

How Risky is the Value-at-Risk ? Evidence from Financial Crisis

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INTRODUCTION



Disclosure of quantitative measures of market risk, such as value-at-risk, is enlightening only when accompanied by a thorough discussion of how risk measures were calculated and how they related to actual performance.

Alan Greenspan (1996)

Motivation

- Basle II believes in statistical models and quality of estimates
- The tragedy of the VaR
 - extreme events are rare !
 - financial returns are (almost) impossible to predict!
 - volatilities are also difficult to predict (Christofferson & Diebold (2000))
- Risk managers tend to believe that
 - there are no standard errors
 - there is little heterogeneity (w.r.t. assets, time periods, models)

Some Aspects of VaR Model Risk

1. parameter change / structural instability vs. sample size
2. model choice and misspecification
3. estimation uncertainty
4. error accumulation
5. pretesting and endogenous model selection

Goal of the Paper

- Analysis of the robustness of the VaR *before and during the actual crisis*.
 - financial assets (stocks: large-, middle-, small-cap, commodities, exchange rates, etc);
 - different historical information (from 20 to 2 years);
 - different mathematical assumptions (normal vs. fat-tailed distributions).
- Meta Study: Development of “Map of Stylized Facts”
- Recommendations for a reduction of model risk

Previous VaR Horse Races

Examples: Gençay, Selçuk & Ulugülyağcı (2003), Gençay & Selçuk (2004), Giot & Laurent (2005), Kuester, Mittnik & Paolletta (2006), McAleer & da Veiga (2008) ...

Typical Features:

- fixed sample size, rolling window
- one day ahead forecasts
- popular large cap stocks, major currencies and indices
- sample size: 2 years in practice, usually more than two years in academic papers

Stocks under Investigation

- Randomly chosen stocks of different caps:
 - 11 large cap (ABT, APD, BK, CL, COST, DD, EMR, JPM, MRK, PEP, SYY)
 - 11 middle cap (ACV, ADSK, BCR, BMS, CCK, CSC, DPL, GM, HIT, MAS, NAV)
 - 11 small cap (AMR, BDN, BIG, BXS, CBRL, CBT, COO, DLX, GAS, TXI, UNS)
- All stocks are tradeable since at least Jan 1st, 1987
- close-to-close returns, NYSE and NASDAQ

