1)	0.167892	0.061082	2.748637	0.0060
ARCH(2)	0.105180	0.054612	1.925953	0.0541
ARCH(3)	0.062782	0.044666	1.405590	0.1598
ARCH(4)	-0.016949	0.027183	-0.623515	0.5329
ARCH(5)	0.131163	0.050106	2.617706	0.0089

R-squared	0.326741	Mean dependent var	-0.001711
Adjusted R-squared	0.317643	S.D. dependent var	0.323004
S.E. of regression	0.266817	Akaike info criterion	0.152181
Sum squared resid	42.14535	Schwarz criterion	0.218051
Log likelihood	-36.73050	F-statistic	35.91320
Durbin-Watson stat	1.931813	Prob(F-statistic)	0.000000
Inverted AR Roots	.16		
Inverted MA Roots	.89		

ARCH LM test

F-statistic	0.048859	Probability	0.999525
Obs*R-squared	0.296495	Probability	0.999514

Test Equation:
Dependent Variable: STD_RESID^2
Method: Least Squares

Sample(adjusted): 3/10/1999 6/19/2001
Included observations: 595 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.025104	0.111252	9.214220	0.0000
STD_RESID^2(-1)	-0.005142	0.033067	-0.155498	0.8765
STD_RESID^2(-2)	-0.015833	0.029849	-0.530434	0.5960
STD_RESID^2(-3)	-0.002377	0.030990	-0.076714	0.9389
STD_RESID^2(-4)	-0.003515	0.030054	-0.116954	0.9069
STD_RESID^2(-5)	-0.004349	0.028358	-0.153352	0.8782
STD_RESID^2(-6)	0.013715	0.041775	0.328300	0.7428

R-squared	0.000498	Mean dependent var	1.007325
Adjusted R-squared	-0.009701	S.D. dependent var	1.510690
S.E. of regression	1.518000	Akaike info criterion	3.684359
Sum squared resid	1354.942	Schwarz criterion	3.735989
Log likelihood	-1089.097	F-statistic	0.048859
Durbin-Watson stat	1.999564	Prob(F-statistic)	0.999525

Appendix 5: The GARCH(5,1) Model– Estimation Output andTests

GARCH(5,1)

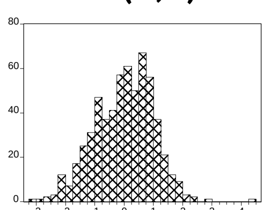
Dependent Variable: LRRDUSD
Method: ML - ARCH

Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 56 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Backcast: 3/01/1999

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002757	0.001344	-2.050391	0.0403
AR(1)	0.160804	0.043059	3.734533	0.0002
MA(1)	-0.887793	0.018388	-48.28073	0.0000
	Variance Equation			
C	0.031423	0.014392	2.183298	0.0290
ARCH(1)	0.167166	0.062348	2.681191	0.0073
ARCH(2)	0.075077	0.074537	1.007254	0.3138
ARCH(3)	0.046026	0.058391	0.788238	0.4306
ARCH(4)	-0.029236	0.037003	-0.790106	0.4295
ARCH(5)	0.132249	0.049483	2.672640	0.0075
GARCH(1)	0.167995	0.318218	0.527922	0.5976

R-squared	0.327002	Mean dependent var	-0.001711
Adjusted R-squared	0.316753	S.D. dependent var	0.323004
S.E. of regression	0.266991	Akaike info criterion	0.154792
Sum squared resid	42.12906	Schwarz criterion	0.227980
Log likelihood	-36.51488	F-statistic	31.90665
Durbin-Watson stat	1.936784	Prob(F-statistic)	0.000000
Inverted AR Roots	.16		
Inverted MA Roots	.89		

GARCH(5,1) Histogram



Series: Standardized Residuals	
Sample 3/02/1999 6/19/2001	
Observations 601	
Mean	0.004310
Median	0.097515
Maximum	4.379824
Minimum	-3.246629
Std. Dev.	1.000771
Skewness	-0.149492
Kurtosis	3.251197
Jarque-Bera	3.818633
Probability	0.148182

GARCH(5,1) Correlogram

Sample: 3/02/1999 6/19/2001
Included observations: 601
Q-statistic probabilities adjusted for 2 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	-0.004	-0.004	0.0078	
.|. |	.|. |	2	-0.012	-0.012	0.0949	
.|. |	.|. |	3	-0.001	-0.001	0.0956	0.757
.|. |	.|. |	4	-0.001	-0.002	0.0968	0.953
.|. |	.|. |	5	-0.001	-0.002	0.0981	0.992
.|. |	.|. |	6	-0.003	-0.003	0.1033	0.999
.|. |	.|. |	7	0.001	0.001	0.1039	1.000
.|. |	.|. |	8	-0.026	-0.026	0.5080	0.998
.|. |	.|. |	9	0.015	0.015	0.6462	0.999
.|. |	.|. |	10	-0.023	-0.023	0.9650	0.998
.|. |	.|. |	11	-0.047	-0.047	2.3350	0.985
.|. |	.|. |	12	-0.021	-0.022	2.6112	0.989
.|. |	.|. |	13	-0.044	-0.045	3.7869	0.976
.|. |	.|. |	14	0.028	0.027	4.2721	0.978

.|* |	.|* |	15	0.081	0.081	8.3470	0.820
.|. |	.|. |	16	-0.042	-0.042	9.4545	0.801
.|. |	.|. |	17	-0.026	-0.025	9.8772	0.827
.|. |	.|. |	18	-0.026	-0.029	10.284	0.851
.|. |	.|. |	19	0.010	0.007	10.344	0.889
*|. |	*|. |	20	-0.068	-0.069	13.213	0.779
.|. |	.|. |	21	0.063	0.061	15.732	0.675
.|. |	.|. |	22	0.008	0.006	15.772	0.731
.|. |	.|. |	23	0.003	0.004	15.778	0.782
.|. |	.|. |	24	0.003	-0.005	15.785	0.826
.|. |	.|. |	25	0.000	0.004	15.785	0.864
.|. |	.|. |	26	0.013	0.016	15.884	0.892
.|. |	.|. |	27	0.018	0.021	16.084	0.912
.|. |	*|. |	28	-0.057	-0.061	18.108	0.872
.|. |	.|. |	29	0.014	0.008	18.227	0.896
.|. |	.|. |	30	0.023	0.011	18.560	0.911
.|. |	.|. |	31	0.030	0.034	19.136	0.918
.|. |	.|. |	32	0.018	0.027	19.345	0.932
.|. |	.|. |	33	-0.043	-0.044	20.536	0.924
.|. |	.|. |	34	-0.031	-0.027	21.149	0.928
.|. |	.|. |	35	0.001	0.009	21.149	0.945
.|. |	*|. |	36	-0.045	-0.066	22.451	0.935

ARCH test

F-statistic	0.024111	Probability	0.999940
Obs*R-squared	0.146351	Probability	0.999938

Test Equation:
Dependent Variable: STD_RESID^2
Method: Least Squares

Sample(adjusted): 3/10/1999 6/19/2001
Included observations: 595 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.036102	0.112345	9.222525	0.0000
STD_RESID^2(-1)	-0.006071	0.033437	-0.181578	0.8560
STD_RESID^2(-2)	-0.013839	0.030318	-0.456466	0.6482
STD_RESID^2(-3)	-0.002243	0.031249	-0.071792	0.9428
STD_RESID^2(-4)	-0.002024	0.030771	-0.065767	0.9476
STD_RESID^2(-5)	-0.001662	0.028797	-0.057724	0.9540
STD_RESID^2(-6)	-0.002982	0.036679	-0.081300	0.9352

R-squared	0.000246	Mean dependent var	1.007104
Adjusted R-squared	-0.009956	S.D. dependent var	1.506180
S.E. of regression	1.513659	Akaike info criterion	3.678632
Sum squared resid	1347.204	Schwarz criterion	3.730262
Log likelihood	-1087.393	F-statistic	0.024111
Durbin-Watson stat	1.999331	Prob(F-statistic)	0.999940

Appendix 6: The GARCH(5,2) Model – Estimation Output and Tests

GARCH(5,2)

Dependent Variable: LRRDUSD
Method: ML - ARCH

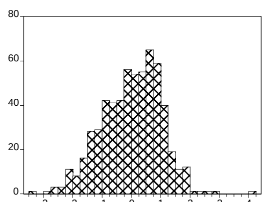
Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 156 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Backcast: 3/01/1999

