Presentation of the seminar paper:

GARCH-models dealing with daily stock prices of two different banks (VPB and LLB) and TAR-models regarding monthly unemployment data (Austria, Switzerland and Liechtenstein)

PhD-Course „Nonlinear Time Series Analysis"
Hosted by Prof. Robert Kunst
University of Vienna (Department of Economics)
January 18th, 2011

Motivation

1. Investigation of daily stock prices of the banks “Liechtensteinische Landesbank” and “Verwaltungs- und Privatbank“ from 2006 until 2010 and assessing the impact of the financial crisis and the “Zumwinkel-Affair” on performance and risk (using GARCH-models)

2. Examination of monthly unemployment figures from Austria, Switzerland and Liechtenstein from 1995 until 2009 applying Threshold Autoregressive (TAR) models in order to check whether the dynamics in economic contractions are different from those in expansions

2. GARCH-models on stock prices

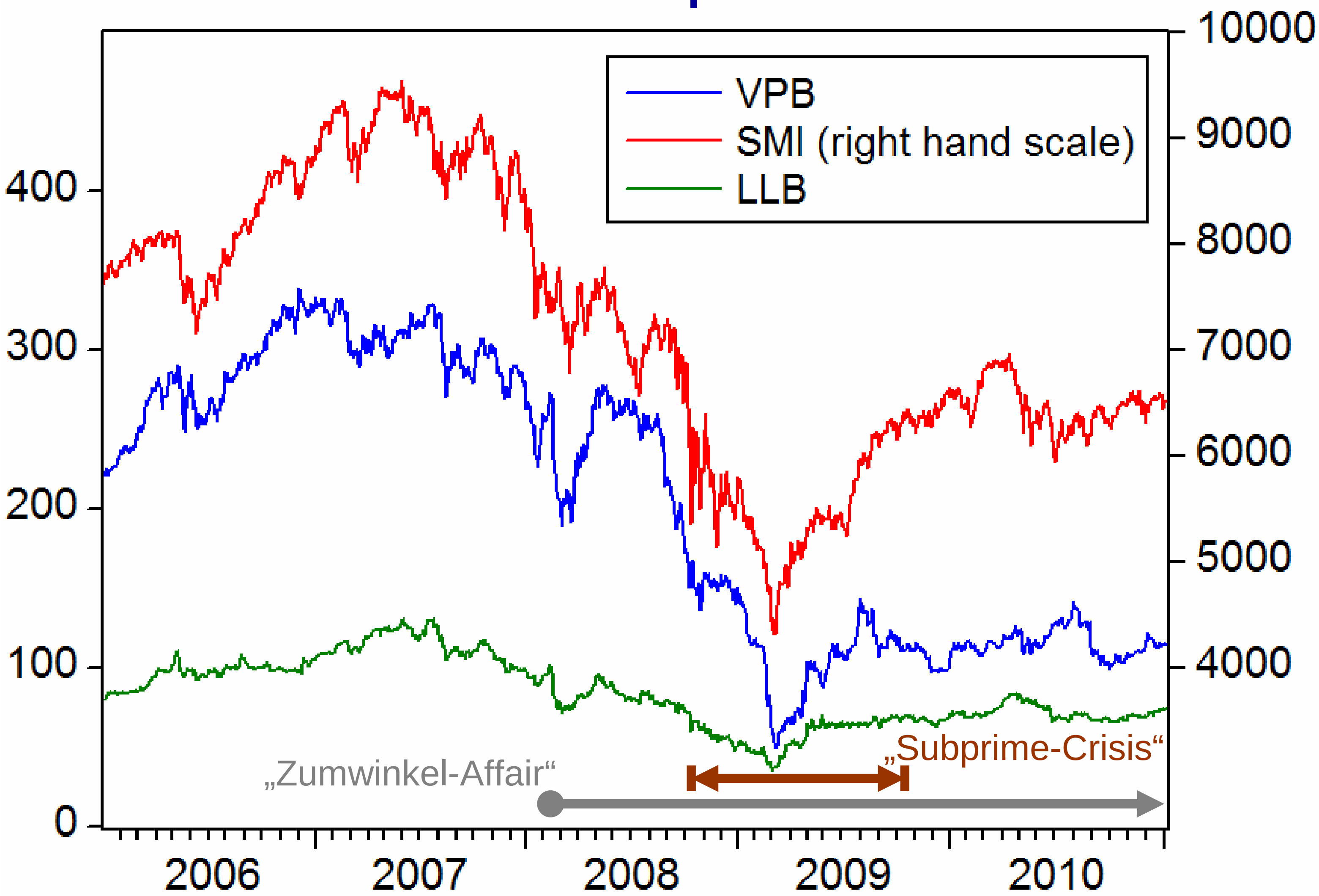
Investigating daily stock prices of the two banks “Liechtensteinische Landesbank AG (LLB)” and “Verwaltungs- und Privatbank AG (VPB)” from January 1st 2006 until December 31th 2010:

- GARCH-approach following Engle [1982] and Bollerslev [1986]
- Dependent variables: Daily percentage change of stock price (VPB or LLB)
- ? Influence on performance (mean equation) AND risk (variance equation):
  - Controlling variables: Performance of Swiss Market Index (%-change of SMI) and past performance of bank’s stock price (%-change of VPB or LLB)
  - Additional impact of financial/subprime crisis: Time dummy from october 6th (2008) until october 19th (2009)
  - Additional impact of data theft (“Zumwinkel-affair”): Time dummy from february 15th (2008) until december 31th (2010)
  - Augmented GARCH-specification of variance equation: Squared past residuals and past conditional variance are supplemented by squared control variables (same as in mean euqation) and by the dummy variables (“subprime crisis” and “data theft”)

Data theft: „Zumwinkel-affair“

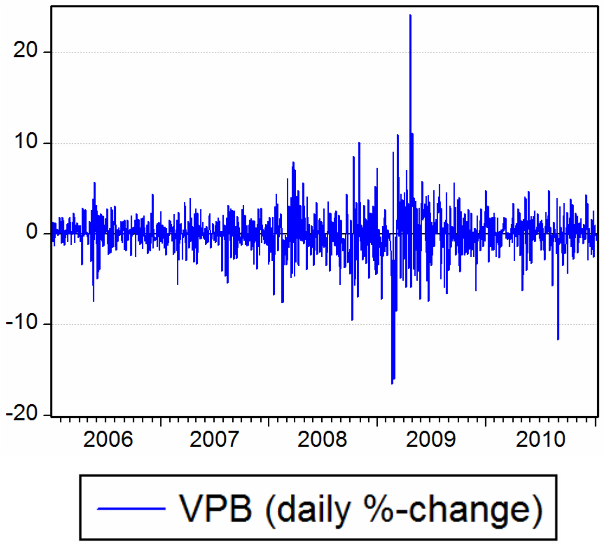
Heinrich Kieber sold stolen data (containing clients of the LGT Bank) to the german intelligence service (BND) for 5 Million Euro, which led to approximately 600 tax evasion proceedings in 2008. He also sold data to 13 other countries. Direct and indirect consquences for Liechtenstein: Strong capital outflow, trial against LGT and political pressure on Liechtenstein, which led to agreements on tax information exchange with (so far) 25 countries. Kieber’s domicil is still unknown...

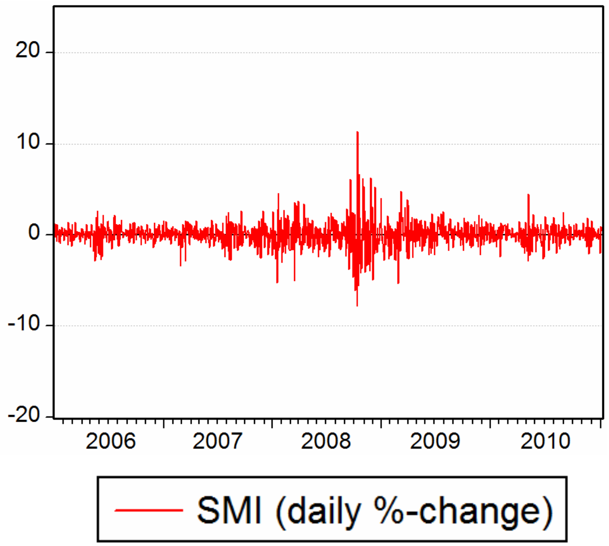
Used data series: Visual inspection

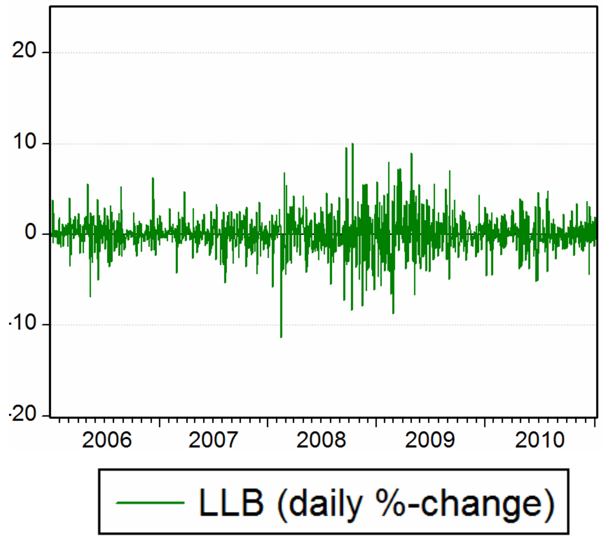


Modified data series: Visual and descriptive inspection

➔ Calculation of daily percentage differences (%ΔVPB, %ΔSMI, %ΔLLB):



