

Model Risk and Stress Testing

Discussion of Stéphane Crépey's Presentation

Thierry Roncalli^{*†}

^{*}Amundi Asset Management¹, France

June 2020



¹The views and opinions expressed in this presentation are those of the authors and are not meant to represent the opinions or official positions of Amundi Asset Management or any other institutions.

References



Albanese, C., Crépey, S., and Iabichino, S. (2020)
A Darwinian Theory of Model Risk, *SSRN*,
<https://ssrn.com/abstract=3544862>.



Albanese, C., Crépey, S., and Iabichino, S. (2020)
Reverse Stress Testing, *SSRN*,
<https://ssrn.com/abstract=3544866>.

Model risk

Model risk

- Two definitions (ex-ante vs ex-post viewpoint)
 - ① Difference between the intrinsic value of an instrument and its model price (Derman, 2000)
 - ② Difference between the selling price of an instrument and its model price (Rebonato, 2000)
- What are the components of model risk?
 - ① Pricing model (e.g. Black-Scholes vs Heston)
 - ② Parameters (e.g. dividend and correlation)
 - ③ Risk factors (e.g. yield curve)
 - ④ Hedging model (e.g. delta hedging frequency)
 - ⑤ Calibration set (e.g. caplets vs swaptions)
 - ⑥ Etc.

⇒ Asset management: real assets, real estate, private equity, etc.

Model risk

Mark-to-market price \neq **mark-to-model** price

- Stocks, bonds \Rightarrow mark-to-market
- Vanilla options \Rightarrow mark-to-market & mark-to-model
- Exotic options \Rightarrow mark-to-model

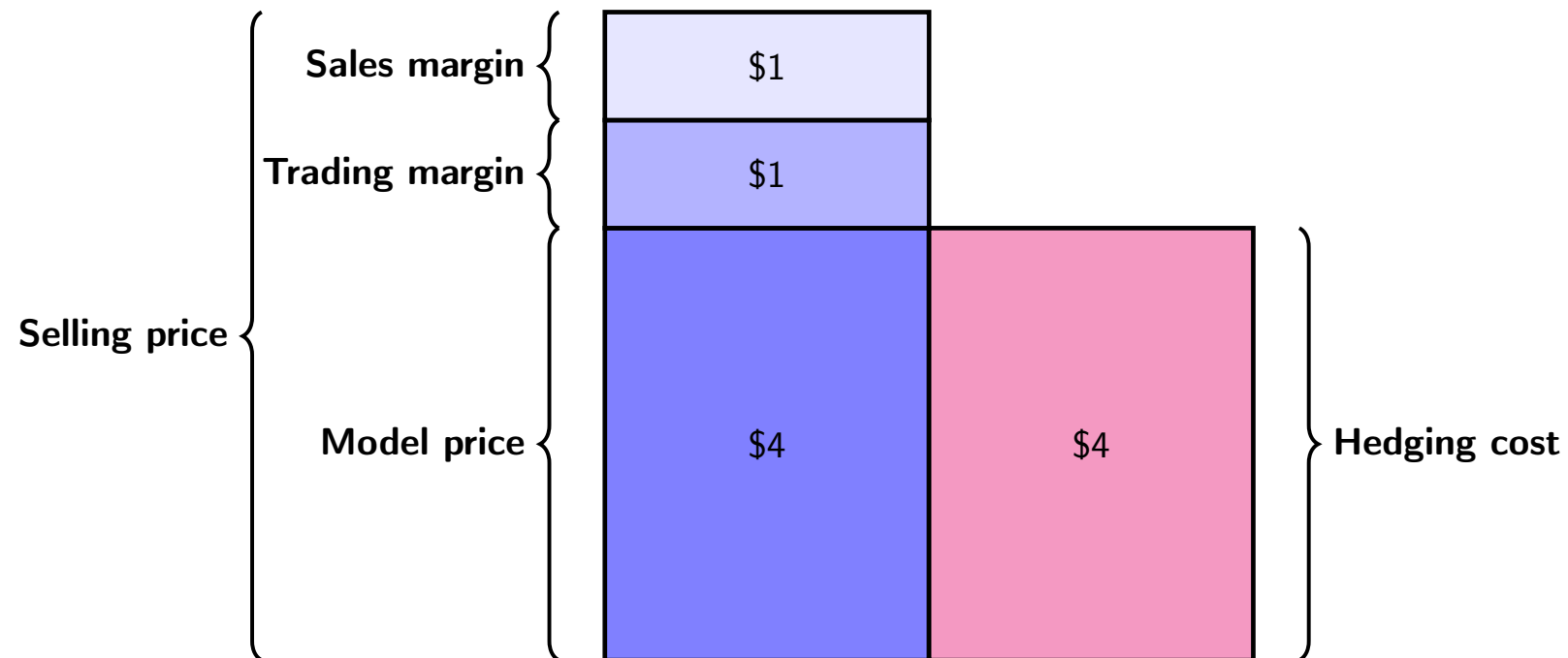
e.g. 90% Guaranteed Capital + BestOf(5Y return of CAC 40 Index, 5Y return of DAX 30 Index) \Rightarrow BS = \$3, Heston = \$4 and Dupire = \$5

How does model risk impact financial institutions?

