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Abstract[1]

This paper uses the multiple variance ratio test procedure developed by Chow and Denning (1993) to test for a random walk of stock returns on the Austrian Stock Exchange. I find that with daily data the test rejects the random walk hypothesis at all conventional significance levels for each and every title and for both indeces tested. Individual shares, however, do seem to follow a random walk when weekly returns are considered, while the hypothesis is rejected for both indices.

Zusammenfassung

Dieser Artikel überprüft die Random Walk Hypothese mittels des von Chow und Denning (1993) entwickelten Variance Ratio Tests auf dem österreichischen Aktienmarkt. Tägliche Renditen folgen keinem Random Walk. Die Nullhypothese wird für jede Aktie auf allen üblichen Signifikanzniveaus abgelehnt. Wöchentliche Renditen scheinen eher einem Random Walk zu folgen, während bei wöchentlichen Renditen der Indizes die Nullhypothese ebenfalls abgelehnt werden kann.

JEL Classification Numbers: G14

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1. Introduction

The hypothesis that stock market notations follow a random walk is at the center of much of the empirical finance literature. To test for this hypothesis a wide range of tests have been suggested. However, since the Lo and MacKinlay's (1988) contribution, attention has focused on variance ratio testing procedures. The particular strength of the variance ratio test is that it can be applied at different lags and therefore, in case of rejection, provides some indication as to what alternative explanation could be given for the observed patterns in the data.

Yet, it is well understood that when testing a number of subhypotheses at the overall confidence interval of the test, too many rejections of the null-hypothesis will result. Chow and Denning (1993) have drawn attention to this fact in the context of the variance ratio test literature. They suggest a Multiple Variance Ratio (MVR) testing procedure that controls for the overall level of significance. In their empirical application they show that this multiple test procedure will yield very different results than would the method used by Lo/MacKinlay (1988).

In most empirical applications the pattern of rejections of variance ratio test procedures plays an important role when looking for alternative theories that could explain stock market prices.

The availability of this new procedure suggests that retesting stock market data in the light of the new methods may be an activity, which aside from providing new results may give some indication as to the underlying structure driving returns on the stock exchange. In this paper I therefore present results using these new methods and a newly edited data set on the Vienna Stock Exchange that allows the analysis of a wide range of titles for the first time.

To this end I first present a short theoretical section in which the importance of the random walk hypothesis and the development of variance ratio tests are repeated. In the same part the MVR-test is shortly discussed. I address the question of data quality and some of the features of the new data set in section 3 and present results in section 4.

I find that daily Austrian Stock Exchange notations do not follow a random walk, the null hypothesis being rejected at very high significance levels indeed. Evidence on weekly data for individual shares, however, is more in favor of the random walk hypothesis. The only rejections in the sample of individual shares occur for those shares where trading is not as frequent that is where markets are thin. However, results concerning indices suggest that these may not follow random walks.

These results I argue are very suggestive for further research on the factors that cause deviations from the random walk in the Viennese market: The high probability values we get for daily data suggest that the "micro-structure" of the market often abstracted from in empirical research may be a very important factor indeed. Furthermore tightness of the market may explain much of the results in weekly data.

2. Variance Ratio Testing Procedures

Ever since the classical works of Kendall (1953) and Fama (1970) financial economists have been interested in the random walk hypothesis of stock market prices. The reason for this high interest probably lies with the hope that stock market prices could be made predictable, if it is shown that returns show some systematic variation. The methods that have been suggested for testing the random walk hypothesis are almost as diverse as the literature on the random walk hypothesis itself: Autocorrelation tests, spectral tests, unit root tests and the runs test are only some of the tests proposed (Taylor, 1988)

However, recent finance literature has been increasingly concerned with the variance ratio test, because this test can give some indication as to what alternative processes may drive stock market prices. At the same time simulation results seem to show that the Variance ratio tests are more powerful at the hypotheses where unit root tests are less powerful (for simulation results see Chow/Denning (1993)). The central statistical property of random walks exploited by variance ratio is that the variances between observations of random walks are the same at all lags.