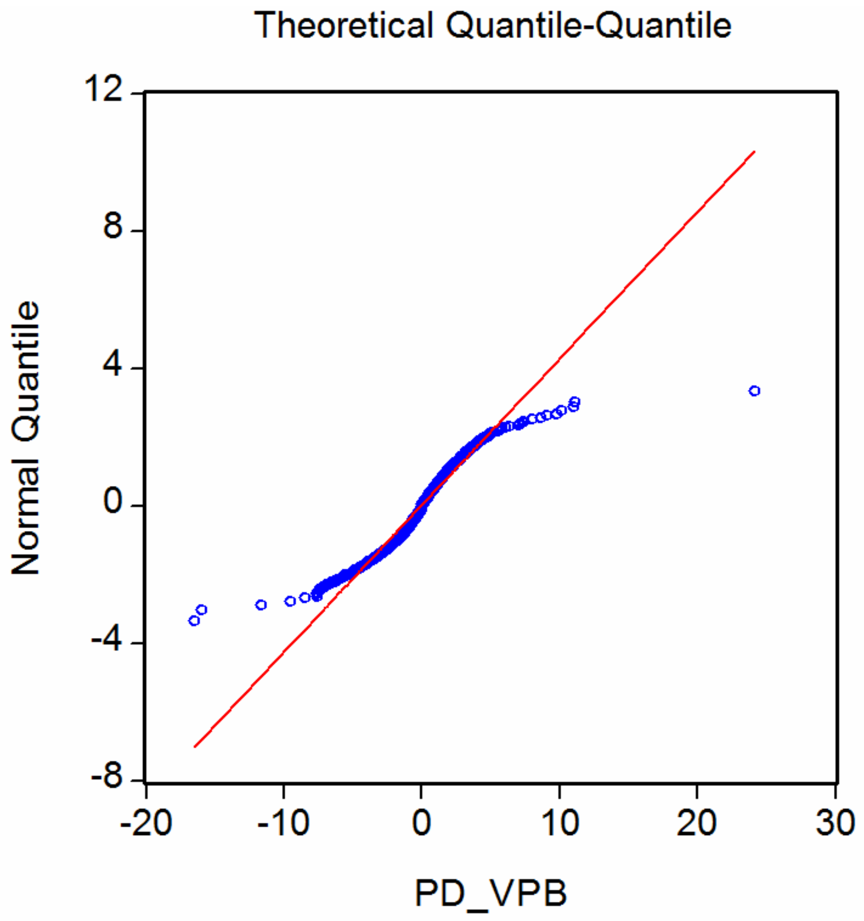


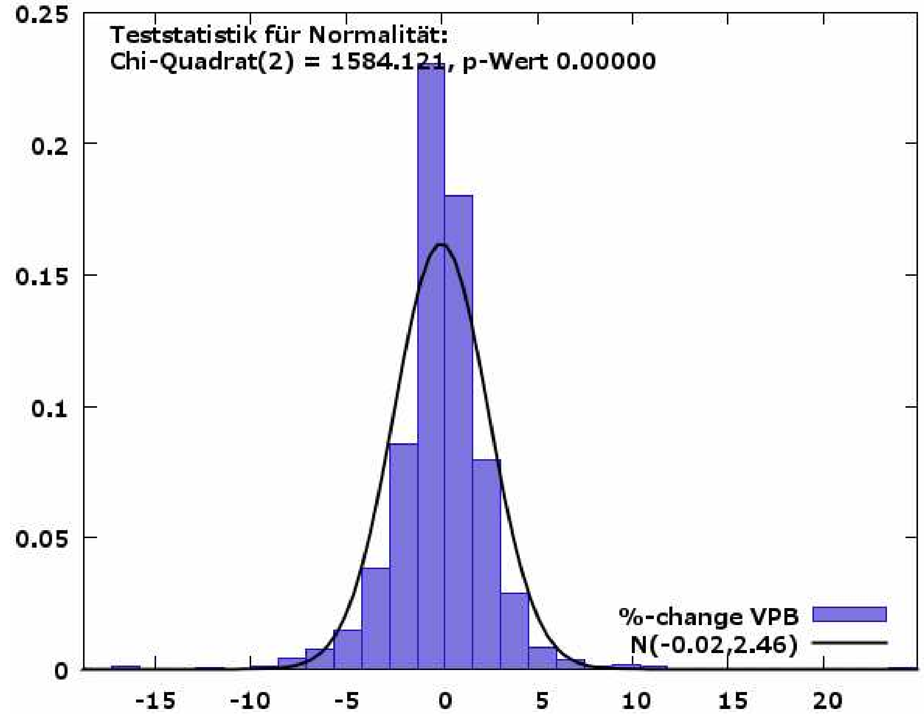


	%ΔLLB	%ΔSMI	%ΔVPB
Mean (1st moments)	0.0149	-0.0035	-0.0224
Median	0.0000	0.0496	0.0000
Maximum	10.0000	11.3910	24.1782
Minimum	-11.3918	-7.7881	-16.5276
Std. Dev. (2nd moments)	2.0472	1.3427	2.4599
Skewness (3rd moments)	-0.01668	0.3070	0.2726
Kurtosis (4th moments)	6.3034	11.0651	15.0161

❗ Pattern of all three series: Leptokurtosis and volatility clustering. First indications that a GARCH-model could be fruitful.

Stock prices VPB (%Δ): First impression





➔ Heavy tails: Leptokurtic property of fourth moments evident (Kurtosis = 15.02 > 3)

Stock prices VPB (%Δ): First impression

- ➔ ACF of %-change of VPB stock prices (denoted below as „PD_VPB“) unveils no autocorrelation, while ACF of squared stock prices (PD_VPB^2) shows significant autocorrelation and therefore heteroskedastic characteristics.
- ➔ Ordinary estimation (without GARCH-modeling) yields autocorrelated squared residuals, while non-squared residuals are not autocorrelated: Positive dependency of residuals‘ second moments means that variance is not constant over time (heteroskedasticity, volatility clustering). Results are shown below:

Dependent Variable: PD_VPB
Method: Least Squares
Date: 01/16/11 Time: 21:25
Sample (adjusted): 1/05/2006 1/04/2011
Included observations: 1256 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PD_VPB(-1)	0.043607	0.026374	1.653386	0.0985
PD_SMI	0.652914	0.048323	13.51158	0.0000
SUBPRIMECRISIS	-0.019899	0.178008	-0.111785	0.9110
DATATHEFT	-0.061710	0.106261	-0.580735	0.5615

R-squared	0.129675	Mean dependent var	-0.022798
Adjusted R-squared	0.127590	S.D. dependent var	2.460821
S.E. of regression	2.298478	Akaike info criterion	4.505551
Sum squared resid	6614.315	Schwarz criterion	4.521906
Log likelihood	-2825.486	Durbin-Watson stat	2.042928

Correlogram of squared residuals ($\hat{u}_t^2$)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.134	0.134	22.751	0.000
		2	0.085	0.068	31.922	0.000
		3	0.130	0.113	53.382	0.000
		4	0.133	0.101	75.560	0.000
		5	0.208	0.173	130.04	0.000
		6	0.030	-0.038	131.16	0.000
		7	0.048	0.004	134.04	0.000
		8	0.081	0.026	142.35	0.000
		9	0.076	0.028	149.69	0.000
		10	0.101	0.052	162.52	0.000

Stock prices VPB (%Δ): First impression

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ARCH Test:

F-statistic	19.78249	Probability	0.000000
Obs*R-squared	92.07405	Probability	0.000000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/12/11 Time: 17:46
Sample (adjusted): 1/12/2006 1/04/2011
Included observations: 1251 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.808677	0.601979	4.665742	0.0000
RESID^2(-1)	0.088483	0.027914	3.169867	0.0016
RESID^2(-2)	0.031312	0.027928	1.121157	0.2624
RESID^2(-3)	0.092864	0.027818	3.338267	0.0009
RESID^2(-4)	0.082709	0.027928	2.961512	0.0031
RESID^2(-5)	0.172990	0.027914	6.197282	0.0000

R-squared	0.073600	Mean dependent var	5.283407
Adjusted R-squared	0.069880	S.D. dependent var	19.81501
S.E. of regression	19.11013	Akaike info criterion	8.743099
Sum squared resid	454670.5	Schwarz criterion	8.767712
Log likelihood	-5462.808	F-statistic	19.78249
Durbin-Watson stat	1.986909	Prob(F-statistic)	0.000000

! ARCH tests (Engle [1982]) supports findings of sample quantile, observed distribution (leptokurtic), ACF of squared residuals: Existence of autoregressive conditional heteroskedasticity.