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002834	0.001185	-2.390901	0.0168
AR(1)	0.144056	0.041490	3.472090	0.0005
MA(1)	-0.893441	0.015036	-59.41908	0.0000
	Variance Equation			
C	0.047263	0.009245	5.112064	0.0000
ARCH(1)	0.194490	0.067382	2.886360	0.0039
ARCH(2)	0.080307	0.062159	1.291967	0.1964
ARCH(3)	0.135174	0.052509	2.574307	0.0100
ARCH(4)	0.019411	0.037717	0.514655	0.6068
ARCH(5)	0.187504	0.043559	4.304556	0.0000
GARCH(1)	0.165839	0.092236	1.797987	0.0722
GARCH(2)	-0.422584	0.126555	-3.339146	0.0008

R-squared	0.324486	Mean dependent var	-0.001711
Adjusted R-squared	0.313037	S.D. dependent var	0.323004
S.E. of regression	0.267716	Akaike info criterion	0.154371
Sum squared resid	42.28652	Schwarz criterion	0.234878
Log likelihood	-35.38857	F-statistic	28.34095
Durbin-Watson stat	1.885998	Prob(F-statistic)	0.000000

Inverted AR Roots	.14
Inverted MA Roots	.89

GARCH(5,2) Histogram



Series: Standardized Residuals
Sample 3/02/1999 6/19/2001
Observations 601

Mean	0.006186
Median	0.093366
Maximum	4.249342
Minimum	-3.279881
Std. Dev.	1.000923
Skewness	-0.174724
Kurtosis	3.198913
Jarque-Bera	4.048743
Probability	0.132077

GARCH(5,2) Correlogram

Sample: 3/02/1999 6/19/2001
Included observations: 601
Q-statistic probabilities adjusted for 2 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	-0.011	-0.011	0.0680	
.|. |	.|. |	2	-0.018	-0.018	0.2607	
.|. |	.|. |	3	-0.008	-0.009	0.3031	0.582
.|. |	.|. |	4	-0.001	-0.002	0.3038	0.859
.|. |	.|. |	5	-0.013	-0.013	0.4080	0.939

.|. |	.|. |	6	-0.016	-0.016	0.5578	0.968
.|. |	.|. |	7	0.061	0.061	2.8549	0.722
.|. |	.|. |	8	0.004	0.004	2.8633	0.826
.|. |	.|. |	9	-0.004	-0.003	2.8756	0.896
.|. |	.|. |	10	-0.033	-0.032	3.5345	0.896
.|. |	.|. |	11	-0.044	-0.046	4.7501	0.856
.|. |	.|. |	12	-0.008	-0.009	4.7856	0.905
.|. |	.|. |	13	-0.039	-0.039	5.7017	0.893
.|. |	.|. |	14	0.032	0.027	6.3422	0.898
.|* |	.|* |	15	0.069	0.067	9.2600	0.753
.|. |	.|. |	16	-0.039	-0.039	10.214	0.746
.|. |	.|. |	17	-0.027	-0.023	10.670	0.776
.|. |	.|. |	18	-0.026	-0.022	11.075	0.805
.|. |	.|. |	19	0.011	0.009	11.147	0.849
*|. |	*|. |	20	-0.070	-0.066	14.229	0.714
.|. |	.|. |	21	0.062	0.057	16.668	0.612
.|. |	.|. |	22	0.020	0.007	16.918	0.658
.|. |	.|. |	23	0.006	0.008	16.944	0.714
.|. |	.|. |	24	0.003	0.006	16.951	0.766

ARCH test

F-statistic	0.109870	Probability	0.995293
Obs*R-squared	0.666323	Probability	0.995189

Test Equation:
Dependent Variable: STD_RESID^2
Method: Least Squares

Sample(adjusted): 3/10/1999 6/19/2001
Included observations: 595 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.084965	0.115078	9.428121	0.0000
STD_RESID^2(-1)	-0.013744	0.034717	-0.395882	0.6923
STD_RESID^2(-2)	-0.020178	0.030898	-0.653070	0.5140
STD_RESID^2(-3)	-0.010476	0.031423	-0.333389	0.7390
STD_RESID^2(-4)	-0.002570	0.030615	-0.083950	0.9331
STD_RESID^2(-5)	-0.013856	0.029279	-0.473231	0.6362
STD_RESID^2(-6)	-0.016317	0.035628	-0.457990	0.6471

R-squared	0.001120	Mean dependent var	1.007518
Adjusted R-squared	-0.009073	S.D. dependent var	1.488404
S.E. of regression	1.495141	Akaike info criterion	3.654013
Sum squared resid	1314.443	Schwarz criterion	3.705643
Log likelihood	-1080.069	F-statistic	0.109870
Durbin-Watson stat	1.997411	Prob(F-statistic)	0.995293

Appendix 7: The GARCH(5,3) Model – Estimation Output

GARCH(5,3)

Dependent Variable: LRRDUSD
Method: ML - ARCH

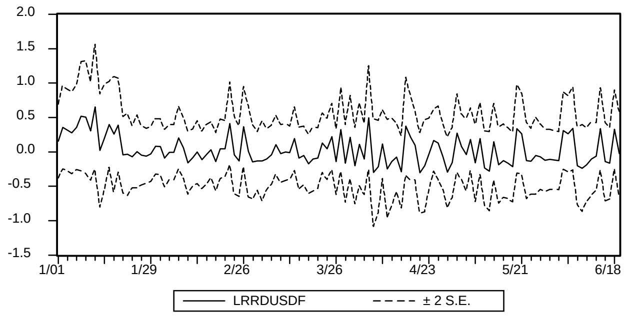
Sample(adjusted): 3/02/1999 6/19/2001
Included observations: 601 after adjusting endpoints
Convergence achieved after 31 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Backcast: 3/01/1999

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.002775	0.001153	-2.407369	0.0161
AR(1)	0.160991	0.040987	3.927807	0.0001
MA(1)	-0.900043	0.008525	-105.5751	0.0000
	Variance Equation			
C	0.005137	0.001495	3.435775	0.0006
ARCH(1)	0.198731	0.062244	3.192769	0.0014
ARCH(2)	-0.056013	0.083815	-0.668293	0.5039
ARCH(3)	-0.130776	0.074176	-1.763035	0.0779
ARCH(4)	-0.008460	0.085469	-0.098983	0.9212
ARCH(5)	0.030607	0.054180	0.564916	0.5721
GARCH(1)	0.757421	0.085144	8.895801	0.0000
GARCH(2)	0.857511	0.059132	14.50169	0.0000
GARCH(3)	-0.720560	0.085925	-8.385875	0.0000

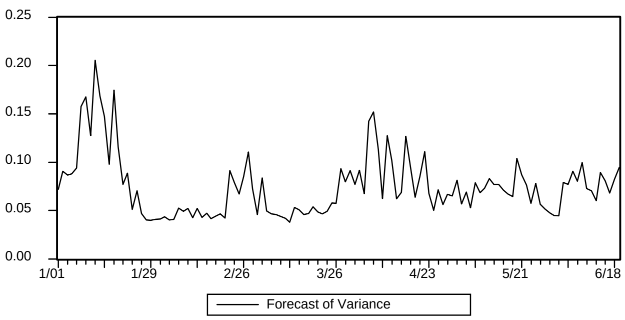
R-squared	0.324407	Mean dependent var	-0.001711
Adjusted R-squared	0.311789	S.D. dependent var	0.323004
S.E. of regression	0.267959	Akaike info criterion	0.144765
Sum squared resid	42.29151	Schwarz criterion	0.232591
Log likelihood	-31.50190	F-statistic	25.71146
Durbin-Watson stat	1.906293	Prob(F-statistic)	0.000000
Inverted AR Roots	.16		
Inverted MA Roots	.90		

Appendix 8a: Static Forecast

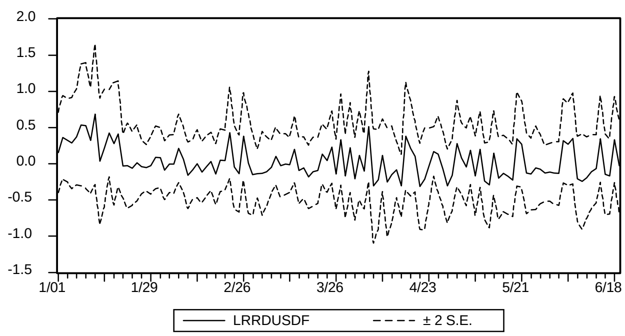
GARCH(5,1)



