Non-gaussian Mark-to-Future

RiskLab-Toronto

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Sources of risk

- Market Risk. The risk in reducing the value of the Institution's positions due to changes in markets.
- Credit Risk. The risk in reducing the value of the Institution's assets due to changes in the credit quality of the counterparties.
  - Counterparty deafult is an extreme case, but losses can also occur when a counterparty's credit quality decreases.
  - Credit risk is an issue even when the bank holds only payment obligations.
- Liquidity Risk. The risk of losses because of travel-time delays of assets.
- Operational Risk.
  - Fraud.
  - Model risk (using the wrong pricing model, for instance)
  - Human Factor
- Legal and Regulatory Risk.
  - Transactions that are voided due lack of appropriate licenses.
  - Changes in Tax Laws

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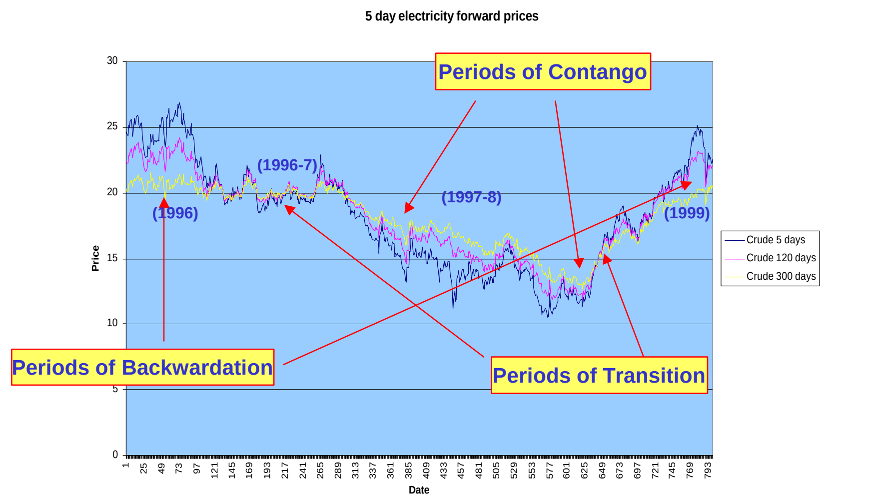
Topic for today

Metalgesellschaft: 1993

- It decided to market long dated futures contracts to US clients (up to 30 years), when the market only had futures un tp 18 months.
- Their strategy relied on rolling over the contracts at expiration.
- A change in the convexity of the futures curve gave rise to margin payments that they could not meet.
- They lost over $1B.

Gas Crude Forwards: 1996-99



Orange County and Bob Citron

In December 1994, Orange County stunned the markets by announcing that its investment pool had suffered a loss of $1.6 billion, the largest loss ever recorded by a local government investment pool, and led to the bankruptcy of the county .

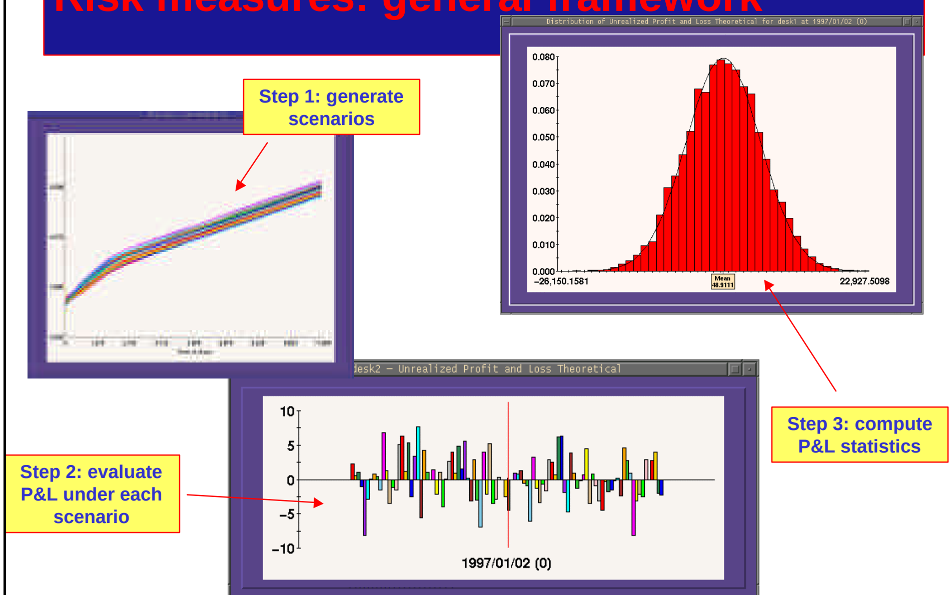
This loss was the result of unsupervised investment activity of Bob Citron, the County Treasurer, who was entrusted with an $7.5 billion portfolio belonging to county schools, cities, special districts and the county itself. In times of fiscal restraints, Citron was viewed as a wizard who could painlessly deliver greater returns to investors. Indeed, Citron delivered returns about 2% higher than the comparable State pool.