Stock prices VPB (%Δ): Estimated GARCH-model

$$\%\Delta VPB_t = \alpha_1 + \beta_1 \cdot \%\Delta VPB_{t-1} + \beta_2 \cdot \%\Delta SMI_t + \beta_3 \cdot SUBPRIMECRISIS_t + \beta_4 \cdot DATATHEFT_t + \hat{u}_t$$

$$u_t \mid \Omega_t \sim \text{iid N}(0, h_t)$$

$$h_t = \alpha_2 + \sum_{i=1}^{p} \delta_i \cdot h_{t-i} + \sum_{j=1}^{q} \gamma_j \cdot u_{t-j}^2 + \beta_5 \cdot \%\Delta VPB_{t-1}^2 + \beta_6 \cdot \%\Delta SMI_{t-1}^2 + \beta_7 \cdot SUBPRIMECRISIS_t + \beta_8 \cdot DATATHEFT_t$$

- Dependent variable: Daily percentage change of stock price (VPB)
- Influence on performance (mean equation) AND risk (variance equation):
  - Controlling variables: Performance of Swiss Market Index (%-change of SMI) and past performance of bank's stock price (%-change of VPB)
  - Additional impact of financial crisis/subrime crisis (<u>additional effect beyond influence of crisis via SMI</u>): Time dummy from october 6th (2008) until october 19th (2009)
  - Additional impact of data theft (<u>separated from impact of financial crisis</u>): Time dummy from february 15th (2008) until december 31th (2010)
  - Augmented GARCH-specification of variance equation: Squared past residuals and past conditional variance are supplemented by squared control variables (same as in mean equation) and by the dummy variables ("financial crisis" and "data theft")

Stock prices VPB (%Δ): Estimation output

Dependent Variable: PD_VPB
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 01/14/11 Time: 00:49
Sample (adjusted): 1/05/2006 1/04/2011
Included observations: 1256 after adjustments
Convergence achieved after 42 iterations
Variance backcast: ON
GARCH = C(5) + C(6)*GARCH(-1) + C(7)*PD_VPB(-1)^2 + C(8)
*PD_SMI(-1)^2 + C(9)*SUBPRIMECRISIS + C(10)*DATATHEFT

	Coefficient	Std. Error	z-Statistic	Prob.
PD_VPB(-1)	-0.010239	0.031656	-0.323430	0.7464
PD_SMI	0.594137	0.042882	13.85515	0.0000
SUBPRIMECRISIS	-0.019577	0.261002	-0.075007	0.9402
DATATHEFT	-0.017935	0.091245	-0.196553	0.8442
Variance Equation				
C	0.307309	0.084682	3.628972	0.0003
GARCH(-1)	0.645165	0.064753	9.963490	0.0000
PD_VPB(-1)^2	0.108462	0.022197	4.886225	0.0000
PD_SMI(-1)^2	0.169894	0.041518	4.092028	0.0000
SUBPRIMECRISIS	1.982111	0.497751	3.982132	0.0001
DATATHEFT	0.454955	0.121831	3.734311	0.0002

R-squared	0.125485	Mean dependent var	-0.022798
Adjusted R-squared	0.119169	S.D. dependent var	2.460821
S.E. of regression	2.309545	Akaike info criterion	4.147858
Sum squared resid	6646.159	Schwarz criterion	4.188747
Log likelihood	-2594.855	Durbin-Watson stat	1.926045

➔ Impact on performance (mean equation):
- Controlling variables:
  - ✓ No indicated autocorrelation of %-change of VPB stocks
  - ✓ %-change of SMI-Index highly significant
- Variables of main interest:
  - ✓ Data theft had no significant influence
  - ✓ Financial/subprime crisis had no significant effect (which has not been covered by the SMI so far)

➔ Impact on risk/volatility (variance equation):
- Controlling variables:
  - ✓ %-change of VPB stock prices (one day before) has a positive significant effect on conditional variance
  - ✓ %-change of SMI-Index (one day before) has a positive significant effect on conditional variance
  - ✓ Conditional variance is positively dependent on past conditional variance
- Variables of main interest:
  - ✓ Data theft had increasing effect on conditional variance additional to influence of financial crisis
  - ✓ Financial/subprime crisis had a strong effect that was not covered by the impact of crisis via SMI

Stock prices VPB (%Δ): Estimation output

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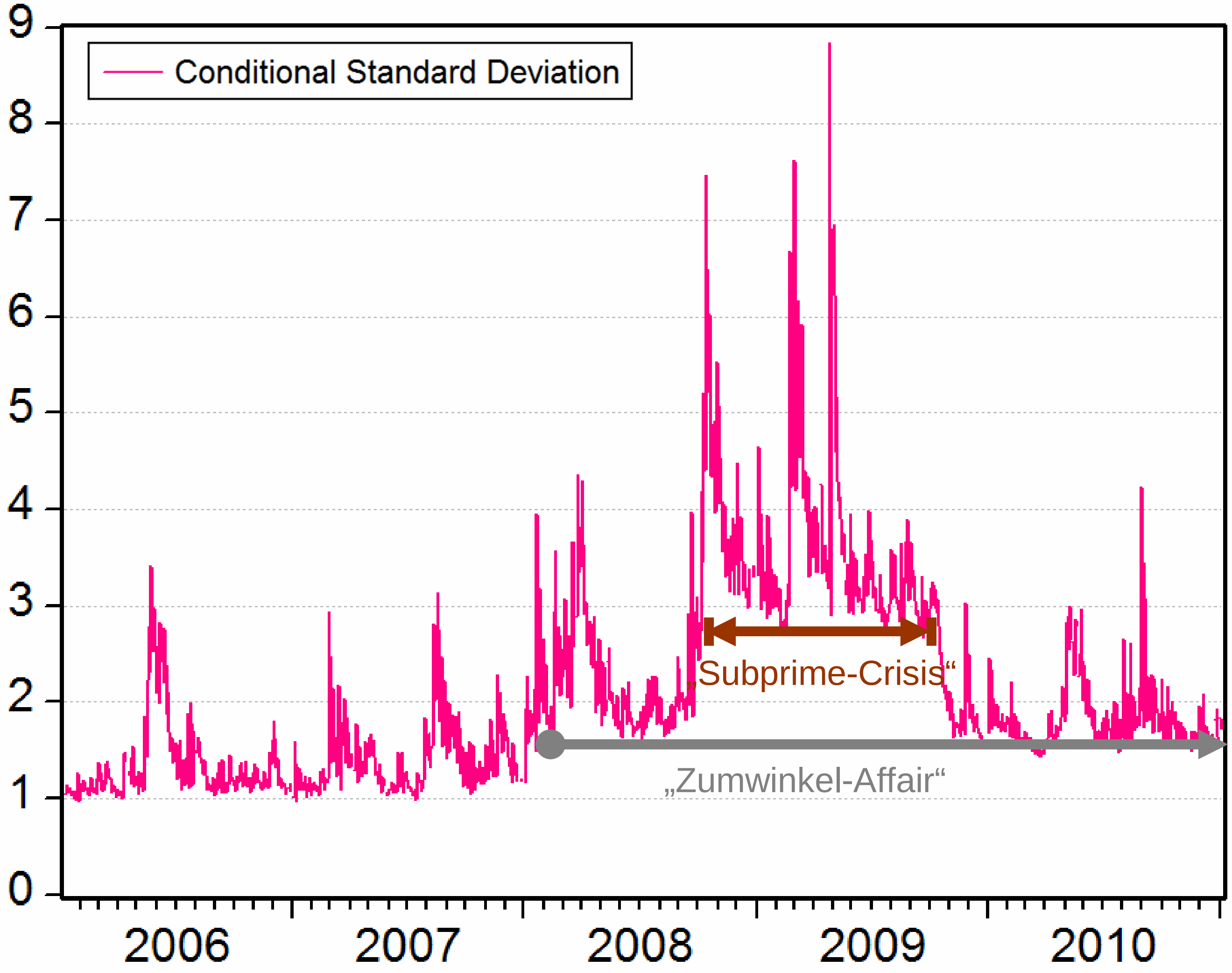
Correlogram of squared residuals ($\hat{u}_t^2$)