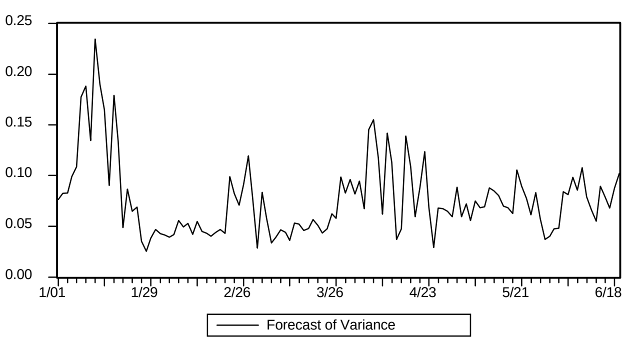
Forecast: LRRDUSDF	
Actual: LRRDUSD	
Forecast sample: 1/01/2001 6/1	
Included observations: 122	
Root Mean Squared Error	0.280974
Mean Absolute Error	0.224294
Mean Abs. Percent Error	213.1563
Theil Inequality Coefficient	0.514375
Bias Proportion	0.014536
Variance Proportion	0.208112
Covariance Proportion	0.777353



GARCH(5,2)

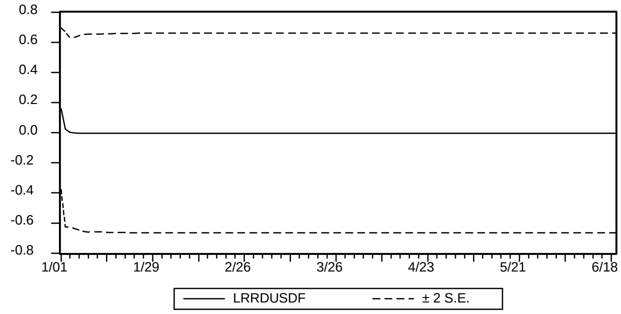


Forecast: LRRDUSDF	
Actual: LRRDUSD	
Forecast sample: 1/01/2001 6/1	
Included observations: 122	
Root Mean Squared Error	0.282048
Mean Absolute Error	0.224843
Mean Abs. Percent Error	216.0078
Theil Inequality Coefficient	0.509613
Bias Proportion	0.015863
Variance Proportion	0.184432
Covariance Proportion	0.799705

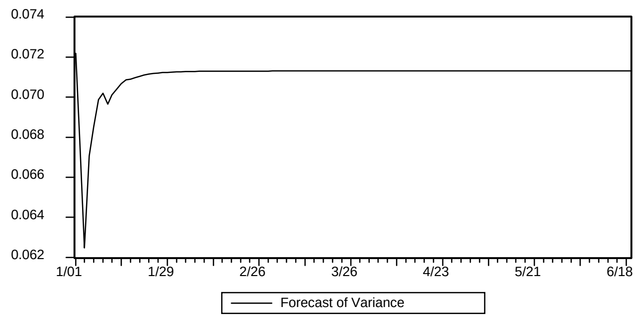


Appendix 8b: Dynamic Forecast

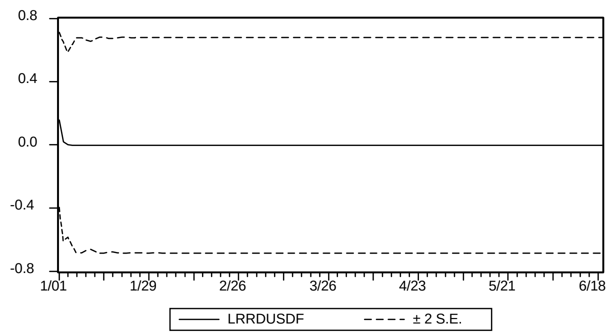
GARCH(5,1)



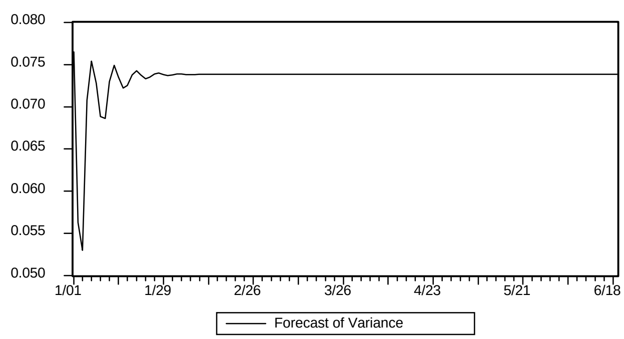
Forecast: LRRDUSDF	
Actual: LRRDUSD	
Forecast sample: 1/01/2001 6/1	
Included observations: 122	
Root Mean Squared Error	0.337721
Mean Absolute Error	0.247469
Mean Abs. Percent Error	95.97607
Theil Inequality Coefficient	0.962190
Bias Proportion	0.000153
Variance Proportion	0.906441
Covariance Proportion	0.093406



GARCH(5,2)



Forecast: LRRDUSDF	
Actual: LRRDUSD	
Forecast sample: 1/01/2001 6/1	
Included observations: 122	
Root Mean Squared Error	0.337712
Mean Absolute Error	0.247431
Mean Abs. Percent Error	95.94019
Theil Inequality Coefficient	0.962363
Bias Proportion	0.000145
Variance Proportion	0.906955
Covariance Proportion	0.092900



Annex 1: The data-set

Date	Open	High	Low	Close	Log_abs_return	Log_range_return
01.03.1999	12700	12830	12700	12820	0	0
02.03.1999	12800	13015	12800	13000	0,006055327	0,218495108
03.03.1999	12950	13200	12900	13155	0,0051475	0,144682795
04.03.1999	13115	13400	13115	13395	0,007851866	-0,022276395
05.03.1999	13390	13470	13200	13330	-0,002112569	-0,023481096
08.03.1999	13330	13330	12920	13050	-0,009219638	0,181420093
09.03.1999	13010	13450	12950	13400	0,011494287	0,086186148
10.03.1999	13400	13599	13360	13490	0,002907151	-0,320572103
11.03.1999	13520	13650	13450	13550	0,001927346	-0,077367905
12.03.1999	13600	13600	13425	13550	0	-0,057991947
15.03.1999	13500	13900	13500	13850	0,009510478	0,359021943
16.03.1999	13825	14445	13780	14350	0,015402128	0,220761654
17.03.1999	14300	15510	14100	15500	0,033479797	0,326397467
18.03.1999	15500	17500	13000	15800	0,008325389	0,503993401
19.03.1999	15500	16000	12500	14500	-0,037289085	-0,109144469
22.03.1999	14200	15100	14000	14600	0,002984854	-0,502675359
23.03.1999	14000	15230	14000	14569	-0,000923112	0,048512426
24.03.1999	14500	14650	13750	14450	-0,003561896	-0,135662602
25.03.1999	14250	14590	14250	14500	0,001500155	-0,422763592
26.03.1999	14500	14770	14400	14700	0,005949333	0,036722807
29.03.1999	14700	14980	14500	14920	0,006451488	0,113039513
30.03.1999	14800	15400	14700	15150	0,00664381	0,163856803
31.03.1999	15200	15570	14400	14750	-0,011620613	0,223087822
01.04.1999	14800	14900	14500	14700	-0,001474686	-0,46612587
02.04.1999	14800	14925	14550	14750	0,001474686	-0,028028724
05.04.1999	14900	14910	14600	14835	0,00249553	-0,082669574
06.04.1999	14900	14900	14620	14700	-0,003970216	-0,044203662
07.04.1999	14700	14750	14400	14400	-0,008954843	0,096910013
08.04.1999	14400	14700	14200	14200	-0,006074148	0,15490196
09.04.1999	14400	14480	14100	14150	-0,001531905	-0,119186408
12.04.1999	14300	14550	14150	14150	0	0,022276395
13.04.1999	14200	14620	14200	14575	0,012852124	0,021189299
14.04.1999	14700	14950	14650	14830	0,007532588	-0,146128036
15.04.1999	14850	14980	14600	14800	-0,000879436	0,102662342
16.04.1999	14820	14890	14750	14840	0,001172186	-0,433655561
19.04.1999	14850	14950	14750	14875	0,001023073	0,15490196
20.04.1999	14850	14900	14750	14840	-0,001023073	-0,124938737
21.04.1999	14830	14850	14700	14750	-0,002641881	0
22.04.1999	14750	14865	14750	14825	0,002202682	-0,115393419
23.04.1999	14790	14840	14770	14770	-0,001614207	-0,2155998
26.04.1999	14850	14905	14702	14770	0	0,462397998
27.04.1999	14770	14850	14750	14815	0,001321161	-0,307496038
28.04.1999	14800	14885	14800	14820	0,000146548	-0,070581074
29.04.1999	14850	14970	14850	14950	0,003792989	0,14976232
30.04.1999	14965	15000	14300	14850	-0,002914739	0,765916794
03.05.1999	14950	14960	14830	14900	0,001459815	-0,731154688
04.05.1999	14900	14930	14875	14915	0,000436989	-0,373580663
05.05.1999	14910	14935	14850	14930	0,00043655	0,189056236
06.05.1999	14950	14950	14910	14933	8,72574E-05	-0,327358934
07.05.1999	14920	14985	14770	14950	0,000494128	0,730378469
10.05.1999	14960	14970	14880	14955	0,000145225	-0,37819595
11.05.1999	14960	14970	14860	14940	-0,00043582	0,087150176
12.05.1999	14940	14960	14800	14935	-0,000145371	0,162727297
13.05.1999	14955	14996	14955	14980	0,001306586	-0,591336126