Orange County and Bob Citron

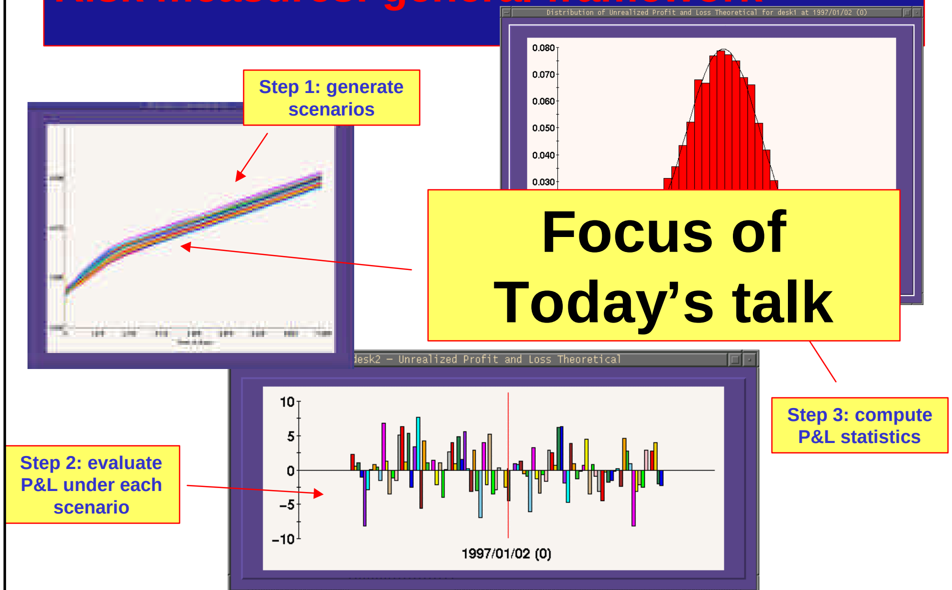
Citron's main purpose was to increase current income by exploiting the fact that medium-term maturities had higher yields than short-term investments. On December 1993, for instance, short-term yields were less than 3%, while 5-year yields were around 5.2%. With such a positively sloped term structure of interest rates, the tendency may be to increase the duration of the investment to pick up an extra yield. This boost, of course, comes at the expense of greater risk.

The strategy worked fine as long as interest rates went down. In February 1994, however, the Federal Reserve Bank started a series of 6 consecutive interest rate increases which led to a bloodbath in the bond market. The large duration led to a $1.6 billion loss

Risk measures: general framework



Risk measures: general framework



Scenario generation basics

- Reproduce the marginal structure
  - ✓ Account for large events (fat tails).
  - ✓ Dependence of returns from day to day.
  - ✓ Take into account possible lack of stationarity of returns.
- Reproduce the dependence structure
  - ✓ Dependence of large events
  - ✓ Re-define the “large event” concept when dealing with changes in dependence conditions.

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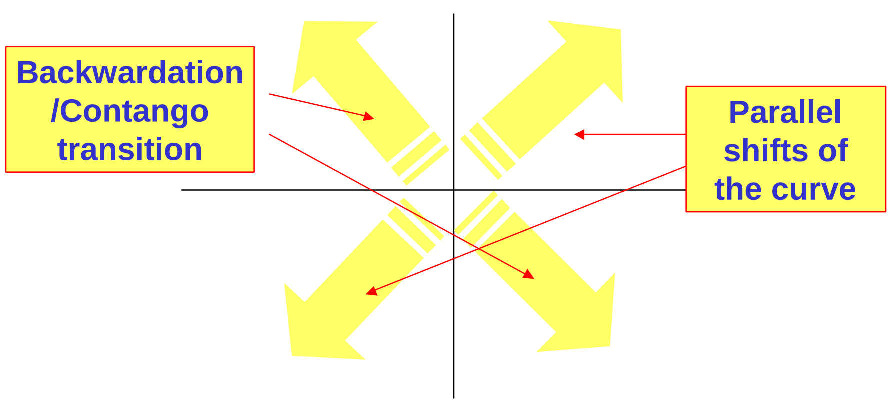
Subject for Today

The gaussian dependence structure



Other movements are much less likely

Regulatory aspects of the methodology

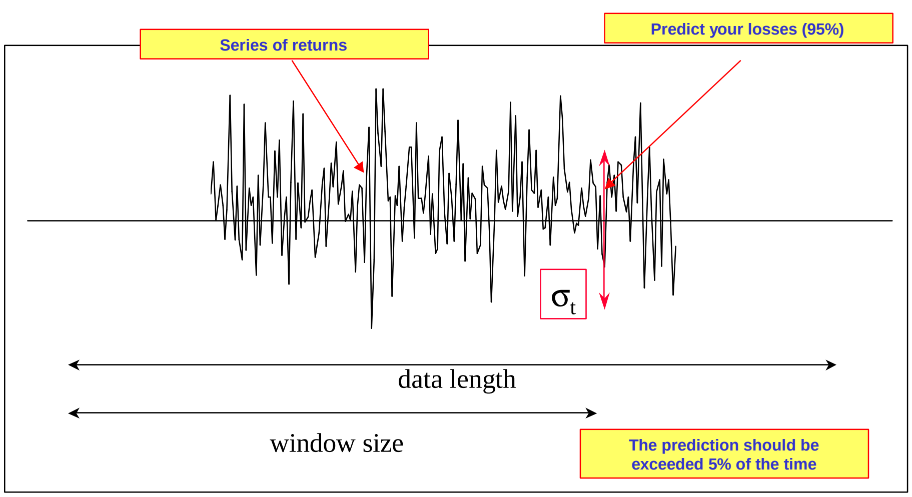
Regulatory institutions inspect yearly the number of violation of a bank regarding its VAR measure (left tail 95% confidence interval).

It is necessary to provide a good forecast, at least, in one-day horizon basis, by the natural procedure called "**moving windows**", in order to avoid violation of the VAR limit.

Commodities forward time series available at the market are not **homogeneous** or comparable in the sense that you can not hold a forward price series for the **same time-to-maturity every day**.

So any transformation of this data to an "apparently" more suitable series may be a big source of inaccuracy in the forecasting.

Back-testing Risk Measures



How to deal with a vector of Oil Forwards

- Assume that interest rate and convenience yields are constant and that all uncertainty arise from the spot price of the commodity.

