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The Value of Long-Term Contracts for New Investments in Generation

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The Problem

- Can adequate baseload generation be built without the benefit of long-term power purchase contracts?
- The least cost baseload generation plants require large up-front capital investments and are therefore expensive to finance. Financiers look to long-term power purchase contracts to provide the necessary security that makes low-cost capital available.
- Without a long-term power purchase contract, the cost of capital escalates and the new investment is discouraged in favor of other technologies with lower capital costs but that ultimately provide power at a higher total cost.
- Nuclear or coal vs. combined cycle gas.

The Problem (cont.)

- Regulated, vertically integrated utilities resolve this problem with long-term resource planning and PUC approval of investment choices as prudent to meet forecasted load growth.
- Market restructuring has discouraged negotiation of long-term power purchase contracts by Load Serving Entities.
- Will this reshape the mix of generation technologies to higher cost electricity over the long-term, i.e., “distort” the market outcome?

Current Policy Focus: Encouraging Renewables

- **In Massachusetts…**
  - NStar (Boston based transmission & distribution utility) traditionally purchases its basic service electricity on a rolling 1, 2 and 3-year contract basis for 50%, 25% and 25% of its load. But in 2007 it announced a plan to buy wind-generated electricity under long-term contract, supported by Massachusetts Attorney General Martha Coakley and the Conservation Law Foundation. But this was opposed by others saying it violated the 1997 restructuring law. Can NStar sign 10-year contracts, or is it restricted to short-term power supply contracts?
  - Governor Deval Patrick in an address at MIT on Earth Day, April 22, 2008, spoke about the energy bill before the legislature: “The legislation will also require utilities to enter into long-term contracts for renewable energy, providing renewable power developers the means to get financing for their projects.”
  - The bill has passed both the House and the Senate is in conference committee. This provision is supported by both the Speaker of the House and the Senate President. Contracts for renewables with lengths of 10-20 years would be permitted.

Current Policy Focus: Encouraging Renewables (cont.)

- In Rhode Island…
  - There is a similar bill currently before the legislature to give National Grid authority to procure renewable energy through long-term contracts.
  - Renewables advocates, especially solar company, say the long-term contract authority is essential to the projects. National Grid opposed it for specific projects, but supports the authority for renewables generation in general. Governor is concerned with “who” has the authority to pick which renewables projects, with whether the projects are in- or out-of-state, and with whether the legislation is expansive enough for all of the state’s customers.

Traditional Focus

- Long-term contracts are a common feature for large-scale natural gas development; especially in remote locations where major dedicated infrastructure facilities are to be constructed. LNG gasification facilities and transport infrastructure.
- Long-term contracts had been a common feature of the development of mine-mouth coal fired power plants – see Joskow (1985).
- Project finance for infrastructure development.

Why Long-Term Contracts?

- **Remember, long-term contracts for output is *not the norm* in most industries, for most goods!**
- **But, long-term contracts make the financing possible.**
  - **This begs the question.**
- **What about risk-sharing, risk-shifting.**
  - **Where does the risk go? Who gets the hot potato?**
  - **Are we just burdening consumers, hiding the cost of risk and declaring victory?**
  - **A subsidy by another name, or a meaningful institutional reform? Why targeted to renewables only?**
  - **What is the capital market failure that long-term contracts are meant to treat?**
- **Choices change, and for some reason: Algeria's recent decision to market its natural gas short-term.**

Why Long-Term Contracts? (cont.)

- Need to identify a clear objective, well specified; need to identify the non-zero sum gain made uniquely possible by this contract form.
- Numbers. Where are the numbers?
- The numbers should clearly be identified with the targeted objective.
- Results should vary based on circumstances. Contracts should sometime be better and sometimes not. Hence the need for calibration, for numbers.

The Problem with Long-Term Contracts

- **Rigidity and ex-post regret.**
  - Stranded costs revisited?
  - Who will attest that the contract was entered into prudently?
  - Will the prudence judgment withstand hindsight scrutiny?

- **Retail competition and Market Power.**
  - Restructuring rules and market monitors have looked unfavorably on the use of long-term contracts to protect franchises and block customer flexibility and therefore competition.
  - EU Commission Oct. 07 decision against Distrigas in Belgium forcing it to reduce the volumes tied to long-term contracts. New contracts with gas resellers will not exceed two years, with electricity generators five years.
  - Bundeskartellamt 2006 decision against E.ON/Ruhrgas to stop writing contracts with distributors that cover more than 50% of demand for more than four years and 80% for two years.

Modeling the “Value” of Long-Term Contracts

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Outline of Research

- Explicit model.
- Uncertain evolution of demand through time.
- Alternative generation technologies with varying features.
- Intersect demand with supply to determine capacity additions.
- First, analyze optimum decision rules, independent of institutional rules.
  - How much capacity of each type should be built, and when?
  - Result is an uncertain evolution of cost of service; calculate average cost of supply.

Outline of Research (cont.)