14.05.1999	14981	15050	14981	15035	0,001591619	0,226065234
17.05.1999	15025	15255	14995	15255	0,00630878	0,576124257
18.05.1999	15245	15480	15215	15400	0,004108509	0,008272526
19.05.1999	15275	15570	15275	15450	0,001407763	0,046576142
20.05.1999	15440	15495	15400	15450	0	-0,492098411
21.05.1999	15460	15538	15450	15500	0,001403214	-0,033240933
24.05.1999	15460	15580	15430	15440	-0,001684402	0,231608587
25.05.1999	15440	15535	15380	15495	0,001544285	0,014240439
26.05.1999	15490	15530	15450	15500	0,000140118	-0,287241711
27.05.1999	15600	15685	15500	15600	0,0027929	0,364081741
28.05.1999	15500	15660	15500	15600	0	-0,063051746
31.05.1999	15600	15630	15515	15600	0	-0,143422142
01.06.1999	15550	15630	15500	15610	0,000278305	0,053245512
02.06.1999	15630	15685	15600	15605	-0,00013913	-0,184524427
03.06.1999	15650	15730	15635	15700	0,002635879	0,04830468
04.06.1999	15700	15760	15650	15737	0,001022292	0,06366908
07.06.1999	15750	15780	15680	15775	0,001047423	-0,041392685
08.06.1999	15750	15800	15500	15750	-0,00068881	0,477121255
09.06.1999	15760	15768	15555	15755	0,000137849	-0,148741651
10.06.1999	15750	15800	15715	15770	0,000413286	-0,398960678
11.06.1999	15780	15785	15740	15775	0,000137675	-0,276206412
14.06.1999	15765	15795	15710	15720	-0,001516826	0,276206412
15.06.1999	15710	15715	15680	15690	-0,000829598	-0,385350881
16.06.1999	15700	15705	15660	15670	-0,000553947	0,109144469
17.06.1999	15700	15800	15670	15800	0,00358809	0,460730839
18.06.1999	15720	15880	15700	15780	-0,000550088	0,141329153
21.06.1999	15780	15820	15750	15750	-0,000826441	-0,410174465
22.06.1999	15795	15795	15650	15690	-0,001657615	0,316269962
23.06.1999	15690	15775	15680	15710	0,000553241	-0,183644397
24.06.1999	15720	15775	15700	15740	0,000828543	-0,102662342
25.06.1999	15745	15755	15710	15725	-0,000414074	-0,22184875
28.06.1999	15740	15820	15685	15770	0,001241039	0,477121255
29.06.1999	15760	15940	15760	15899	0,003538116	0,124938737
30.06.1999	15875	15900	15800	15800	-0,002712722	-0,255272505
01.07.1999	15800	15850	15700	15825	0,000686632	0,176091259
02.07.1999	15820	15855	15680	15840	0,000411459	0,06694679
05.07.1999	15825	15840	15770	15820	-0,000548698	-0,397940009
06.07.1999	15820	15870	15750	15855	0,000959767	0,234083206
07.07.1999	15840	15870	15800	15850	-0,00013698	-0,234083206
08.07.1999	15850	15910	15820	15850	0	0,109144469
09.07.1999	15845	15858	15810	15825	-0,000685548	-0,273001272
12.07.1999	15830	15845	15800	15820	-0,00013724	-0,028028724
13.07.1999	15850	15860	15820	15840	0,000548698	-0,051152522
14.07.1999	15845	15882	15790	15870	0,00082175	0,361727836
15.07.1999	15880	15920	15842	15920	0,001366137	-0,071693225
16.07.1999	15920	15990	15850	15950	0,000817624	0,254033433
19.07.1999	15950	15985	14955	15940	-0,00027237	0,866709189
20.07.1999	15935	16002	15935	15975	0,00095255	-1,186762422
21.07.1999	16000	16002	15820	15940	-0,00095255	0,433996585
22.07.1999	15940	15995	15940	15955	0,000408491	-0,519708698
23.07.1999	16002	16002	15925	15935	-0,000544741	0,146128036
26.07.1999	15950	15955	15915	15915	-0,000545425	-0,284430734
27.07.1999	15920	15960	15910	15945	0,000817881	0,096910013
28.07.1999	15945	16020	15935	16005	0,001631155	0,230448921
29.07.1999	16000	16040	15990	16000	-0,000135696	-0,230448921
30.07.1999	16000	16045	15910	16030	0,00081354	0,431363764
02.08.1999	16030	16045	15980	16037	0,000189607	-0,317420412

03.08.1999	16025	16055	15950	16045	0,000216592	0,208275942
04.08.1999	16050	16070	16000	16050	0,000135315	-0,176091259
05.08.1999	16050	16090	16050	16085	0,000946028	-0,243038049
06.08.1999	16085	16090	15950	16020	-0,001758553	0,544068044
09.08.1999	16020	16030	16015	16015	-0,000135569	-0,970036777
10.08.1999	16030	16045	16000	16030	0,000406579	0,477121255
11.08.1999	16045	16065	16015	16060	0,000812019	0,045757491
12.08.1999	16035	16080	16005	16055	-0,000135231	0,176091259
13.08.1999	16000	16095	16000	16090	0,000945734	0,102662342
16.08.1999	16090	16090	16020	16075	-0,000405063	-0,132625565
17.08.1999	16080	16085	16065	16080	0,000135063	-0,544068044
18.08.1999	16070	16080	16060	16065	-0,000405315	0
19.08.1999	16070	16095	16020	16090	0,000675314	0,574031268
20.08.1999	16100	16125	16002	16100	0,000269832	0,214843848
23.08.1999	16100	16120	16080	16110	0,000269664	-0,48784512
24.08.1999	16110	16130	16010	16126	0,000431115	0,477121255
25.08.1999	16125	16150	16115	16135	0,000242314	-0,535113202
26.08.1999	16145	16175	16140	16160	0,000672387	0
27.08.1999	16165	16195	16160	16185	0,000671347	0
30.08.1999	16185	16233	16115	16210	0,000670311	0,527813963
31.08.1999	16210	16225	16195	16210	0	-0,594760753
01.09.1999	16200	16225	16115	16220	0,000267835	0,56427143
02.09.1999	16225	16285	16180	16270	0,001336703	-0,020203386
03.09.1999	16270	16295	16250	16280	0,000266848	-0,367976785
06.09.1999	16270	16317	16240	16300	0,000533204	0,233278211
07.09.1999	16300	16310	16250	16300	0	-0,108339475
08.09.1999	16285	16315	16285	16301	2,6643E-05	-0,301029996
09.09.1999	16300	16385	16290	16325	0,000638943	0,500602351
10.09.1999	16320	16350	16300	16330	0,000132995	-0,278753601
13.09.1999	16325	16355	16325	16330	0	-0,22184875
14.09.1999	16335	16350	16285	16345	0,00039874	0,335792102
15.09.1999	16340	16365	16290	16365	0,000531085	0,062147907
16.09.1999	16360	16371	16342	16365	0	-0,412663265
17.09.1999	16370	16385	16255	16320	-0,001195855	0,651545354
20.09.1999	16370	16383	16340	16370	0,001328525	-0,480474897
21.09.1999	16373	16380	16350	16370	0	-0,156347201
22.09.1999	16375	16376	16340	16373	7,95824E-05	0,079181246
23.09.1999	16380	16388	16365	16380	0,000185636	-0,194574665
24.09.1999	16370	16390	16370	16385	0,000132548	-0,06069784
27.09.1999	16385	16420	16360	16410	0,000662135	0,477121255
28.09.1999	16410	16460	16340	16445	0,000925297	0,301029996
29.09.1999	16445	16467	16358	16450	0,000132024	-0,041754748
30.09.1999	16440	16500	16410	16475	0,000659521	-0,083183989
01.10.1999	16495	16512	16405	16495	0,000526897	0,075141268
04.10.1999	16490	16536	16450	16470	-0,000658721	-0,094885326
05.10.1999	16520	16570	16360	16568	0,002576487	0,387720843
06.10.1999	16570	16595	16510	16585	0,00044539	-0,392800369
07.10.1999	16580	16655	16330	16645	0,001568324	0,582464435
08.10.1999	16645	16678	16380	16653	0,000208683	-0,037667097
11.10.1999	16395	16670	16395	16660	0,000182515	-0,03488357
12.10.1999	16665	16691	16610	16691	0,00080736	-0,530847675
13.10.1999	16680	16694	16650	16680	-0,000286311	-0,265032342
14.10.1999	16630	16991	16605	16700	0,000520425	0,943134628
15.10.1999	16705	16720	16620	16705	0,000130009	-0,586587305
18.10.1999	16705	16725	16705	16721	0,000415767	-0,698970004
19.10.1999	16717	16752	16640	16750	0,000752564	0,748188027
20.10.1999	16755	16785	16650	16680	-0,001818765	0,081115746

