Financial Metrics Useful for Grid Management
Introduction to Hedging in the Grid Space

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Overview

- Description of financial assets.
- How we see risk in finance.
- How we measure risk in finance.
- How we manage risk in finance.
- Potential know-how transfer from finance to managing the electricity grid.
Examples of financial assets: stocks, bonds, options, futures, real estate, alternative investments.

In finance we evaluate assets based on their expected risk and return. Such assessment is made based on different asset’s characteristics:
- Historical assets returns.
- Publicly available financial statements which represent a snapshot of the financial health of firms from an accounting point of view.
- Analysts estimates.

The best way to describe how we see risk in finance is by using the Chinese symbols for risk, reproduced below:

危機

- The first symbol is the symbol for “danger”, while the second is the symbol for “opportunity”, making risk a mix of danger and opportunity.
How we measure risk in finance

- In general we can think of risk as the chance of not delivering to our expectations.
- Broadly speaking, in finance, risk and return models can be categorized as:
  - Theory based models that begin with an economic (and quantitative) definition of risk and derive risk measures based on that definition.
  - Alternative models that are based upon either intuitive or qualitative measures of risk.
- Ways to quantitatively measure risk in finance are many:
  - Volatility – this is the standard deviation of assets’ returns
  - Downside risk – Semivariance, Expected shortfall, Value at Risk, Conditional Value at Risk
  - Credit or default risk: failure to deliver on debt obligations
How we manage risk in finance

- Managing price risk – many firms who face uncertainty in prices that they have to pay or receive use hedging.

- Meaning of hedging: Modern definitions of “hedge” as a verb based on Merriam-Webster Dictionary are: “to protect oneself from losing or failing by a counterbalancing action”.

- Examples of hedges:
  - Physical - Firms that face the risk of rising corn prices (Tyson foods) - may just purchase corn and store it. They will face storage costs.
  - Financial - Airlines (Southwest) are exposed to the fluctuations in jet fuel prices; they enter long fuel oil futures or purchase fuel oil call options – available on CME Group. [https://www.cmegroup.com/trading/energy/fuel-oil.html](https://www.cmegroup.com/trading/energy/fuel-oil.html)

- Credit risk or default risk:
  - Credit ratings
  - Probability of default
Credit risk

- Credit ratings:
  - They are issued by credit agencies – Standard and Poor’s, Moody’s and Fitch.
  - Credit rating agencies use information from firms’ financial statements and market-based data from the prices of securities associated with the firm.

Source: Standard & Poor’s credit services
Default risk

In general we see different providers estimating probabilities of default or expected default frequencies. Bloomberg:

Source: Bloomberg
EDF stands for Expected Default Frequency and is a measure of the probability that a firm will default over a specified period of time (typically one year). “Default” is defined as failure to make scheduled principal or interest payments.

COMPONENTS OF EDF

- The current market value of the firm (market value of assets)
- The level of the firm’s obligations (default point)
- The vulnerability of the market value to large changes (asset volatility)

Source: Moody’s
Default probabilities implied out of derivative prices (options)

Financial firms' default probabilities and at the beginning of the 2008 financial crisis (bold).

Credit risks:

- Default risk is the risk that a bond defaults,
- Credit spread risk is the risk that a bond's spread widens above a comparable risk-free bond, and
- Downgrade risk is the risk that a bond gets a ratings downgrade.

Derivative instruments used to hedge above three risks:

- Binary Credit Options (Puts/Calls): Pay off if a "specific negative credit event" occurs.
- Credit Spread Options: Pay off if the spread on the bond you're insuring rises above a certain level.
- Credit Forwards: Both parties lock in a commitment to pay off (or, rather, one party will pay the other) based on a bond's price or spread at a specific time.
- Credit Default Swaps: You pay regular premiums to a CDS dealer, who will pay off in the event of a "credit event". These instruments are often used to protect against default risk and downgrade risk.
How could we translate this into managing power assets?

- Similarities between power assets and financial assets. What assets’ characteristics should be taken into account?
  - Base load units (nuclear and coal plants) – similar to fixed income securities in finance, assets with low risk and predictable return (capacity).
  - Peaking units (natural gas) - similar to stocks in finance, higher risk (higher operating costs) and higher return (have capacity during high demand – higher prices)
  - Distributed energy resources - similar to alternative assets in finance, high risk (they can produce only when the energy source is available) but with a potentially high reward since the energy sources are free, wind and solar for example.

- Dependency structure between assets:
  - In finance we use correlation, or other metrics of similarity, like grouping firms based on industry or sector.
  - Power assets similarities could be defined based on their primary energy source:
    - Natural gas, Coal, Renewables, Nuclear, Petroleum

- In finance we construct optimal portfolios by taking into account assets’ risks, return, and correlations
Managing power assets should involve some type of hedging. There is already such opportunity on the transmission side – Financial transmission rights.

How about having such opportunity for all assets that face resource performance risk?

Physical hedging –
- Some power assets may be willing to take the role of hedging instruments for fee. They should be able to produce power fast once the hedging contract is called.
- For example peaking units may decide to sell such contracts. They will receive fees and will have the obligation to deliver capacity when the contract expires or is being called.
- Similar to the corn example, investment in a battery may be seen appropriate.

Financial instruments hedging: Financial markets already have electricity derivatives. See https://www.cmegroup.com/trading/energy/#electricity
How could we translate this into managing power assets?

- Risks and hedging:
- Base load units:
  - What are their risks? They worry about low demand and low prices.
  - Why? Because low demand will drive down prices and peaking units will become competitive.
  - Should they hedge? They can sell derivative contracts.
- Peaking units:
  - What are their risks? They also worry about low demand, since it will drive prices down and they will not be able to cover higher operating costs.
  - Should they hedge? They can sell derivative contracts.
- Renewable resources:
  - What are their risks? Nature?
  - Should they hedge? Using weather derivatives?
How could we translate this into managing power assets?

- Constructing reliability/credit score for power assets similar to credit ratings in finance.

- There may be a need of establishing an independent agency that has access to individual power assets’ physical and historical performance data.

- In finance we also perform “backtesting”. This means that once we design a certain strategy (it could be trading or for risk management), we could pretend to use it in the past in order to see how it would have performed.

- Such backtesting could be used in managing power assets - if detailed power asset data is available.