To understand the workings of variance ratio tests consider a random walk process X(t)= μ+X(t-1) +e(t) where e(t) is a random disturbance term, μ is an arbitrary drift parameter and X(t) is a series of stock returns of length nq+1. The random disturbance term can either be assumed to be i.i.d. with mean zero and constant variance or the variance itself can be assumed to be time varying i.e. heteroskedastic. Lo and MacKinlay (1988) develop tests both for homoskedastic and heteroskedastic random disturbances e(t): The central figure of both these tests is the variance ratio given by:

(1) $MR(q) = (\sigma^2(q)/\sigma^2(1))-1$

where:

(2) $\sigma^2(q) = (q(nq-q+1)(1-q/nq))^{-1}\sum_{k=q}^{nq}(X(k)-X(k-q)-q\overline{X})^2$

(3) $\sigma^2(1) = (nq-1)^{-1}\sum_{k=1}^{nq}(X(k)-X(k-1)-\overline{X})^2$

(4) $\overline{X} = (nq)^{-1}(X(nq)-X(0))$

Under the null hypothesis that X(t) is a random walk MR(q) should be equal to zero. As already stated, both the test for homoskedastic and heteroskedastic residuals make use of MR(q). In the case of homoskedastic residuals the statistic

$$(5)\ Z_1(q) = \sqrt{nq}\,MR(q)(2(2q-1)(q-1)/3q)^{-1/2}$$

is asymptotically normal distributed with mean zero and variance 1 for all "step lengths" q. In the case where heteroskedastic disturbance terms are used the test statistic

$$(6)\ Z_2(q) = \sqrt{nq}\,MR(q)(V(q))^{-1/2}$$

with

$$(7)\quad (q) = \sum_{j=1}^{q-1} (A(j))^2 \frac{(nq)\sum_{k=j+1}^{nq}((X(k)-X(k-1)-\overline{X})^2(X(k-j)-X(k-j-1)-\overline{X})^2)}{(\sum_{k=1}^{nq}(X(k)-X(k-1)-\overline{X})^2)^2}$$

with

$$A(j) = 2(q-j)/q$$

is also asymptotically N(0,1) distributed.

As already mentioned the particular strength of the variance ratio test is that it can provide some evidence at which lags the random walk hypothesis can be rejected. In most empirical applications this is achieved by estimating the variance ratios at a number of q's, and thereby generating a number of subhypotheses, that MR(q) is equal to zero at one particular q, to the original global hypotheses that MR(q) is equal to zero at all q.

However, multiple testing problems arise when this procedure is followed. To overcome this problem Chow and Denning (1993) propose to use the critical value of $1-(1-\alpha)^{1/m}$ (where α is the size of the overall test and m is the number of subhypotheses tested) for all the subhypotheses; rejecting the null when p(i), the probability value at a given q, is smaller than $1-(1-\alpha)^{1/m}$. Aside from controlling for the overall size of the test, they also remark that this procedure could be used to identify where the random walk hypothesis breaks down. This may be valuable information concerning the reasons for the rejection of the random walk hypothesis, for instance Lo and MacKinlay (1988) point out mean reversion would imply increasingly stronger rejections as q rises.

3. The Data

I apply the MVR procedure to weekly and daily data of the Austrian stock exchange. The data used are closing prices for 9 of the most traded shares on the Vienna stock exchange and the two indeces that are reported on the Vienna Stock exchange.[2] The indeces are: the Wiener Börse Kammer (WBK) index and the ATX index. The WBK index is an index comprised of all shares traded in the stock exchange supplied by the stock exchange authority while the ATX index only includes the shares that are continuously traded on the stock exchange. However, the data available on the Vienna Stock exchange reach only from January 7, 1986 to August 31, 1992. Using weekly data this leaves 348 observations while with daily data 1648 observations are available.

Lo/MacKinlay point out it is preferable to use weekly observations to avoid excessive rejection of the random walk hypothesis that is due to the micro structure of the market.

[2]The shares and their industry affiliation are listed at the end of the paper in Appendix 1.

It was anticipated that this number of observations may be too low to provide reliable results. The compromise made therefore was to test both daily and weekly data. This besides providing a sufficiently long time series for daily data (1648 observations), also allows to evaluate how important the factors termed "micro-structure" are for the Vienna Stock exchange.