21.10.1999	16750	16794	16750	16770	0,002337016	-0,486881092
22.10.1999	16770	16800	16670	16800	0,000776219	0,470490676
25.10.1999	16790	16810	16790	16790	-0,000258586	-0,812913357
26.10.1999	16790	16808	16790	16802	0,000310284	-0,045757491
27.10.1999	16805	16852	16754	16811	0,000232568	0,735953571
28.10.1999	16825	16850	16780	16840	0,000748539	-0,146128036
29.10.1999	16840	16877	16780	16875	0,000901694	0,141673694
01.11.1999	16850	16990	16780	16930	0,001413177	0,33544756
02.11.1999	16930	17025	16870	17005	0,001919678	-0,131887597
03.11.1999	16995	17090	16995	17060	0,001402391	-0,212608093
04.11.1999	17055	17145	17050	17090	0,000763036	0
05.11.1999	17070	17115	17065	17075	-0,00038135	-0,278753601
08.11.1999	17075	17140	17025	17125	0,001269868	0,361727836
09.11.1999	17140	17167	17075	17160	0,000886703	-0,096910013
10.11.1999	17170	17180	17125	17180	0,000505876	-0,223425138
11.11.1999	17190	17238	17115	17220	0,001009988	0,349542422
12.11.1999	17230	17315	17190	17300	0,002012956	0,007004902
15.11.1999	17290	17346	17250	17330	0,00075246	-0,11463878
16.11.1999	17332	17422	17270	17420	0,002249588	0,199572355
17.11.1999	17430	17560	17400	17550	0,00322897	0,022276395
18.11.1999	17480	17800	17480	17750	0,004921237	0,301029996
19.11.1999	17770	17880	17600	17820	0,001709342	-0,057991947
22.11.1999	17820	17975	17750	17850	0,000730521	-0,094975513
23.11.1999	17850	17990	17800	17880	0,000729294	-0,073428917
24.11.1999	17840	17910	17770	17830	-0,001216171	-0,132625565
25.11.1999	17850	17975	17820	17900	0,001701688	0,044203662
26.11.1999	17990	17990	17820	17850	-0,001214811	0,040117223
29.11.1999	17940	17940	17850	17895	0,001093482	-0,276206412
30.11.1999	17885	17890	17775	17870	-0,00060715	0,106455331
01.12.1999	17913	17915	17774	17870	0	0,088521272
02.12.1999	17940	17940	17773	17870	0	0,073497358
03.12.1999	17850	17894	17775	17870	0	-0,14716951
06.12.1999	17870	17975	17845	17970	0,002423525	0,038396391
07.12.1999	17900	18090	17890	18085	0,002770436	0,187086643
08.12.1999	18090	18100	18000	18020	-0,001563726	-0,301029996
09.12.1999	18090	18100	17910	17950	-0,001690334	0,278753601
10.12.1999	17945	17970	17820	17880	-0,001696938	-0,102662342
13.12.1999	17870	17920	17870	17895	0,000364188	-0,477121255
14.12.1999	17910	17955	17890	17940	0,001090736	0,113943352
15.12.1999	17935	17940	17850	17940	0	0,141329153
16.12.1999	17920	17955	17830	17955	0,000362971	0,142667504
17.12.1999	17940	17940	17870	17895	-0,001453707	-0,251811973
20.12.1999	17915	17915	17880	17908	0,000315383	-0,301029996
21.12.1999	17905	17914	17890	17912	9,69949E-05	-0,163856803
22.12.1999	17900	18005	17900	17945	0,000799382	0,640978057
23.12.1999	17900	17980	17900	17900	-0,001090432	-0,118099312
24.12.1999	17940	18160	17940	18160	0,006262813	0,439332694
27.12.1999	18130	18210	18070	18150	-0,000239215	-0,196294645
28.12.1999	18200	18200	17950	18200	0,001194759	0,251811973
29.12.1999	18150	18350	18150	18200	0	-0,096910013
30.12.1999	18200	18320	18150	18200	0	-0,070581074
31.12.1999	18225	18225	18200	18200	0	-0,832508913
03.01.2000	17960	18060	17960	18060	-0,003353642	0,602059991
04.01.2000	18180	18330	18150	18310	0,005970598	0,255272505
05.01.2000	18300	18360	18230	18335	0,00059257	-0,141329153
06.01.2000	18330	18340	18249	18280	-0,001304723	-0,15490196
07.01.2000	18295	18307	18275	18307	0,00064099	-0,453891414

10.01.2000	18310	18325	18250	18322	0,000355697	0,369911285
11.01.2000	18310	18327	18220	18305	-0,000403146	0,154322514
12.01.2000	18310	18380	18289	18300	-0,000118643	-0,070342385
13.01.2000	18305	18352	18305	18340	0,000948242	-0,286943534
14.01.2000	18330	18374	18325	18325	-0,000355348	0,018098222
17.01.2000	18350	18350	18260	18310	-0,000355639	0,264046429
18.01.2000	18320	18345	18225	18310	0	0,124938737
19.01.2000	18300	18335	18300	18330	0,000474121	-0,535113202
20.01.2000	18335	18360	18250	18350	0,000473604	0,497324641
21.01.2000	18300	18360	18300	18345	-0,000118352	-0,263241435
24.01.2000	18350	18377	18290	18290	-0,001304011	0,161368002
25.01.2000	18365	18380	18350	18375	0,002013642	-0,462397998
26.01.2000	18370	18400	18270	18395	0,000472444	0,636822098
27.01.2000	18380	18467	18345	18435	0,00094335	-0,027583522
28.01.2000	18440	18470	18430	18440	0,000117775	-0,484299839
31.01.2000	18450	18462	18427	18460	0,00047078	-0,057991947
01.02.2000	18470	18470	18440	18460	0	-0,06694679
02.02.2000	18450	18480	18390	18450	-0,000235326	0,477121255
03.02.2000	18460	18550	18397	18550	0,002347543	0,230448921
04.02.2000	18535	18605	18520	18585	0,000818651	-0,255272505
07.02.2000	18500	18612	18500	18595	0,000233617	0,119799097
08.02.2000	18605	18605	18530	18580	-0,000350473	-0,174156759
09.02.2000	18580	18605	18560	18595	0,000350473	-0,22184875
10.02.2000	18595	18675	18550	18650	0,001282653	0,443697499
11.02.2000	18650	18680	18645	18680	0,000698036	-0,552841969
14.02.2000	18685	18690	18585	18680	0	0,477121255
15.02.2000	18675	18695	18630	18690	0,000232429	-0,208275942
16.02.2000	18690	18750	18610	18745	0,001276143	0,333214679
17.02.2000	18750	18795	18735	18780	0,000810143	-0,367976785
18.02.2000	18710	18825	18710	18780	0	0,28254659
21.02.2000	18775	18802	18765	18795	0,000346742	-0,492496116
22.02.2000	18790	18810	18685	18800	0,000115519	0,528708289
23.02.2000	18800	18834	18790	18800	0	-0,453457337
24.02.2000	18840	18857	18820	18845	0,001038293	-0,075250952
25.02.2000	18860	18871	18850	18865	0,000460668	-0,245982429
28.02.2000	18865	18880	18812	18870	0,000115091	0,510289618
29.02.2000	18870	18890	18800	18885	0,000345089	0,121733597
01.03.2000	18880	18940	18880	18935	0,00114832	-0,176091259
02.03.2000	18850	18957	18850	18950	0,000343905	0,251232527
03.03.2000	18940	18970	18940	18960	0,000229119	-0,552262523
06.03.2000	18960	19010	18885	18995	0,000800965	0,619788758
07.03.2000	19015	19055	18925	19041	0,001050455	0,017033339
08.03.2000	18950	19085	18950	19060	0,000433143	0,016390416
09.03.2000	19060	19088	19050	19075	0,00034165	-0,550550172
10.03.2000	19080	19085	19060	19083	0,000182104	-0,181843588
13.03.2000	19080	19103	19025	19085	4,5514E-05	0,494154594
14.03.2000	19105	19130	19089	19120	0,000795724	-0,279310746
15.03.2000	19125	19178	19120	19165	0,001020936	0,150644137
16.03.2000	19177	19228	19165	19220	0,00124456	0,035912556
17.03.2000	19230	19280	19210	19260	0,000902899	0,045757491
20.03.2000	19230	19285	19220	19265	0,000112731	-0,032184683
21.03.2000	19240	19286	19240	19280	0,000338016	-0,150155525
22.03.2000	19265	19320	19240	19310	0,000675244	0,240332155
23.03.2000	19260	19364	19260	19350	0,000898696	0,113943352
24.03.2000	19320	19370	19320	19360	0,000224384	-0,318063335
27.03.2000	19275	19384	19275	19370	0,000224268	0,338456494
28.03.2000	19370	19410	19305	19410	0,000895915	-0,016237199