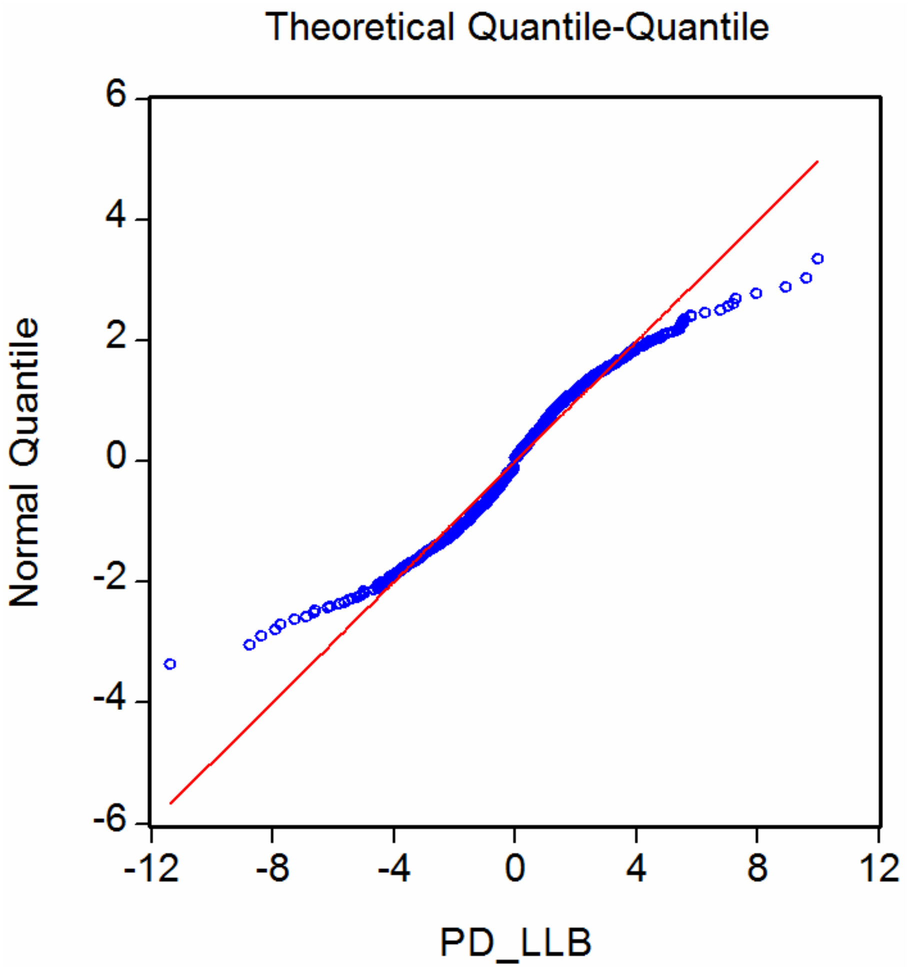
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.005	0.005	0.0258	0.872
		2	-0.005	-0.005	0.0634	0.969
		3	-0.014	-0.013	0.2934	0.961
		4	0.005	0.005	0.3196	0.989
		5	0.010	0.010	0.4559	0.994
		6	-0.037	-0.038	2.2232	0.898
		7	-0.019	-0.019	2.6997	0.911
		8	0.000	0.000	2.6997	0.952
		9	0.005	0.003	2.7277	0.974
		10	0.014	0.013	2.9626	0.982

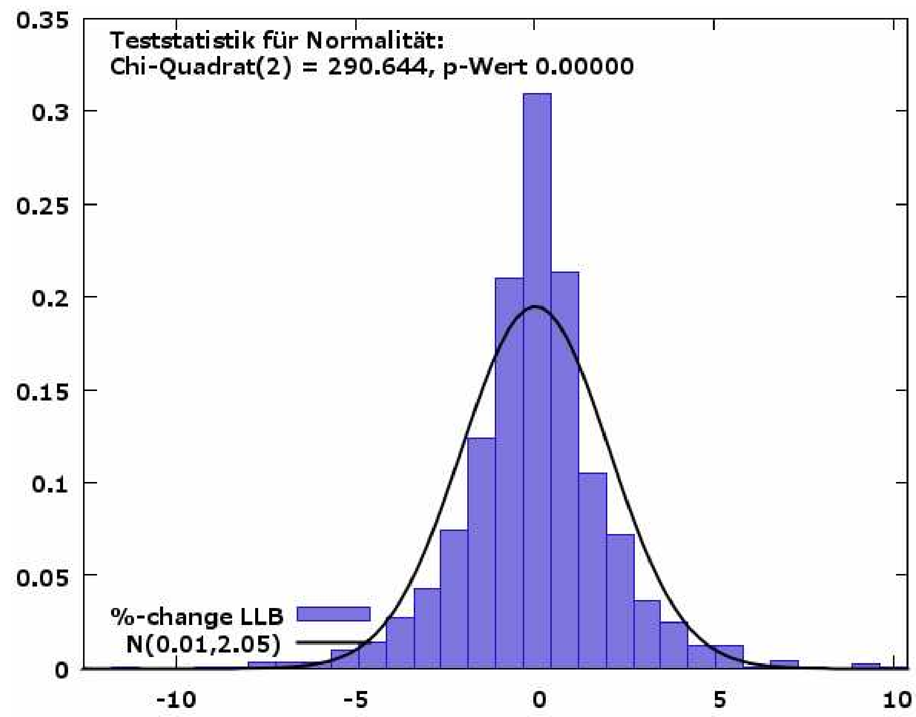
- ✓ As a result of the incorporation of GARCH-equation, squared residuals feature no autocorrelation anymore.

Stock prices VPB (%Δ): Estimated conditional variance



Stock prices LLB (%Δ): First impression





➔ Heavy tails: Leptokurtic property of fourth moments evident (Kurtosis = 6.30 > 3)

Stock prices LLB (%Δ): First impression

➔ ACF of %-change of LLB stock prices (denoted below as „PD_LLB“) unveils only autocorrelation of the first lag, while ACF of squared stock prices (PD_LLB^2) shows strong autocorrelation (for several lags) and therefore heteroskedastic characteristics.

➔ Ordinary estimation (without GARCH-modeling) yields autocorrelated squared residuals, while non-squared residuals are not autocorrelated: Positive dependency of residuals‘ second moments means that variance is not constant over time (heteroskedasticity, volatility clustering). Results are shown below:

Dependent Variable: PD_LLB
Method: Least Squares
Date: 01/16/11 Time: 21:35
Sample (adjusted): 1/05/2006 1/04/2011
Included observations: 1256 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PD_LLB(-1)	-0.055013	0.027140	-2.027017	0.0429
PD_SMI	0.416425	0.041392	10.06045	0.0000
SUBPRIMECRISIS	0.080021	0.152443	0.524923	0.5997
DATATHEFT	-0.041855	0.090990	-0.459994	0.6456

R-squared	0.078506	Mean dependent var	0.014775
Adjusted R-squared	0.076298	S.D. dependent var	2.047996
S.E. of regression	1.968317	Akaike info criterion	4.195415
Sum squared resid	4850.590	Schwarz criterion	4.211770
Log likelihood	-2630.720	Durbin-Watson stat	2.063262

Correlogram of squared residuals ($\hat{u}_t^2$)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.225	0.225	63.565	0.000
		2	0.110	0.063	78.890	0.000
		3	0.101	0.067	91.670	0.000
		4	0.120	0.084	109.92	0.000
		5	0.149	0.103	138.09	0.000
		6	0.128	0.064	158.69	0.000
		7	0.185	0.131	201.95	0.000
		8	0.015	-0.083	202.23	0.000
		9	0.099	0.072	214.74	0.000
		10	0.073	0.002	221.42	0.000

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Log likelihood	-2630.720	Durbin-Watson stat	2.063262

ARCH Test:

F-statistic	17.49565	Probability	0.000000
Obs*R-squared	126.6722	Probability	0.000000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/13/11 Time: 19:16
Sample (adjusted): 1/17/2006 1/04/2011
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.893423	0.316564	5.981176	0.0000
RESID^2(-1)	0.188414	0.028310	6.655276	0.0000
RESID^2(-2)	0.026926	0.028512	0.944367	0.3452
RESID^2(-3)	0.041435	0.028497	1.454037	0.1462
RESID^2(-4)	0.060222	0.028409	2.119808	0.0342
RESID^2(-5)	0.089206	0.028406	3.140347	0.0017
RESID^2(-6)	0.042265	0.028471	1.484501	0.1379
RESID^2(-7)	0.145438	0.028483	5.106122	0.0000
RESID^2(-8)	-0.083109	0.028285	-2.938254	0.0034

R-squared	0.101500	Mean dependent var	3.872228
Adjusted R-squared	0.095699	S.D. dependent var	8.891254
S.E. of regression	8.455117	Akaike info criterion	7.114606
Sum squared resid	88574.87	Schwarz criterion	7.151596
Log likelihood	-4430.514	F-statistic	17.49565
Durbin-Watson stat	1.987927	Prob(F-statistic)	0.000000

! ARCH tests (Engle [1982]) supports findings of sample quantile, observed distribution (leptokurtic), ACF of squared residuals: Existence of autoregressive conditional heteroskedasticity.