The only correction made to the data was correction for holidays (and weekends): In the application to daily data days without trade were reported as missing values. Clearly this may bias results, since the information generating process that presumably drives stock market prices does not stop on holidays. Yet, as is shown below the results concerning daily data are so robust that I feel confident that any other method of dealing with the problem will generate the same results.

When using weekly data we use observations from every Wednesday. The choice of this day was guided by the attempt to avoid the effects of weekend trading and to minimize the number of holidays. I corrected for holidays in weekly data by using the Thursday notation when Wednesday was a day without trade. If Thursday was a day without trade too, I use Tuesday notations and finally when all three days were holidays the data is reported as missing.[3]

There are a number of peculiarities of the Viennese market that make it unlikely that stock market prices follow a random walk: Markets are very thin in Vienna with only few institutional investors holding much of the liquidity (Pichler 1993). Furthermore, all

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[3] The number of instances in which Thursday's observations had to be used were altogether 7, while 2 Tuesdays and two missing data points had to be included as well.

but the 19 most traded stocks are traded only once a day in Vienna, with their prices being formed by sales maximization.

The fact that some of the stocks are not continuously traded has no effect on our results concerning individual shares, since they are all members of the class of continuously traded shares, but the index includes non-continuously traded shares, so that results may be distorted by this. Although we do not have any data on volume, evidence for the narrowness of the market comes from looking at the instances where two successive end of day notations were equal (presented in table 1). The percentage of instances where the stock prices did not move within the interval of a day is between 12% and 23% for all shares. It is to be expected that a substantial part of these are instances where no trade occurred in the relevant title.[4]

Table 1: Number of days without price changes on the Vienna Stock Exchange by Titles

	BAV	CAV	EAS	LEN	LKM	STE	UNI	VEI	WIE
days without price change	315	353	222	197	272	384	322	193	238
percentage of total observations in percent	19.11	21.42	13.47	11.95	16.50	23.30	19.54	11.71	14.44

The total number of observations is given by 1641

Looking at the development of the total number of days on which the price of a share did not change over time, it becomes evident that the pattern closely follows the development of the Vienna Stock Exchange. This has seen a boom in trading done since

[4] Note that this is data on the 9 most traded shares on the Vienna Stock Exchange.

the beginning of the 1990's. Of the in total 2496 instances in which a share did not change prices 1892 occurred in the period before 1990. Within this period the highest number was reached in 1988 with 559 and the lowest count in 1989 with 412. In 1990 there was a sharp drop in figures to 291 instances and since then every successive year has brought a reduction of about 100 occurrences.

As pointed out by Chow and Denning Variance Ratios are very closely related to autocorrelations. Indeed the Variance Ratio at q=2 is just an approximation of the autocorrelation at lag one. Looking at the autocorrelation structure will therefore provide further prior information concerning the outcomes of the testing procedures.

Table 2: Autocorrelation Structure of Daily and Weekly Stock Returns on the Viennese Stock Exchange

Daily Data

at lag	1	2	3	4	5
BAV	0.195	0.020	-0.033	0.066	0.016
CAV	0.209	-0.026	0.009	0.061	0.052
EAS	0.270	0.004	-0.031	0.026	0.052
LEN	0.263	0.077	-0.039	0.003	0.026
LKM	0.239	0.041	-0.025	-0.008	0.030
STE	0.189	-0.100	-0.106	-0.036	0.008
UNI	0.325	0.075	-0.035	-0.029	-0.029
VEI	0.204	0.030	-0.039	-0.028	-0.038
WIE	0.271	0.015	-0.078	-0.028	0.018
WBK	0.398	0.090	-0.019	0.039	0.061

Weekly Data

at lag	1	2	3	4	5
BAV	0.045	0.061	0.097	-0.006	0.001
CAV	0.109	0.103	0.082	0.036	0.002
EAS	0.071	0.060	0.060	-0.068	-0.063
LEN	0.066	0.072	0.019	-0.036	-0.064
LKM	0.055	0.002	0.115	-0.035	-0.033
STE	0.044	0.006	-0.045	0.049	0.077
UNI	-0.032	0.111	0.115	-0.044	0.035
VEI	-0.044	0.080	0.123	-0.204	0.028
WIE	0.006	0.130	0.045	0.006	0.027
WBK	0.169	0.120	0.111	-0.034	0.018

The numbers reported are estimated Autocorrelation coefficients from a time series of length 1648 with daily data and 331 with weekly data

As table 2 reports these autocorrelations are very high indeed for daily returns. The autocorrelation at a lag of one day is highest for the index, which reflects the fact that less traded shares are also included in this index. In weekly data the autocorrelations at lag one reduce substantially with all shares except for the Creditanstalt Bank (CAV in the table) when compared to the daily autocorrelations. At the same time the autocorrelations remain high for the weekly returns of the index. Autocorrelations at lags higher than one seem to play a lesser role both in daily and weekly data.

