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Risk Management in Electricity Market Design

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Outline

- Introduction
- Basic questions of risk management
- Effects of restructuring on regulatory compact
- How to restructure utility service obligation
- Conclusion

Attributes of Electricity and Incomplete Markets

- Electricity is not storable
  - Demand and supply must be balanced in real-time
  - System reliability is a **public good**
- **Externality** is prevalent throughout the system
  - Excessive peak demand reduces system reliability
  - Transmission congestion/losses due to loop flows
  - Environmental impacts
- The network is governed by **non-convexity**
  - Economies of scale/scope
  - Shift factors vary with power flow patterns
  - Fixed unit commitment costs, minimum run
- Commercial exchange is handicapped by the limited **availability of** real-time transaction **information**

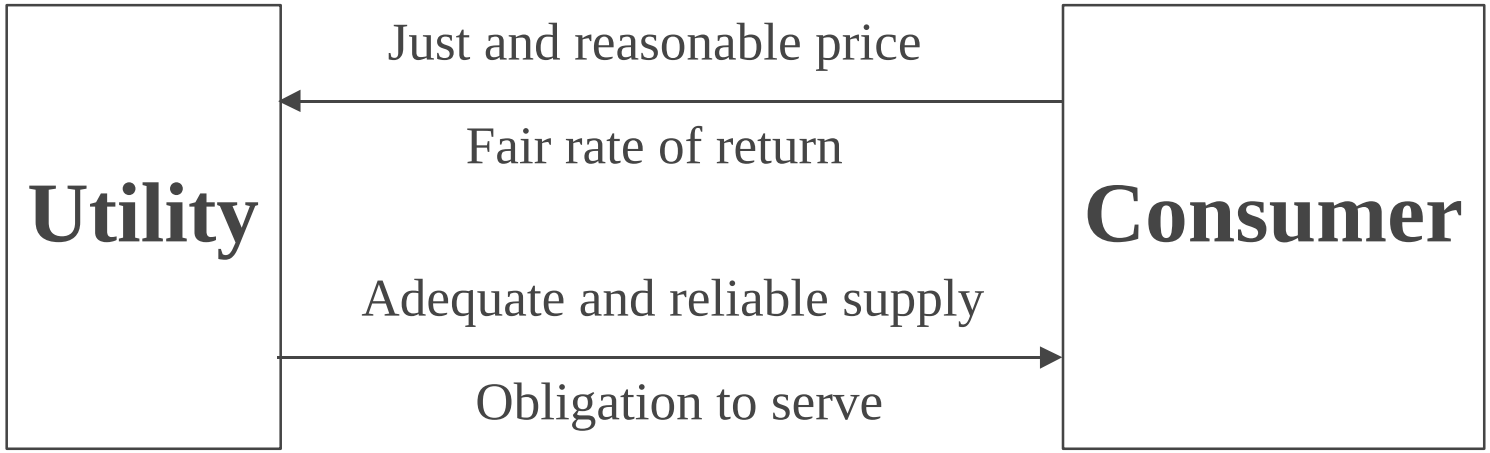
Two Types of Risk

- Price risk: private risk ⇔ investment adequacy
  - Spot markets
  - Forward/futures/options markets
  - Long-term contracts
- Quantity risk: public risk ⇔ system reliability
  - Generation scarcity ⇒ market power & unreliable system operation
  - Transmission scarcity ⇒ fragmented system & local market power

Restructuring Raises Basic Questions of Risk Management

- Vertical integration provides insurance along supply chain
  - Vertical integration buffered price volatility
  - Retail rate regulation smoothed effects on customers
  - ROR regulation insured utilities and their investors
- Vertical unbundling results in redistribution of risks
  - Utility becomes a financial intermediary using long-term contracts and other financial instruments
  - Default service obligation needs to be restructured
  - Develop price-responsive demand so that some risk can be shifted to retail customers

