Risk management in Electricity Market

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Why the need of financial risk management

- Financial risk management is often a high priority for participants in deregulated electricity markets due to the substantial price and volume risks that the markets can exhibit.
- The wholesale electricity market has extremely high price volatility at times of peak demand and supply shortages.
  - Price highly dependent on the physical fundamentals of the market
    - the mix of types of generation plant
    - relationship between demand and weather patterns.
  - Price risk can be manifest by price "spikes" which are hard to predict and price "steps" when the underlying fuel or plant position changes for long periods.
- "Volume risk" is often used to denote the phenomenon whereby electricity market participants have uncertain volumes or quantities of consumption or production.
  - a retailer is unable to accurately predict consumer demand for any particular hour more than a few days into the future
  - a producer is unable to predict the precise time that they will have plant outage or shortages of fuel.
- A compounding factor is also the common correlation between extreme price and volume events
  - price spikes frequently occur when some producers have plant outages or when some consumers are in a period of peak consumption.
  - The introduction of intermittent power sources such as wind energy may have an impact on market prices (increases the uncertainty about the volume for traditional power plants)

What is the price volatility

- **Volatility** is a measure for variation of price
- The symbol σ is used for volatility, and corresponds to standard deviation
- The variance is the square of standard deviation σ^2.
- **The variance** measures how far a set of numbers is spread out.
  - A variance of zero indicates that all the values are identical.
  - Variance is always non-negative
  - A small variance indicates that the data points tend to be very close to the mean and hence to each other
  - A high variance indicates that the data points are very spread out around the mean and from each other

$$\operatorname{Var}(X) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2. \qquad \mu = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\operatorname{Var}(X) = \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\frac{1}{2}(x_i - x_j)^2.$$

Hedge contracts

- Electricity retailers and generators are exposed to these price and volume effects and to protect themselves from volatility
- They will enter into "hedge contracts" with each other.
- The structure of these contracts varies by regional market due to different conventions and market structures.
- The two simplest and most common forms are
  - simple fixed price forward contracts for physical delivery
  - contracts for differences where the parties agree a strike price for defined time periods.

Forward contracts for physical delivery

- A **forward contract** or simply a **forward** is a non-standardized contract between two parties to buy or to sell an asset at a specified future time at a price agreed upon today, making it a type of derivative instrument
- This is in contrast to a spot contract, which is an agreement to buy or sell an asset today.
- The party agreeing to buy the underlying asset in the future assumes a long position
- The party agreeing to sell the asset in the future assumes a short position.
- The price agreed upon is called the delivery price, which is equal to the forward price at the time the contract is entered into
- The forward price of such a contract is commonly contrasted with the spot price, which is the price at which the asset changes hands on the spot date.
- The difference between the spot and the forward price is the forward premium or forward discount, generally considered in the form of a profit, or loss, by the purchasing party.

Payoffs

- The value of a forward position *at maturity* depends on the relationship between the delivery price (Pd) and the underlying price (Pu) at that time:
  - For a long position the payoff is: Pu-Pd
  - For a short position, it is: Pd-Pu

- Since the final value (at maturity) of a forward position depends on the spot price which will then be prevailing, this contract can be viewed, from a purely financial point of view, as *a bet on the future spot price*

Example

- Suppose that Bob wants to buy a house a year from now.
- At the same time, suppose that Andy currently owns a $100,000 house that he wishes to sell a year from now.
- Both parties could enter into a forward contract with each other.
- Suppose that they both agree on the sale price in one year's time of $104,000 (more below on why the sale price should be this amount).
- Andy and Bob have entered into a forward contract.
  - Bob is buying the underlying, is said to have entered a long forward contract.
  - Andy will have the short forward contract.
- At the end of one year, suppose that the current market valuation of Andy's house is $110,000.
  - Andy is obliged to sell to Bob for only $104,000
  - Bob will make a profit of $6,000: Bob can buy from Andy for $104,000 and immediately sell to the market for $110,000. Bob has made the difference in profit
  - Andy has made a potential loss of $6,000, and an actual profit of $4,000.

CfD

- A **contract for difference** (**CFD**) is a contract between two parties, typically described as "buyer" and "seller", stipulating that
  - the seller will pay to the buyer the difference between the current value of an asset and its value at contract time
  - If the difference is negative, then the buyer pays instead to the seller.

Example

- Consider a deal between an electricity producer and an electricity retailer, both of whom trade through an electricity market pool.
- If the producer and the retailer agree to a strike price of $50 per MWh, for 1 MWh in a trading period, and if the actual pool price is $70, then the producer gets $70 from the pool but has to rebate $20 (the "difference" between the strike price and the pool price) to the retailer.
- Conversely, the retailer pays the difference to the producer if the pool price is lower than the agreed upon contractual strike price.
- In effect, the pool volatility is nullified and the parties pay and receive $50 per MWh.
- However, the party who pays the difference is "out of the money (Moneyness)" because without the hedge they would have received the benefit of the pool price.

The Firm Transmission Rights (FTRs)

- Firm Transmission Rights (FTRs) are issued by TSOs and can be bought by market operators in order to hedge the risk connected to the volatility of price differentials in a zonal market
- FTRs are typically defined w.r.t. a couple of zones;
  - their owners have the right or the obligation (depending on the nature of the title) to receive back from the TSO an amount of money equal to the difference between the prices in the “downstream” and “upstream” zones times the quantity object of the right.
  - If the difference is negative, obligation owners must pay this amount to the TSO, while no payment is due from option owners

The issue of revenue sufficiency

- It is necessary to evaluate in advance the maximum quantity of FTRs that can be issued by the TSO so that the total amount of payments to the title owners does not exceed the revenues coming from congestion rents.
- This condition, known as revenue sufficiency, ensures the TSO to be able to settle all the payments due to FTR owners without any need to socialize portions of it into the national tariffs.