Stock prices LLB (%Δ): Estimation output

$$\%\Delta LLB_t = \alpha_1 + \beta_1 \cdot \%\Delta LLB_{t-1} + \beta_2 \cdot \%\Delta SMI_t + \beta_3 \cdot SUBPRIMECRISIS_t + \beta_4 \cdot DATATHEFT_t + \hat{u}_t$$

$$u_t \,|\, \Omega_t \sim \text{iid N}\left(0, h_t\right)$$

$$h_t = \alpha_2 + \sum_{i=1}^{p} \delta_i \cdot h_{t-i} + \sum_{j=1}^{q} \gamma_j \cdot u_{t-j}^2 + \beta_5 \cdot \%\Delta LLB_{t-1}^2 + \beta_6 \cdot \%\Delta SMI_{t-1}^2 + \beta_7 \cdot SUBPRIMECRISIS_t + \beta_8 \cdot DATATHEFT_t$$

- Dependent variable: Daily percentage change of stock price (LLB)
- Influence on performance (mean equation) AND risk (variance equation):
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Convergence achieved after 17 iterations
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*PD_SMI(-1)^2 + C(9)*SUBPRIMECRISIS + C(10)*DATATHEFT

	Coefficient	Std. Error	z-Statistic	Prob.
PD_LLB(-1)	-0.086890	0.032827	-2.646936	0.0081
PD_SMI	0.416952	0.039077	10.67009	0.0000
SUBPRIMECRISIS	0.078399	0.188691	0.415490	0.6778
DATATHEFT	-0.010578	0.074336	-0.142297	0.8868
Variance Equation				
C	0.421693	0.092447	4.561443	0.0000
GARCH(-1)	0.533147	0.060467	8.817209	0.0000
PD_LLB(-1)^2	0.163867	0.022305	7.346628	0.0000
PD_SMI(-1)^2	0.244959	0.050403	4.859966	0.0000
SUBPRIMECRISIS	1.224834	0.383799	3.191338	0.0014
DATATHEFT	0.161700	0.076432	2.115617	0.0344

R-squared	0.077355	Mean dependent var	0.014775
Adjusted R-squared	0.070691	S.D. dependent var	2.047996
S.E. of regression	1.974282	Akaike info criterion	3.949250
Sum squared resid	4856.648	Schwarz criterion	3.990139
Log likelihood	-2470.129	Durbin-Watson stat	2.001918

➔ Impact on performance (mean equation):

- Controlling variables:
  - ✓ Significant autocorrelation of %-change of LLB stocks
  - ✓ %-change of SMI-Index highly significant
- Variables of main interest:
  - ✓ Data theft had no significant influence
  - ✓ Financial/subprime crisis had no significant effect (which has not been covered by the SMI so far)

➔ Impact on risk/volatility (variance equation):

- Controlling variables:
  - ✓ %-change of LLB stock prices (one day before) has positive significant effect on conditional variance
  - ✓ %-change of SMI-Index (one day before) has positive significant effect on conditional variance
  - ✓ Conditional variance is positively dependent on past conditional variance
- Variables of main interest:
  - ✓ Data theft had (small) increasing effect on conditional variance additional to influence of financial crisis
  - ✓ Financial/subprime crisis had a strong effect that was not covered by the impact of crisis via SMI

Stock prices LLB (%Δ): Estimation output

Dependent Variable: PD_LLB
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 01/14/11 Time: 17:00
Sample (adjusted): 1/05/2006 1/04/2011
Included observations: 1256 after adjustments
Convergence achieved after 17 iterations
Variance backcast: ON
GARCH = C(5) + C(6)*GARCH(-1) + C(7)*PD_LLB(-1)^2 + C(8)
*PD_SMI(-1)^2 + C(9)*SUBPRIMECRISIS + C(10)*DATATHEFT

	Coefficient	Std. Error	z-Statistic	Prob.
PD_LLB(-1)	-0.086890	0.032827	-2.646936	0.0081
PD_SMI	0.416952	0.039077	10.67009	0.0000
SUBPRIMECRISIS	0.078399	0.188691	0.415490	0.6778
DATATHEFT	-0.010578	0.074336	-0.142297	0.8868
		Variance Equation		
C	0.421693	0.092447	4.561443	0.0000
GARCH(-1)	0.533147	0.060467	8.817209	0.0000
PD_LLB(-1)^2	0.163867	0.022305	7.346628	0.0000
PD_SMI(-1)^2	0.244959	0.050403	4.859966	0.0000
SUBPRIMECRISIS	1.224834	0.383799	3.191338	0.0014
DATATHEFT	0.161700	0.076432	2.115617	0.0344

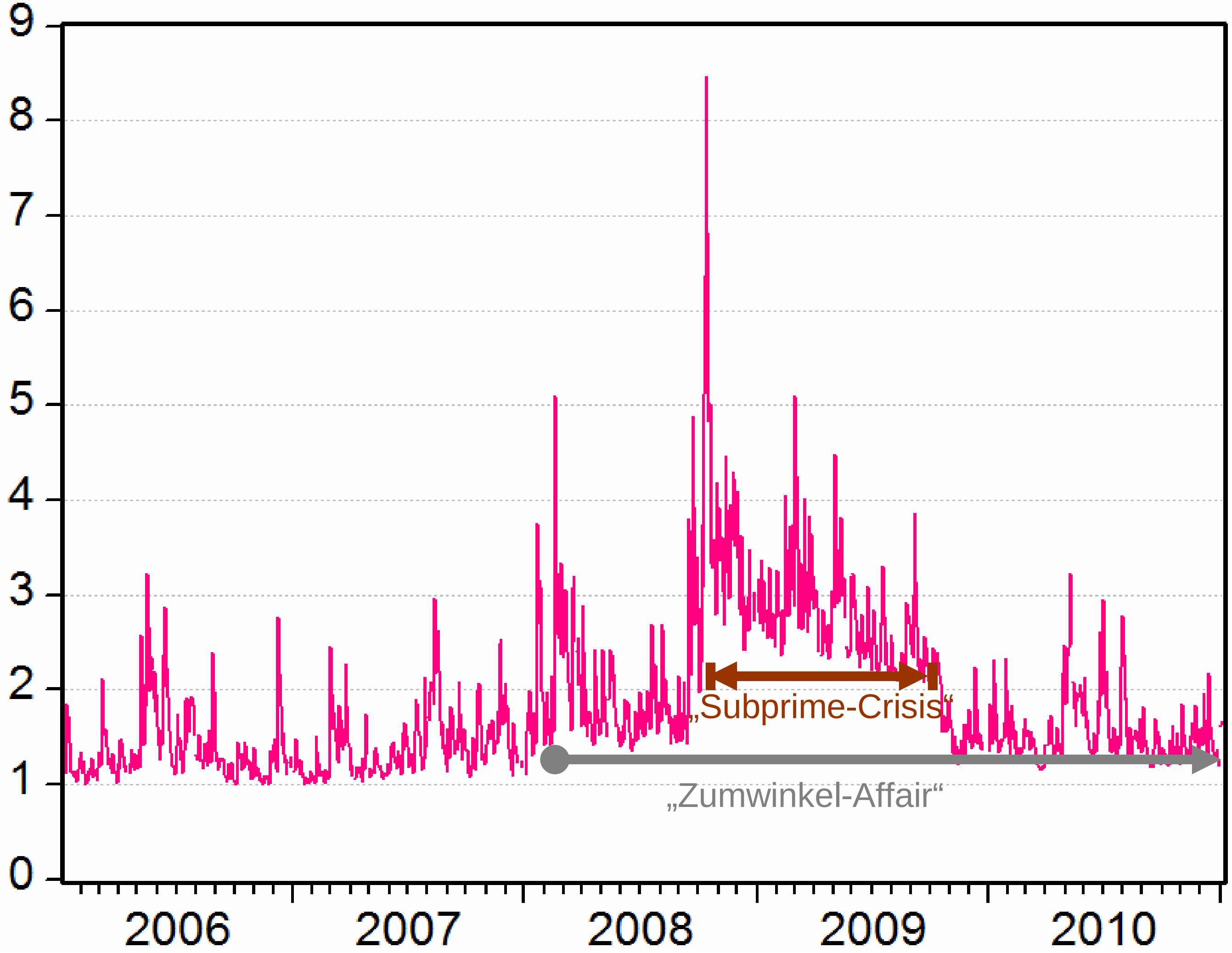
R-squared	0.077355	Mean dependent var	0.014775
Adjusted R-squared	0.070691	S.D. dependent var	2.047996
S.E. of regression	1.974282	Akaike info criterion	3.949250
Sum squared resid	4856.648	Schwarz criterion	3.990139
Log likelihood	-2470.129	Durbin-Watson stat	2.001918

Correlogram of squared residuals ($\hat{u}_t^2$)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.031	0.031	1.1891	0.276
		2	-0.020	-0.021	1.7011	0.427
		3	-0.031	-0.030	2.9305	0.402
		4	0.019	0.020	3.3643	0.499
		5	0.053	0.050	6.8522	0.232
		6	0.045	0.041	9.3559	0.155
		7	0.014	0.014	9.5958	0.213
		8	-0.063	-0.060	14.635	0.067
		9	-0.021	-0.017	15.209	0.085
		10	-0.009	-0.014	15.322	0.121

- ✓ As a result of the incorporation of GARCH-component, squared residuals feature no autocorrelation anymore.