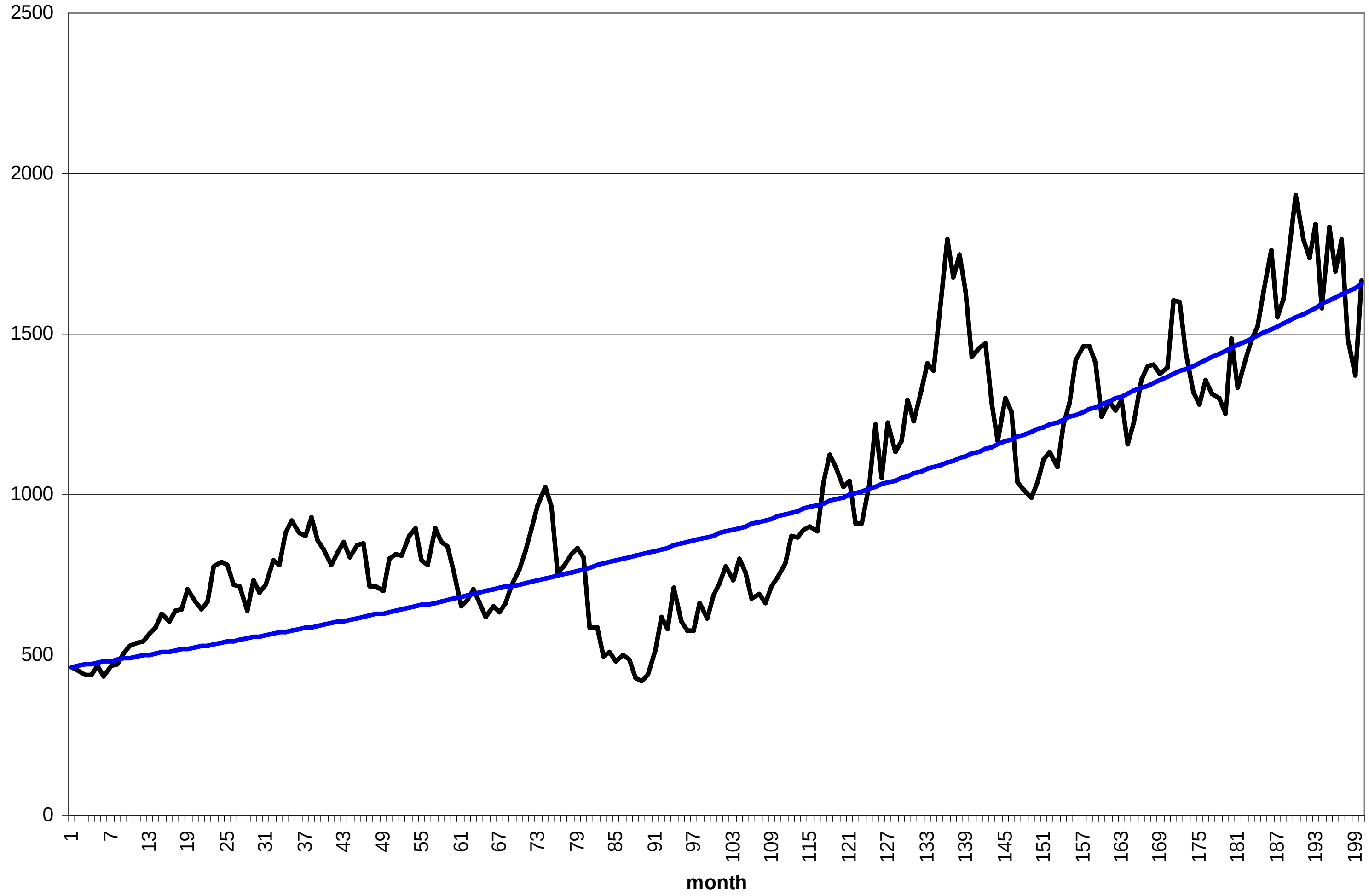
- **Second, analyze competition between alternative generation technologies.**
  - **Absent long-term contracts, one-technology is implicitly favored by the institutional structure.**
  - **Reflected in the evolution of the cost of supply.**
- **A positive role arises for a long-term contract.**
  - **Reflected in the lower <u>average</u> cost of supply. Here is the number!**
  - **Still, there is ex-post regret. Who bears this risk? Do the appropriate institutions exist?**

Long-term Volatility in Load

- **Load evolves unevenly and with uncertainty**
  - **Abstracting from daily and seasonal volatility**
  - **Forecasting load 5 and 10 years out**
- **Model load as a stochastic process**
  - **Time trend, e.g., constant drift – 2.5%**
  - **Volatility – 30%**

$$\frac{dx}{x} = \mu\, dt + \sigma\, dz$$

Sample Path of Load, 200 months



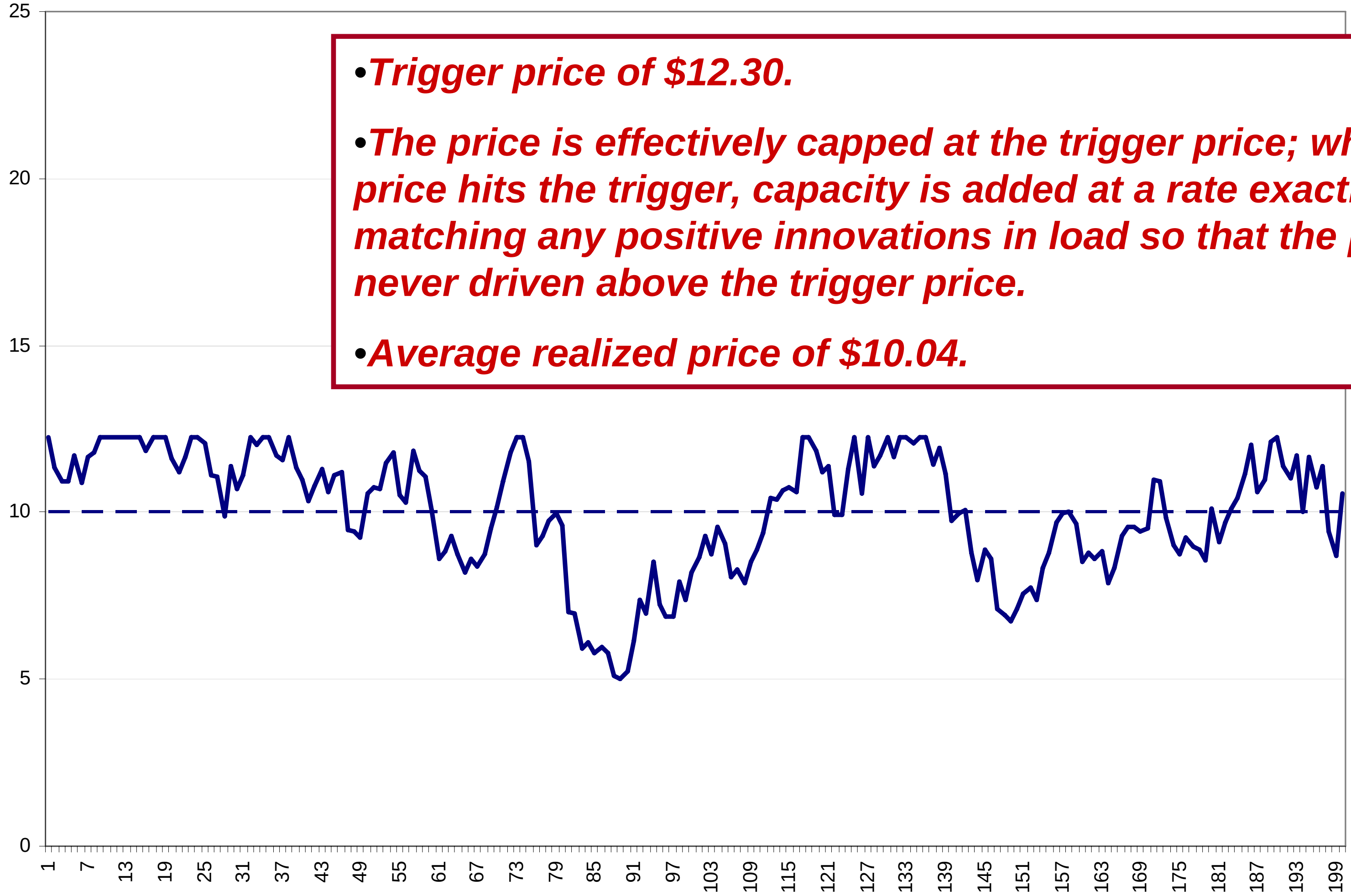
Model Equilibrium Decision to Install Capacity

- Competitive equilibrium following Leahy, QJE 1993
- A single constant returns to scale technology in capacity, q
  - Initially abstract from the time to build nuclear plants – capacity can be instantly added
  - Abstracts from the on/off decision and the premium to gas for operating flexibility
- Inverse demand function, $D^{-1}(x,q)= x\, q^{-1/n}$ where x is the demand factor
- Firms choose a trigger price at which to add capacity
  - Starting from an initially low price due to excess capacity, as load increases, the price increases until it hits the trigger
  - If load continues to increase when price is at the trigger, new capacity is added at the rate load is expanding so that the price stays at the trigger,
  - Whenever load drops, capacity additions stop, and price falls below the trigger to equilibrate supply and demand