Regulatory Compact

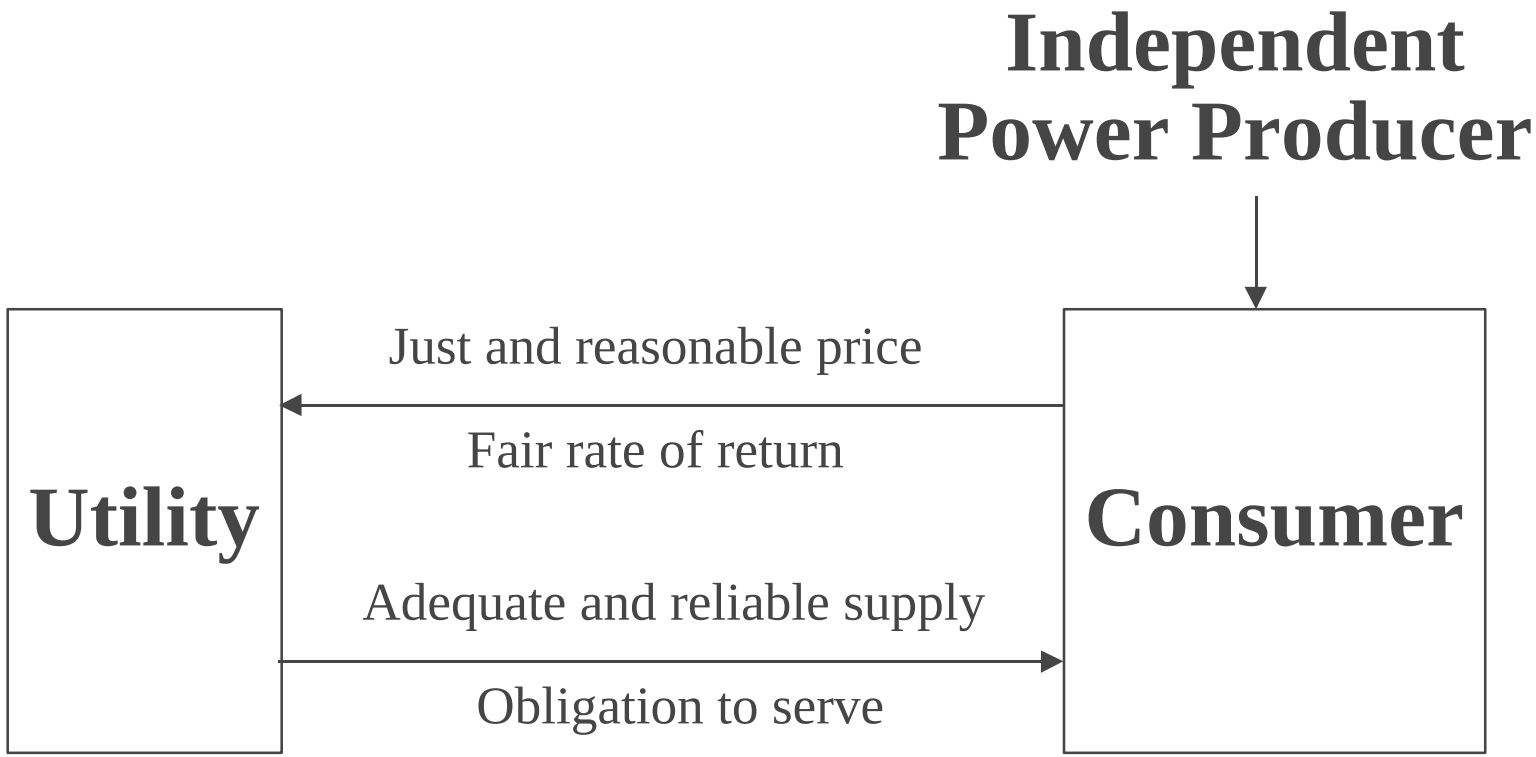


- Franchise control
- Rate making
- Utility service obligation

More on Regulatory Compact

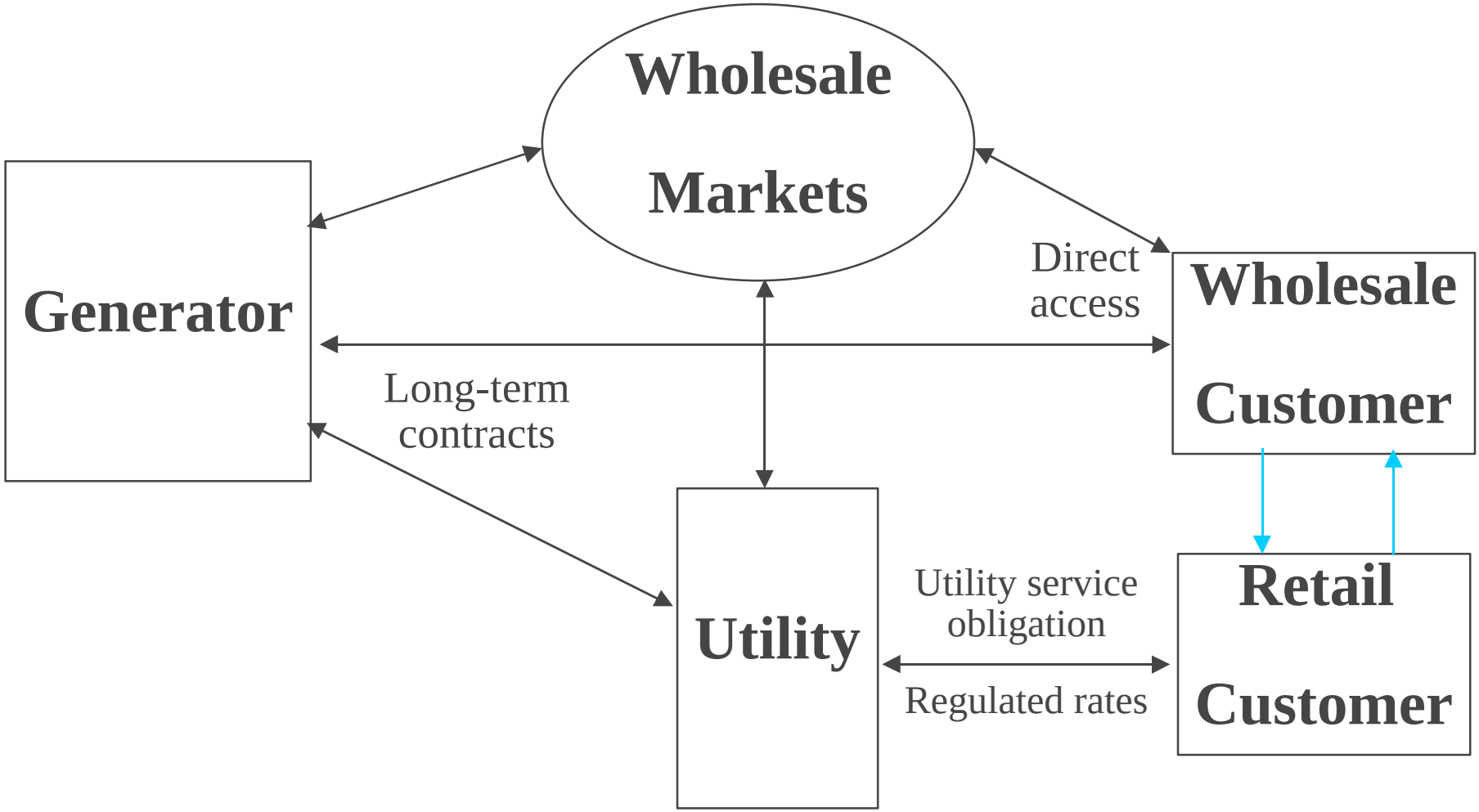
- Franchise control - The state commission controls the entry of the utility's competitors and the exit of its customers
- Rate making - The commission authorizes rates that allow the utility a reasonable opportunity to earn a fair rate of return on investment that reflects the cost of capital financed in debt and equity markets
- Utility Service Obligation (USO)
  - The utility must comply with regulatory accounting procedures for cost disclosure and price regulation
  - The utility must meet service quality standards and invest in transmission and access services to all customers within its service territory
  - The utility must operate efficiently and make only prudent investments as determined by the regulatory commission