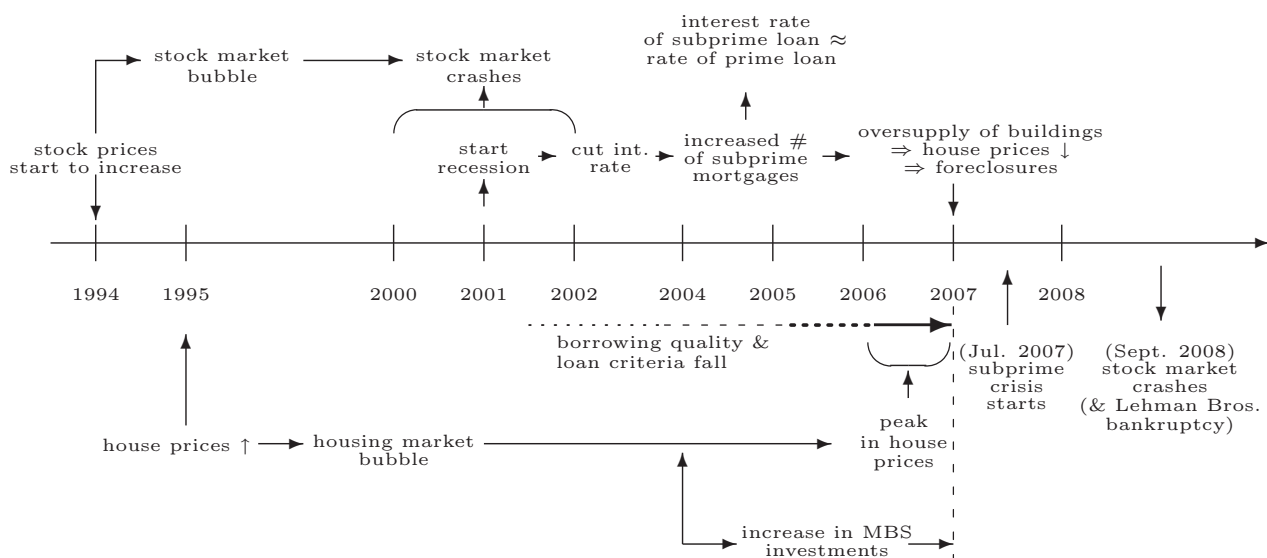
VaR Approaches under Investigation

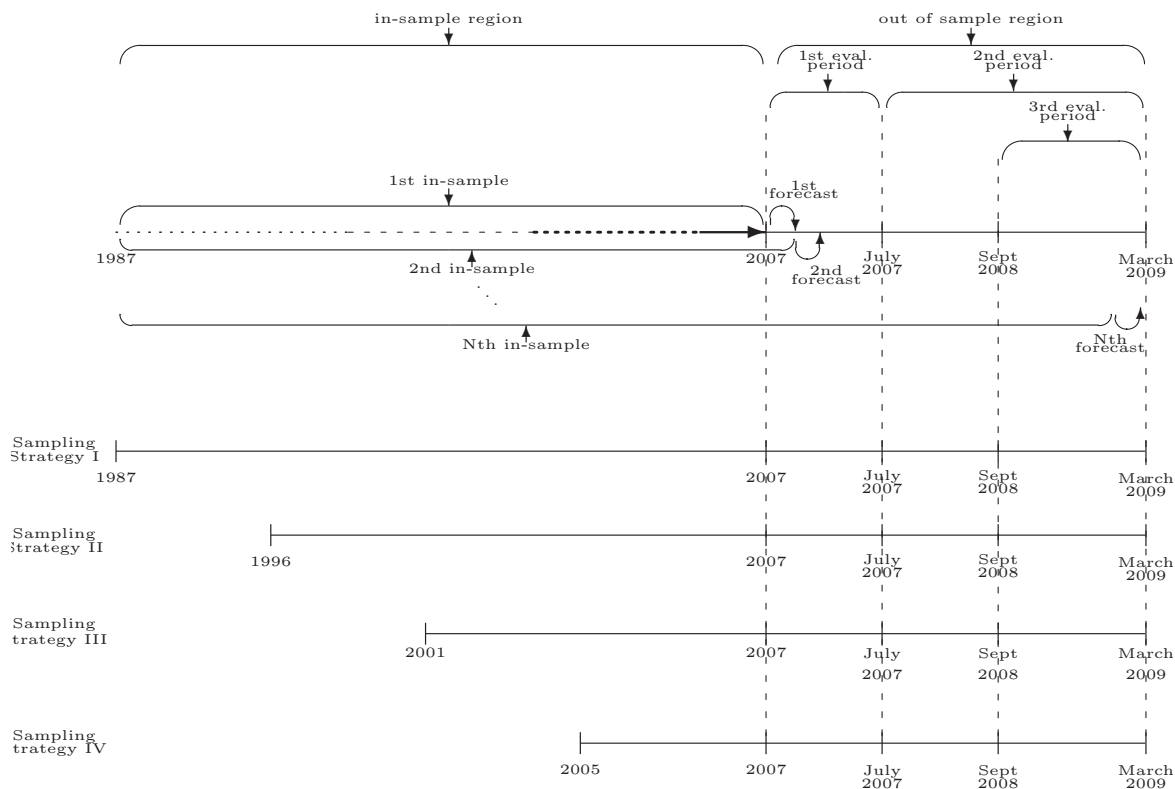
- ARMA(1,0)-GARCH(1,1)*
- Estimated Risk Metrics*
- Risk Metrics with fixed parameters ($\lambda = 0.94$, $d.f. = 7$)*
- ARMA(1,0)-FIGARCH(1,1)*
- historical simulation

* assuming normality and t-distribution

Sampling Strategies

- augmented window sampling
- First observation:
 - I: Jan 1st, 1987 (including Black Monday, Oct. 19th, 1987)
 - II: Jan 1st, 1996 (including dot-com bubble crash March - October, 2002 and Sept. 11th, 2001)
 - III Jan 1st, 2001 (including Sept. 11th, 2001)
 - IV: Jan. 1st, 2005
- First forecast:
 - before crisis (from Jan 1st to July 18th, 2007)
 - in crisis period (after July 18th, 2007, peak in housing prices)
 - in crash period (after Sept. 1st, 2008, Lehman Bros. bankruptcy)