☹ Spot and futures prices varies substantially over time, thereby indicating that the modeling of spot commodity prices can not hold the multivariate characteristics of forward prices.

- Transform the market set of forward prices from theirs respective time-to-maturity to an standard set of time-to-maturity and modelling it.
  - Capture the dependency structure using second moments or the Normal Rank Correlation technique on the returns or residuals.
  - Apply the inverse transformation to recover the market forwards prices.

☹ There is a very special relation among forward prices in Oil series, explained by the contango and backwardation phenomena, which can not be captured by an structure, like the previously mentioned.

A Term Structure Model

There are 12 maturity times in Oil forwards (from January to December , Ti i=1,…,12).

Ft,Ti = forward price at time t with maturity Ti. (Obtained from the Market)

hi = Ti –t (Time to maturity)

Ft,hi = a0t + a1t * hi + a2t * hi ^2 + et (1)

- et : Normal(0,σ2) residuals from a regression.
- a0t , a1t ,, a2t , time series with the following properties :
  - log a0,t = log a0,t-1 + rest0 ; a1,t = a1,t-1 + rest1 ;,. a2,t = a2,t-1 + rest2 ;,
  - restj - residuals.

Possible Models for the residuals on the Term Structure

- Empirical Distribution, taking into account last 100 values from the historical time series.
- Empirical Distribution, taking into account last 250 values from the historical time series.
- Normal Multivariate Distribution, taking into account last 250 values under assumption of independence.
- Normal Multivariate Distribution, taking into account last 250 values, assumption of correlations.

RiskWatch Backtesting

Analyzing the goodness of the model for risk management purposes

Graphics of the Parameters

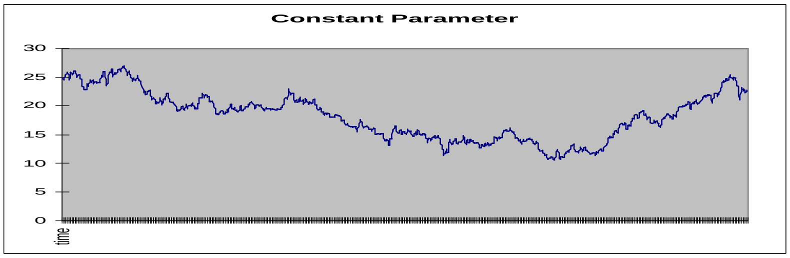


Figure 1) Graphical of the constant parameter in our model

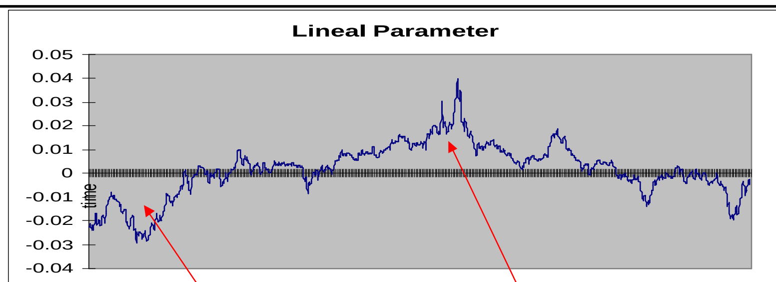


Figure 2) Graphical of the lineal parameter in our model

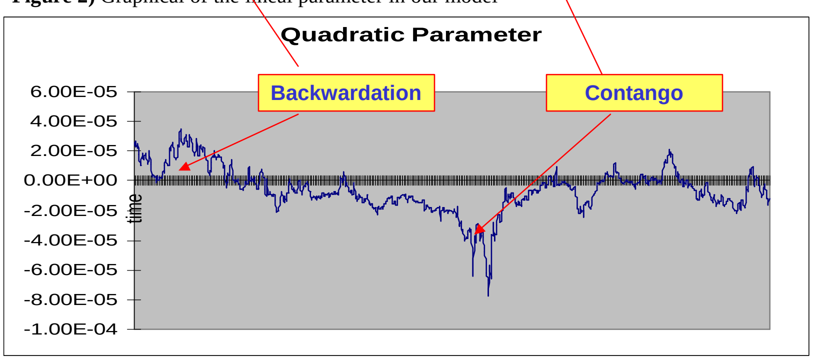
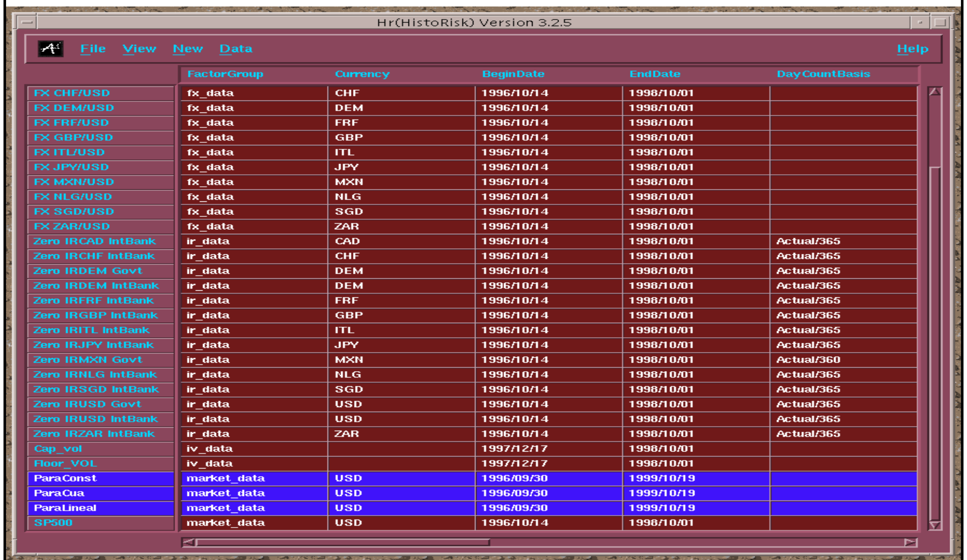