4. Results

I label the statistics where the MVR test suggests that the random walk hypotheses should be rejected at the 0.05 rejection region by a superscript (*). (The full names of the shares abbreviated in the tables are listed in Appendix 1 at the end of the paper).

Daily Data

Daily data for the individual titles suggest that the random walk hypothesis can be rejected for all of the reported shares, independently of allowing for heteroskedasticity or not (see table 3). This accords with our prior belief and the studies cited above. The surprising feature of the results is the extremely high values of the test statistics. Probability values associated with the statistics are somewhere in the realms of 10^{-32} (in the most extreme cases).

Since the prior considerations suggest that data before 1990 are considerably burdened by days in which there was no change in notation I run tests for daily data on the subperiod reaching from January 2, 1990 to August 31, 1992 with 662 observations. (The results of this additional procedure are presented in Appendix 2.) However, although the Z-values considerably reduce with no double digit entries occurring any more, still the test with homoskedastic resuduals rejects the null hypothesis for each and every title at very high probability values indeed.

The heteroscedasticity robust test fares a little better: At least for one share (Steyr-(STE)) the null hypothesis cannot be rejected and the Z-values for most other shares are lower than in the test under the assumption of homoskedastic error terms. The slight fall in the strength of rejection in the subsample that is less influenced by days without change in price is indication that at least some of the rejection can be explained by the thinness of the market.

Table 3: The MVR test procedure when applied to daily Vienna stock exchange data (single shares)

Homoskedastic test

	q=2	q=4	q=8	q=16	q=32
BAV	7.967*	6.478*	5.759*	5.334*	4.934*
CAV	8.464*	6.208*	6.328*	7.030*	6.573*
EAS	10.981*	8.604*	6.540*	5.841*	4.489*
LEN	10.713*	9.797*	7.706*	7.026*	5.479*
LKM	9.699*	8.367*	6.514*	5.504*	4.818*
STE	7.583*	2.671*	0.589	0.813	0.712
UNI	13.250*	11.902*	8.076*	7.865*	7.326*
VEI	8.320*	6.960*	4.216*	4.247*	3.020*
WIE	11.056*	8.391*	5.455*	5.248*	5.001*

Heteroskedasticity robust test

	q=2	q=4	q=8	q=16	q=32
BAV	5.271*	6.109*	6.193*	6.258*	6.281*
CAV	3.920*	4.322*	5.514*	7.524*	7.919*
EAS	7.174*	8.330*	7.133*	7.305*	5.909*
LEN	6.899*	9.149*	8.133*	8.106*	6.974*
LKM	6.518*	7.855*	7.037*	6.451*	6.114*
STE	4.857*	2.364+	0.616	0.901	0.860
UNI	8.786*	11.002*	8.944*	10.168*	10.252*
VEI	5.918*	6.768*	4.785*	5.222*	3.941*
WIE	6.204*	6.636*	5.225*	6.065*	6.266*

The values reported are the values of the test statistics which are N(0,1) under the null hypothesis. * signals that both the MVR test rejects the hypothesis at the given lag q at the 5% rejection region. The full names of the shares and the industry to which they belong is given in an appendix at the end of the paper. The results presented apply for daily returns from January 7 1986 to August 31, 1992 (1648 observations).The number of subhypotheses tested was 5 at lags of q=2,4,8,16,32

Table 4: **The MVR test procedure when applied to daily Vienna stock exchange data (indices)**

Homoskedastic test

	q=2	q=4	q=8	q=16	q=32
WBK	16.182*	14.768*	12.667*	12.633*	10.952*
ATX	13.934*	11.614*	9.364*	9.350*	7.777*