DESIGN OF META STUDY



Evaluation (Backtesting) Criteria

- 1188 forecasts (33 stocks, 4 models with 2 distr., 1 HS, 4 samples)
- Test for unconditional coverage (Christoffersen, 1998)
- Test for independence (Christoffersen, 1998)
- 1 percent VaR, 1 day ahead forecast

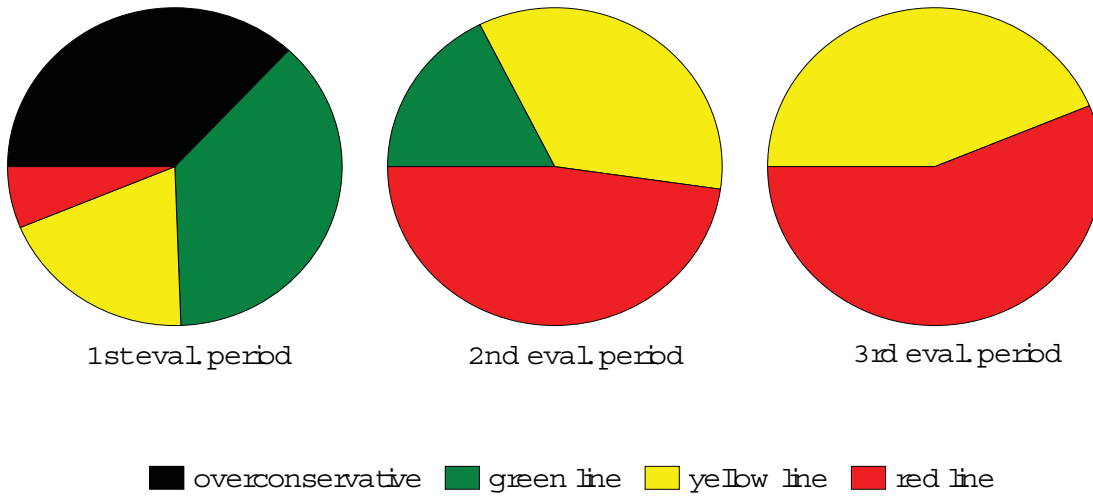
	1 st eval. period			2 nd eval. period			3 rd eval. period		
	large	middle	small	large	middle	small	large	middle	small
Normal distr.	0.375	0.255	0.147	0.176	0.164	0.204	0.000	0.096	0.119
t - distr.	0.426	0.255	0.272	0.556	0.579	0.460	0.181	0.176	0.278
1987	0.386	0.250	0.204	0.443	0.454	0.409	0.090	0.170	0.181
1996	0.420	0.250	0.215	0.420	0.454	0.375	0.113	0.125	0.227
2001	0.409	0.261	0.193	0.363	0.340	0.306	0.090	0.125	0.193
2005	0.386	0.261	0.227	0.238	0.238	0.238	0.068	0.125	0.193
ARMA - GARCH	0.443	0.204	0.215	0.363	0.488	0.238	0.090	0.170	0.227
RM est.	0.352	0.193	0.250	0.306	0.352	0.306	0.034	0.090	0.090
RM fix	0.363	0.363	0.181	0.500	0.227	0.545	0.136	0.136	0.227
FIGARCH	0.443	0.261	0.193	0.295	0.420	0.238	0.102	0.147	0.250
HS - 250	0.045	0.030	0.060	0.030	0.015	0.000	0.015	0.000	0.000
HS - 500	0.075	0.030	0.015	0.000	0.000	0.000	0.015	0.000	0.000
HS - 750	0.090	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.000
HS - 1000	0.015	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000
HS - 3000	0.015	0.000	0.015	0.045	0.060	0.000	0.000	0.000	0.000
HS - 5000	0.015	0.015	0.015	0.045	0.030	0.030	0.000	0.015	0.000

Rate of green type realizations (VaR at 1%)