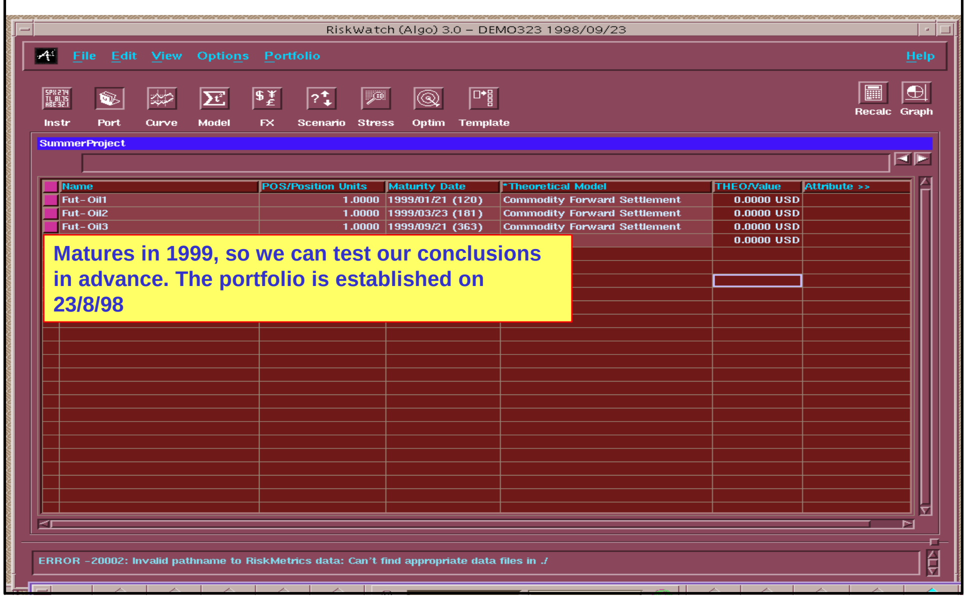
Figure 3) Graphical of the quadratic parameter in our model



	FactorGroup	Currency	BeginDate	EndDate	DayCountBasis
FX CHF/USD	fx_data	CHF	1996/10/14	1998/10/01	
FX DEM/USD	fx_data	DEM	1996/10/14	1998/10/01	
FX FRF/USD	fx_data	FRF	1996/10/14	1998/10/01	
FX GBP/USD	fx_data	GBP	1996/10/14	1998/10/01	
FX ITL/USD	fx_data	ITL	1996/10/14	1998/10/01	
FX JPY/USD	fx_data	JPY	1996/10/14	1998/10/01	
FX MXN/USD	fx_data	MXN	1996/10/14	1998/10/01	
FX NLG/USD	fx_data	NLG	1996/10/14	1998/10/01	
FX SGD/USD	fx_data	SGD	1996/10/14	1998/10/01	
FX ZAR/USD	fx_data	ZAR	1996/10/14	1998/10/01	
Zero IRCAD IntBank	ir_data	CAD	1996/10/14	1998/10/01	Actual/365
Zero IRCHF IntBank	ir_data	CHF	1996/10/14	1998/10/01	Actual/365
Zero IRDEM Govt	ir_data	DEM	1996/10/14	1998/10/01	Actual/365
Zero IRDEM IntBank	ir_data	DEM	1996/10/14	1998/10/01	Actual/365
Zero IRFRF IntBank	ir_data	FRF	1996/10/14	1998/10/01	Actual/365
Zero IRGBP IntBank	ir_data	GBP	1996/10/14	1998/10/01	Actual/365
Zero IRITL IntBank	ir_data	ITL	1996/10/14	1998/10/01	Actual/365
Zero IRJPY IntBank	ir_data	JPY	1996/10/14	1998/10/01	Actual/365
Zero IRMXN Govt	ir_data	MXN	1996/10/14	1998/10/01	Actual/360
Zero IRNLG IntBank	ir_data	NLG	1996/10/14	1998/10/01	Actual/365
Zero IRSGD IntBank	ir_data	SGD	1996/10/14	1998/10/01	Actual/365
Zero IRUSD Govt	ir_data	USD	1996/10/14	1998/10/01	Actual/365
Zero IRUSD IntBank	ir_data	USD	1996/10/14	1998/10/01	Actual/365
Zero IRZAR IntBank	ir_data	ZAR	1996/10/14	1998/10/01	Actual/365
Cap_vol	iv_data		1997/12/17	1998/10/01	
Floor_VOL	iv_data		1997/12/17	1998/10/01	
ParaConst	market_data	USD	1996/09/30	1999/10/19	
ParaCua	market_data	USD	1996/09/30	1999/10/19	
ParaLineal	market_data	USD	1996/09/30	1999/10/19	
SP500	market_data	USD	1996/10/14	1998/10/01	