Heteroskedasticity robust test

	q=2	q=4	q=8	q=16	q=32
WBK	7.781*	7.515*	6.774*	7.418*	7.013*
ATX	7.560*	6.665*	5.641*	6.018*	5.320*

The values reported are the values of the test statistics which are N(0,1) under the null hypothesis. * signals that the MVR rejects the hypothesis at the given lag q at the 5% rejection region. The full names of the shares and the industry to which they belong is given in an appendix at the end of the paper. The results presented apply for daily returns from January 7 1986 to August 31, 1991 (1648 observations).The number of subhypotheses tested was 5 at lags of q=2,4,8,16,32

However, we lack a real explanation why these values are so extremely high even in the subsample where less trading occurred. Yet, the strength of the results seems to indicate that "micro-structure" of the market could be very important when attempting to predict prices on the Vienna Stock exchange on a daily basis. Further research on what the determinants of this clear deviation from a random walk are may therefore be warranted.

Comparing the results for individual titles with results for the indices reported in table 4 we see that rejection of the random walk hypothesis is stronger for almost all suphypotheses with both shares. In particular there seems to be very little difference between the two indices: The null being rejected at very high values for both the ATX index as well as the WBK index. Again this general pattern is retained when moving to the restricted sample reported in Appendix two although as above probability values do increase somewhat.

Weekly Data

As reported in Table 5 things are less clear cut with weekly data. In the homoskedastic variant of the tests the global null (that stock market returns follow a random walk) is rejected in only two cases with the individual shares. In the Heteroskedasticity robust test the null is rejected at the 5% level in the same instances as in the homoskedastic case, suggesting that this additional correction does not alter results much.

The two shares where the null hypothesis can be clearly rejected are the Creditanstalt (CAV) and the Universale (UNI). Some indication for the reasons of rejection of the random walk can be found when comparing the days without trade in the sample with these result: Both titles belong to the shares which have a high percentage of days with the same notations. (They rank second and third respectively in table one.) Shares which experience changes in notation more frequently on the other hand tend to have much lower statistics than shares with fewer notation changes.

Table 5: The MVR test procedure when applied to weekly Vienna stock exchange data

weekly data; Homoskedastic

	q=2	q=4	q=8	q=16	q=32
BAC	1.490	2.139	2.060	1.455	0.878
CAV(2)	2.664*	3.875*	3.718*	3.141*	3.405*
EAS	0.350	1.335	0.851	0.269	0.947
LEN	1.614	1.087	1.292	0.656	1.064
LKM	0.609	1.378	1.353	1.307	0.833
STE(1)	0.002	0.516	0.911	0.984	0.418
UNI (3)	0.409	2.252+	2.275+	3.123*	4.578*
VEI	-0.256	1.266	0.281	0.079	0.181
WIE	0.587	1.804	1.966	1.918	2.708

weekly data; Heteroskedasticity robust variant

	q=2	q=4	q=8	q=16	q=32
BAV	1.150	1.667	1.638	1.174	0.728
CAV	2.023+	3.060*	2.999*	2.621*	2.893*
EAS	0.280	1.094	0.711	0.228	0.806
LEN	1.147	1.593	1.046	0.564	0.991
LKM	0.451	1.099	1.132	1.142	0.761
STE	0.002	0.398	0.739	0.844	0.376
UNI	0.337	1.832	1.881	2.628*	4.055*
VEI	-0.203	1.011	0.230	0.066	0.156
WIE	0.415	1.354	1.563	1.592	2.370

The values reported are the values of the test statistics which are N(0,1) under the null hypothesis * signals that the MVR test rejects the hypothesis at the given lag q at the 5% level. The full names of the shares and the industry to which they belong is given in an appendix at the end of the paper. The results presented apply for weekly returns from January 7 1986 to August 31, 1991 (341 observations).The number of subhypotheses tested was 5 at lags of q=2,4,8,16,32

This suggests that the thinness of the market may be a major contributor to the deviations from the random walk hypothesis. The one exception that seems to contradict this finding is the Steyr share which has the highest percentage of non-changing notations while it has very low statistics indeed.