	1 st eval. period			2 nd eval. period			3 rd eval. period		
	large	middle	small	large	middle	small	large	middle	small
Normal distr.	0.778	0.715	0.892	0.892	0.960	0.920	0.937	0.960	0.977
t - distr.	0.767	0.596	0.806	0.812	0.977	0.965	0.897	0.948	0.988
1987	0.772	0.670	0.829	0.818	0.988	0.977	0.909	0.954	0.977
1996	0.772	0.636	0.840	0.852	0.965	0.965	0.920	0.965	0.988
2001	0.761	0.636	0.829	0.875	0.943	0.909	0.920	0.943	0.965
2005	0.784	0.681	0.897	0.863	0.977	0.920	0.920	0.954	1.000
ARMA - GARCH	0.727	0.579	0.795	0.840	0.931	0.977	0.909	0.931	0.988
RM est.	0.772	0.647	0.875	0.829	0.943	0.897	0.920	0.931	0.965
RM fix	0.863	0.818	0.818	0.772	1.000	0.909	0.863	0.954	1.000
FIGARCH	0.727	0.579	0.909	0.965	1.000	0.988	0.977	1.000	0.977
HS - 250	0.136	0.121	0.121	0.166	0.166	0.151	0.151	0.166	0.166
HS - 500	0.121	0.106	0.136	0.136	0.136	0.151	0.151	0.151	0.166
HS - 750	0.121	0.090	0.136	0.151	0.106	0.136	0.151	0.151	0.166
HS - 1000	0.030	0.030	0.090	0.075	0.121	0.121	0.151	0.121	0.166
HS - 3000	0.030	0.030	0.060	0.090	0.106	0.106	0.136	0.136	0.151
HS - 5000	0.030	0.030	0.060	0.090	0.106	0.106	0.121	0.136	0.166

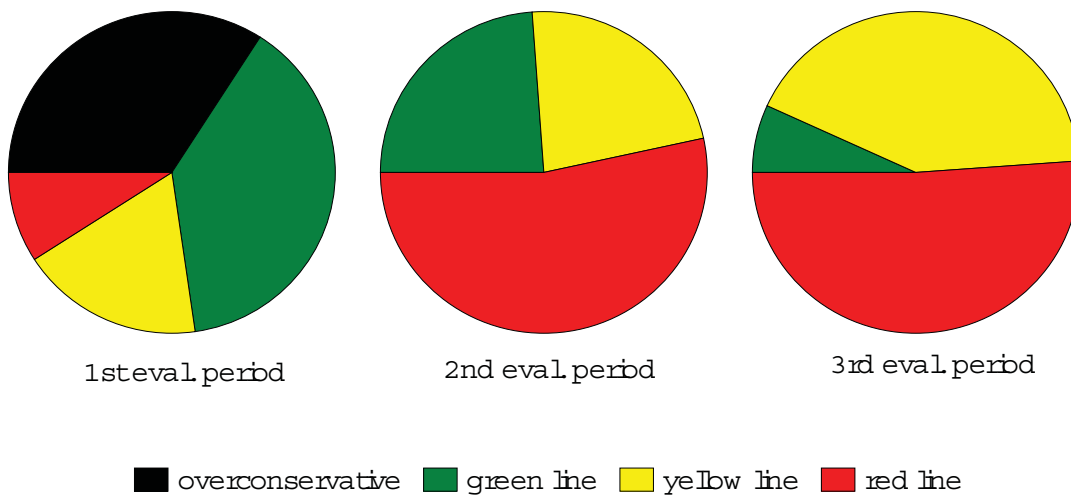
Rate of p-values larger than 10% for the independence test (VaR at 1%)

