Date of completion	08 November	Group number	MIF Full time
Instructor	Dr. C.G.H. Diks	Academic year	2007/2008
Course name	Financial Econometrics-1	Semester, block	First

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Assignment # 2

1. Testing coefficients in CAPM

Estimated CAPM:

Dependent Variable: Y
Method: Least Squares
Date: 11/06/07 Time: 00:47
Sample (adjusted): 4/19/1999 4/16/2004
Included observations: 1305 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.032485	0.048418	-0.670918	0.5024
X	1.175437	0.039029	30.11730	0.0000

R-squared	0.410421	Mean dependent var	-0.047709
Adjusted R-squared	0.409969	S.D. dependent var	2.276948
S.E. of regression	1.749003	Akaike info criterion	3.957501
Sum squared resid	3985.893	Schwarz criterion	3.965430
Log likelihood	-2580.269	Hannan-Quinn criter.	3.960475
F-statistic	907.0516	Durbin-Watson stat	2.269792
Prob(F-statistic)	0.000000		

Testing α=0:

$H_0 : \alpha = 0$

$H_1 : \alpha \neq 0$

Null-distribution: $\frac{\hat{\alpha} - \alpha_{H_0}}{S.E.(\hat{\alpha})} \sim t\left[\delta/2, n-2\right]$, where δ — significance level (5% by default), n — sample size.

$$t = \frac{\hat{\alpha} - \alpha_{H_0}}{S.E.(\hat{\alpha})} = \frac{-0.032485 - 0}{0.048418} = -0.67$$

$t\left[\delta/2, n-2\right] = t\left[2,5\%, 1305-2\right] = 1.96$

As calculated t-stat is lower (in absolute values) than critical t-stat. we do not reject the null Hypothesis at 5% significance level against H_1.

Testing β=1:

$H_0 : \beta = 1$

$H_1 : \beta \neq 1$

Null-distribution: $\frac{\hat{\beta} - \beta_{H_0}}{S.E.(\hat{\beta})} \sim t\left[\delta/2, n-2\right]$, where δ — significance level (5% by default), n — sample size.

$$t = \frac{\hat{\beta} - \beta_{H_0}}{S.E.(\hat{\beta})} = \frac{1,18 - 1,00}{0.039029} = 4,61$$

As calculated t-stat is higher (in absolute values) than critical t-stat. we reject the null Hypothesis at 5% significance level against H_1.

Testing α=0 and β=1:

$H_0 : \alpha = 0 \;\; and \;\; \beta = 1$

$H_1 : \alpha \neq 0 \;\; and / or \;\; \beta \neq 1$

$F_{calculated} \sim F_\delta(q, n-k)$

, where q is a number of restriction. In our case $q = 2$, k – number parameters to estimate (here k=2), n — sample size.

Calculated F-stat is taken from Eviews and equals:

$$F = 10,36$$

Critical value equals $F_{5\%}(2, 1305-2) = 2.996$

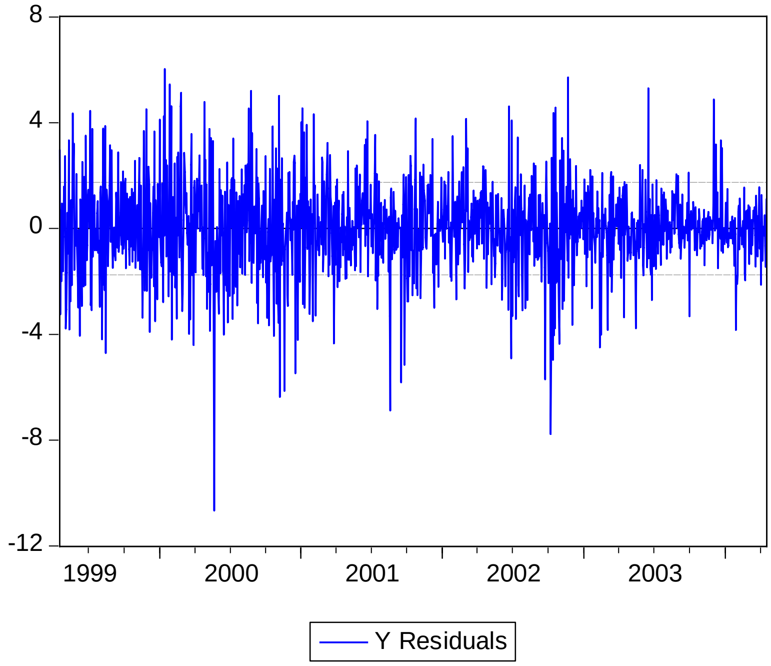
As calculated F-stat is higher than critical value — we reject the null hypotheses against alternative at 5% significance level.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	10.36053	(2, 1303)	0.0000
Chi-square	20.72107	2	0.0000