In contrast to daily data, statistics concerning weekly observations (reported in table 6) on the indeces show quite a different pattern from the individual shares: For both indeces the null hypothesis of a random walk can be rejected at the 5% confidence interval in the case of homoskedastic errors. However, when correcting for possible heteroskedasticities in the residual term the null hypothesis cannot be rejected any more. This suggests that the process driving the indices may be of quite different nature than the process for individual shares. One explanation for this may be that indices, in particular the WBK-Index, are more "contaminated" by the less traded shares. This may introduce some deviations from the random walk. This explanation is supported to some degree by the fact that the changes in results for the WBK-index which includes more of the less traded shares on the stock exchange are more dramatic than for the ATX index.

Table 6: The MVR test procedure when applied to weekly Vienna stock exchange data (indices)

Homoskedastic test

	q=2	q=4	q=8	q=16	q=32
WBK	1.532	3.087*	2.907*	2.276+	2.946*
ATX	1.081	2.600*	2.086	1.465	1.960

Heteroskedasticity robust test

	q=2	q=4	q=8	q=16	q=32
WBK	1.033	2.196	2.118	1.704	2.305
ATX	0.735	1.859	1.532	1.120	1.577

The values reported are the values of the test statistics which are N(0,1) under the null hypothesis. * signals that the MVR rejects the hypothesis at the given lag qat the 5% rejection region. The full names of the shares and the industry to which they belong is given in an appendix at the end of the paper. The results presented apply for weekly returns from January 7 1986 to August 31, 1991 (341 observations).The number of subhypotheses tested was 5 at lags of q=2,4,8,16,32

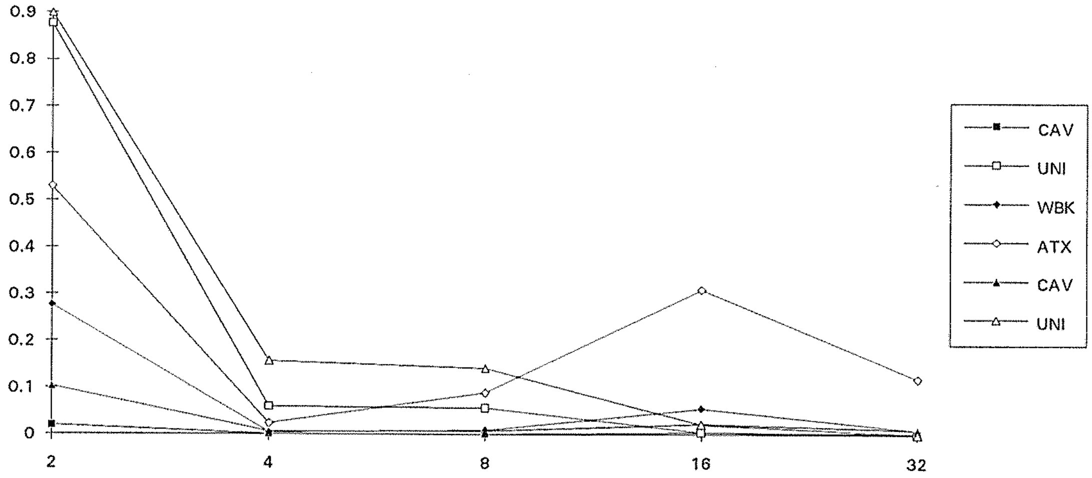
Pattern of rejection

As stated in the introduction, one of the strengths of the variance ratio test is that it can provide some information concerning the pattern of rejection in order to provide insights into what processes could possibly explain the deviation from the random walk hypothesis. Lo/MacKinley for instance point out that a mean reversion process would generate successively stronger rejections of the random walk hypothesis at longer lags. In order to exploit this particular strength of the MVR-test we look at the p-values of the test at the different subhypotheses for all those instances where rejections occurred in weekly data.

In order to visualize the result, in graph 1 we plotted the p-value according to the MVR test against the lag length. A clear pattern seems to evolve for individual titles: Rejection hardly ever occurs at q=2 but at higher lags. The p value falling rapidly in between the lags 2 and 4. This tendency for falling p-values (with the exception of the ATX) continues as the lag length increases leading to the conclusion that the long lags and in particular those over two weeks are responsible for the rejection.