Normal distribution, large cap stocks^a



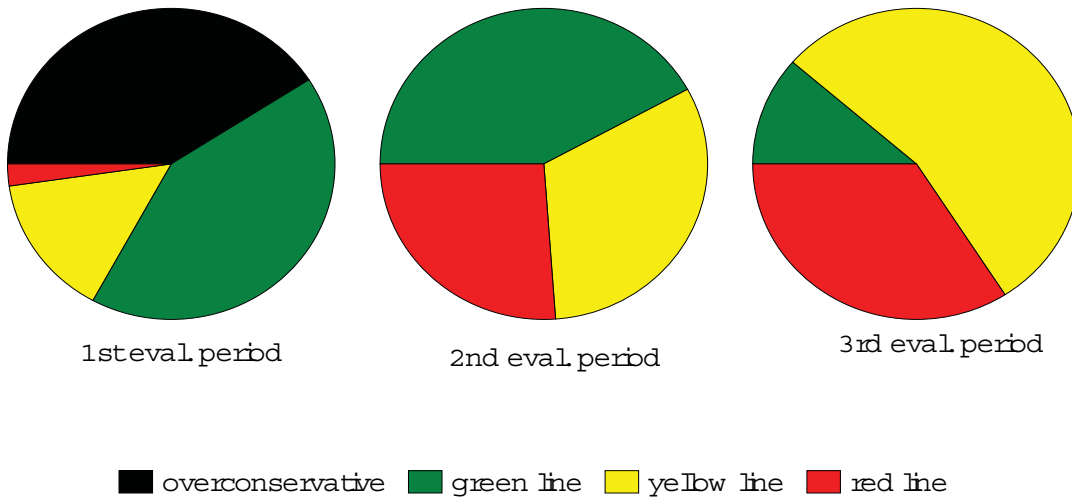
^a performance of the normal distribution assumption over all models, all sample sizes and all LARGE stocks

Sample from 2005, large cap stocks^a



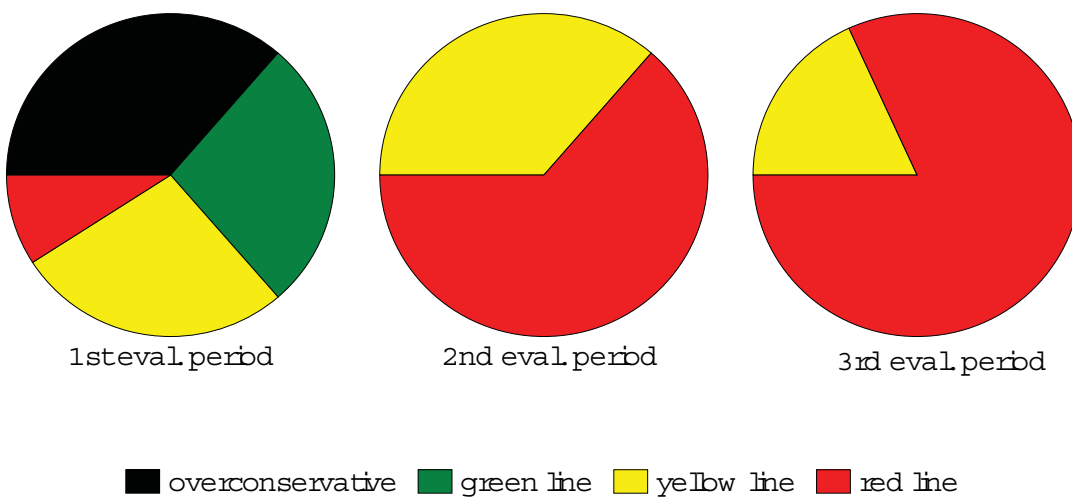
^a performance of sampling from 2005 over all models, all distributions and all LARGE stocks

Sample from 1996, large cap stocks^a



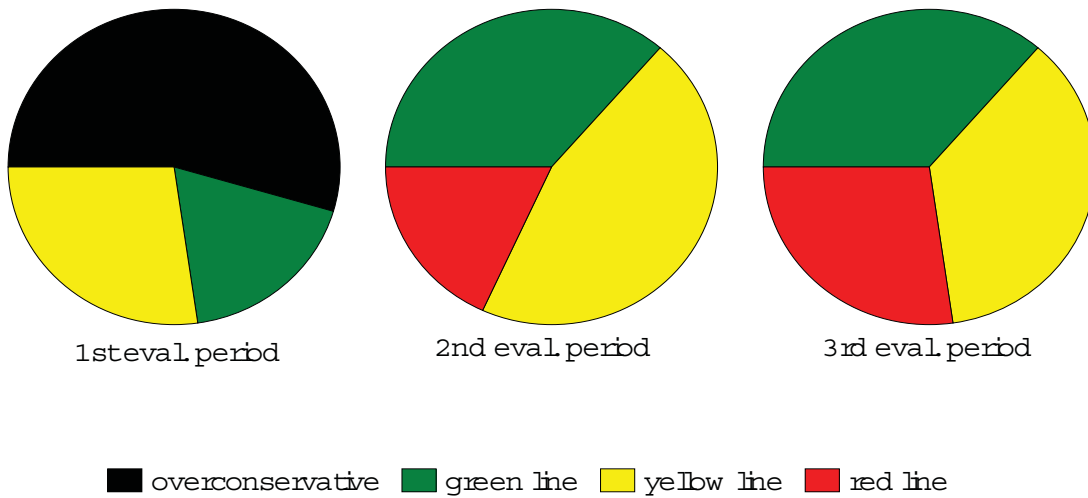
^a performance of sampling from 1996 over all models, all distributions and all LARGE stocks