Change Began with PURPA Which Gives the IPP's an Option to Enter



***PURPA: Public Utility Regulatory Policy Act, 1978**

Restructuring Gives Large Customers the Option to Exit



Restructuring Causes Utility's Cost and Risk to Rise

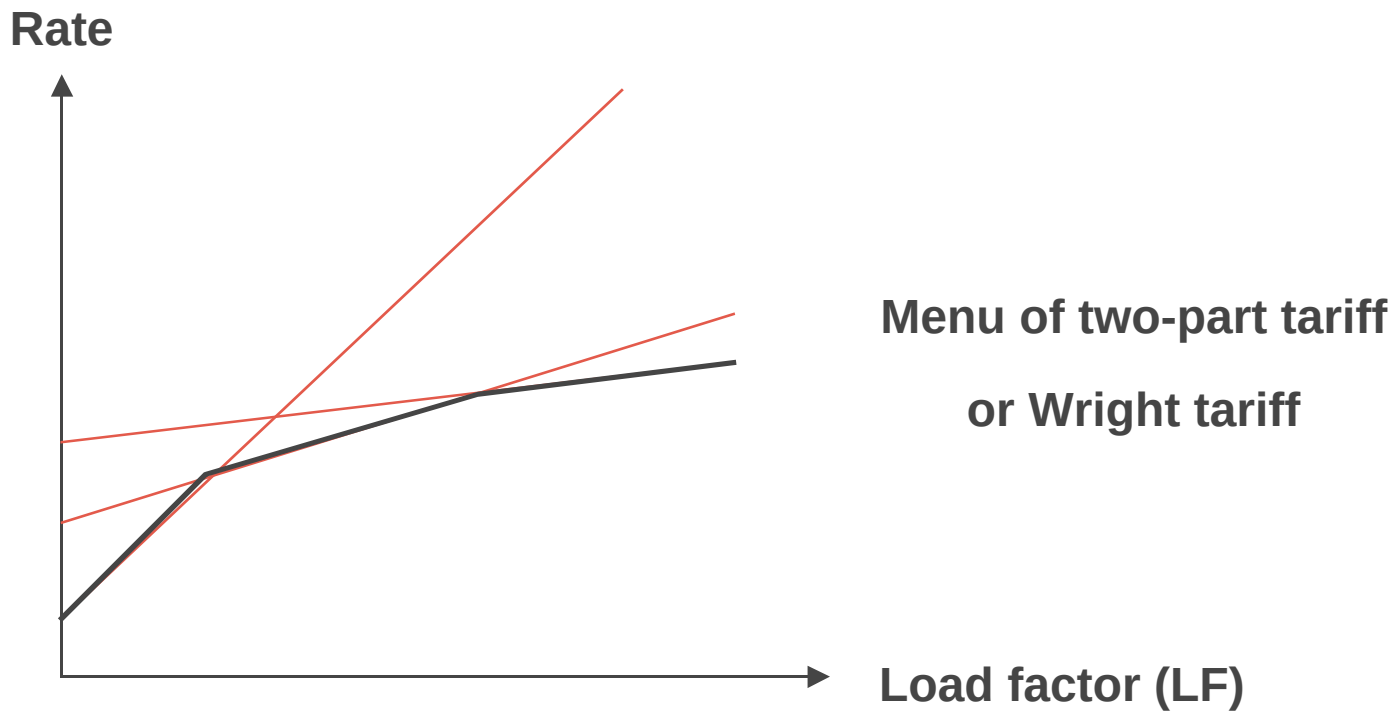
- Large base-load customers find bilateral contracts more attractive
- The utility is susceptible to adverse selection with a deteriorating load shape
- The cost of service will rise, causing an increase in the number of rate hearings
- Long-term contracts will receive close scrutiny in regulatory review with unpredictable results
- This results in an increase in the business risk and the cost of capital
- The cost of service will increase still further

Restructuring Utility Service Obligation is Key to a Sustainable Regulatory Contract

- Differentiated service pricing is essential to mitigate the problem of adverse selection
- Price-responsive demand is imperative to allow some risk to be shifted to retail customers
- Key elements of USO restructuring
  - Differentiation of load shape
  - Risk sharing of reliability

Load Shape Pricing Mitigates the Adverse Selection Problem

- Rate = Min [Fixed capital charge + Variable charge*Load factor]
- Payment = Rate*Maximum contracted load