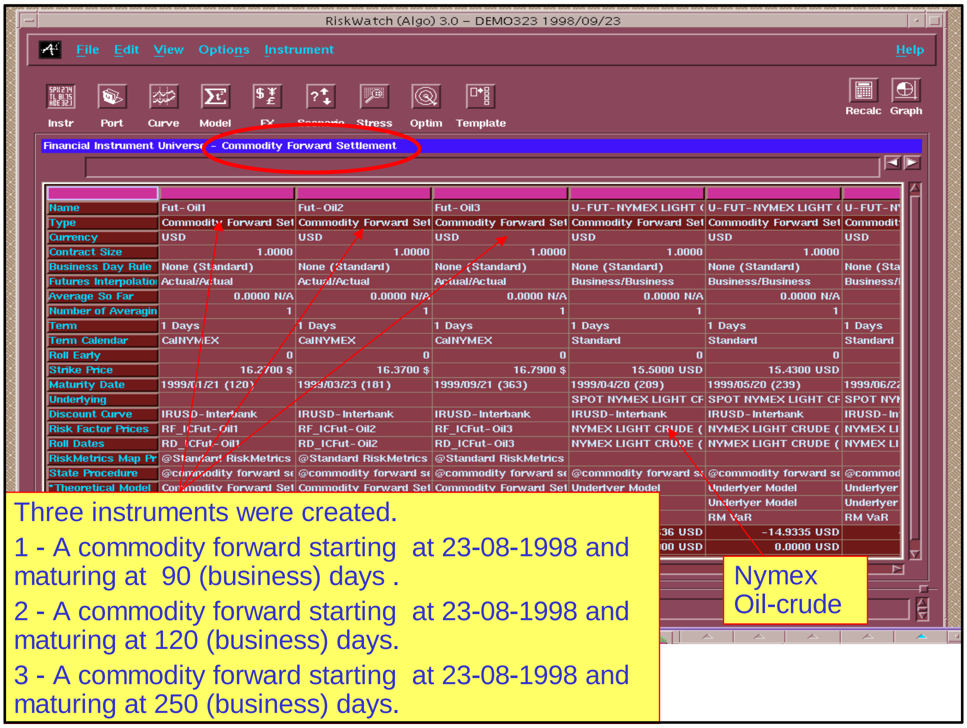
We will incorporate the model parameters to the list of standard risk factors

We consider a portfolio of forwards



Name	POS/Position Units	Maturity Date	*Theoretical Model	THEO/Value	Attribute >>
Fut-Oil1	1.0000	1999/01/21 (120)	Commodity Forward Settlement	0.0000 USD	
Fut-Oil2	1.0000	1999/03/23 (181)	Commodity Forward Settlement	0.0000 USD	
Fut-Oil3	1.0000	1999/09/21 (363)	Commodity Forward Settlement	0.0000 USD	
				0.0000 USD	

Matures in 1999, so we can test our conclusions in advance. The portfolio is established on 23/8/98