Stock prices LLB (%Δ): Estimated conditional variance



3. TAR-models on unemployment

Analysing monthly unemployment figures of Austria, Switzerland and Liechtenstein from January 1995 until December 2009:

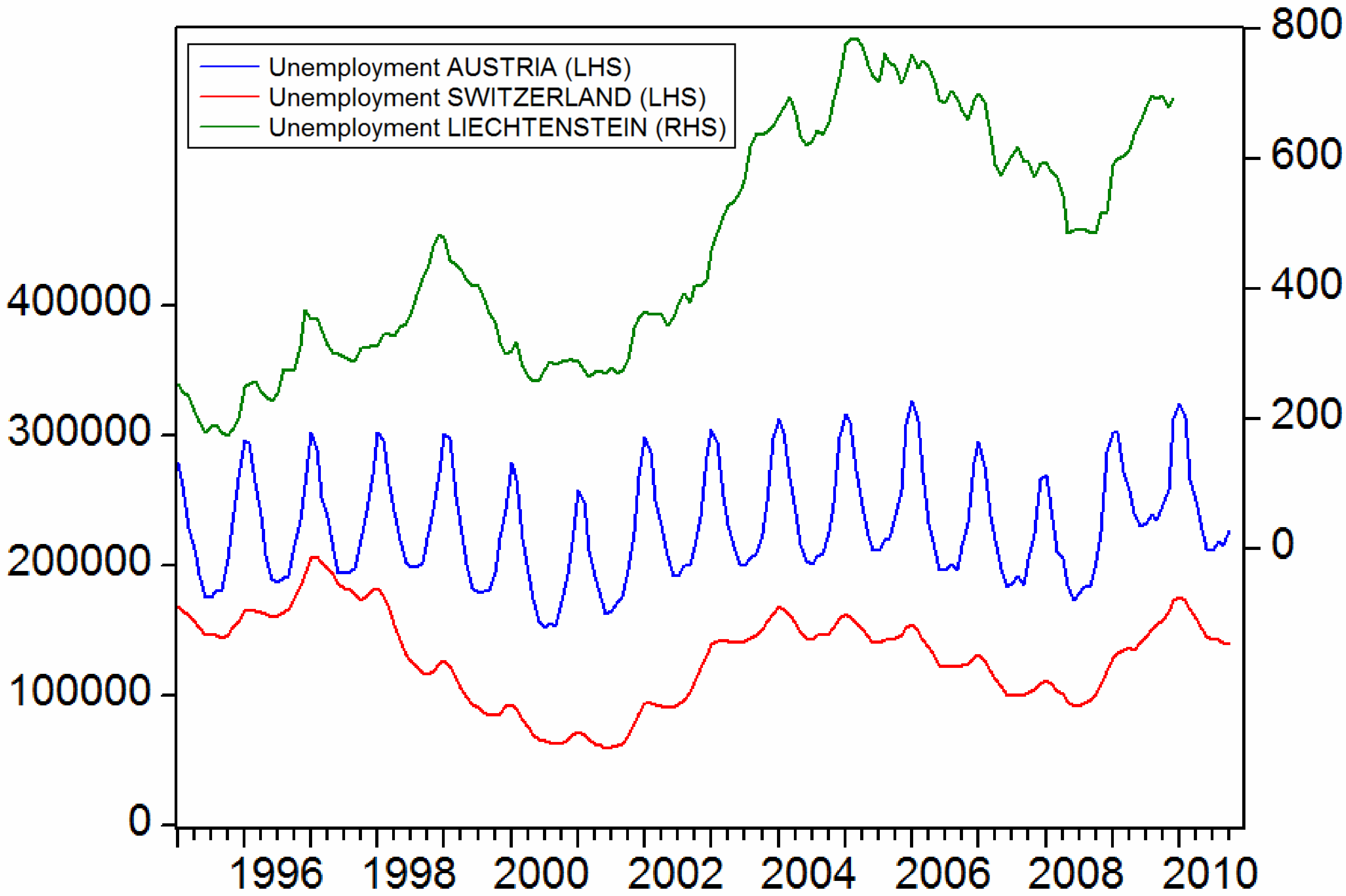
- Threshold Autoregressive (TAR)-model after Tong [1977]
- Dependent variables: Monthly, seasonally-adjusted percentage change of number of unemployed people (Austria, Switzerland or Liechtenstein)

? Inspection whether approach applying two different regimes is more appropriate than an "ordinary" AR(MA)-model for entire sample:

  - Two different AR-models depending on past unemployment (Seasonally adjusted %-change one month before: Either greater or smaller than 0)
  - Approach of Baragona/Cucina [2009] to find TAR-specification: Genetic algorithm to evaluate the number of regimes, delay, delay parameter, lag length and estimation of model parameters[1)].

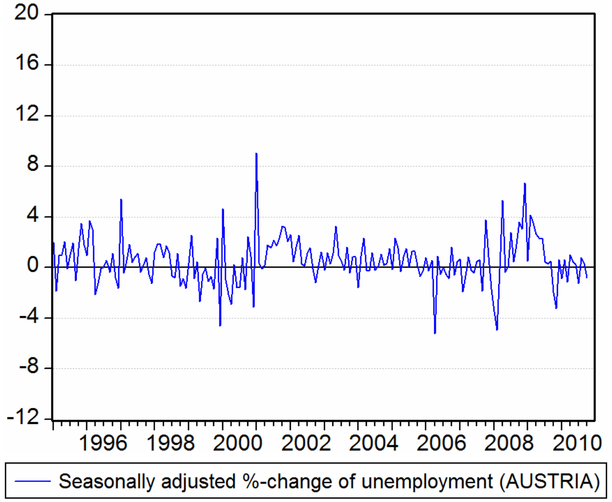
[1)] Program downloadable: http://w3.uniroma1.it/statstsmeh/index.htm

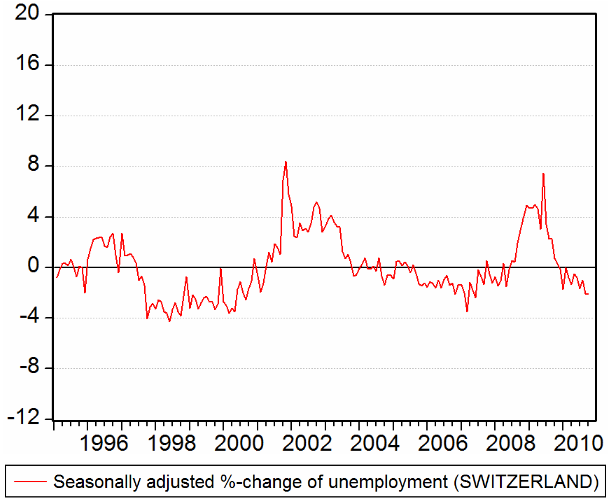
Unemployment: Visual inspections

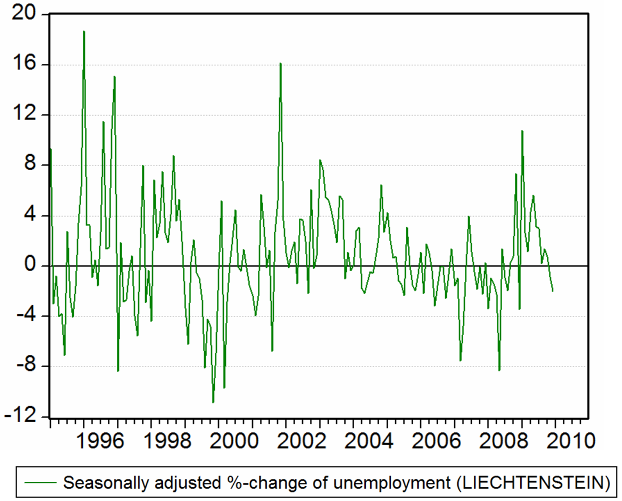


Unemployment: Data transformation

➔ Calculation of %-differences and seasonal adjustment:

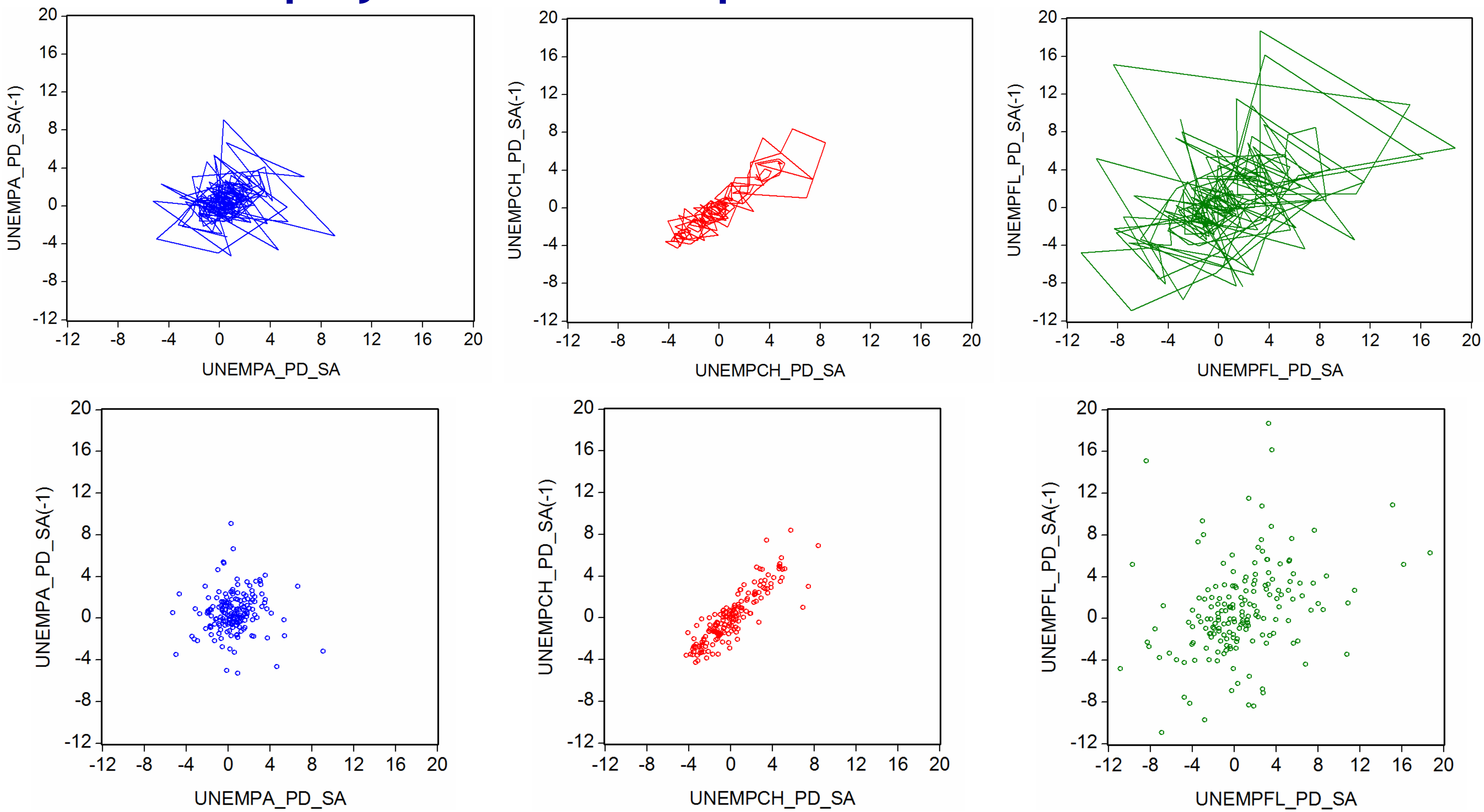






	%Δ A	%Δ CH	%Δ FL
Mean	0.5504	0.1151	0.7788
Median	0.4667	-0.1414	0.2553
Maximum	9.0740	8.3964	18.7077
Minimum	-5.2648	-4.2627	-10.8919
Std. Dev.	1.9010	2.4723	4.3815
Skewness	0.4281	0.6863	0.7280
Kurtosis	5.7494	3.2580	5.2864

Unemployment: First impression



TAR-models: Estimation output

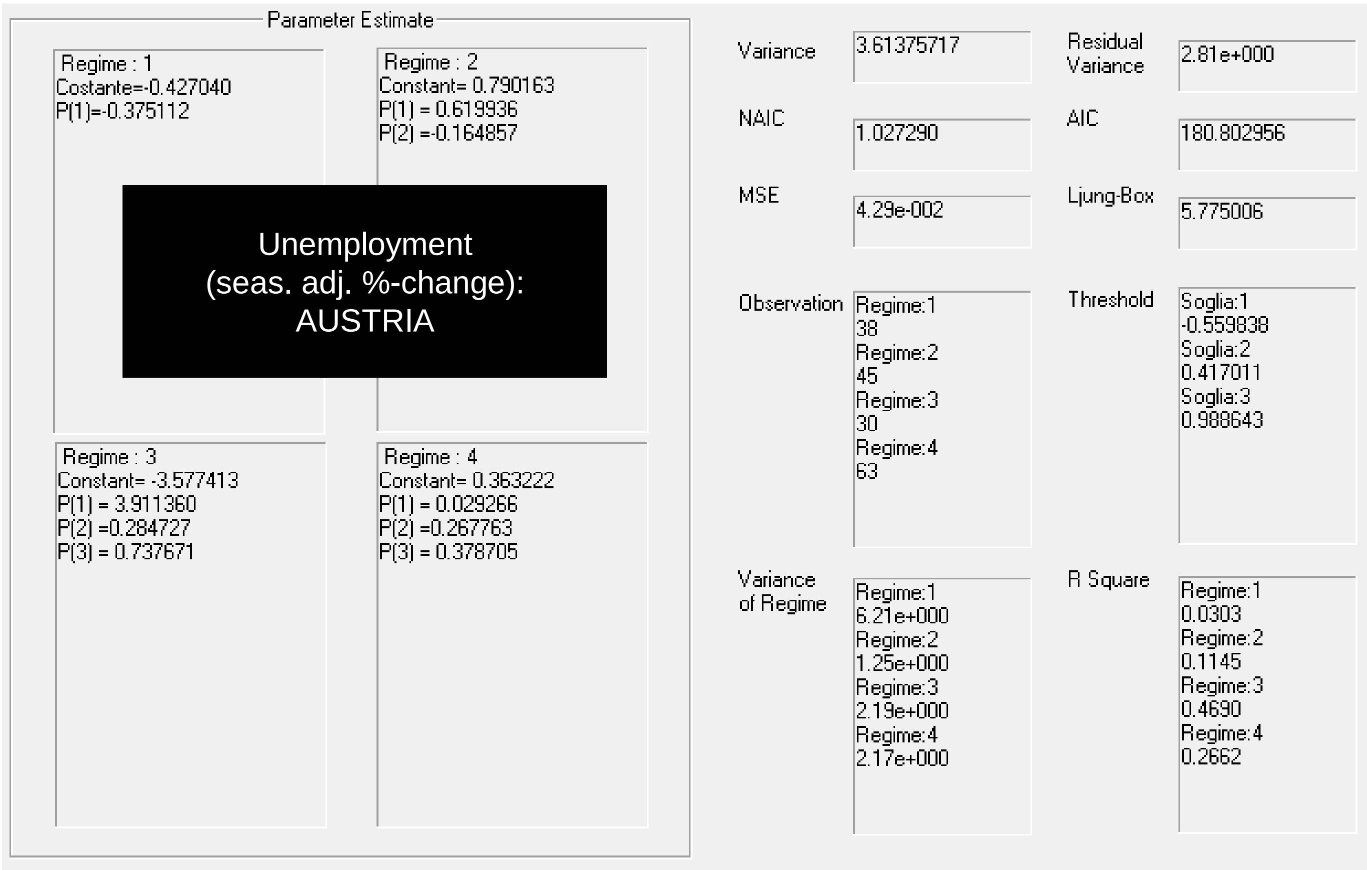
Dependent variable: %ΔUNEMPLOYMENT (unemployed people)			
	Austria	**Switzerland**	**Liechtenstein**
„Ordinary" AR-model			
C	0.517791**		
AR(1)	0.047877	0.739395***	0.336554***
AR(2)	0.122843*	-0.010189	
AR(3)	0.211878***	0.190453**	
AR(4)			
TAR-model: Regime 1 (%ΔUNEMPLOYMENT(-1) ≥ 0)			
C			1.874499***
AR(1)	0.126395*	0.895759***	0.136907
AR(2)	0.190537**		
AR(3)	0.431713***		
AR(4)			
TAR-model: Regime 2 (%ΔUNEMPLOYMENT(-1) < 0)			
C			
AR(1)	-0.222412	0.540186***	0.262869**
AR(2)		-0.027000	
AR(3)		0.429183***	
AR(4)			

Root Mean Squared Error	Austria	Switzerland	Liechtenstein
AR	1.7960	1.1258	4.1327
ARMA	1.8507 [(1,2) ohne c]	1.1368 [(1,1) ohne c]	4.1277 [(1,1) ohne c]
TAR	1.7275	1.0902	4.0148

- ➔ No visual indication of TAR-structure (previous slide)
- ➔ Also the estimation results do not clearly support the usage of TAR-models as a „very" superior alternative to „ordinary" AR(MA)-models, even though the TAR-models yield slighty better RMSE-scores for all three countries

TAR-models: Genetic algorithm

- Baragona and Cucina [2009] apply a algorithm (which minimizes either AIC or RMSE) to find the optimal TAR-structure and estimates