Trigger Price

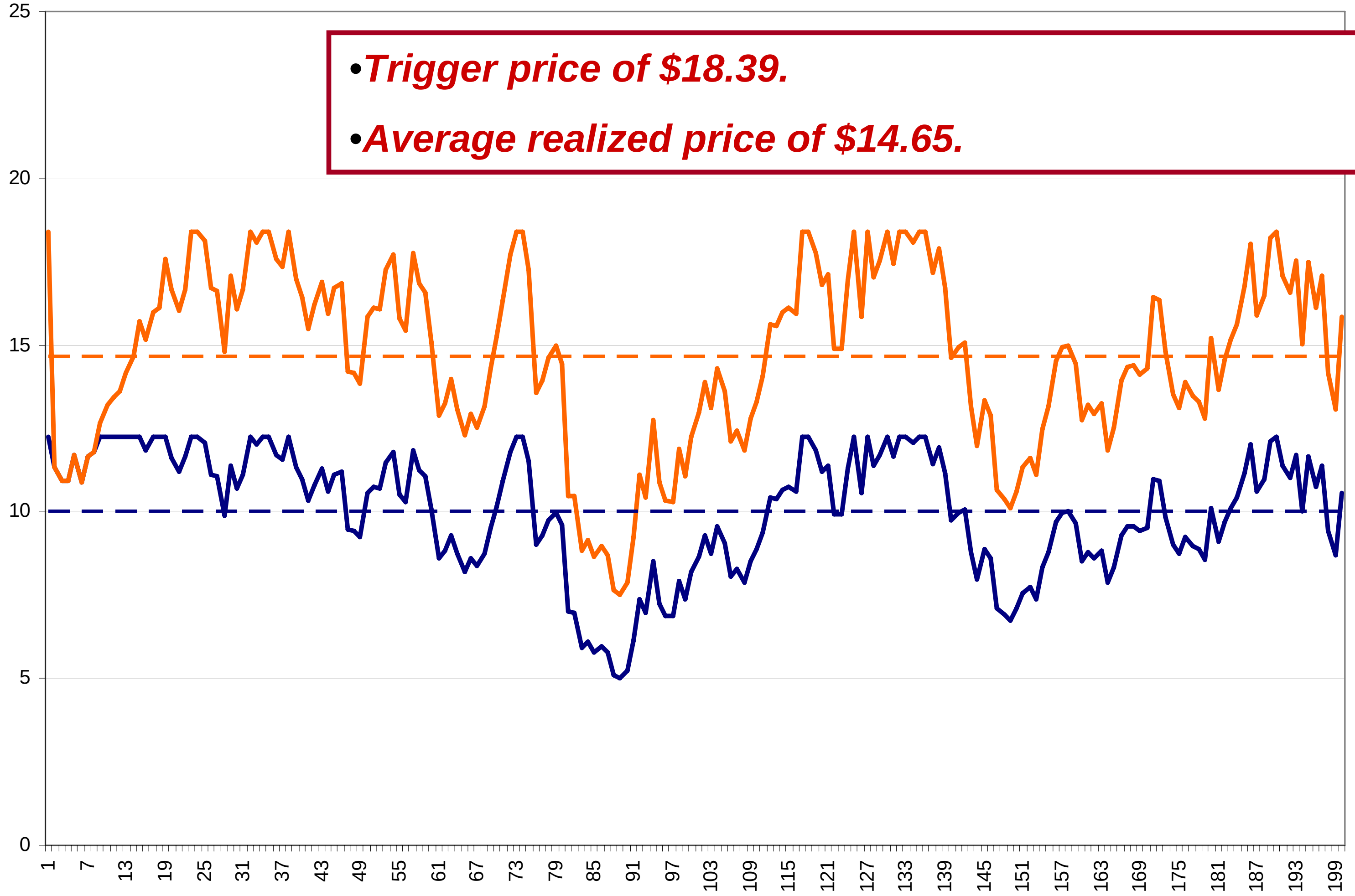
- If demand growth were certain, then the trigger price would exactly cover marginal cost plus the rental price of capital
- With demand growth uncertainty, there is a danger of periods of low realized demand and therefore excess capacity
- Therefore the trigger price must include a premium to cover this possibility

Equilibrium Price Process



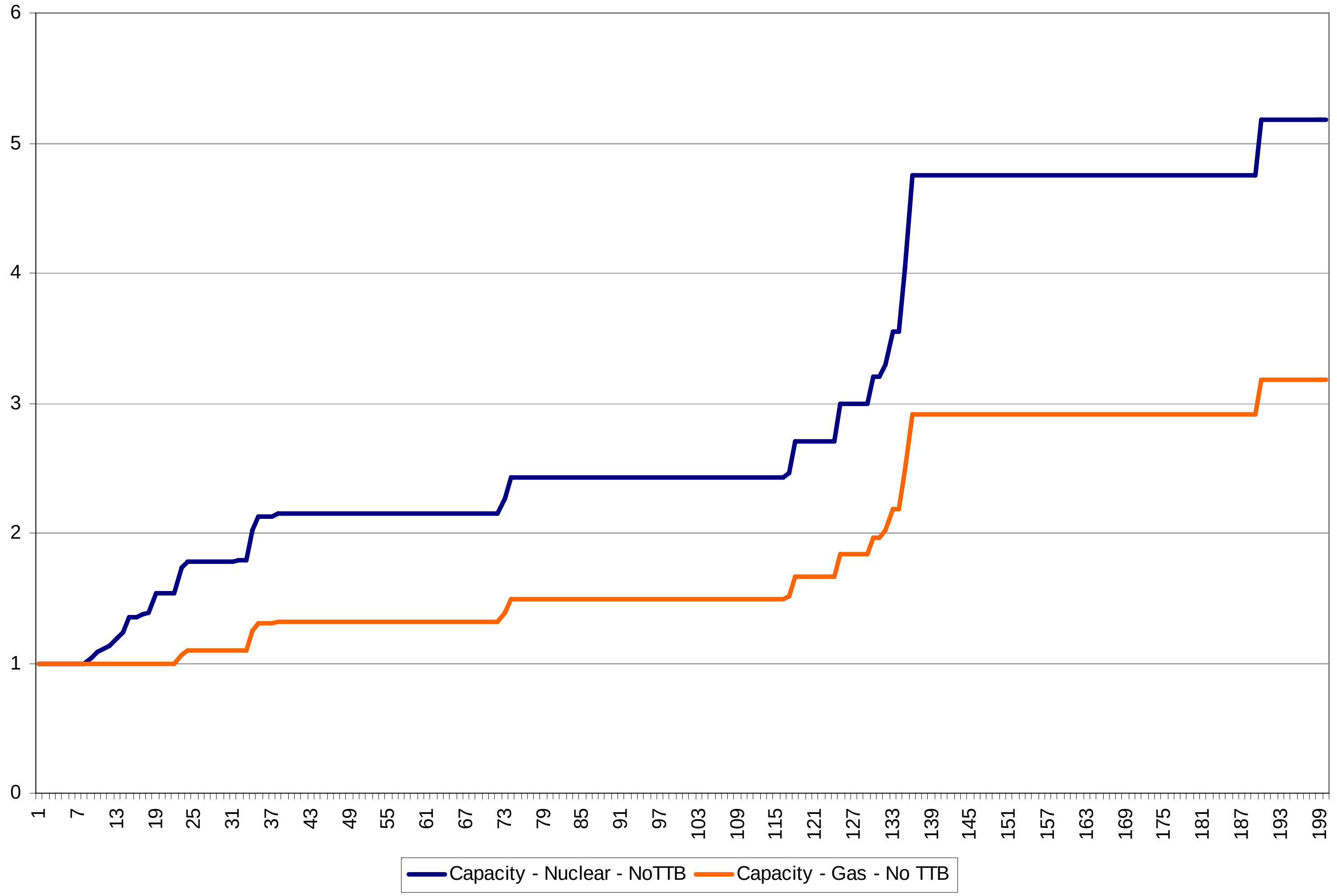
- ***Trigger price of $12.30.***
- ***The price is effectively capped at the trigger price; when the price hits the trigger, capacity is added at a rate exactly matching any positive innovations in load so that the price is never driven above the trigger price.***
- ***Average realized price of $10.04.***