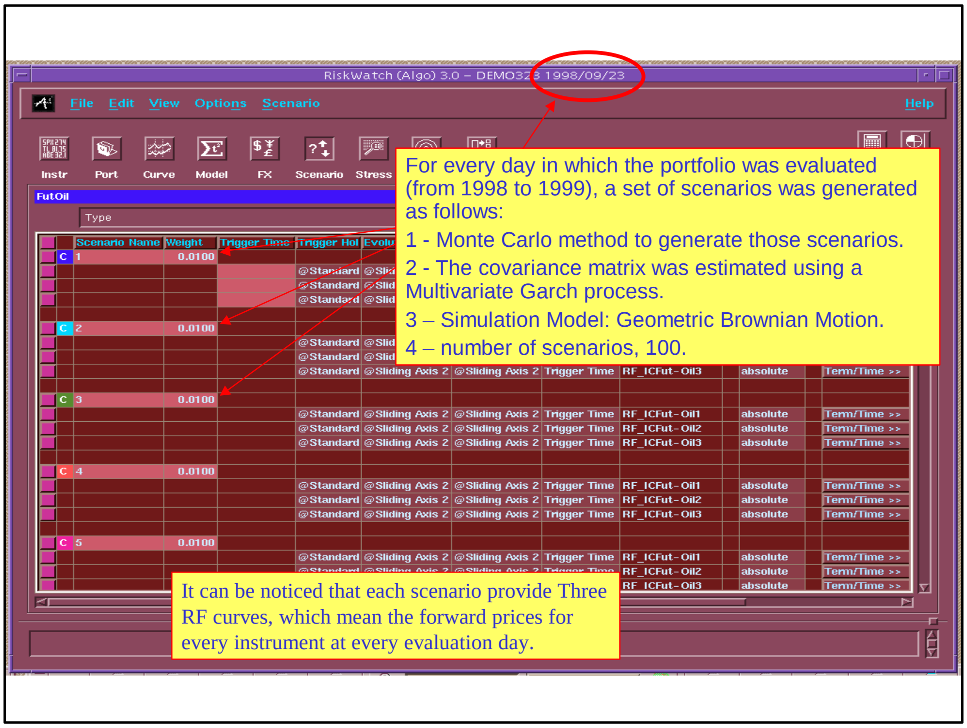
Backtesting

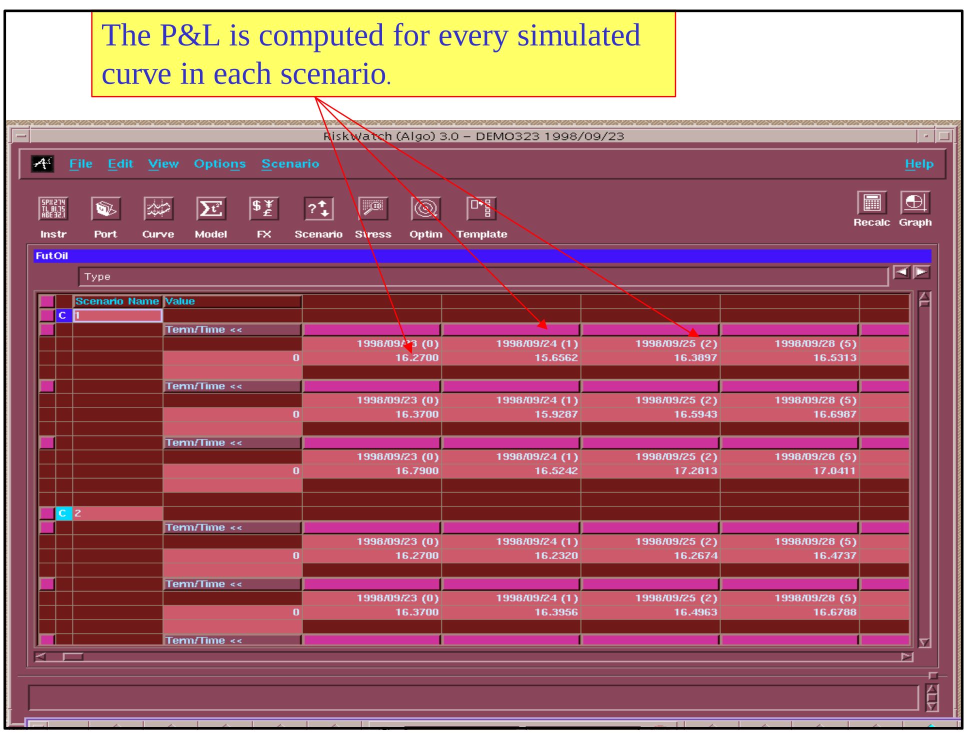
We followed the Forward Commodity Settlement pricing method.

Three instruments were created.

- 1 - A commodity forward starting at 23-08-1998 and maturing at 90 (business) days .
- 2 - A commodity forward starting at 23-08-1998 and maturing at 120 (business) days.
- 3 - A commodity forward starting at 23-08-1998 and maturing at 250 (business) days.

- Six curves of two different kinds called RF and RD were created .
- 1 - The RD curve provide the day in which the instrument mature and its strike price.
- 2 - The RF curve provide the moments at which the instrument will be evaluated and the forward prices at those moments.


RiskWatch (Algo) 3.0 – DEMO323 1998/09/23
File Edit View Options Scenario Help
Instr Port Curve Model FX Scenario Stress
FutOil
For every day in which the portfolio was evaluated (from 1998 to 1999), a set of scenarios was generated as follows:
1 - Monte Carlo method to generate those scenarios.
2 - The covariance matrix was estimated using a Multivariate Garch process.
3 – Simulation Model: Geometric Brownian Motion.
4 – number of scenarios, 100.
It can be noticed that each scenario provide Three RF curves, which mean the forward prices for every instrument at every evaluation day.


The P&L is computed for every simulated curve in each scenario.
RiskWatch (Algo) 3.0 – DEMO323 1998/09/23
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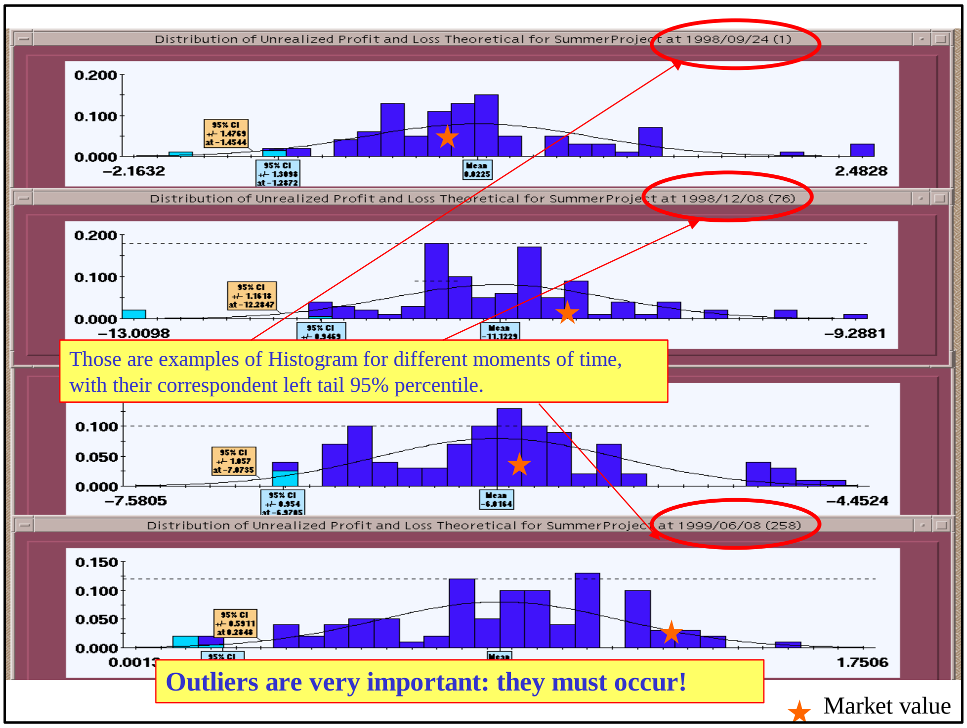
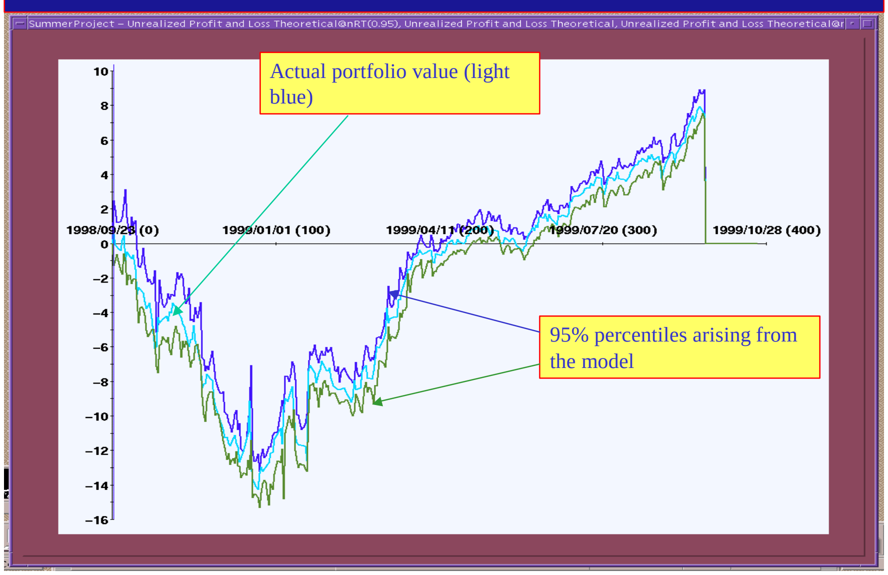
Instr Port Curve Model FX Scenario Stress Optim Template Recalc Graph
FutOil