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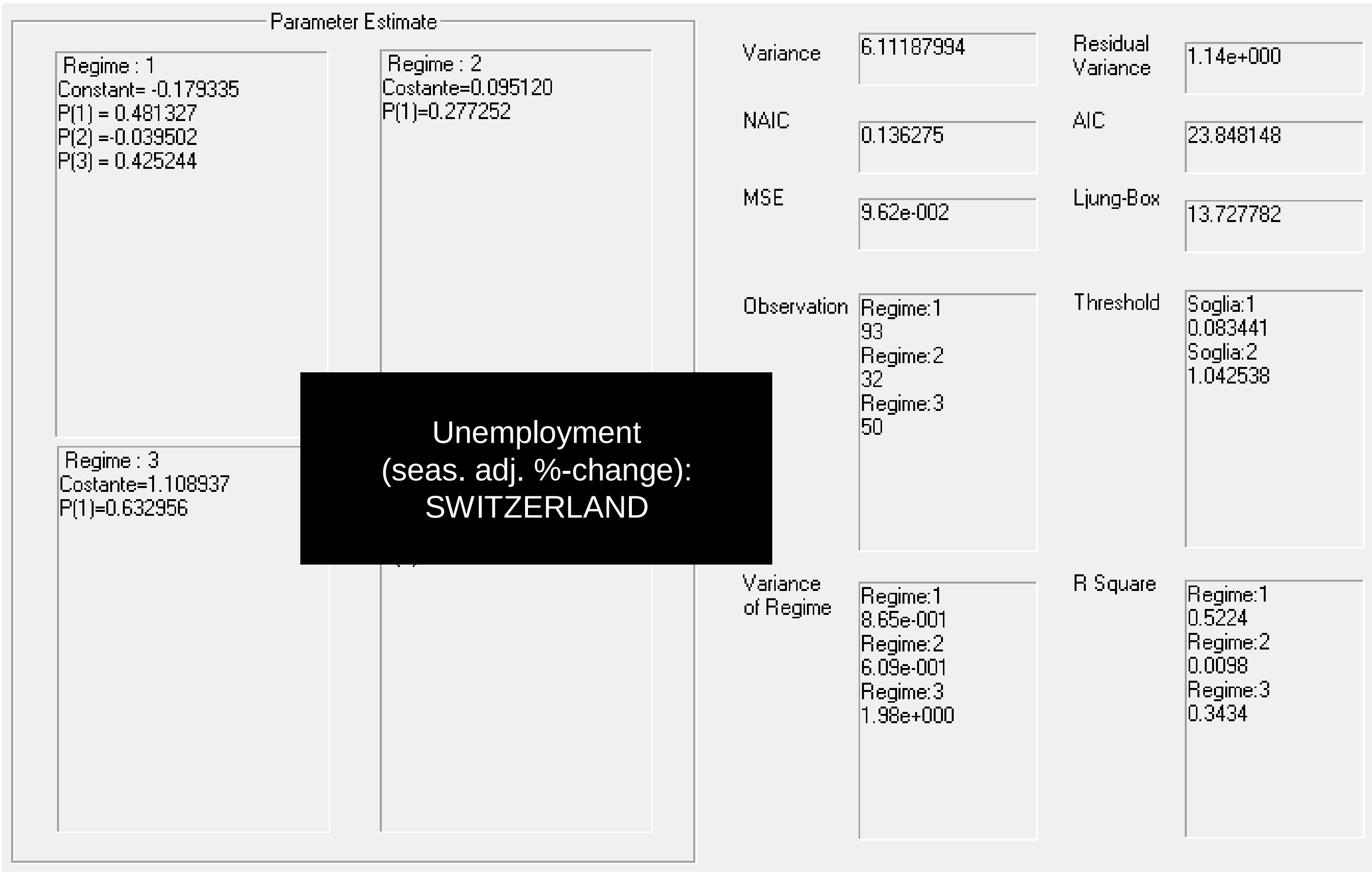

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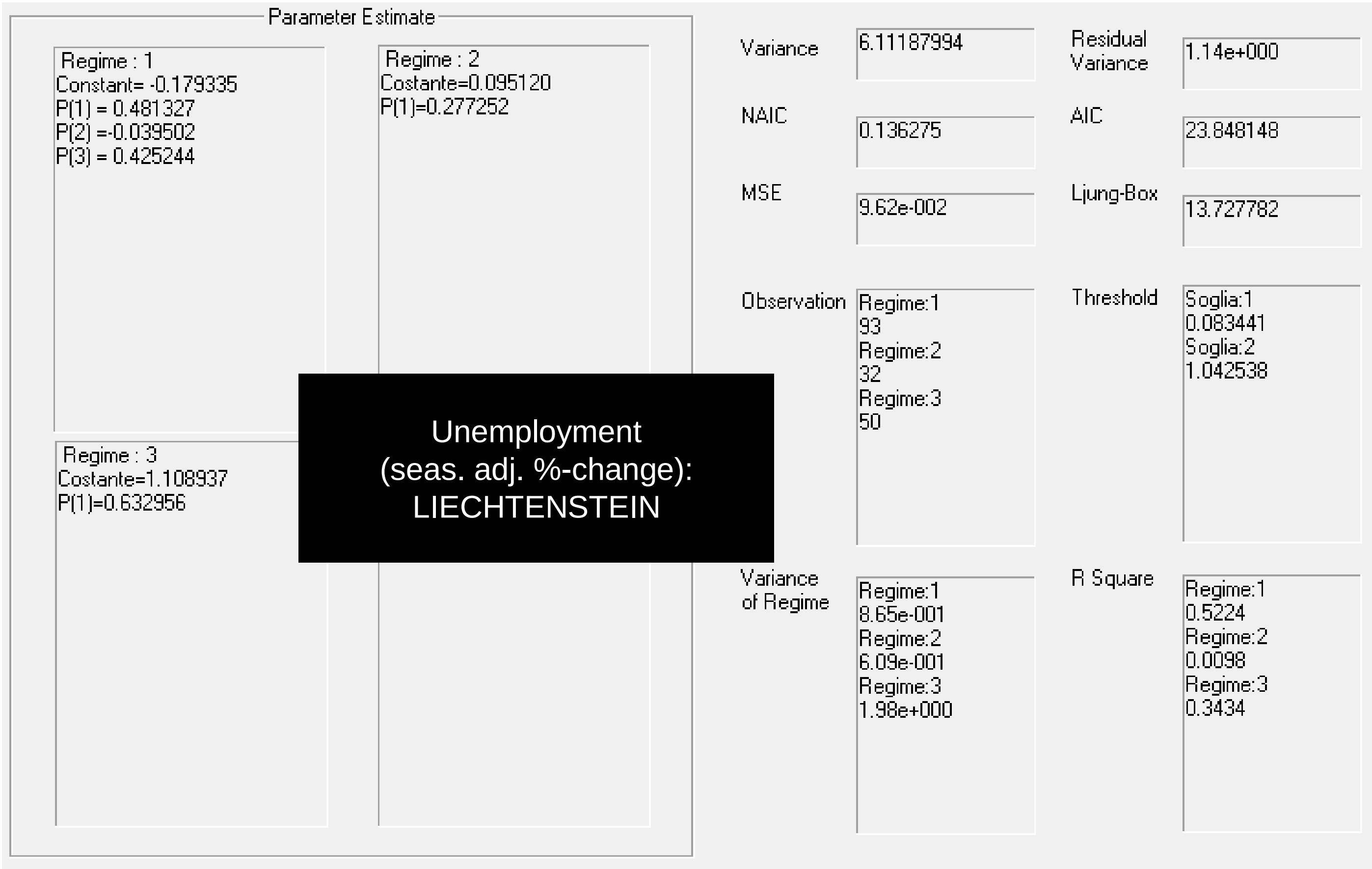

4.Conclusions

- The two factors of main interest, namely the additional effect of the financial crisis (not already captured by SMI) and the additional effect of the "Zumwinkel-Affair" (separated from impact of financial crisis), do not affect the performance (daily %-change in stock prices) of the two investigated banks. However, they have had a significant (cumulating) impact on risk/volatility: While the financial crisis had a strong effect on both stocks (LLB and VPB), the additional impact of the „Zumwinkel-Affair" was more intense refering to the VPB stock (yet significant for both stocks).

- The TAR-models for unemployment were just estimated as an illustration. They don't seem to be very appropriate to model the data in focus.

Thanks for your attention!

Questions and comments VERY welcome…

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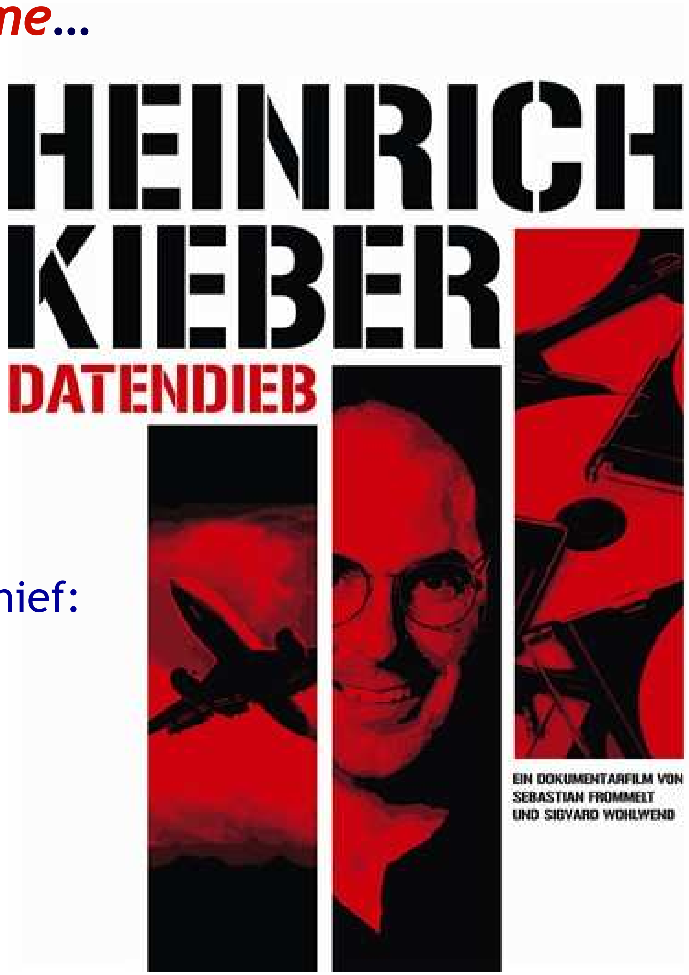

➔ Very interesting documentary about the data thief:

Quoted Literature

BARAGONA, R. AND D. CUCINA (2009): "Genetic search for threshold parameters in time series threshold models: algorithms and computer programs", Technical Report 10/2009, Sapienza University of Rome (Department of Statistics).

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TONG, H. (1977): "Some comments on the Canadian lynx data (with discussion)", *Journal of the Royal Statistical Society (Series A, General)* 140, p.432-436.