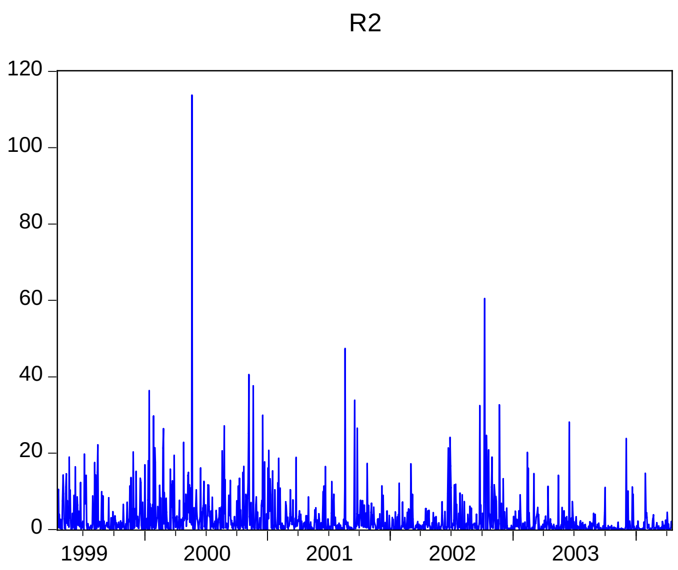
Here we see not only F- but also LM statistics. The p-values of both of them say that we should reject the null hypothesis.

2. Residual: Graphical analysis



As one can see from the graph — residuals do not have a constant volatility in time. We see a periods of high and low volatility (volatility clustering). This property can be also seen from the graph of squared residuals. So, it seems that residuals are subject to heteroskedasticity.

As for the autocorrelation — it is extremely hard to make a judgment on the basis of these graphs.



We can also use graph of squared (or absolute value) residuals for heteroskedasticity and Correlogram for autocorrelation. As we can se from the table below there is a small negative autocorrelation at lag 1 (AC and PAC equal to -0.136).

Date: 11/06/07 Time: 00:49
Sample: 4/16/1999 4/16/2004
Included observations: 1305

Autocorrelation	Partial Correlation	lag	AC	PAC	Q-Stat	Prob
*| |	*| |	1	-0.136	-0.136	24.249	0.000
| |	| |	2	0.012	-0.007	24.436	0.000
| |	| |	3	0.017	0.019	24.835	0.000
| |	| |	4	0.034	0.040	26.340	0.000
| |	| |	5	-0.029	-0.020	27.468	0.000
| |	| |	6	0.024	0.017	28.216	0.000
| |	| |	7	0.013	0.018	28.452	0.000
| |	| |	8	0.030	0.035	29.673	0.000
| |	|* |	9	0.065	0.076	35.215	0.000
| |	| |	10	-0.002	0.014	35.223	0.000

3. White test

In White test we use auxiliary regression:

$$\hat{u}_t^2 = a_0 + a_1 x_t + a_2 x_t^2 + \varepsilon_t$$

, where $\hat{u}$ — residuals from CAPM regression.

The null hypothesis of homoskedasticity:

$$H_0 : a_1 = a_2 = 0$$

The alternative hypothesis:

$$H_1 : a_1 \neq a_2 \neq 0$$

Null distribution: $F_\delta(q, n-k) = F_{5\%}(2, 1305-3) = 2.996$

Calculated F-stat = 5.82 (see table below)

Heteroskedasticity Test: White

F-statistic	5.818068	Prob. F(2,1302)	0.0031
Obs*R-squared	11.55964	Prob. Chi-Square(2)	0.0031
Scaled explained SS	24.15373	Prob. Chi-Square(2)	0.0000

As calculated F-stat is higher than critical value — reject null hypothesis against alternative one at 5% significance level. So we cannot accept hypothesis of homoskedasticity.

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/06/07 Time: 00:50
Sample: 4/19/1999 4/16/2004
Included observations: 1305

	Coefficient	Std. Error	t-Statistic	Prob.
C	2.783949	0.189885	14.66121	0.0000
X	0.015414	0.139129	0.110789	0.9118
X^2	0.175807	0.051540	3.411098	0.0007

R-squared	0.008858	Mean dependent var	3.054324
Adjusted R-squared	0.007335	S.D. dependent var	6.255798
S.E. of regression	6.232811	Akaike info criterion	6.499828
Sum squared resid	50580.01	Schwarz criterion	6.511722
Log likelihood	-4238.138	Hannan-Quinn criter.	6.504290
F-statistic	5.818068	Durbin-Watson stat	1.816400
Prob(F-statistic)	0.003051		

4. Heteroskedasticity consistent S.E.

Dependent Variable: Y
Method: Least Squares
Date: 11/06/07 Time: 00:51
Sample (adjusted): 4/19/1999 4/16/2004
Included observations: 1305 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.032485	0.048420	-0.670893	0.5024
X	1.175437	0.046494	25.28168	0.0000

R-squared	0.410421	Mean dependent var	-0.047709
Adjusted R-squared	0.409969	S.D. dependent var	2.276948
S.E. of regression	1.749003	Akaike info criterion	3.957501
Sum squared resid	3985.893	Schwarz criterion	3.965430
Log likelihood	-2580.269	Hannan-Quinn criter.	3.960475
F-statistic	907.0516	Durbin-Watson stat	2.269792
Prob(F-statistic)	0.000000		

Using heteroskedasticity consistent estimates increases the estimate for standard errors for both of estimates (constant and beta).