- Banks: **balance sheet** (Basel III capital requirements) & **income statement** (IFRS provisioning/reserves)
- Asset managers: best execution under MiFID (e.g. structured products)
- Investors: performance, option selling (e.g. gap risk swaps, put options, hedge funds)

Model risk

Figure: The old world of mark-to-model pricing



- Competition between trading desks of different banks
- Competition between the trading desk and the risk management within the bank
- Impact of model risk on provisioning and reserves

Stress testing

Stress testing

Stress testing is a simulation method to identify events that could have a great impact on the soundness of the bank:

We shock market risk factors \Rightarrow we measure the impact on the P&L

Example: what is the loss for the trading desk if the S&P 500 drops by 50% in the next two months?

- \Rightarrow Intensively used by banks and banking regulation (income \Rightarrow market risk transformation)
- \Rightarrow Weakly used by asset managers (management fees)
- \Rightarrow Moderated used by investors (less sophisticated approach)

Liquidity stress testing (ESMA, 2019) \Rightarrow Asset Managers

Reverse stress testing

Reverse stress testing

In the case of stress testing, we have:

Given stress scenario \Rightarrow **Calculated** loss of the financial institution?
 \Rightarrow Bankruptcy if the loss is greater than the capital (adverse scenario identification)

In the case of reverse stress testing, we:

- first identify the loss which is unacceptable
- second identify the most plausible stress scenario that corresponds to this loss

Maximum loss of the financial institution \Rightarrow **Corresponding** stress scenario?

Remark

The second part of reverse stress testing is less interesting, because the solution is not unique (~~most~~ plausible stress scenario(s))

Darwinian principles of model risk

First Darwinian principle

A lower-quality model surviving the test of time must over-value the structured product at inception.

Second Darwinian principle

A surviving lower-quality model must over-hedge and harvest profits from excessive hedge positions which offset and surpass the systematic losses engendered by the initial over-valuation, in the short to medium term.



⇒ A viable model must generate alpha returns that are positively autocorrelated:

“From among the plethora of econometrically unrealistic models, the ones that survive Darwinian selection tend to generate systematic short term profits while exposing the bank to long term risks”.

Market risk versus model risk

- Market risk: second and higher moments of the return distribution
- Model risk: first moment of the return distribution

⇒ Drift in the P&L generation \approx deterministic (*predictable*) alpha

Pricing	Hedging
Upfront P&L	Recurrent P&L
	

⇒ Hedging simulation engine... (back to the BestOf example)

General comments

- ⇒ Two interesting topics: model risk & stress testing
- ⇒ Very good understanding of the challenges: hedging (and not pricing)
- ⇒ Very technical and conceptual
- ⇒ Well illustrated (pricing of callable range accruals, counterparty credit risk)
- ⇒ Not easy to read for non-experts
- ⇒ What is the public: Academics? Professionals? Regulators?

The definition of a lower-quality model

In practice, very few mathematical models are used by professionals: Black-Scholes, Heston, Dupire, SABR, HJM (or statistical factor models), shifted and mixture models.

Why? because they have proved to be the only **robust** models that can be used in an **industrial** point of view

Is Black-Scholes model a *surviving lower-quality model*?

Are Heston, Dupire, SABR and HJM *surviving lower-quality models*?

What about Vasicek, CIR, LMM/BGM, HW, CGMY, etc.

The concept of model risk

- Model risk \Rightarrow carry strategy (positive performance in the short-term during good times, and negative performance in bad times)
 \Rightarrow This is the life of many investors and the life of financial markets
- Confusion between model risk and unpredictable events?
- Alpha = compensation to take a skewness risk (positive autocorrelation of P&L)
- Negative P&L of structured products:
 - Ratchet options (2000): forward transition probabilities
 - PRDC (power reverse dual currency) (2000's): long-term implied JPY volatility
 - Lehman bankruptcy (2008): liquidity and rebalancing issues (put \gg call)
 - Autocall crisis (2019): forward transition probabilities
 - Covid-19 crisis (2020): dividend forecasting

Changes in parameters \gg changes in mathematical models

The concept of model risk

⇒ We must distinguish idiosyncratic risk model crisis and systematic (or systemic) risk model crisis

Model risk \approx market risk of complex securities?

⇒ Option price \neq (deterministic) hedging cost

⇒ Option price = expected hedging cost?

There is no free lunch

- Alpha must compensate the skewness risk taken by the bank
- Alpha is positively autocorrelated
- Business of options and derivatives \neq business of sale margins, commissions and fees
- Business of options and derivatives \approx (volatility) carry strategy, which is also implemented by investors

⇒ Alternative risk premia strategies

Bayesian averaging and stress testing

What is the link with the Black-Litterman approach?

In defense of the regulation

- Stressed expected shortfall
- Multiplicative factor
- Reserves
- Stress testing
- Targeted review of internal models (TRIM)
- **Maturity**
- Etc.

Be careful not to destroy the banking industry!!!

Shadow banking \Rightarrow **shadow trading**

The place of risk management

What is the place of the risk management in The Darwinian Theory of Model Risk?

⇒ Risk department, capital requirement, model validation, provisioning, worst-case scenarios, stress-testing, deferred bonus schemes, etc.

Challenges in asset management with the liquidity stress testing program

- Model risk of liquidity management (asset, liability & matching)
- Validation process by regulators
- Business issues for asset managers (business, risk department)