A Consumer Choice Model for Spot Purchase and Contract

- Consumers decide on spot purchase (q_s) and contract (q_c)
- Spot price at time t is $p_s(t)$; price schedule for contract is (k, c)
- The capital cost for generation in spot market is k_s

$$\underset{q_s, q_c, \hat{q}_c}{Max} \int_0^T U_t(q_s(t)+q_c(t)) - p_s(t)q_s(t)dt - k\hat{q}_c - c\int_0^T q_c(t)dt$$

$$q_c(t) \le \hat{q}_c, q_c(t) \ge 0,\ q_s(t) \ge 0$$

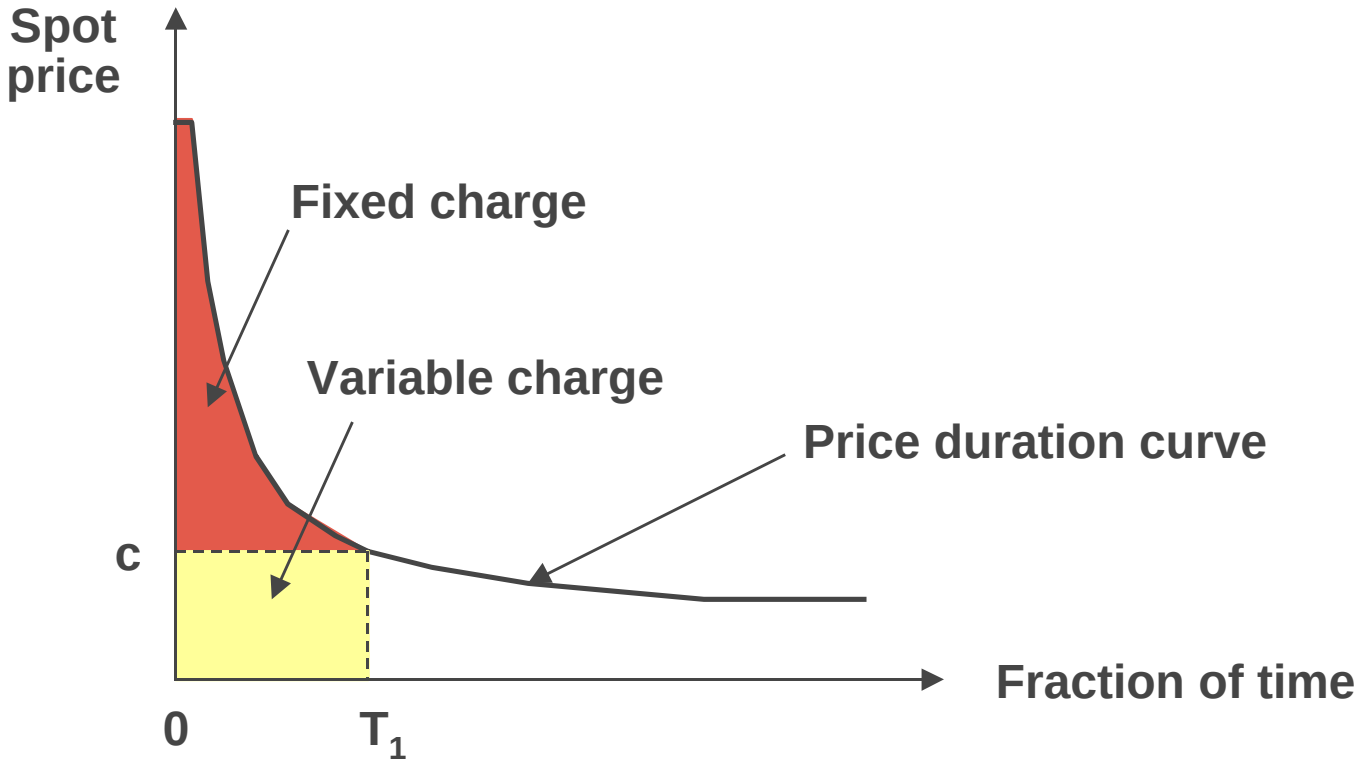
$$k\hat{q}_c + c\int_0^T q_c(t)dt = \int_0^T p_s(t)q_c(t)dt \Leftrightarrow k = \int_0^T [p_s(t)-c]^+ dt = k_s$$