Testing β=1:

$H_0 : \beta = 1$

$H_1 : \beta \neq 1$

Null-distribution: $\frac{\hat{\beta} - \beta_{H_0}}{S.E.(\hat{\beta})} \sim t\left[\delta/2, n-2\right]$, where δ — significance level (5% by default), n — sample size.

$$t = \frac{\hat{\beta} - \beta_{H_0}}{S.E.(\hat{\beta})} = \frac{1,18 - 1,00}{0.046494} = 3,87$$

As calculated t-stat is higher (in absolute values) than critical t-stat. we reject the null Hypothesis at 5% significance level against H_1. So there is no difference in comparison with results in 1.

5. Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	12.33185	Prob. F(2,1301)	0.0000
Obs*R-squared	24.27925	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 11/06/07 Time: 00:54
Sample: 4/19/1999 4/16/2004
Included observations: 1305
Presample missing value lagged residuals set to zero.

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000191	0.048003	-0.003988	0.9968
X	-0.005790	0.038719	-0.149545	0.8811
RESID(-1)	-0.137235	0.027741	-4.947084	0.0000
RESID(-2)	-0.006743	0.027741	-0.243060	0.8080

R-squared	0.018605	Mean dependent var	7.08E-17
Adjusted R-squared	0.016342	S.D. dependent var	1.748333
S.E. of regression	1.733988	Akaike info criterion	3.941786
Sum squared resid	3911.737	Schwarz criterion	3.957645
Log likelihood	-2568.015	Hannan-Quinn criter.	3.947735
F-statistic	8.221233	Durbin-Watson stat	1.997118
Prob(F-statistic)	0.000020		

Breusch-Godfrey Serial Correlation LM Test uses auxiliary regression:

$$\hat{u}_t = c_0 + c_1 x_t + b_1 \hat{u}_{t-1} + b_2 \hat{u}_{t-2} + \vartheta_t$$

$H_0 : b_1 = b_2 = 0$
$H_1 : b_1 \neq b_2 \neq 0$

Null Distribution: $F_\delta(q, n-k)$ or $F_{5\%}(2, 1305-4)$
Calculated F-stat (12.33) is higher critical value of F-stat: $F_{5\%}(2, 1305-4) = 2.996$. So we reject null hypothesis of no autocorrelation against H_1.

6. Question 6

Dependent Variable: Y
Method: Least Squares
Date: 11/06/07 Time: 00:55
Sample (adjusted): 4/20/1999 4/16/2004
Included observations: 1304 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.038966	0.047988	-0.812005	0.4169
X	1.171269	0.038686	30.27620	0.0000
Y(-1)	-0.136282	0.027456	-4.963740	0.0000
X(-1)	0.189283	0.050346	3.759656	0.0002

R-squared	0.422438	Mean dependent var	-0.049519
Adjusted R-squared	0.421105	S.D. dependent var	2.276882
S.E. of regression	1.732369	Akaike info criterion	3.939920
Sum squared resid	3901.434	Schwarz criterion	3.955788
Log likelihood	-2564.828	Hannan-Quinn criter.	3.945873
F-statistic	316.9463	Durbin-Watson stat	1.995797
Prob(F-statistic)	0.000000		

a. Test for Heteroskedasticity

In this specification both lagged y and lagged x are significant variables (p-values less than 5%).

Heteroskedasticity Test: White

F-statistic	3.459051	Prob. F(9,1294)	0.0003
Obs*R-squared	30.63501	Prob. Chi-Square(9)	0.0003
Scaled explained SS	66.85879	Prob. Chi-Square(9)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/06/07 Time: 00:56
Sample: 4/20/1999 4/16/2004
Included observations: 1304

	Coefficient	Std. Error	t-Statistic	Prob.
C	2.382412	0.217737	10.94171	0.0000
X	0.001301	0.140300	0.009274	0.9926
X^2	0.164455	0.052946	3.106115	0.0019
X*Y(-1)	0.025335	0.072702	0.348483	0.7275
X*X(-1)	0.110158	0.127623	0.863152	0.3882
Y(-1)	-0.055790	0.100405	-0.555644	0.5786
Y(-1)^2	0.092998	0.028261	3.290746	0.0010
Y(-1)*X(-1)	-0.145238	0.102116	-1.422284	0.1552
X(-1)	0.201801	0.182919	1.103229	0.2701
X(-1)^2	0.093087	0.119608	0.778267	0.4366

