Financial derivatives in Risk Management

A practical introduction for the MSc class of the UvA Business School
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Risk categories

- Market risk
- Credit risk
- Model risk
- Concentration risk
- Operational risk
- Settlement risk

These categories are discussed in more detail.
Market risk

Overview

• Risks related to changes in the financial market or the instrument itself

• Ways to measure and manage market risk
  • Changes in
    • price of underlying - Delta
    • interest rate - Rho
    • in volatility - Vega
    • value over time - Theta
  • Second order effects of the above
  • Stress testing
  • Scenario Analyses
  • VAR calculations
Market risk

The structure

All market risks

Theoretically hedgeable market risks

Hedged market risks

Delta  Rho  Vega  Theta

Secondary Greeks

Calculated risks taken
Market risk

Risk Management

• No-arbitrage assumption
  • A riskless investment cannot be profitable (or loss making)
  • This is a model dependent assumption – in the real market it fails ➔ Model risk!
• Risk can be managed (reduced) by trading other financial derivatives ➔ hedging
  • Hedging can be static and dynamic
  • Hedging comes at costs – decreasing profit directly
  • Hedging is model dependent ➔ Model risk!
• Part of the risk is calculated risk – these risks are taken (management’s view)
  • These risks might or might not decrease profit
  • The calculations are model dependent ➔ Model risk!
• Finally, part of the risk cannot be hedged or calculated – these risks have to be controlled by restricting the trading
  • The set of un-hedgeable investments is model dependent ➔ Model risk!
Market risk

Hedging

• Hedging is an active way of managing risk
• The goal is to reduce risks taken by trading
• Hedging can also be used for risks (e.g. FX, Interest rate) arising from other instruments
  • Insurance policies
  • Real estate investments
• The hedging comes at a cost – you pay for the reduction in risk
  • ➔ no free lunch principle applies
• Hedging is typically done with a different counterparty than the counterparty of the hedged instrument
  • ➔ additional credit risk!
• Hedging is often not perfect
  • ➔ The differences all attribute to the calculated risk
Market risk

Risk metrics

- The risks related to the trading have to be calculated
- The taken (i.e. unhedged) risks have to be limited and monitored
- There is no risk metric accepted by everybody
- Common practices include
  - Value at Risk (VaR): quantifying losses that occur with low probability (e.g. loss given a 1-in-a-1000 event)
  - Stress testing: how would the value of the portfolio change in case of specific market movements
  - Scenario analyses – Best and Worst case scenarios
  - All these metrics are model dependent ➔ Model risk again
Market risk

Risk of a portfolio

- In case of related instruments (e.g. options on the same underlying) the market risks can be handled together
  - The Greeks are theoretically speaking stemming from differentiation, so they are linear (e.g. the Delta of two options on S&P 500 can be summed)
  - The FX risk of investments in the same currency are naturally nettable
- Some underlyings are strongly correlated
  - The calculation of risk on one instrument can lead to different results than the calculation of risk for the whole of the portfolio
  - Correlated instruments have to be stress tested together
  - Similar markets are often correlated, but this might be different locally (see next slide)
  - The scenario analyses must take into account the correlation as well
- Correlation can be used in hedging
  - You can hedge an instrument with a strongly correlated instrument
  - E.g. EUR/USD FX rate strongly correlates with gold and oil prices, so you can hedge your EUR/USD FX risk by investing into (or going short in) gold and/or oil
Example of correlated instruments

PLN and HUF in EUR
Example of correlated instruments
Fed rate versus Gold

Real Fed Funds Rate (EFF–CPI) vs. Gold

Source: BullionVault.com
Market risk – Examples I/a

Foreign currency variable rate loan

- Consider an NL based company taking a variable rate loan in the UK
- The loan is in GBP and is dependent on the interest rates in the UK
- Risks on this financial derivative:
  - Market risk
  - FX risk
  - Interest rate risk
  - Credit risk – N/A (the party taking the loan doesn’t run credit risk)
  - Model risk – only when trying to predict future market risks
- Possible ways to manage risk:
  - No action – both risks are taken as calculated risk
  - Hedge the FX risk only
  - Hedge the interest rate risk only
  - Hedge both risks
Market risk – Examples I/b