100-day empirical, taken over time



Out-of-sample backtesting using 250 values for the Empirical Distribution.

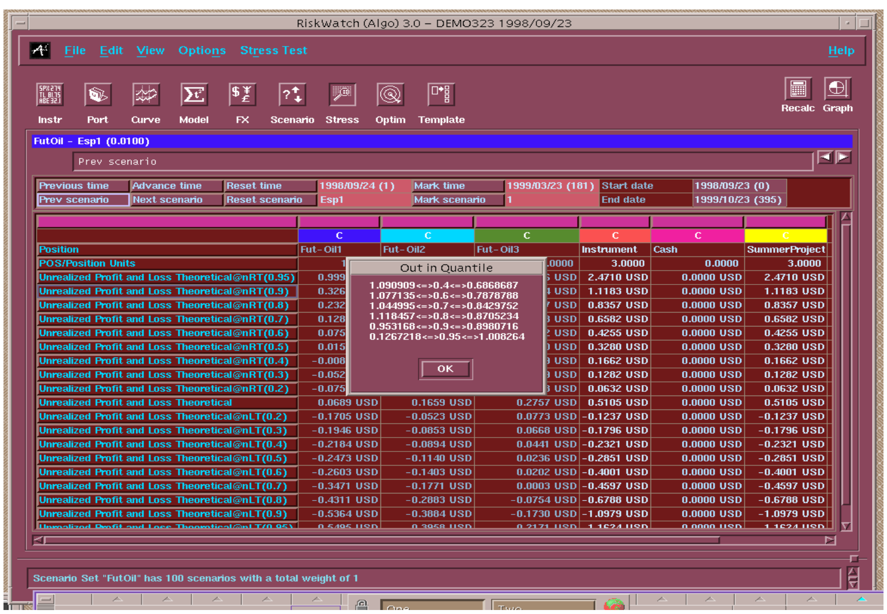


Figure 22) Results for the Empirical 250.

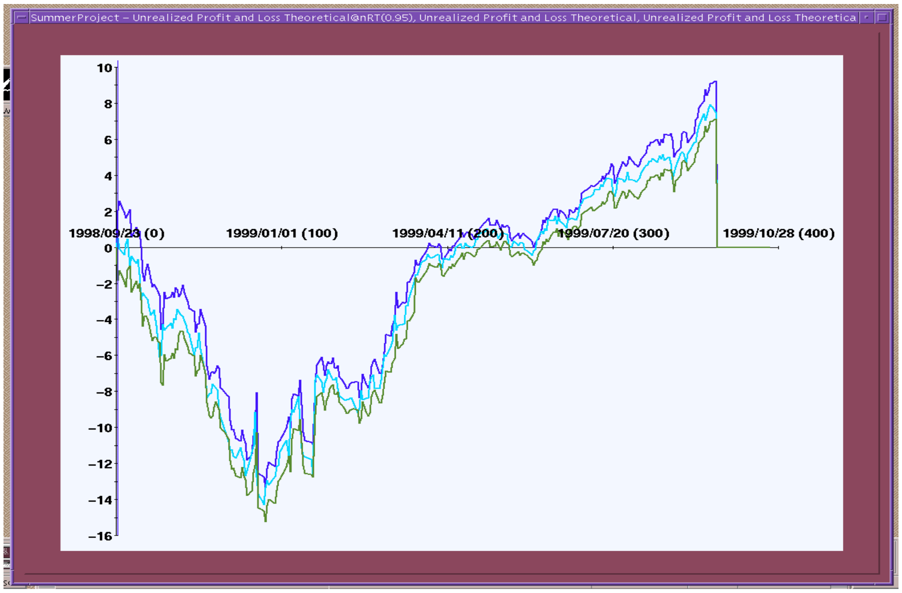


Figure 23) This is in the case of a Multivariate Normal Dependent assumption for the time series considered.