R-squared	0.023493	Mean dependent var	2.991897
Adjusted R-squared	0.016701	S.D. dependent var	6.272385
S.E. of regression	6.219786	Akaike info criterion	6.500987
Sum squared resid	50059.34	Schwarz criterion	6.540659
Log likelihood	-4228.644	Hannan-Quinn criter.	6.515870
F-statistic	3.459051	Durbin-Watson stat	2.009003
Prob(F-statistic)	0.000315		

In White test we use auxiliary regression:

$$\hat{u}_t^2 = a_0 + a_1 x_t + a_2 x_t^2 + a_3 x_t x_{t-1} + a_4 x_{t-1}^2 + a_5 y_{t-1} x_t + a_6 x_{t-1} + a_7 y_{t-1} + a_8 y^2_{t-1} + a_9 x_{t-1} y_{t-1} + \varepsilon_t$$

, where $\hat{u}$ — residuals from CAPM regression.

The null hypothesis of homoskedasticity:

$$H_0 : a_1 = a_2 = \ldots = a_9 = 0$$

The alternative hypothesis:

$$H_0 : a_1 \neq a_2 \neq \ldots \neq a_9 = 0$$

Null distribution: $F_{\delta}(q,n-k)=F_{5\%}(9,1304-10)=1.880$
Calculated F-stat =3.46 (see table before)

As calculated F-stat is higher than critical value — reject null hypothesis against alternative one at 5% significance level. So we cannot accept hypothesis of homoskedasticity.

b. Test for Serial Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.521882	Prob. F(2,1298)	0.5935
Obs*R-squared	1.047746	Prob. Chi-Square(2)	0.5922

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 11/06/07 Time: 00:56
Sample: 4/20/1999 4/16/2004
Included observations: 1304
Presample missing value lagged residuals set to zero.

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016466	0.050693	-0.324814	0.7454
X	-0.000553	0.038714	-0.014279	0.9886
Y(-1)	-0.504043	0.499351	-1.009396	0.3130
X(-1)	0.589256	0.585238	1.006866	0.3142
RESID(-1)	0.505079	0.500178	1.009798	0.3128
RESID(-2)	-0.072991	0.073528	-0.992694	0.3210

R-squared	0.000803	Mean dependent var	-8.77E-17
Adjusted R-squared	-0.003045	S.D. dependent var	1.730374
S.E. of regression	1.733007	Akaike info criterion	3.942183
Sum squared resid	3898.299	Schwarz criterion	3.965986
Log likelihood	-2564.304	Hannan-Quinn criter.	3.951113
F-statistic	0.208753	Durbin-Watson stat	1.997441
Prob(F-statistic)	0.958893		

Breusch-Godfrey Serial Correlation LM Test uses auxiliary regression:

$$\hat{u}_t = c_0 + c_1 x_t + c_2 y_{t-1} + c_3 x_{t-1} + b_1 \hat{u}_{t-1} + b_2 \hat{u}_{t-2} + \vartheta_t$$

$H_0: b_1 = b_2 = 0$

$H_1: b_1 \neq b_2 \neq 0$

Null Distribution: $F_{\delta}(q,n-k)$ or $F_{5\%}(2,1304-6)=2.996$

Calculated F-stat 0.52 is lower than critical value of F-stat: $F_{5\%}(2,1304-6)=2.996$. So we reject H_1 against H_0 (“accepts H_0 ”). So we do not reject hypothesis of no autocorrelation at 5% level.

This example proves that there were a dynamic relationship between *y* and *x*: including lagged *x* and *y*, solves the problem with autocorrelation. Unfortunately, it does not lead to elimination of heteroskedasticity (and in general, it should not)

7. Sensitivity to the market return

$$y_t = a_0 + a_1 x_t + a_2 y_{t-1} + a_3 x_{t-1} + \varepsilon_t$$

In the long run all future shocks are set to zero and:

$y_t \to y^*$

$x_t \to x^*$

$$y^* = a_0 + a_1 x^* + a_2 y^* + a_3 x^*$$

$$y^* = \frac{a_0}{1-a_2} + \left(\frac{a_1 + a_3}{1-a_2}\right) x^*$$

, where $\left(\frac{a_1 + a_3}{1-a_2}\right)$ — long term sensitivity of GM excess returns to market excess returns.

Given estimates of a_1, a_2, a_3, long term sensitivity is $\left(\frac{1.171269 + 0.189283}{1 + 0.136282}\right) = 1.197$, which is slightly higher than the short terms sensitivity (common beta) 1,17.