29.03.2000	19385	19430	19385	19415	0,000111859	-0,367976785
30.03.2000	19440	19460	19430	19452	0,000826866	-0,176091259
31.03.2000	19445	19492	19415	19480	0,000624692	0,40936947
03.04.2000	19485	19513	19470	19490	0,000222887	-0,25302227
04.04.2000	19495	19518	19495	19510	0,00044543	-0,27174062
05.04.2000	19515	19550	19495	19520	0,000222544	0,378634853
06.04.2000	19525	19555	19525	19555	0,000778007	-0,263241435
07.04.2000	19530	19580	19530	19580	0,000554867	0,22184875
10.04.2000	19595	19626	19505	19610	0,000664906	0,383815366
11.04.2000	19600	19645	19529	19641	0,000686002	-0,018327381
12.04.2000	19640	19680	19630	19680	0,000861498	-0,365487985
13.04.2000	19628	19717	19610	19699	0,000419086	0,330413773
14.04.2000	19685	19735	19635	19730	0,000682905	-0,029383778
17.04.2000	19735	19775	19715	19758	0,000615896	-0,22184875
18.04.2000	19760	19794	19700	19790	0,000702813	0,194976603
19.04.2000	19790	19820	19712	19820	0,000657856	0,060295902
20.04.2000	19845	19900	19795	19880	0,00131273	-0,012234456
21.04.2000	19875	19888	19844	19880	0	-0,377736623
24.04.2000	19900	19910	19890	19907	0,000589436	-0,342422681
25.04.2000	19885	19980	19885	19955	0,001045916	0,67669361
26.04.2000	19940	19990	19886	19985	0,00065242	0,039309734
27.04.2000	20030	20085	19965	20050	0,001410224	0,062147907
28.04.2000	20030	20090	20030	20085	0,000757459	-0,301029996
01.05.2000	20044	20093	20040	20085	0	-0,057991947
02.05.2000	20058	20095	20050	20050	-0,000757459	-0,06694679
03.05.2000	20090	20140	20070	20140	0,001945089	0,191885526
04.05.2000	20140	20165	20105	20145	0,000107806	-0,06694679
05.05.2000	20120	20162	20100	20150	0,000107779	0,014240439
08.05.2000	20130	20185	20130	20182	0,000689151	-0,052029
09.05.2000	20175	20220	20150	20198	0,000344166	0,104735351
10.05.2000	20215	20260	20140	20243	0,000966507	0,234083206
11.05.2000	20265	20280	20230	20270	0,000578874	-0,380211242
12.05.2000	20280	20320	20260	20310	0,000856175	0,079181246
15.05.2000	20290	20342	20250	20340	0,000641025	0,185636577
16.05.2000	20320	20375	20320	20375	0,000746669	-0,223425138
17.05.2000	20370	20397	20370	20393	0,000383502	-0,308998925
18.05.2000	20440	20454	20344	20440	0,000999772	0,610028921
19.05.2000	20460	20500	20430	20500	0,00127297	-0,196294645
22.05.2000	20520	20580	20425	20535	0,000740846	0,345233658
23.05.2000	20570	20584	20525	20530	-0,000105758	-0,419479687
24.05.2000	20550	20625	20525	20575	0,000950895	0,229147988
25.05.2000	20555	20605	20555	20595	0,000421952	-0,301029996
26.05.2000	20580	20625	20520	20621	0,000547926	0,322219295
29.05.2000	20615	20653	20615	20645	0,000505165	-0,441405702
30.05.2000	20655	20685	20630	20670	0,000525589	0,160579093
31.05.2000	20700	20700	20675	20697	0,000566923	-0,342422681
01.06.2000	20685	20740	20685	20720	0,000482351	0,342422681
02.06.2000	20720	20746	20720	20720	0	-0,325389342
05.06.2000	20715	20778	20715	20775	0,001151281	0,384367201
06.06.2000	20775	20820	20775	20805	0,000626688	-0,146128036
07.06.2000	20780	20832	20780	20826	0,000438144	0,06279083
08.06.2000	20850	20890	20810	20860	0,00070844	0,187086643
09.06.2000	20870	20890	20840	20877	0,000353787	-0,204119983
12.06.2000	20895	20912	20865	20910	0,000685942	-0,026872146
13.06.2000	20915	20949	20895	20945	0,000726332	0,060295902
14.06.2000	20945	20979	20930	20965	0,000414502	-0,04219768
15.06.2000	21020	21025	20965	21020	0,001137845	0,08795517

16.06.2000	21040	21050	21030	21050	0,000619388	-0,477121255
19.06.2000	21060	21084	21025	21075	0,000515483	0,469822016
20.06.2000	21100	21115	21070	21115	0,000823502	-0,117639498
21.06.2000	21135	21141	21120	21120	0,000102828	-0,330993219
22.06.2000	21160	21185	21160	21170	0,001026944	0,075720714
23.06.2000	21140	21210	21108	21205	0,000717419	0,610660163
26.06.2000	21175	21230	21175	21220	0,000307103	-0,268237482
27.06.2000	21210	21248	21210	21245	0,000511356	-0,160579093
28.06.2000	21255	21270	21240	21270	0,000510754	-0,102662342
29.06.2000	21265	21325	21231	21320	0,00101971	0,496006599
30.06.2000	21235	21371	21235	21360	0,000814048	0,160411055
03.07.2000	21330	21375	21255	21350	-0,000203369	-0,054357662
04.07.2000	21365	21393	21360	21387	0,00075199	-0,560667306
05.07.2000	21400	21411	21390	21401	0,000284198	-0,196294645
06.07.2000	21450	21460	21395	21452	0,001033721	0,490694062
07.07.2000	21467	21475	21430	21470	0,000364256	-0,159700843
10.07.2000	21490	21490	21460	21478	0,000161794	-0,176091259
11.07.2000	21470	21502	21470	21497	0,000384018	0,028028724
12.07.2000	21510	21520	21430	21520	0,000464411	0,449092531
13.07.2000	21515	21550	21445	21550	0,000605008	0,06694679
14.07.2000	21545	21562	21545	21555	0,000100753	-0,790740378
17.07.2000	21565	21576	21540	21573	0,000362516	0,325853579
18.07.2000	21550	21597	21550	21595	0,000442665	0,115795357
19.07.2000	21605	21625	21585	21605	0,000201062	-0,070037867
20.07.2000	21637	21665	21610	21665	0,001204423	0,138302698
21.07.2000	21630	21773	21630	21675	0,000200413	0,414973348
24.07.2000	21640	21717	21640	21705	0,000600684	-0,268845312
25.07.2000	21720	21738	21700	21730	0,000499936	-0,306707129
26.07.2000	21730	21780	21655	21780	0,000998149	0,517126416
27.07.2000	21800	21840	21725	21831	0,001015754	-0,036212173
28.07.2000	21830	21870	21790	21865	0,000675852	-0,157607853
31.07.2000	21870	21895	21850	21890	0,00049628	-0,249877473
01.08.2000	21910	21930	21900	21926	0,000713648	-0,176091259
02.08.2000	21950	21967	21910	21963	0,000732252	0,278753601
03.08.2000	22005	22015	21960	22009	0,000908649	-0,015512166
04.08.2000	22030	22045	22000	22043	0,00067039	-0,087150176
07.08.2000	22070	22082	22030	22075	0,000630012	0,06279083
08.08.2000	22075	22123	22034	22120	0,00088441	0,233386663
09.08.2000	22125	22163	22114	22155	0,000686632	-0,259193927
10.08.2000	22205	22250	22118	22250	0,001858261	0,430377851
11.08.2000	22255	22282	22220	22270	0,000390202	-0,328182242
14.08.2000	22300	22317	22240	22280	0,000194969	0,094099036
15.08.2000	22330	22354	22310	22340	0,001167982	-0,243038049
16.08.2000	22375	22465	22325	22445	0,002036441	0,502675359
17.08.2000	22435	22490	22345	22472	0,000522116	0,015239967
18.08.2000	22465	22535	22420	22525	0,001023073	-0,100670162
21.08.2000	22535	22555	22515	22551	0,000501005	-0,458637849
22.08.2000	22580	22617	22500	22605	0,001038706	0,46612587
23.08.2000	22590	22656	22585	22648	0,000825345	-0,216927513
24.08.2000	22710	22780	22610	22720	0,001378471	0,379190573
25.08.2000	22760	22805	22735	22735	0,000286632	-0,385350881
28.08.2000	22790	22897	22705	22820	0,001620682	0,438203189
29.08.2000	22840	22890	22780	22890	0,001330153	-0,241908544
30.08.2000	22845	22910	22800	22890	0	0
31.08.2000	22960	23025	22850	23000	0,002082043	0,201645364
01.09.2000	23010	23060	23000	23050	0,000943094	-0,464886798
04.09.2000	23085	23105	23010	23105	0,001035043	0,199572355