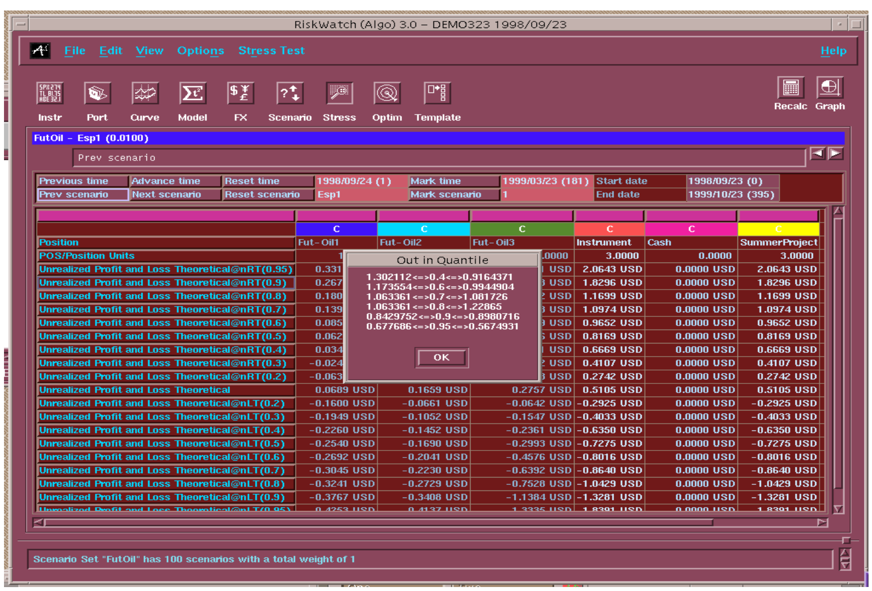


Figure 24) Results for the multivariate normal dependent Assumption.

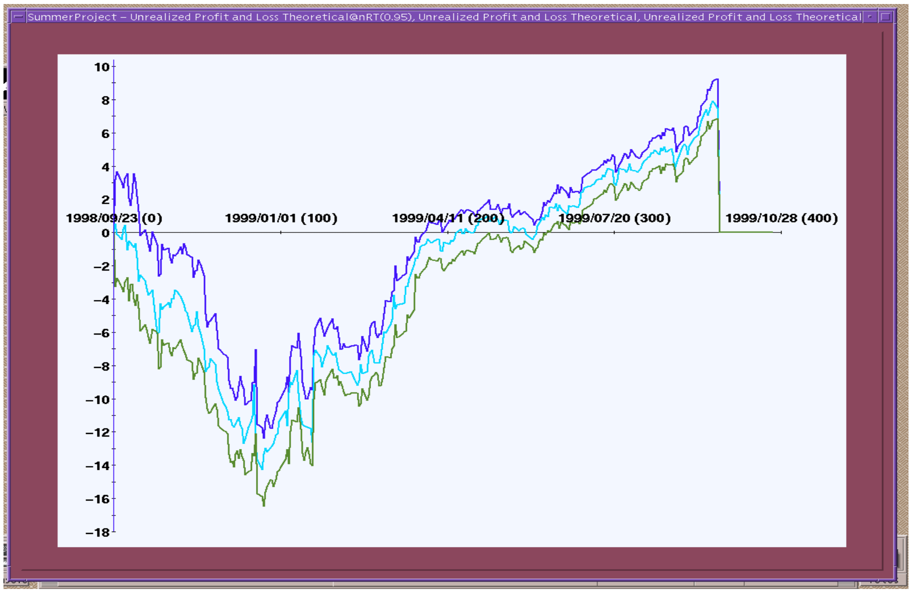


Figure 25) Case of Multivariate Normal Independent assumption.

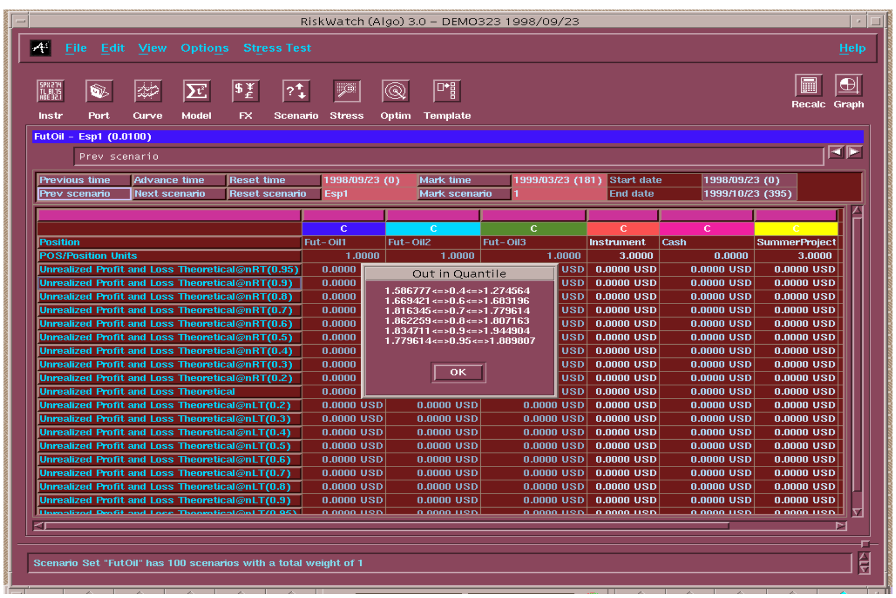


Figure 26) Results for the Independence assumption.

Conclusions

- As for univariate forward Oil time series, we realized there is not significant presence of lineal correlation (ARMA) on the returns, but there is high correlation in the return square (GARCH(1,1)) . It is not significant deterministic seasonality neither stochastic seasonality.
- The "moving windows" test that validate the prediction on a model required few data of history (100-250 data) in order to get good predictions for a one-day-horizon on quantiles less than 0.90-0.95.
- We realized that the most influent characteristic in a Portfolio of Oil forwards is the multivariate dependency structure, this leaded us to focus in the search for a model holding this feature.
- Following the ideas showed in Garbade (Fixed Income Analytics, 1996), it is possible to make the required modification in the proposed term structure in order to get an Arbitrage-Free one. We are working on that and it seem that this new model will give quite interesting results.