# How does Price-Cap Regulation Affect Investment Behavior?

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This paper has been presented at the following international conferences:

- $19^{th}$ Australasian Finance and Banking Conference, Australia 2006.
- $30^{th}$ Conference of the IAEE, New Zealand 2007.

# Motivation

- Since the early 1990's the number of regulated market increases.
- The key issue for regulation is the calculation of adequate cost of capital.
- As a consequence, the finance community gets attracted by this topic.
- Analysis of regulatory activity is set on the ramification of regulation on company's risk and investment.

# Literature Review

- Three different strands can be distinguished:
  - Static models dealing with regulation, i.e. Littlechild (1983); Beesley and Littlechild (1989), Laffont and Tirole (1993) etc.
  - Intertemporal regulation models which analyze the impact of time dependent regulation, e.g. Dobbs (2004), Clark and Easaw (2007) etc.
  - Models and analyzes build on asset pricing and real option theory, e.g. Baldursson (1998), Grenadier (2002).

# Addressed Issues

- Does the fact that a company acts in a regulated market where the price of its sold goods has an upper limit, have implications for the investment behavior of this company?

- Is there a measurable negative (or positive) impact of regulation on the volume or timing of investments?

- How should an optimal regulatory system work in order to take provision for such side effects and provide more incentives for the firm to realize investments?

# The Unregulated Model (1)

- The model without regulation and perfect competition is our benchmark model.

- Assumption 1: The firm faces an unique investment opportunity resulting in an initial outlay I. There are no additional costs for neither investment nor business expenses.

- Assumption 2: Investment is irreversible, i.e. investment once carried out has to be held until the end of its economic life.

- Assumption 3: Each company in the market is confronted with an uncertain demand function. The price process is given by:

$$dp_t = \alpha p_t dt + \sigma p_t dW_t$$

where $dW_t$ is a standard Wiener process.

# The Unregulated Model (2)

- Assumption 4: Investment and accordingly capacity expansion causes prices to fall. This leads to the following picture for the price process:

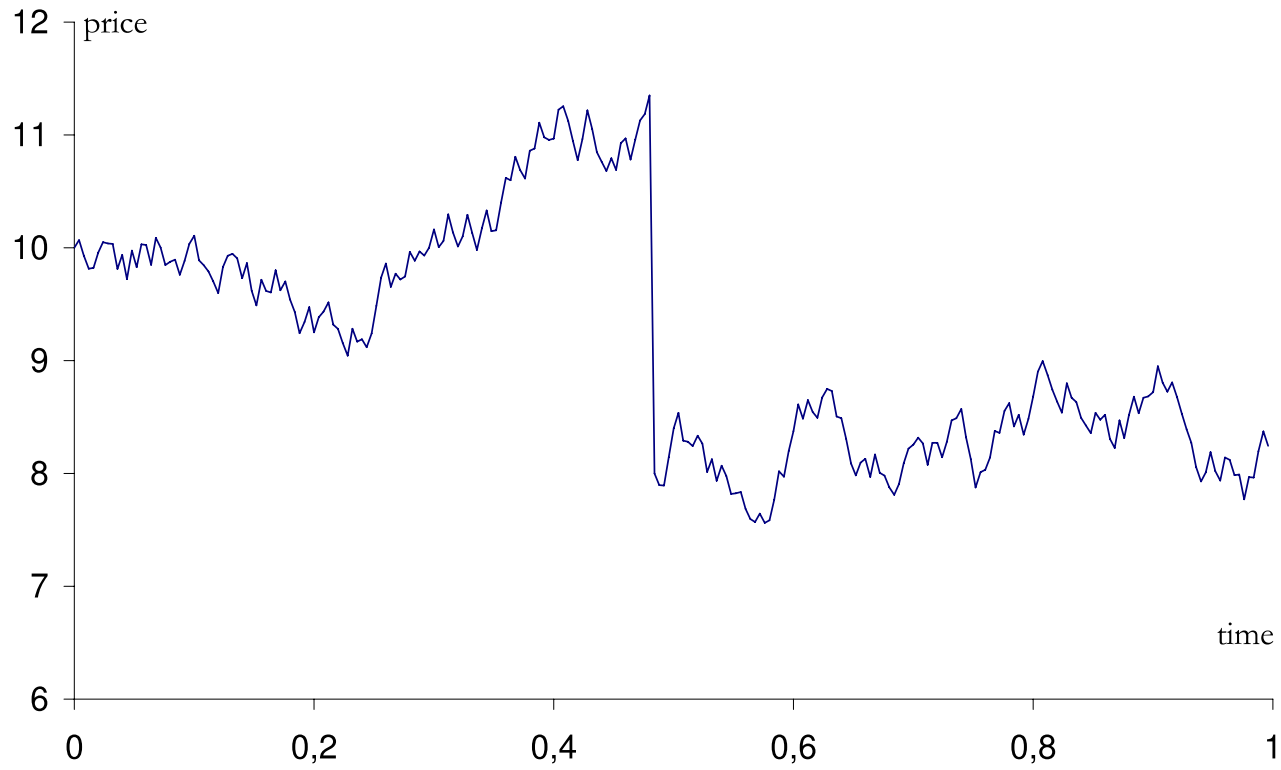


Figure 1: Possible price path where investment is triggered

# The Unregulated Model (3)

- The optimal trigger price for the unregulated framework is given by:

$$p_u^\star = \frac{\beta_1}{(\beta_1 - 1)} \delta I.$$

- In a second step using similar procedure the framework in which price cap regulation takes place is analyzed.

# Model with Price Cap Regulation (1)

- The regulatory authority sets a price cap at level $\bar{p}$.
- The market clearing price $p_t$ is still exogenously determined by a Geometric Brownian Motion.
- We consider a price cap as equivalent to an infinite amount of short call options denoted $\pi(p_t)$, which cut off higher possible values (truncation problem).
- The payoff of these options is given by: $\pi(p_t) = max(p_t - \bar{p}, 0)$.
- The short position is costly whenever $p_t > \bar{p}$

# Model with Price Cap Regulation (2)

- For the determination of the value of the option to invest $(F(p_t))$, we follow the same steps as before.

- Herein again, the smooth pasting and value matching conditions must hold and the optimal trigger price $p_r^\star$ at which new investment is triggered is given by:

$$p_r^\star = \left( \frac{I - \frac{\bar{p}}{r_f}}{(\beta_1 - \beta_2)} \frac{\beta_1}{B_2} \right)^{\frac{1}{\beta_2}} \tag{1}$$

# Model with Price Cap Regulation (3)

In order to assure the same trigger price as in the unregulated framework, the regulatory authority has to set the price cap at:

$$\bar{p} = Ir_f - (p_u^\star)^{\beta_2} r_f \frac{(\beta_1 - \beta_2)}{\beta_2} B_2 \tag{2}$$

Solving for $\bar{p}$, it is easy to show that a particular solution, leading to an optimum is given by $\bar{p} = p_u^\star$.

# Comparative Statics (1)

- We consider the following parameters: I=100, $r_f = \delta = 0.04$, $\bar{p} = 6$ and $\sigma = 0.2$.
- In an unregulated economy we find $p_u^\star = 8$
- We analyze scenarios where the price cap is binding.
- How does a decreasing price cap affect the investment decision?
- How does the volatility affect the trigger prices $p_u^\star$ and $p_r^\star$?

# Comparative Statics (2)

- How does a decreasing price cap affect the investment decision?