05.09.2000	23050	23195	23050	23195	0,001688404	0,183644397
06.09.2000	23130	23300	23130	23210	0,000280764	0,069080919
07.09.2000	23295	23331	23220	23310	0,001867133	-0,185125943
08.09.2000	23265	23344	23265	23341	0,000577185	-0,147695887
11.09.2000	23373	23373	23320	23355	0,000260413	-0,173351222
12.09.2000	23330	23428	23330	23415	0,00111429	0,266950206
13.09.2000	23415	23510	23390	23488	0,001351876	0,08795517
14.09.2000	23550	23600	23465	23580	0,001697763	0,051152522
15.09.2000	23650	23655	23570	23600	0,000368202	-0,200914843
18.09.2000	23655	23670	23610	23655	0,001010949	-0,151267675
19.09.2000	23700	23717	23680	23715	0,001100177	-0,209949526
20.09.2000	23745	23840	23675	23760	0,000823307	0,64928222
21.09.2000	23760	23836	23730	23730	-0,000548698	-0,192178079
22.09.2000	23775	23880	23775	23868	0,002518291	-0,004116566
25.09.2000	23907	23930	23875	23930	0,001126669	-0,28082661
26.09.2000	23950	23975	23905	23975	0,000815917	0,104735351
27.09.2000	24010	24039	23920	24025	0,00090478	0,230448921
28.09.2000	24097	24135	24097	24135	0,001983907	-0,495763365
29.09.2000	24130	24171	24060	24165	0,000539496	0,465539382
02.10.2000	24200	24221	24115	24195	0,000538827	-0,020017114
03.10.2000	24215	24245	24150	24245	0,000896562	-0,04758226
04.10.2000	24252	24273	24200	24259	0,000250706	-0,114400745
05.10.2000	24325	24340	24230	24310	0,000912064	0,178069825
06.10.2000	24380	24380	24290	24333	0,000410697	-0,087150176
09.10.2000	24357	24377	24330	24360	0,000481628	-0,282144652
10.10.2000	24385	24407	24333	24380	0,000356417	0,197133862
11.10.2000	24405	24411	24370	24407	0,0004807	-0,256447863
12.10.2000	24450	24475	24445	24460	0,000942052	-0,135662602
13.10.2000	24430	24490	24430	24475	0,000266248	0,301029996
16.10.2000	24520	24537	24505	24528	0,000939437	-0,273001272
17.10.2000	24550	24575	24460	24565	0,000654631	0,555547862
18.10.2000	24530	24608	24495	24592	0,000477082	-0,007619397
19.10.2000	24655	24661	24556	24630	0,000670562	-0,031889144
20.10.2000	24635	24665	24555	24650	0,000352512	0,020203386
23.10.2000	24670	24690	24620	24650	0	-0,196294645
24.10.2000	24690	24707	24680	24702	0,000915194	-0,413734276
25.10.2000	24725	24750	24650	24750	0,000843086	0,568636236
26.10.2000	24710	24800	24677	24800	0,000876478	0,089905111
27.10.2000	24802	24817	24750	24800	0	-0,263830309
30.10.2000	24800	24829	24770	24820	0,000350096	-0,055222791
31.10.2000	24830	24865	24800	24840	0,000349814	0,042061345
01.11.2000	24875	24875	24820	24860	0,000349533	-0,072550667
02.11.2000	24900	24925	24817	24925	0,001134043	0,293061066
03.11.2000	24863	24925	24840	24915	-0,000174275	-0,10400483
06.11.2000	24880	24942	24880	24935	0,000348481	-0,137027236
07.11.2000	24955	24960	24900	24960	0,000435208	-0,014240439
08.11.2000	24980	24980	24930	24940	-0,000348132	-0,079181246
09.11.2000	24965	25020	24955	24990	0,000869807	0,113943352
10.11.2000	24960	25030	24930	24950	-0,000695706	0,187086643
13.11.2000	24990	25048	24980	25035	0,001477046	-0,167491087
14.11.2000	25000	25060	25000	25060	0,000433471	-0,054357662
15.11.2000	25065	25080	25040	25070	0,000173267	-0,176091259
16.11.2000	25110	25120	25035	25120	0,000865301	0,327358934
17.11.2000	25065	25136	25060	25060	-0,001038568	-0,048605333
20.11.2000	25080	25152	25080	25150	0,001556923	-0,023481096
21.11.2000	25150	25185	25120	25173	0,000396986	-0,04441914
22.11.2000	25140	25190	25140	25145	-0,000483336	-0,113943352

23.11.2000	25170	25245	25120	25225	0,001379535	0,397940009
24.11.2000	25230	25256	25180	25245	0,0003442	-0,216096421
27.11.2000	25200	25285	25200	25270	0,000429867	0,048605333
28.11.2000	25240	25300	25240	25300	0,000515279	-0,151267675
29.11.2000	25340	25340	25285	25325	0,000428933	-0,037788561
30.11.2000	25275	25368	25275	25368	0,000736775	0,228120259
01.12.2000	25355	25382	25288	25355	-0,000222614	0,004644905
04.12.2000	25300	25395	25300	25395	0,000684602	0,004595752
05.12.2000	25395	25420	25335	25350	-0,000770253	-0,04830468
06.12.2000	25415	25420	25318	25415	0,00111215	0,079181246
07.12.2000	25450	25460	25370	25453	0,000648863	-0,054357662
08.12.2000	25472	25485	25400	25485	0,00054566	-0,024823584
11.12.2000	25490	25497	25480	25491	0,000102235	-0,698970004
12.12.2000	25500	25516	25408	25465	-0,000443192	0,802974834
13.12.2000	25525	25535	25510	25535	0,001192182	-0,635483747
14.12.2000	25565	25583	25465	25565	0,000509935	0,673941999
15.12.2000	25580	25594	25570	25575	0,000169845	-0,691670766
18.12.2000	25610	25613	25508	25600	0,000424323	0,640978057
19.12.2000	25540	25631	25540	25625	0,000423909	-0,062147907
20.12.2000	25640	25653	25580	25648	0,000389631	-0,095718532
21.12.2000	25690	25750	25640	25750	0,001723728	0,178069825
22.12.2000	25680	25900	25680	25790	0,000674109	0,301029996
25.12.2000	25710	25886	25703	25790	0	-0,078195333
26.12.2000	25740	25873	25725	25790	0	-0,095435327
27.12.2000	25800	25845	25770	25845	0,000925194	-0,293730757
28.12.2000	25830	25930	25780	25880	0,000587735	0,301029996
29.12.2000	25900	25955	25900	25910	0,000503141	-0,43572857
01.01.2001	25910	25938	25910	25910	0	-0,301029996
02.01.2001	25920	25920	25920	25920	0,000167584	0
03.01.2001	25890	26048	25890	25943	0,000385198	0
04.01.2001	25975	26005	25895	25997	0,000903039	-0,157264402
05.01.2001	26005	26028	25970	26015	0,000300596	-0,277964692
08.01.2001	26025	26050	26000	26042	0,000450504	-0,064457989
09.01.2001	26045	26078	26000	26072	0,000500013	0,193124598
10.01.2001	26065	26083	26060	26065	-0,000116618	-0,530366767
11.01.2001	26125	26160	26025	26160	0,00158001	0,768605932
12.01.2001	26100	26175	26100	26175	0,000248951	-0,255272505
15.01.2001	26170	26205	26168	26205	0,000497474	-0,306859539
16.01.2001	26195	26230	26180	26230	0,000414127	0,13076828
17.01.2001	26230	26235	26205	26228	-3,31156E-05	-0,22184875
18.01.2001	26230	26301	26200	26300	0,001190573	0,527200119
19.01.2001	26220	26320	26220	26315	0,000247626	-0,004321374
22.01.2001	26315	26350	26238	26350	0,000577245	0,049218023
23.01.2001	26350	26370	26280	26370	0,00032951	-0,094975513
24.01.2001	26373	26405	26300	26405	0,000576042	0,06694679
25.01.2001	26365	26430	26320	26425	0,000328824	0,020203386
26.01.2001	26445	26462	26360	26450	0,00041068	-0,032792513
29.01.2001	26470	26482	26410	26473	0,000377483	-0,151267675
30.01.2001	26493	26520	26450	26520	0,00077036	-0,012234456
31.01.2001	26515	26565	26450	26565	0,000736301	0,2155998
01.02.2001	26565	26575	26485	26565	0	-0,106455331
02.02.2001	26580	26590	26500	26590	0,000408517	0
05.02.2001	26600	26626	26580	26625	0,000571279	-0,291484678
06.02.2001	26595	26627	26560	26622	-4,89373E-05	0,163316971
07.02.2001	26642	26710	26580	26650	0,000456534	0,28786855
08.02.2001	26650	26717	26610	26703	0,000862842	-0,084559575
09.02.2001	26640	26725	26640	26715	0,000195123	-0,099964852

