

Financial Metrics Useful for Grid Management

Introduction to Hedging in the Grid Space

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The rising STAR of Texas

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.

Financial Assets

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

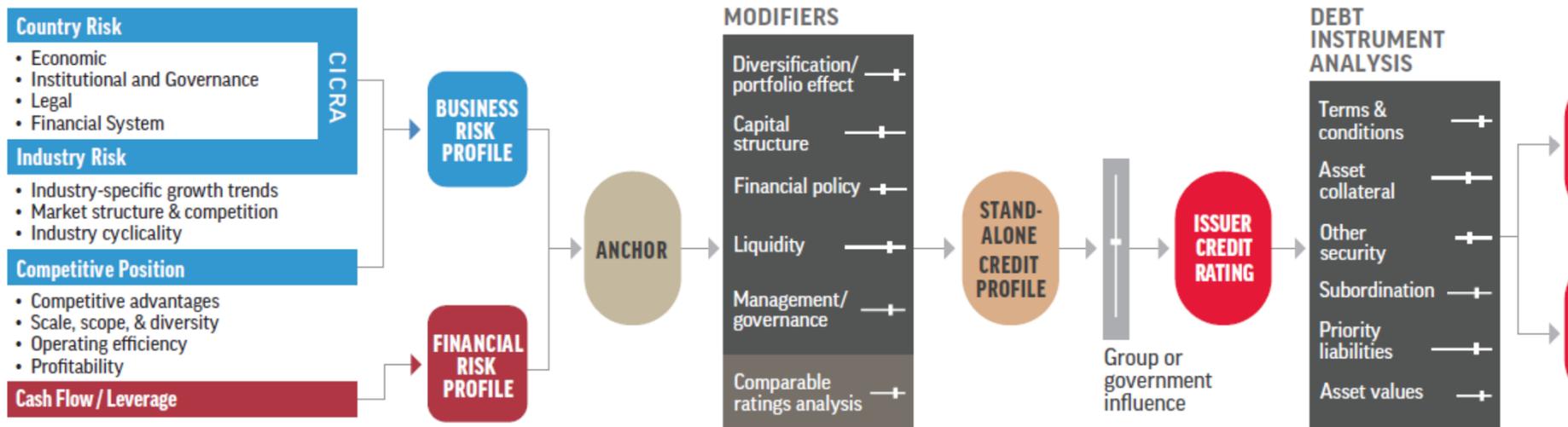
Credit risk

❖ 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.



CORPORATE CRITERIA FRAMEWORK



Source: Standard & Poor’s credit services

Default risk

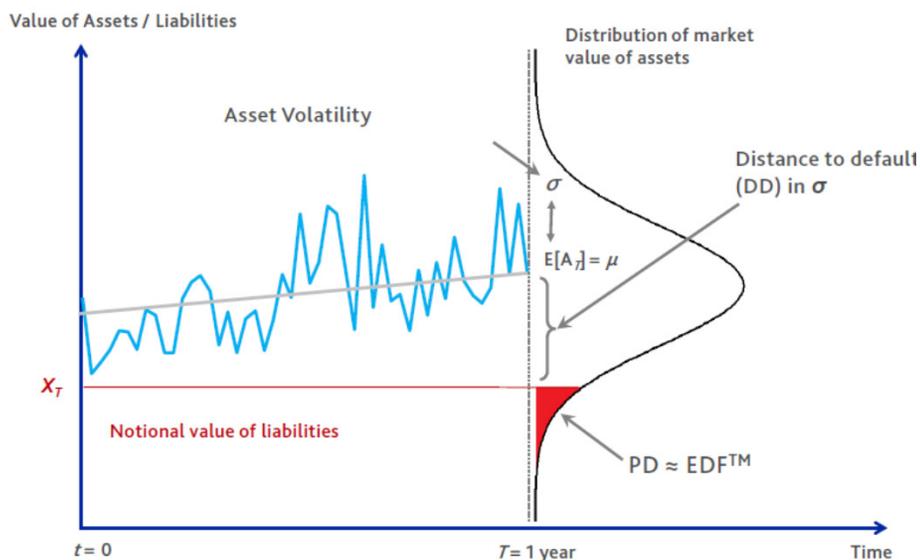
In general we see different providers estimating probabilities of default or expected default frequencies. Bloomberg:



Source: Bloomberg

Expected Default Frequencies by Moody's

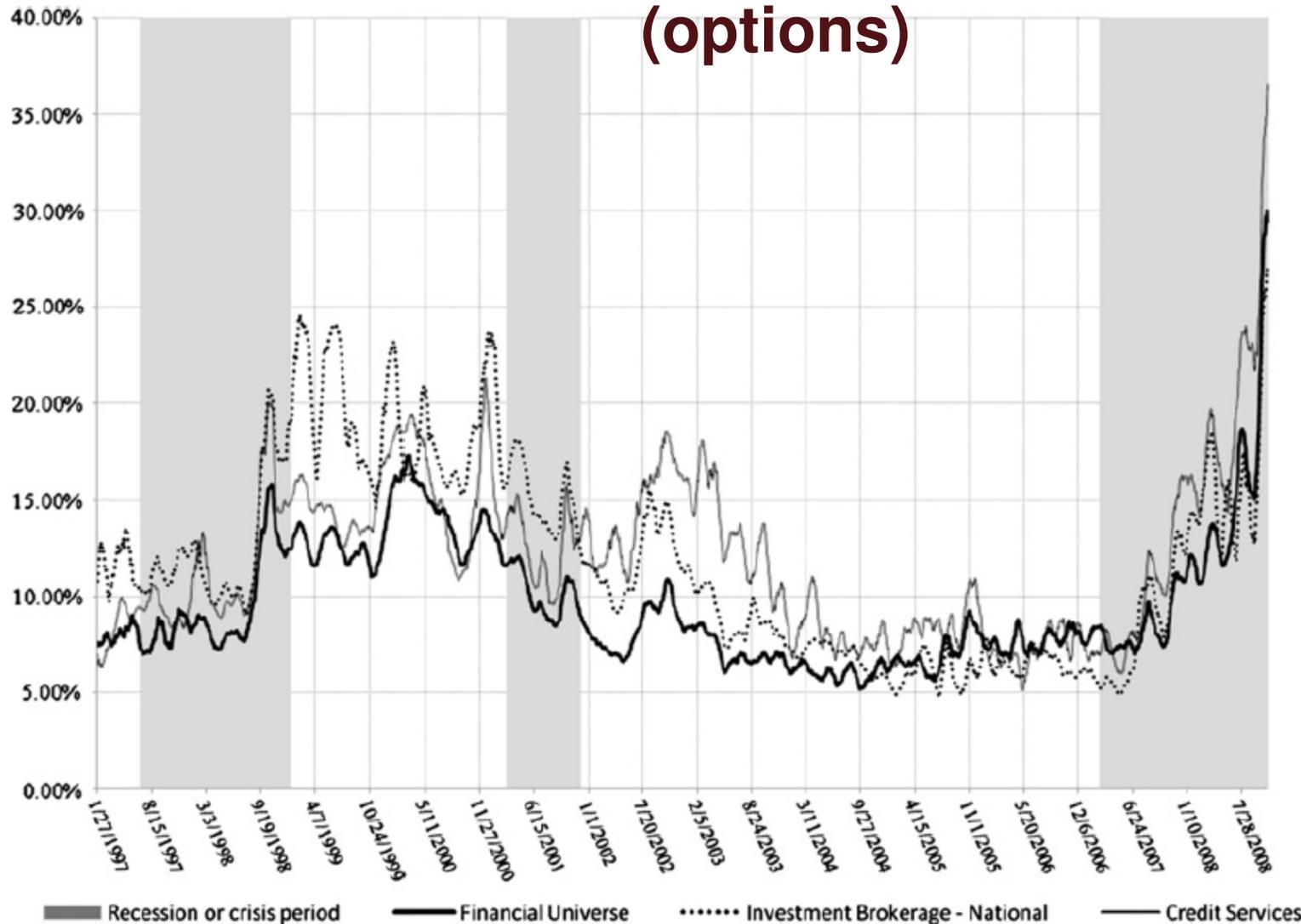
Default Process in the Structural Model



Source: Moody's

- ❖ 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)

Default probabilities implied out of derivative prices (options)



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Source: author's own research, Camara, Popova, Simkins (2012). "A comparative Study of the Probability of Default for Global Financial Firms". *Journal of Banking and Finance*. (36), 3, 717-732.

Hedging credit risk

❖ 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, returns and correlations

How could we translate this into managing power assets?

- ❖ 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.