Equilibrium Price Process for a Higher Cost Technology



- ***Trigger price of $18.39.***
- ***Average realized price of $14.65.***

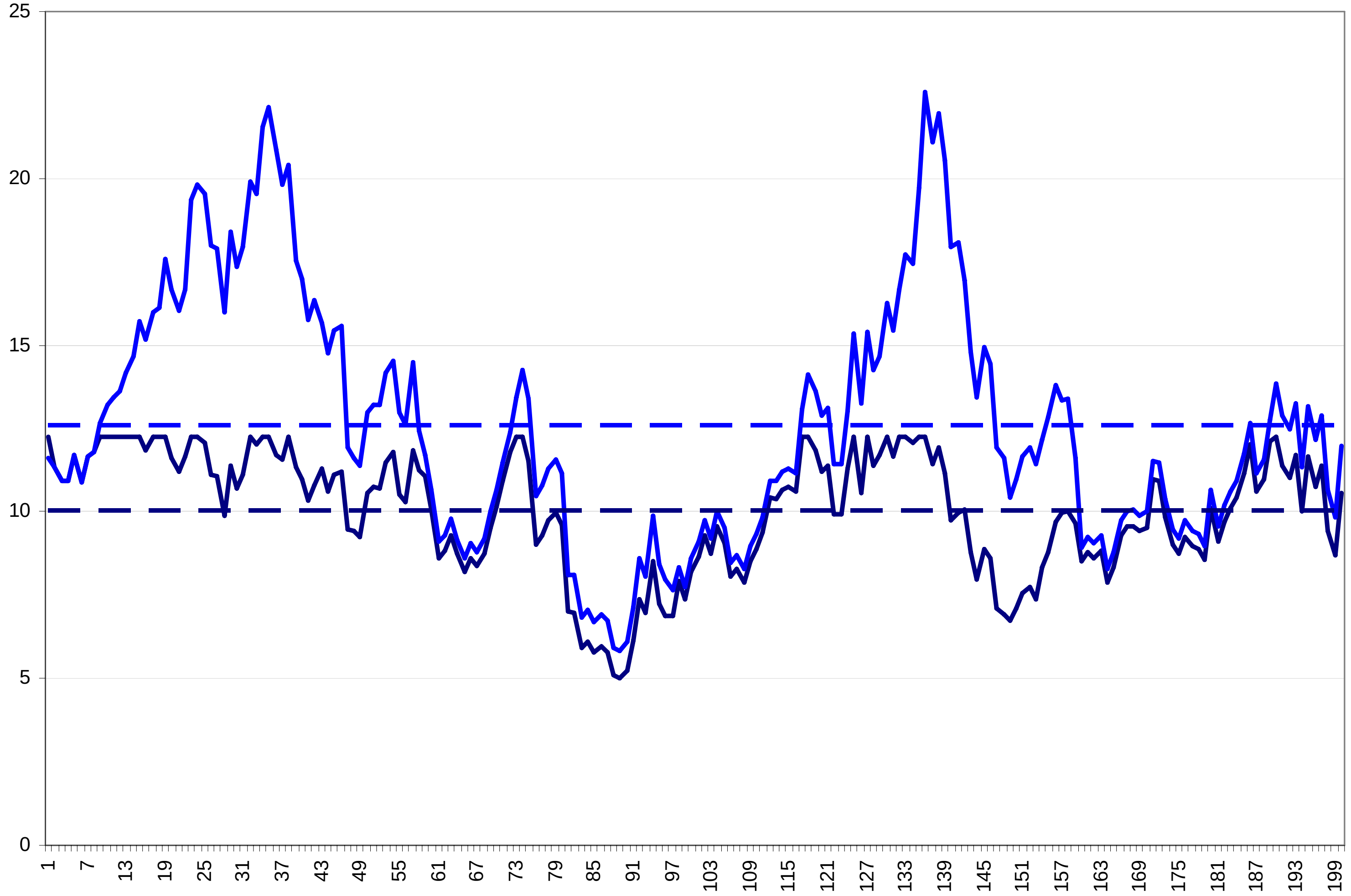
Installed Capacity, low & high cost technologies