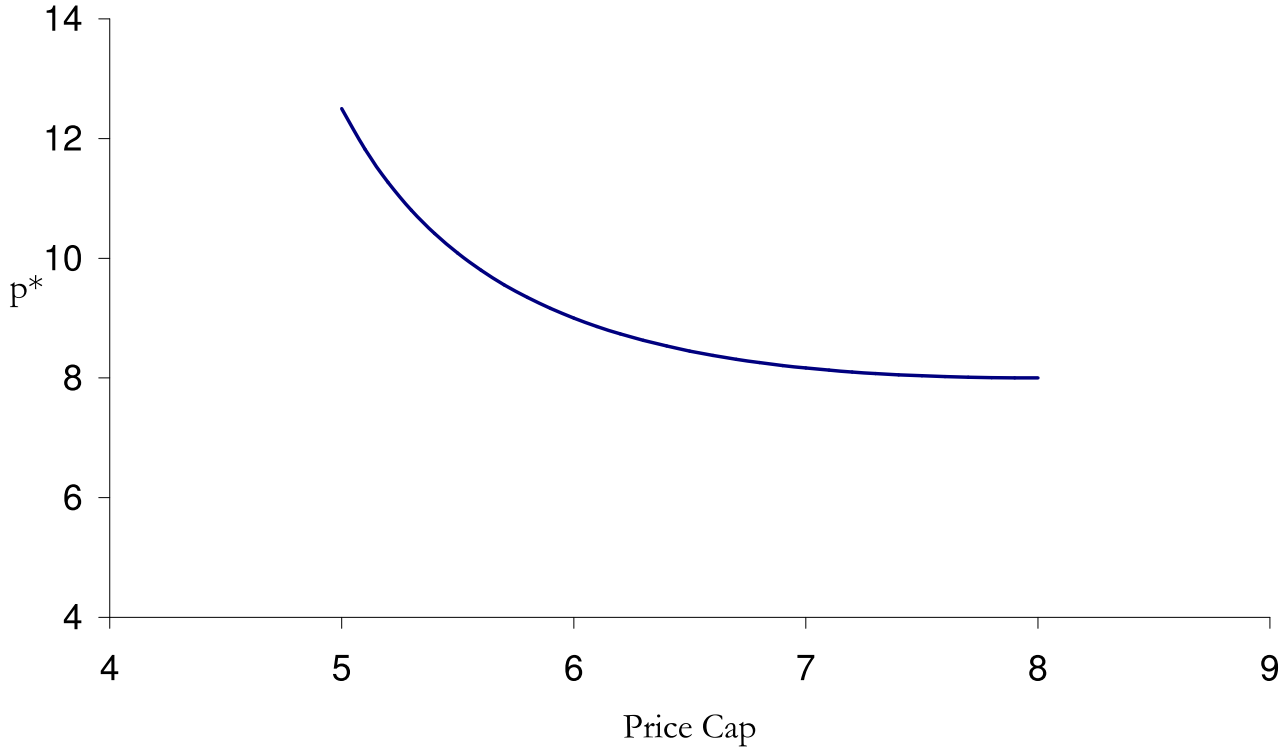


Figure 2: Increasing Price Cap and optimal $p_r^\star$

# Comparative Statics (3)

- In comparing the two different frameworks, the extent of underinvestment can be measured.