Impacts of Competitive Wholesale Markets on Retail Business

- Competing with direct access and bilateral contracting, the utility need to win back base-load customers
- This can be done through differentiation of retail rates by load shape
- Risk averse consumers can subscribe hedging services
- The utility could collect a premium for bearing the risk of the price variation in the spot market
- When the cost-of-capital for production in spot market is greater than the cost-of-capital for contract, the utility will compete in the financial intermediary service

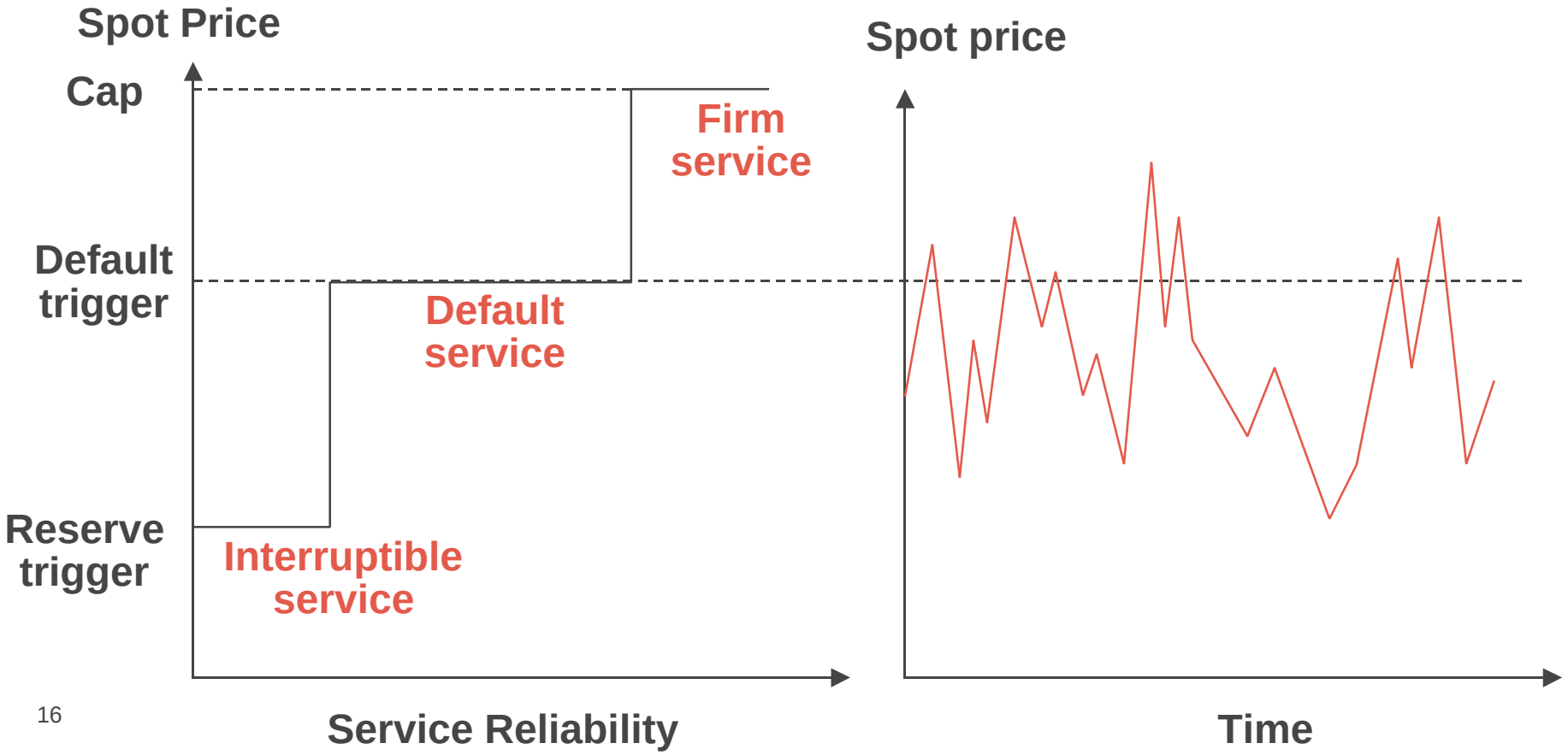
Theoretical Relationship Between Wholesale and Retail Rates

- Retail rate = Expected spot price for each category of service + risk premium
- The first component can be computed using a price duration curve