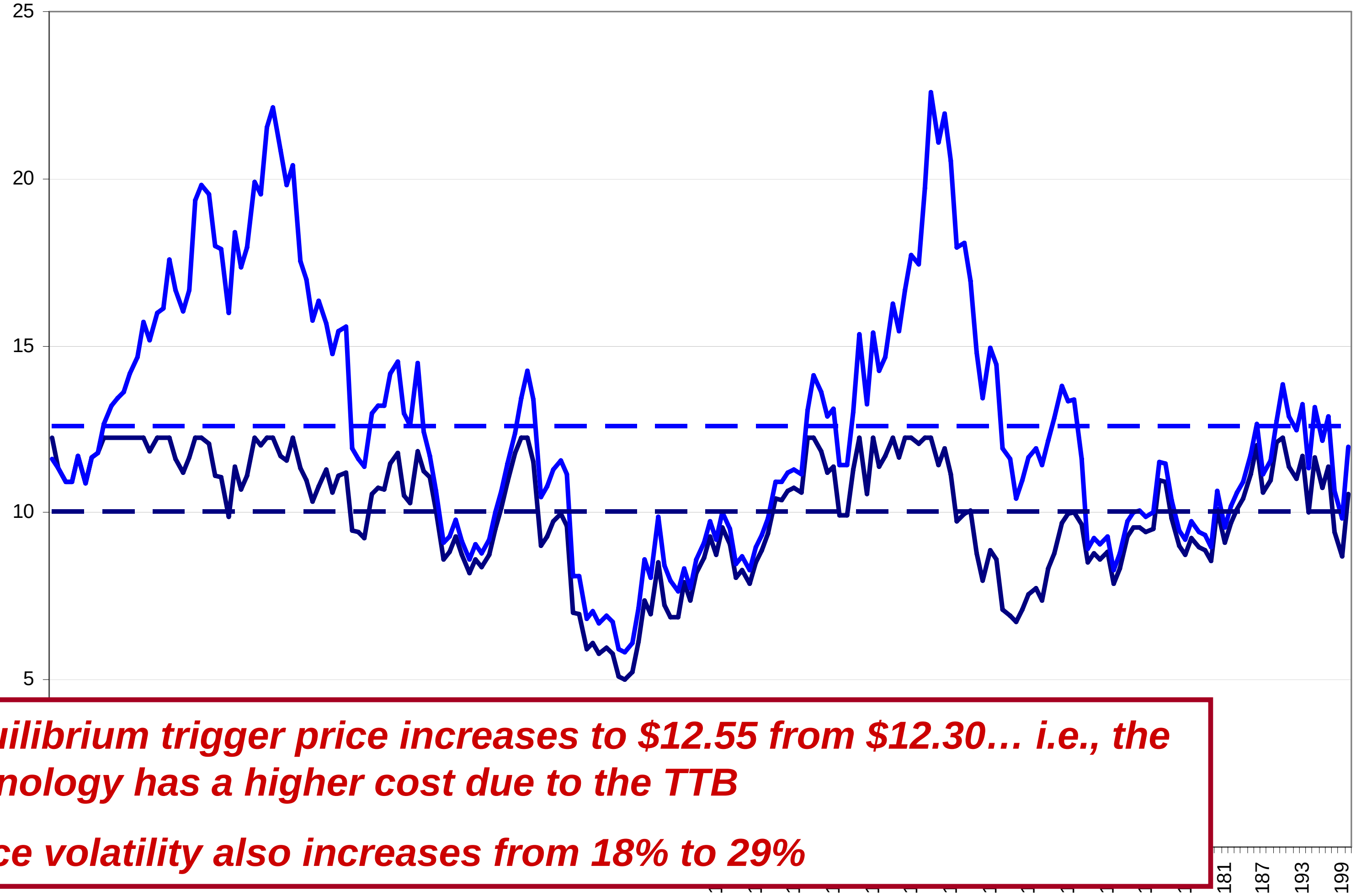
Re-Model Equilibrium Given Time-to-Build

- Competitive equilibrium following Grenadier, RFS 2002
- Equilibrium decisions are altered to forecast price after capacity in construction comes on line
- Firms still choose a trigger price at which point to initiate construction following any period of no construction
- Price is no longer capped, since load may continue to increase while capacity is under construction