The structure found therefore suggests that in those cases where the random walk hypothesis is rejected for single titles the hypothesis will be rejected most strongly at the long lags (that is longer than q=4). This in turn suggests looking for explanations of stock market behavior that will generate rejections of the random walk hypothesis:

Graph 1: Rejection pattern according to the MVR-Test



Lo/MacKinlay who find similar patterns in rejection point to mean reversion as possible explanation of this pattern. However, in their simulations - for realistic values - they produce test statistics that are not nearly as high as ours. The considerations of this paper point to two other sources of rejection that may be responsible for the pattern: The "micro-structure" of the market and thinness of the market in Vienna.

Rejection patterns for the indices differ heavily from the patterns of the individual shares. Here the p- value reaches a minimum at q=4 and then reaches higher levels again. This extreme pattern -which is more pronounced for the ATX than for the WBK index, again represents something of a mystery for which we remain without real explanation

5.Conclusions

In this paper I was mainly interested in applying variance ratio tests to data of the Austrian stock exchange and attempting to find out what the reasons for the significant deviations from the random walk could be. I found that in daily data the null hypothesis of a random walk can be rejected at very high significance levels indeed, while in weekly data the results are generally more affirmative for the random walk. However, in those cases where rejection occurs there seems to be some indication that this is to do with a large share of days in which notations did not change. The conclusion therefore is that the thinness of the market is closely associated with rejection of the random walk hypothesis.

Appendix 1: The shares analyzed

BAV	- Bank Austria Vz.	- Banking (preference shares)
CAV	- Creditanstalt Vz.	- Banking (preference shares)
EAS	- Erste Allgemeine	- Insurance
LEN	- Lenzing	- Paper/chemicals/synthetic materials
LKM	- Leykam	- Paper
STE	- Steyr	- Automobile components
UNI	- Universale	- Construction
VEI	- Veitscher	- Minerals
WIE	- Wienerberger	- Cement/Construction
WBK Index		- Index of the Viennese stock exchange authority

Appendix 2: Results of the MVR Test concerning the subperiod January 2, 1990 to August 31, 1992 (Daily Data)

	q=2	q=4	q=8	q=16	q=32
BAV	5.615*	5.360*	5.568*	5.408*	5.443*
CAV	3.155*	2.367+	3.291*	4.324*	3.528*
EAS	4.224*	3.645*	2.418+	1.851	0.880
LEN	6.301*	5.446*	3.208*	2.374*	1.243
LKM	3.589*	3.212*	2.705*	2.221	2.086
STE	2.585*	0.857	0.172	0.183	0.044
UNI	4.905*	3.128*	0.894	0.957	0.009
VEI	3.935*	2.878*	1.150	1.515	1.202
WIE	4.584*	2.707*	0.732	0.713	0.224

Heteroskedasticity robust test

	q=2	q=4	q=8	q=16	q=32
BAV	4.211*	4.121*	4.410*	4.369*	4.602*
CAV	2.343+	1.914	2.817*	3.953*	3.427*
EAS	3.642*	3.386*	2.293+	1.765	0.840
LEN	3.674*	3.468*	2.113	1.663	0.916
LKM	2.696*	2.506+	2.151	1.803	1.760
STE	1.743	0.597	0.125	0.135	0.034
UNI	4.016*	2.586*	0.760	0.850	0.008
VEI	3.255*	2.464+	1.003	1.329	1.070
WIE	3.049*	1.870	0.529	0.554	0.182

Homoskedastic test

	q=2	q=4	q=8	q=16	q=32
WBK	6.464*	5.870*	4.484*	4.416*	3.302*
ATX	6.440*	5.167*	3.542*	3.346*	2.485*

Heteroskedasticity robust test

	q=2	q=4	q=8	q=16	q=32
WBK	4.633*	4.590*	3.654*	3.716*	2.848*
ATX	5.033*	4.255*	2.943*	2.805*	2.108+

The values reported are the values of the test statistics which is N(0,1) distributedunder the null. * signals that both the SVR test rejects the hypothesis at the given lag q, at the 5% rejection region. The full names of the shares and the industry to which they belong is given in an appendix at the end of the paper. The results presented apply for daily returns from January 2, 1990 to August 31, 1991 (662 observations).The number of subhypotheses tested was 5 at lags of q=2,4,8,16,32

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