12.02.2001	26620	26740	26620	26736	0,000341254	0,14976232
13.02.2001	26755	26756	26660	26750	0,000227354	-0,096910013
14.02.2001	26763	26830	26751	26765	0,000243461	-0,084644142
15.02.2001	26830	26863	26730	26857	0,001490251	0,22622455
16.02.2001	26860	26877	26800	26863	9,70129E-05	-0,237360916
19.02.2001	26820	26896	26820	26896	0,000533184	-0,005677133
20.02.2001	26905	26919	26896	26910	0,000226002	-0,519085756
21.02.2001	26850	26934	26850	26930	0,000322656	0,56255145
22.02.2001	26980	26997	26885	26995	0,001046978	0,124938737
23.02.2001	26984	27005	26981	27000	8,04324E-05	-0,669006781
26.02.2001	27020	27035	26970	27035	0,00056261	0,432702115
27.02.2001	27035	27055	26950	27055	0,000321164	0,208275942
28.02.2001	27050	27105	27000	27056	1,6052E-05	0
01.03.2001	27100	27108	27000	27100	0,000705701	0,012234456
02.03.2001	27120	27129	27025	27122	0,000352421	-0,016390416
05.03.2001	27140	27143	27055	27135	0,000208114	-0,072550667
06.03.2001	27153	27156	27100	27100	-0,000560535	-0,196294645
07.03.2001	27156	27180	27100	27180	0,001280162	0,15490196
08.03.2001	27195	27195	27120	27170	-0,000159814	-0,028028724
09.03.2001	27180	27187	27110	27170	0	0,011429462
12.03.2001	27182	27190	27150	27188	0,000287623	-0,284430734
13.03.2001	27190	27210	27119	27195	0,000111802	0,356981401
14.03.2001	27200	27223	27140	27218	0,000367147	-0,0399633
15.03.2001	27239	27288	27165	27288	0,001115497	0,170827019
16.03.2001	27282	27294	27190	27280	-0,00012734	-0,072871772
19.03.2001	27306	27332	27230	27332	0,000827046	-0,008433168
20.03.2001	27332	27360	27308	27330	-3,17804E-05	-0,292596828
21.03.2001	27348	27405	27340	27405	0,001190175	0,096910013
22.03.2001	27405	27423	27387	27405	0	-0,256610856
23.03.2001	27421	27441	27337	27423	0,000285157	0,460730839
26.03.2001	27445	27460	27435	27443	0,000316622	-0,619093331
27.03.2001	27465	27485	27380	27485	0,000664156	0,62324929
28.03.2001	27485	27498	27465	27495	0,000157983	-0,502675359
29.03.2001	27552	27560	27447	27535	0,000631357	0,534564504
30.03.2001	27538	27583	27538	27583	0,000756419	-0,39986593
02.04.2001	27580	27584	27500	27580	-4,72376E-05	0,271066772
03.04.2001	27602	27603	27590	27597	0,000267612	-0,810335934
04.04.2001	27620	27655	27520	27655	0,000911789	1,016390416
05.04.2001	27680	27693	27580	27690	0,000549293	-0,077255325
06.04.2001	27690	27718	27675	27715	0,000391927	-0,419609988
09.04.2001	27695	27758	27630	27755	0,000626349	0,473741514
10.04.2001	27750	27764	27664	27735	-0,000313061	-0,10720997
11.04.2001	27765	27790	27705	27785	0,000782231	-0,070581074
12.04.2001	27785	27850	27680	27850	0,001014798	0,301029996
13.04.2001	27845	27858	27835	27850	0	-0,868721085
16.04.2001	27858	27879	27846	27850	0	0,163316971
17.04.2001	27870	27900	27856	27880	0,00046757	0,118407869
18.04.2001	27900	27970	27820	27970	0,001399697	0,532638583
19.04.2001	27970	27981	27860	27972	3,10532E-05	-0,093305889
20.04.2001	27998	28005	27930	28000	0,000434512	-0,207724107
23.04.2001	28020	28040	28000	28040	0,000619978	-0,273001272
24.04.2001	28035	28067	28025	28060	0,000309657	0,021189299
25.04.2001	28065	28125	28050	28070	0,000154746	0,251811973
26.04.2001	28125	28184	28027	28165	0,001467343	0,320838389
27.04.2001	28170	28210	28100	28185	0,000308284	-0,154506967
30.04.2001	28205	28230	28200	28230	0,000692839	-0,56427143
01.05.2001	28217	28260	28210	28230	0	0,22184875

02.05.2001	28228	28290	28220	28290	0,000922069	0,146128036
03.05.2001	28285	28295	28260	28290	0	-0,301029996
04.05.2001	28220	28316	28220	28310	0,000306922	0,438203189
07.05.2001	28315	28333	28300	28332	0,000337364	-0,463757293
08.05.2001	28331	28348	28230	28340	0,000122613	0,553368067
09.05.2001	28340	28395	28248	28385	0,000689053	0,095435327
10.05.2001	28390	28410	28368	28405	0,000305895	-0,544068044
11.05.2001	28405	28425	28310	28425	0,00030568	0,43744855
14.05.2001	28425	28440	28340	28438	0,000198577	-0,06069784
15.05.2001	28448	28467	28350	28445	0,000106888	0,068185862
16.05.2001	28465	28515	28370	28515	0,001067438	0,09318214
17.05.2001	28515	28527	28500	28517	3,04597E-05	-0,730004238
18.05.2001	28515	28545	28515	28545	0,000426212	0,045757491
21.05.2001	28470	28563	28470	28560	0,000228156	0,491361694
22.05.2001	28480	28580	28480	28580	0,000304021	0,031517051
23.05.2001	28584	28640	28560	28635	0,000834963	-0,096910013
24.05.2001	28635	28670	28585	28654	0,000288069	0,026328939
25.05.2001	28670	28670	28567	28670	0,000242436	0,083418299
28.05.2001	28670	28682	28580	28680	0,000151454	-0,004237053
29.05.2001	28670	28699	28590	28685	7,57072E-05	0,028826326
30.05.2001	28705	28735	28620	28735	0,000756347	0,023271342
31.05.2001	28740	28770	28740	28770	0,00052866	-0,583576586
01.06.2001	28768	28780	28749	28770	0	0,014240439
04.06.2001	28787	28790	28768	28790	0,000301803	-0,148939013
05.06.2001	28795	28887	28780	28795	7,5418E-05	0,686961097
06.06.2001	28730	28857	28730	28857	0,000934097	0,074419943
07.06.2001	28855	28867	28750	28858	1,50496E-05	-0,035617859
08.06.2001	28859	28871	28775	28775	-0,001250897	-0,085914629
11.06.2001	28870	28887	28800	28800	0,000377155	-0,04275198
12.06.2001	28871	28890	28865	28880	0,001204701	-0,541579244
13.06.2001	28893	28930	28830	28930	0,000751245	0,602059991
14.06.2001	28930	28940	28828	28935	7,50531E-05	0,049218023
15.06.2001	28938	28955	28930	28950	0,000225081	-0,651278014
18.06.2001	28962	28967	28900	28962	0,000179981	0,428134794
19.06.2001	28980	28990	28920	28980	0,000269832	0,019023237