Equilibrium Price, with Time-to-Build

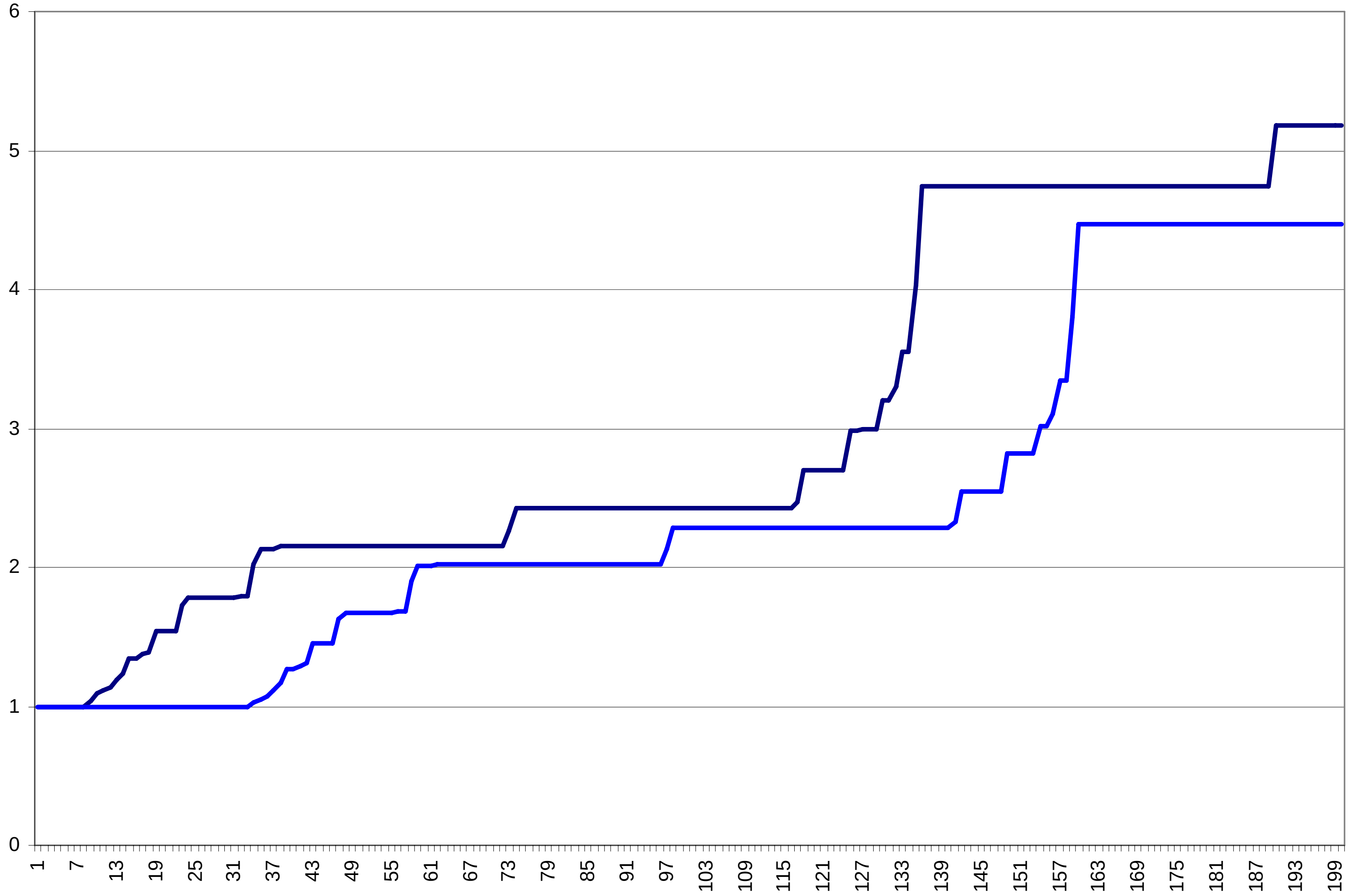


Equilibrium Price, with Time-to-Build

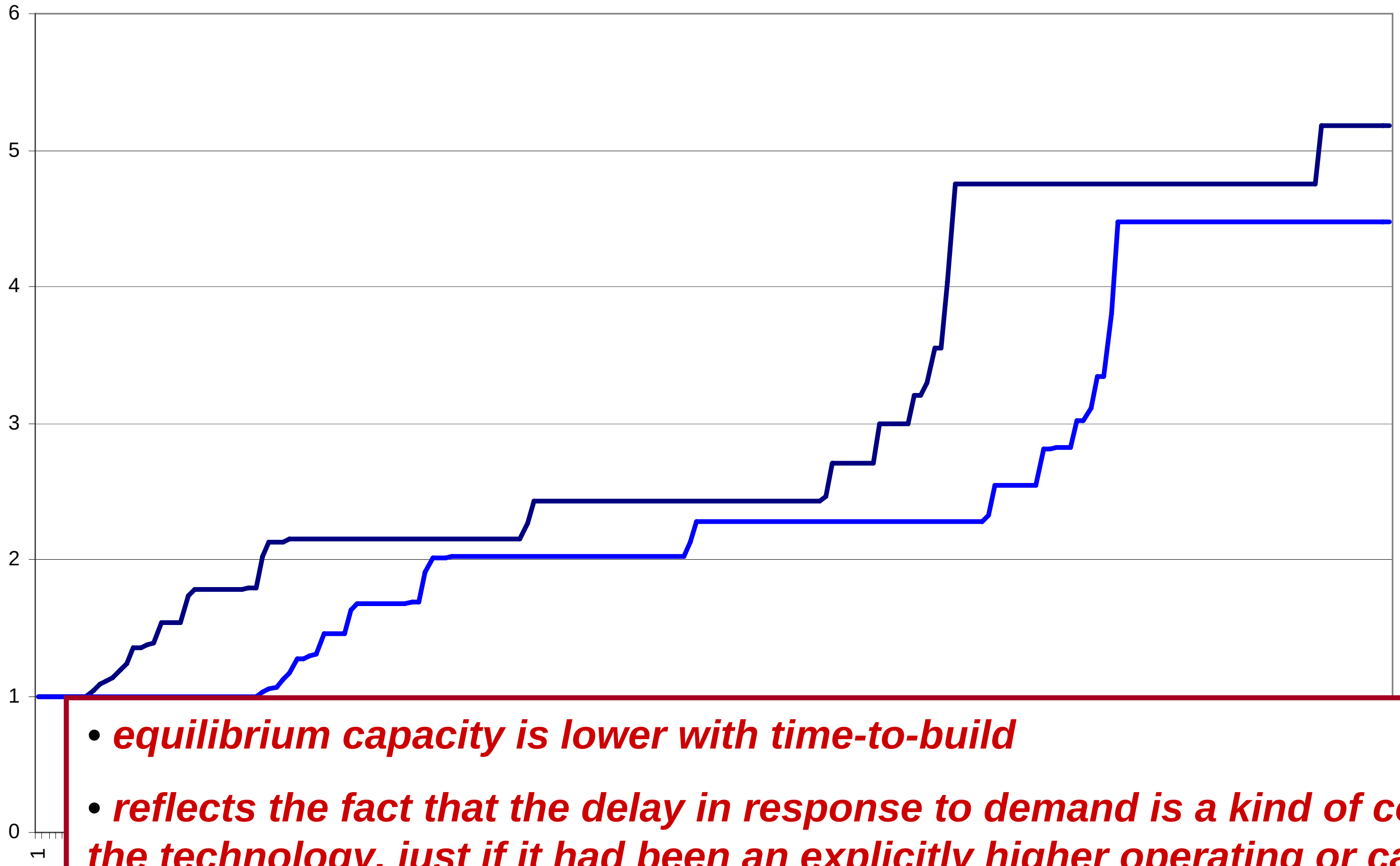


- *equilibrium trigger price increases to $12.55 from $12.30… i.e., the technology has a higher cost due to the TTB*
- *price volatility also increases from 18% to 29%*

Capacity Installed with Time-to-Build



Capacity Installed with Time-to-Build

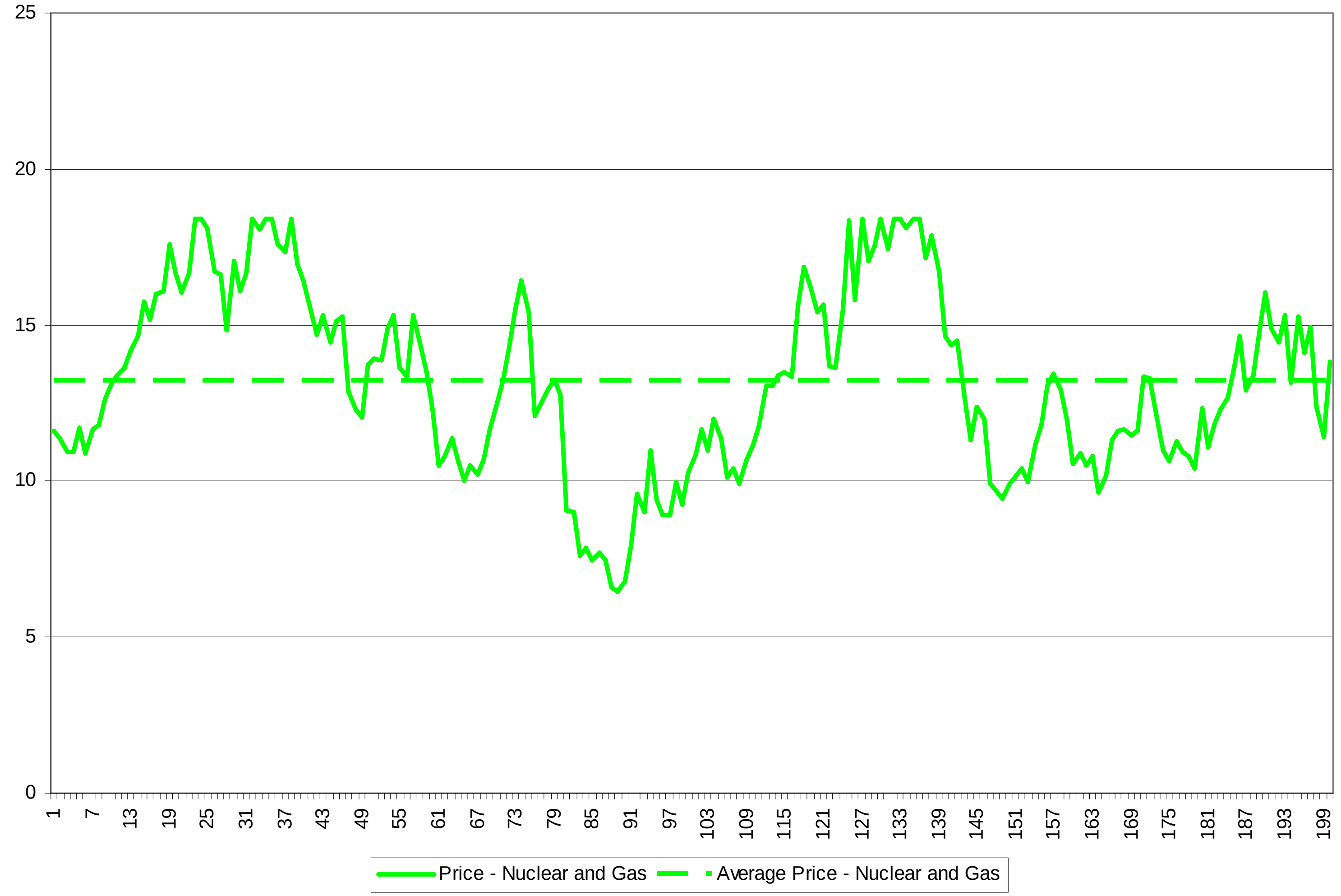


- *equilibrium capacity is lower with time-to-build*
- *reflects the fact that the delay in response to demand is a kind of cost of the technology, just if it had been an explicitly higher operating or capital cost element*
- *the technology cannot readily provide the capacity when it is most needed*