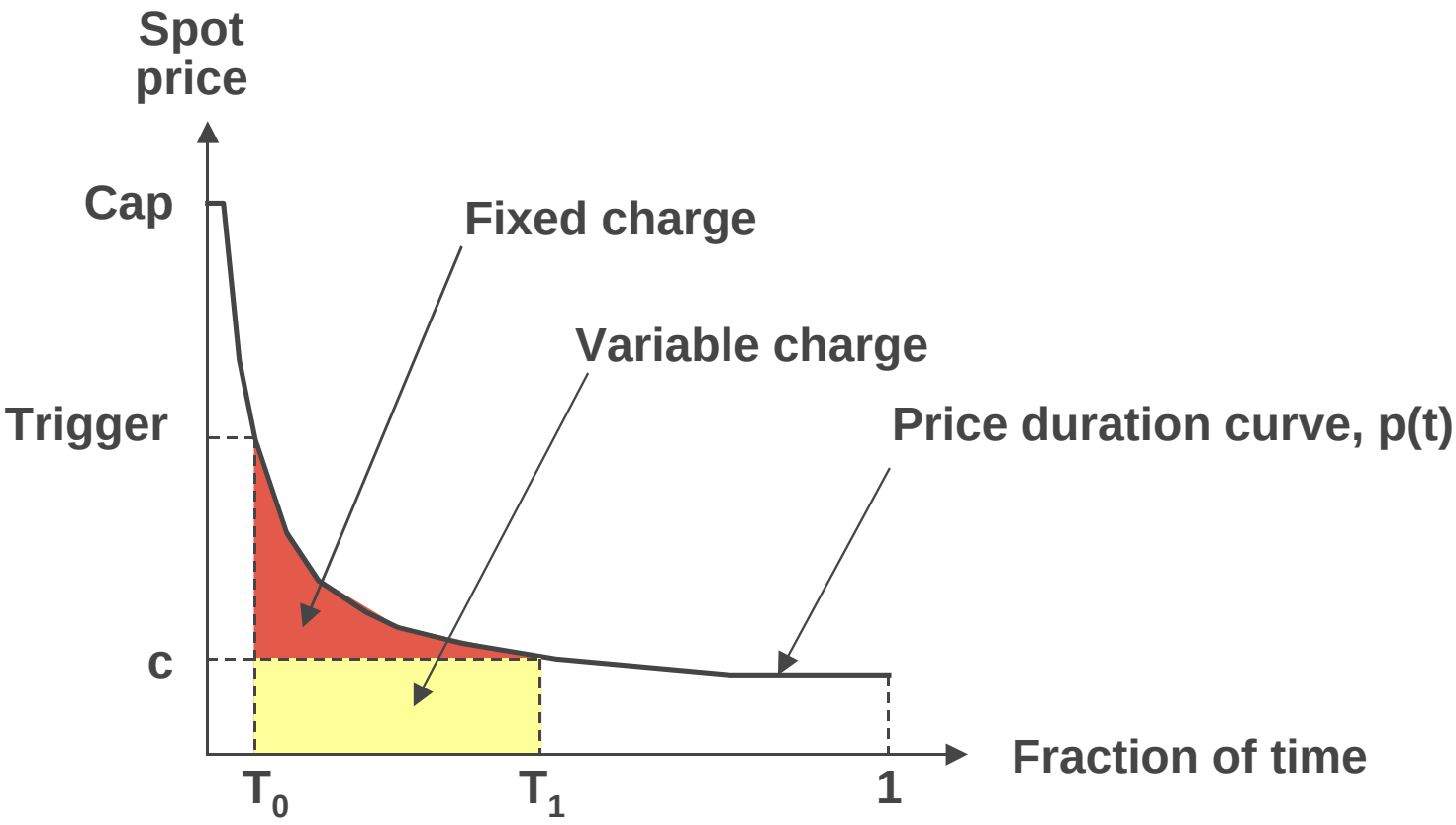
Sharing Reliability Risk Implies Non-firm Default Service

- Under restructuring, the concept of default service becomes ambiguous
- The obligation to serve at any spot price is unsustainable
- Continued ambiguity will deter demand response