What the practice is doing....^a



^a performance of sampling from 2005, normal distribution and RM, large cap

What the practice should do....^a



^a performance of sampling from 1996, t-distribution and FIGARCH, small cap

Table 1: Least square regression for the number of violations

Parameters	1 st eval. period	2 nd eval. period	3 rd eval. period
Constant	0.300***	2.377***	1.701***
ln(Market Cap)	0.000	-0.020***	0.032***
Model	0.034***	-0.071***	-0.154***
Years	-0.027**	-0.064***	-0.039***
Distr.	0.132***	0.298***	0.289***
R^2	0.032	0.183	0.195

Note: Dependent variable equals ln(nr. of violations). Model equals 0, if HS; 1, if RM fix; 2, if RM est.; 3, if ARMA-GARCH; 4, if FIGARCH. Years equals 0, if sample from 2005; 1, if sample from 2001; 2, if sample from 1996; 3, if sample from 1987. Distr. equals 0, if t-distr. and 1, if normal distr. *** significant at 1%; ** at 5%; * at 10%.

Table 2: Ordinary response regression for Basel backtesting rules

Parameters	1 st eval. period	2 nd eval. period	3 rd eval. period
ln(Market Cap)	0.029	0.060***	-0.068***
Model	-0.036	0.138***	0.235***
Years	0.083**	0.152***	0.073**
Distribution	-0.550***	-0.893***	-0.709***
<i>PseudoR</i> ²	0.038	0.088	0.087

Note: Dependent variable equals 2, if nr. of violations lie in the green line; 1, if lie on yellow line; 0, if lie on red line. Model equals 0, if HS; 1, if RM fix; 2, if RM est.; 3, if ARMA-GARCH; 4, if FIGARCH. Years equals 0, if sample from 2005; 1, if sample from 2001; 2, if sample from 1996; 3, if sample from 1987. Distr. equals 0, if t-distr. and 1, if normal distr. *** significant at 1%; ** at 5%; * at 10%.

Table 3: Binary Probit regression for the significance of independence test

Parameters	1 st eval. period	2 nd eval. period	3 rd eval. period
Constant	-0.228**	0.638***	1.89***
ln(Market Cap)	-0.064***	-0.101***	-0.19***
GARCH	0.802***	0.903***	0.048
FIGARCH	0.918***	1.691***	0.631**
RMFIX	1.246***	0.760***	0.035
RMEST	1.000***	0.735***	0.006
Years	-0.020	0.019	-0.014
Distr.	0.184**	0.016	0.102
<i>Pseudo R</i> ²	0.091	0.122	0.072

Note: Dependent variable equals 1 if independency test is not rejected at 10%. GARCH equals 1, if model is ARMA-GARCH, 0 otherwise; etc. Years equals 0, if sample from 2005; 1, if sample from 2001; 2, if sample from 1996; 3, if sample from 1987. Distr. equals 0, if t-distr. and 1, if normal distr. *** significant at 1%; ** at 5%; * at 10%.

Summary

- Simple models (RM, HS) are okay during boring times, they fail in the crisis
- Sample size matters:
The larger the sample the better the results for hectic times
- Type of stock matters: different dynamics
- During crisis it is wise to invest in small cap stocks
- T-distribution significantly reduces the number of violations during crisis times
- Twisted results between calm and chaotic times

Obvious Next Steps for Future Research

- approaches which use intraday information
- nonparametric methods
- evaluation based on 10 trading day forecast horizon
- analysis for portfolios