Ways to hedge FX risk only

• Hedge the FX risk only (static hedging)
  • FX Forward
    • Enter into contracts for all cash-flows at a pre-set FX rate: give EUR and get GBP
    • No upfront costs
    • In case of EUR depreciating, you are fully protected
    • In case of EUR appreciating, you lose the possible profit
  • FX Call Option
    • Buy an option to buy GBP for EUR at a preset rate if it’s beneficial
    • Upfront payment
    • You floor your losses
    • You don’t cap your profit
  • FX Option Collar
    • Buy a call and sell a put
      • Buy an option to buy GBP for EUR at a preset rate if it’s beneficial
      • Sell an option to sell EUR for GBP at a preset rate if it’s beneficial for the counterparty
    • No upfront payment – the parameters are set so that the prices equal
    • You floor your losses and you cap your profit
Market risk – Examples I/c

Effect of changes in FX rate

[Graph showing the effect of changes in FX rate on the FX Rate for Hedger and FX Market Rate, with lines representing FX Forward, FX Call Option, and FX Option collar.]
Market risk – Examples I/d

Ways to hedge IR risk or both risks

• Hedge the Interest Rate risk only (static hedging)
  • Enter into a GBP Interest Rate Swap (IRS) contract
    • Receive variable rate (Floating leg)
    • Pay Fixed Rate (Fixed leg)
    • No upfront costs
    • You can’t have a loss in exchange for no profit
  • Enter into a Swaption contract
    • Buy an Option enabling you to enter into an IRS analogue to the above in case of the Rate increasing too much
    • Upfront payment
    • You floor your loss

• Hedge both risks
  • Choose a combination of the above possibilities
  • Enter into a Cross Currency IRS contract
    • Pay Fixed rate in EUR
    • Receive variable rate in GBP
    • No upfront payment
    • Only one instrument, only one counterparty – concentration risk
Market risk – Examples II

European option

• Consider buying a European Call option on EUROSTOXX 50
• You have the right to buy the underlying at a preset price at a preset time
• The instrument is non-linear ➔ static hedging not possible
• Dynamically the Delta of the option is easily hedgable:
  • When the option is, you go long on the underlying
  • When the option is at-the-money, you don’t hold any of the underlying
  • When the option is in-the-money, you can go short on the underlying (but why would you…)
• The Rho of the option can be hedged by trading Interest Rate instruments
• The Vega of the option is harder, it is typically hedged by either another option, or a more complex strategy dependent on the current and historical volatilities.
• As visible, dynamic hedging involves a whole trading strategy.
• Note: JP Morgan proposes a trading strategy using the correlation between volatilities and the option prices that is (partially) stemming from the Vega and Gamma hedgers! Option hedgers influence the market significantly.
Credit risk

Overview

• Risks related to counterparties
• Some transactions have minimal credit risk
  • Exchange traded instruments - through a clearing house
  • Delivery versus Payment setups – only settlement risk
• Over the Counter (OTC) transactions
  • Direct contract between the trading parties
  • One or both of the counterparties run credit risk
    • Shorting an option means no credit risk
    • Longing an option means taking credit risk
    • An IRS means credit risk for both parties
Credit risk

Risk Management

• For a long time the importance of this type of risk was underestimated

• Credit risk can be managed by
  
  • Hedging, e.g. trading Credit instruments
    • ➔ The hedging instrument itself comes with a credit risk!
  
  • Counterparty limits, i.e. restricting the volume of trade per counterparty
    • How is the volume calculated? ➔ Model risk
    • The calculation has to be done regularly
    • It is important that the limit can be breached because of market movements
      • ➔ Stress testing and scenario analyses play a role here too
  
• Credit risk has to be quantified as well
  
  • Default rate calculation ➔ extremely difficult
  
  • Credit VaR ➔ not used widely (yet)
Example of correlated instruments

Gold price vs Credit Risk “insurance”

Source: www.marketoracle.co.uk
Other risks

Overview

• Model risk
  • Model validation is a requirement in regulations (e.g. Basel II)
  • These risks are very hard to quantify
  • Assumption risk
    • The underlying assumptions might be incorrect
  • Parameter risk ➔ Incorrect parameters fitted affects accuracy
  • Model choice risk ➔ Choice between theoretically equivalent models might affect accuracy (e.g. Short rate vs Forward rate)

• Concentration risk
  • Risk arising when too large part of the portfolio belongs to the same risk category
    • Too many instruments exposed to un-hedged market risk
    • Too many instruments exposed to the default risk of a counterparty