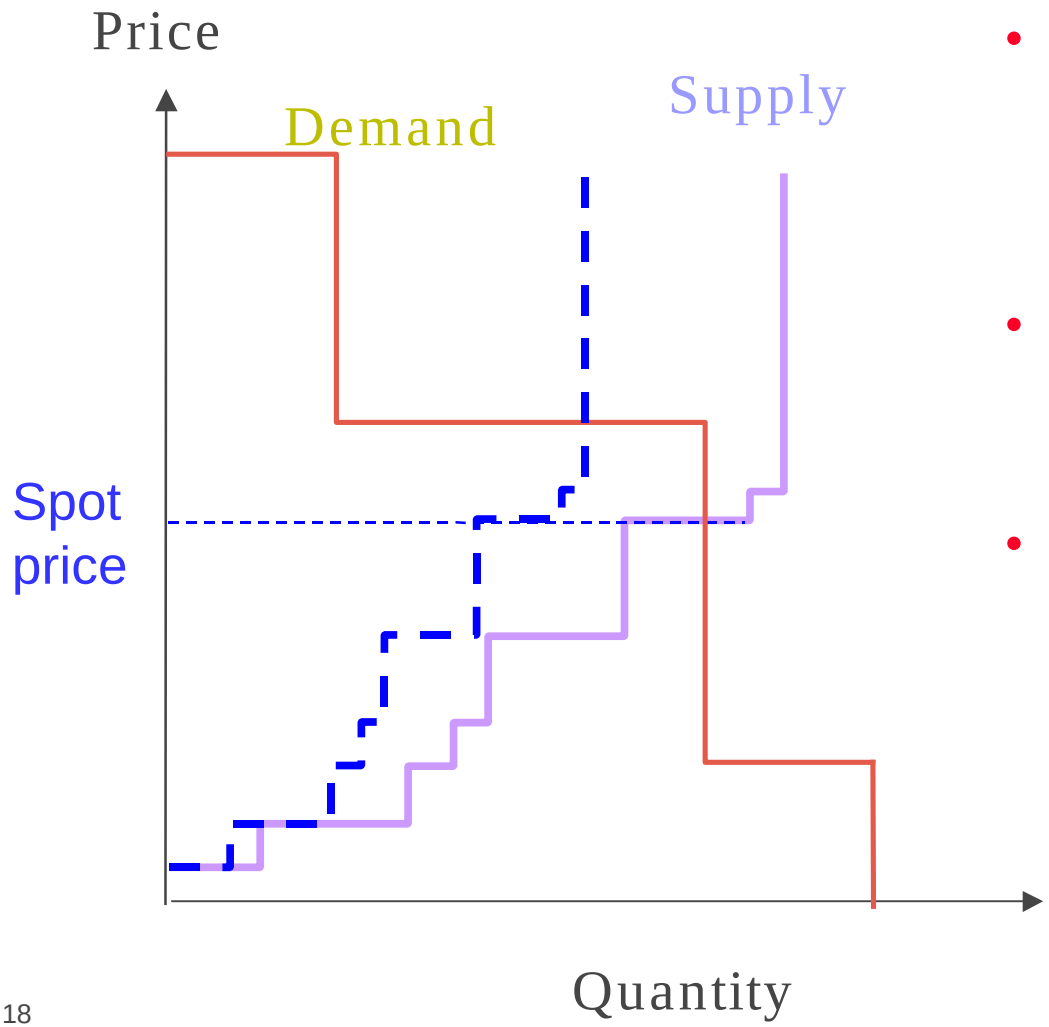


Equilibrium Relationship Between Wholesale and Retail Rates

- Retail rate = $\int E\{p(t) \mid c \le p(t) \le \text{trigger}, T_0 \le t \le T_1\}dt$ + risk premium



Risk Sharing Fosters Demand Response and Competitive Markets



- Risk sharing provides incentives for demand response and reliability differentiation
- This will result in improved system reliability and lowered spot prices
- The retail services will improve with lower prices and higher quality

Conclusion

- Restructuring poses major risk management challenges in power market design
- Vertical unbundling exposes the regulatory compact to the adverse selection problem
- Service differentiation and risk sharing are essential for new regulatory compact
- Effective risk management fosters demand response and competitive markets