A Two-Technology Equilibrium w/o Long-Term Contracts

- **Low Cost with Time-to-Build (nuclear)**
- **High Cost with no Time-to-Build (gas)**
  - But still no option to turn-off
- **Berger Solution: iterate optimal industry reactions**
  - Start with the Nuclear Time-to-Build strategy
  - Let the Gas industry build whenever the price rises high enough
  - Revise the Nuclear strategy to recognize installed gas capacity
- **Note that with the parameters chosen, the low-cost technology, even with time-to-build, dominates the high-cost technology**
- **But occasional high prices while nuclear is being built creates an opportunity for the high-cost technology to generate value**

Equilibrium Price with Two Technologies



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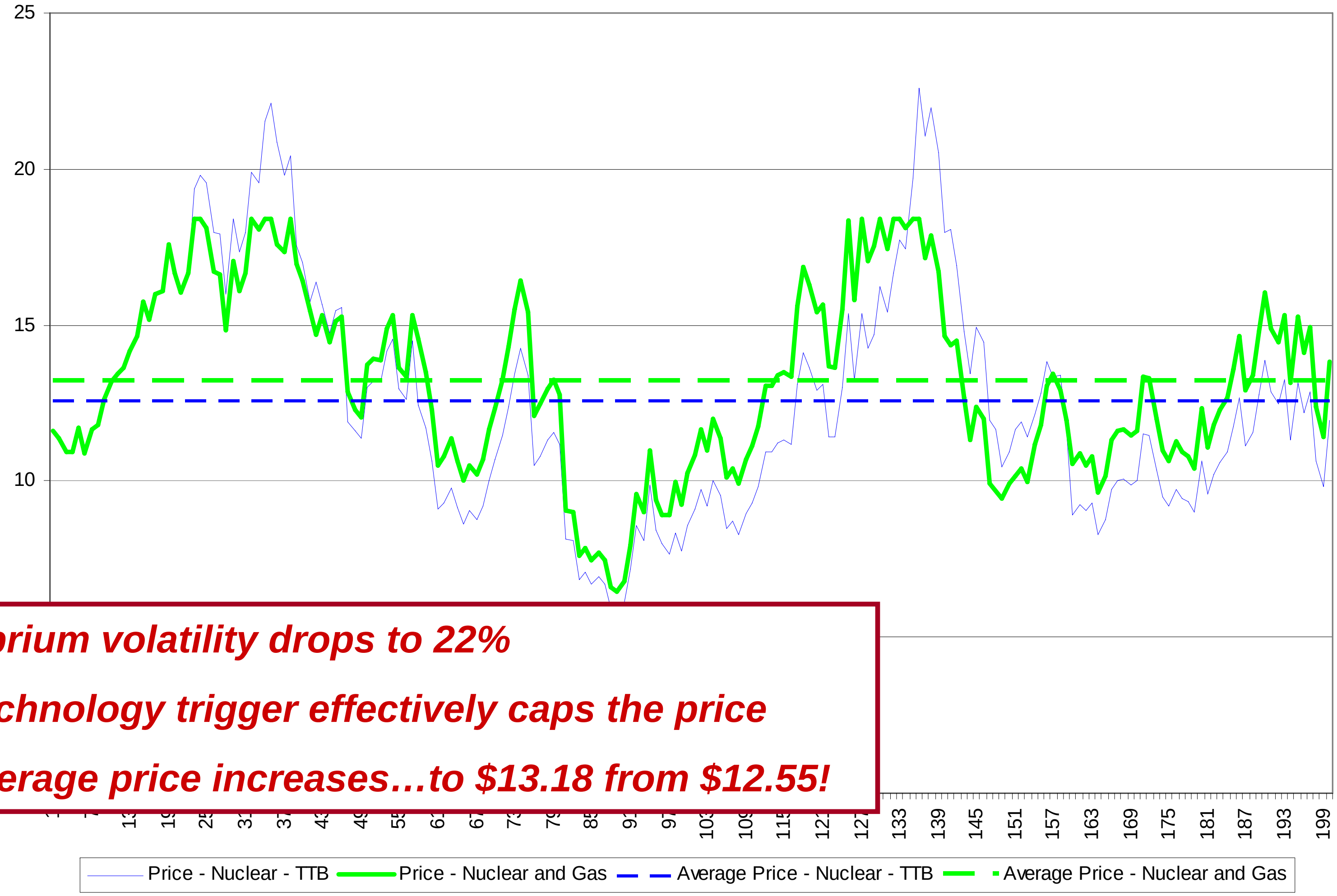
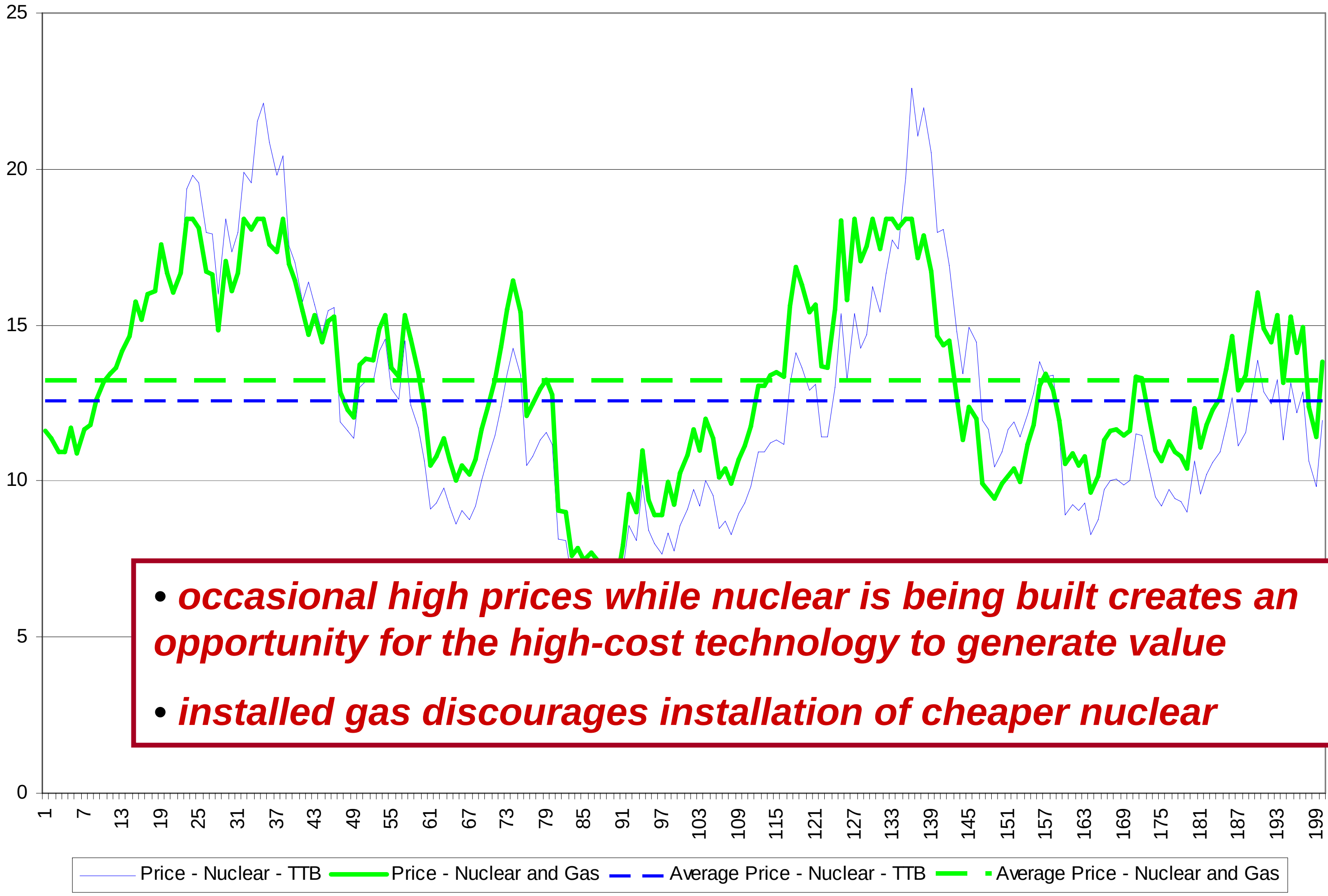
Price Compared to Single Technology Equil.