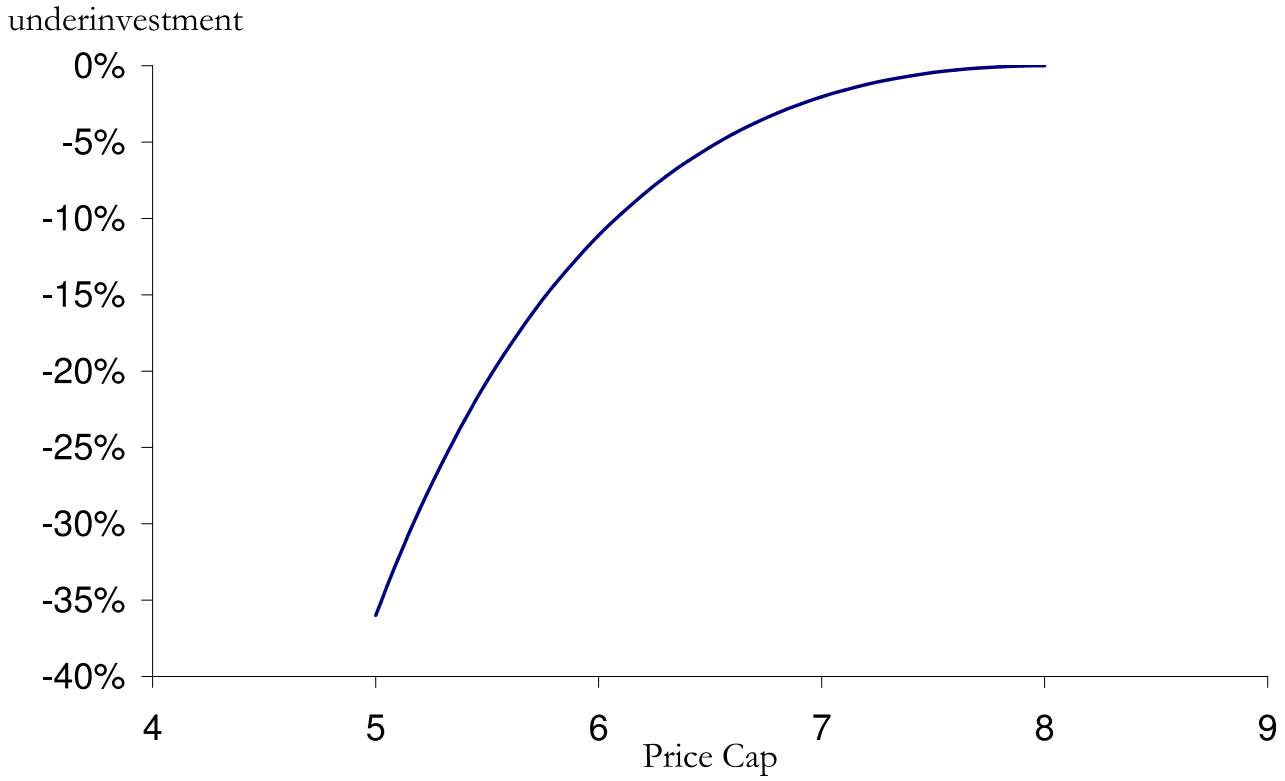


Figure 3: Evolution of the level of underinvestment

# Comparative Statics (4)

- Impact of increasing volatility on the trigger prices $p_u^\star$ and $p_r^\star$:

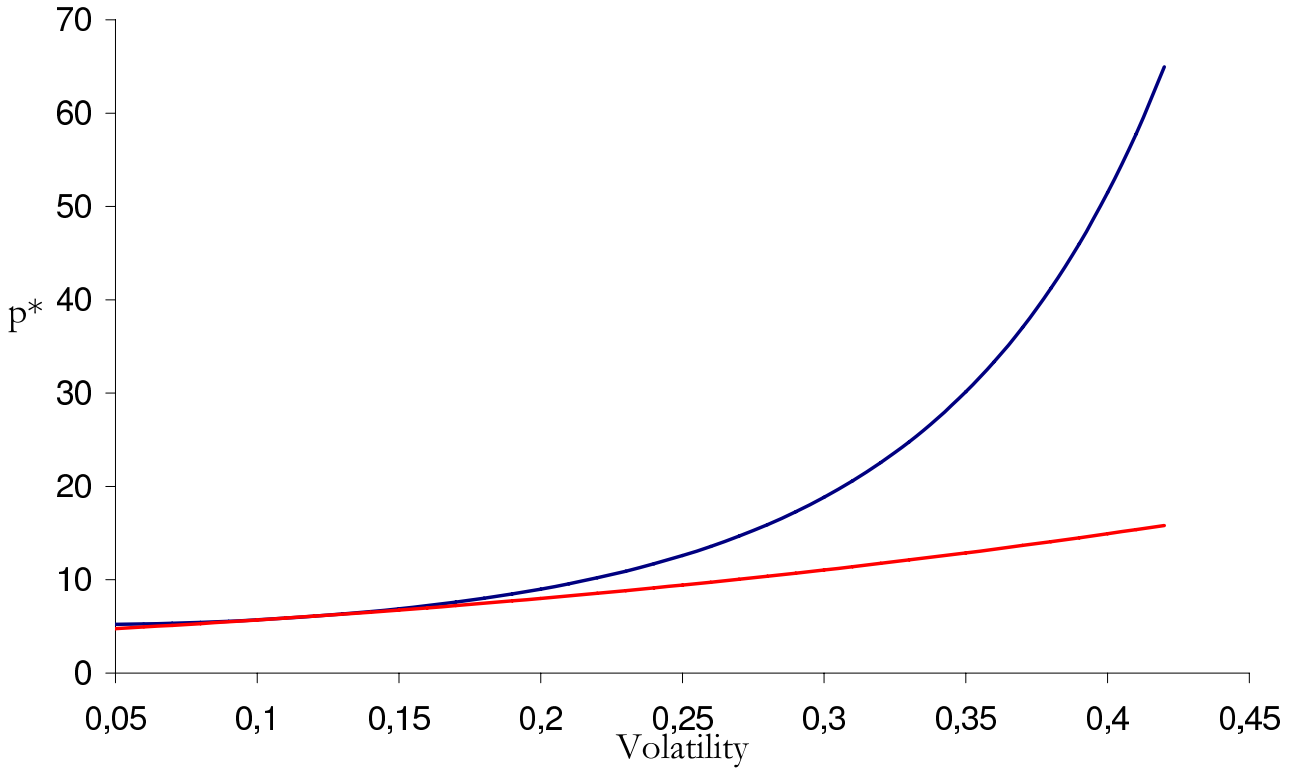


Figure 4: Impact of volatility on trigger prices

# Conclusion

- A price cap implies that certain possible (higher) values of the firm are impeded $\longrightarrow$ It therefore has an impact on the firms' investment decisions.
- Where prices are capped the investment decisions are delayed or in other words underinvestment occurs.
- In order to determine the optimal regulatory system, which triggers investment at the same price as in the unregulated framework, the price cap has to be set at $p_u^\star$.

# Thank you for your Attention!