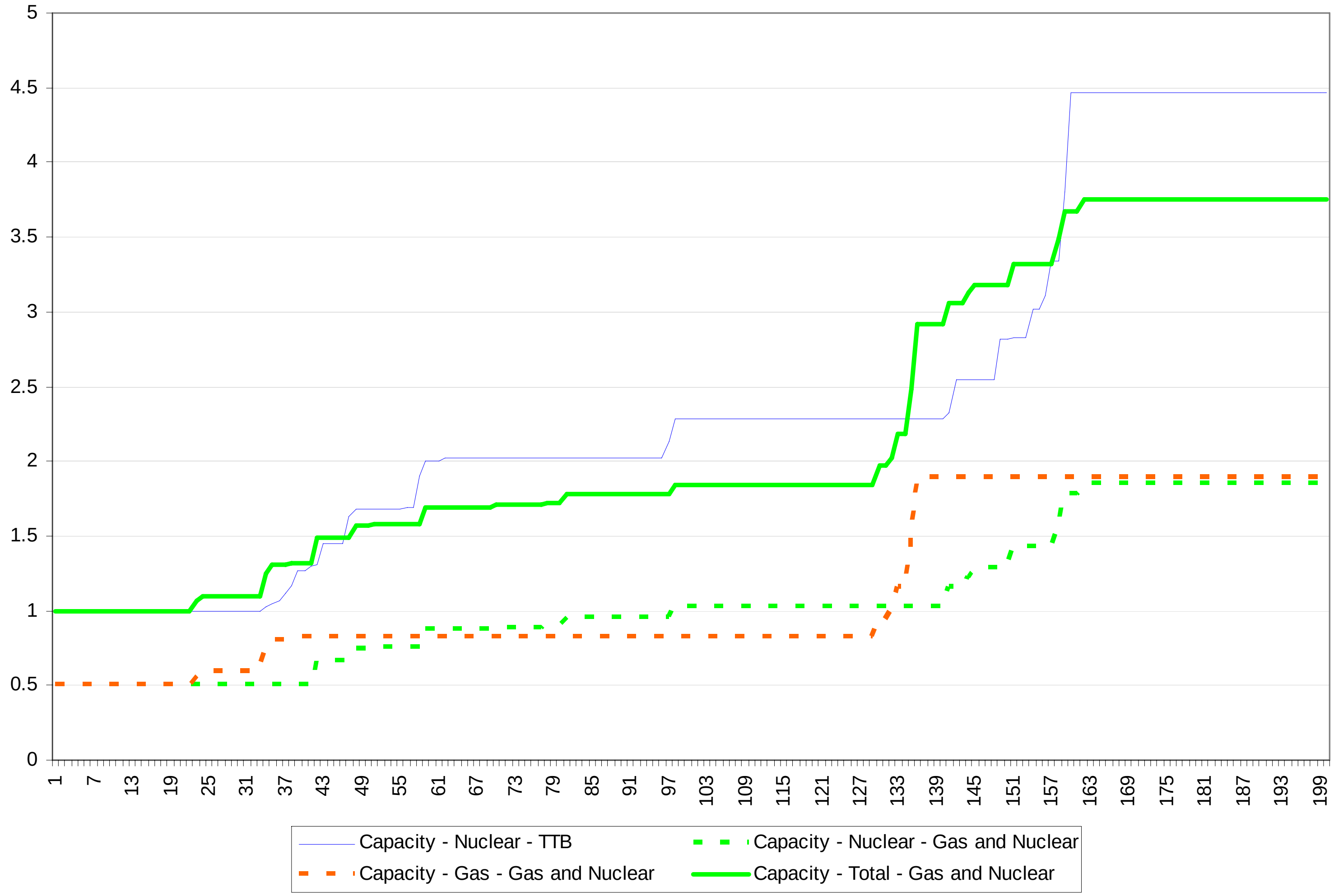
- ***equilibrium volatility drops to 22%***
- ***gas technology trigger effectively caps the price***
- ***but average price increases…to $13.18 from $12.55!***

Price Compared to Single Technology Equil.



- ***occasional high prices while nuclear is being built creates an opportunity for the high-cost technology to generate value***
- ***installed gas discourages installation of cheaper nuclear***

Capacity for Two Technologies



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The Value of a Long-Term Contract

- Without the possibility of long-term contracts, equilibrium investment strategy game ***unduly*** favors smaller scale, less capital intensive projects with shorter time-to-build.
- This raises the average realized cost of power.
- Larger scale, more capital intensive projects with a longer time-to-build can promise a lower average cost of power to buyers who are able to commit to buying the power forward.
- Forward purchases may exhibit ex post regret in some realizations, but, on average, will enjoy lower costs.
- This is a different issue than the “missing money” problem being treated by “capacity markets.”

The End

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