

# Dynamic modelling of regulation

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# Introduction

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- Price cap or revenue regulation
- The periodic review or recalculation of the price cap
- Within period incentive effects changes as a review come closer in time
  - Cost reduction
  - Investment

# Problem

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- Life time of network investments comprise several regulatory periods
  - Investment decisions between periods can be interesting
- How does the depreciation schedule and statutory lifetime interact with periodic updating

## Model framework

- A new network or line must be operated for a period of given length
- Increasing failure rate as network ages
- Maximisation of social surplus implies a reinvestment during the operational period
- Network owner will choose reinvestment time based on regulatory income from capital minus investment cost

# Model formalization

- Cost components
  - Investement cost and reinvestment cost identical:  $K$
  - Fixed cost when a failure occurs:  $J$
- The arrival of failures described by a poisson process with rate  $\lambda$ 
  - Increasing in age
  - Decreasing in vintage
- At reinvestment time we will get a newer network and of a better vintage

# Optimal reinvestment

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- Social optimal solution
  - Balance the saving from postponing investment against the increased cost from failures
- The regulated network owner will in addition consider the effect of reinvestment time on the regulatory revenue allowed

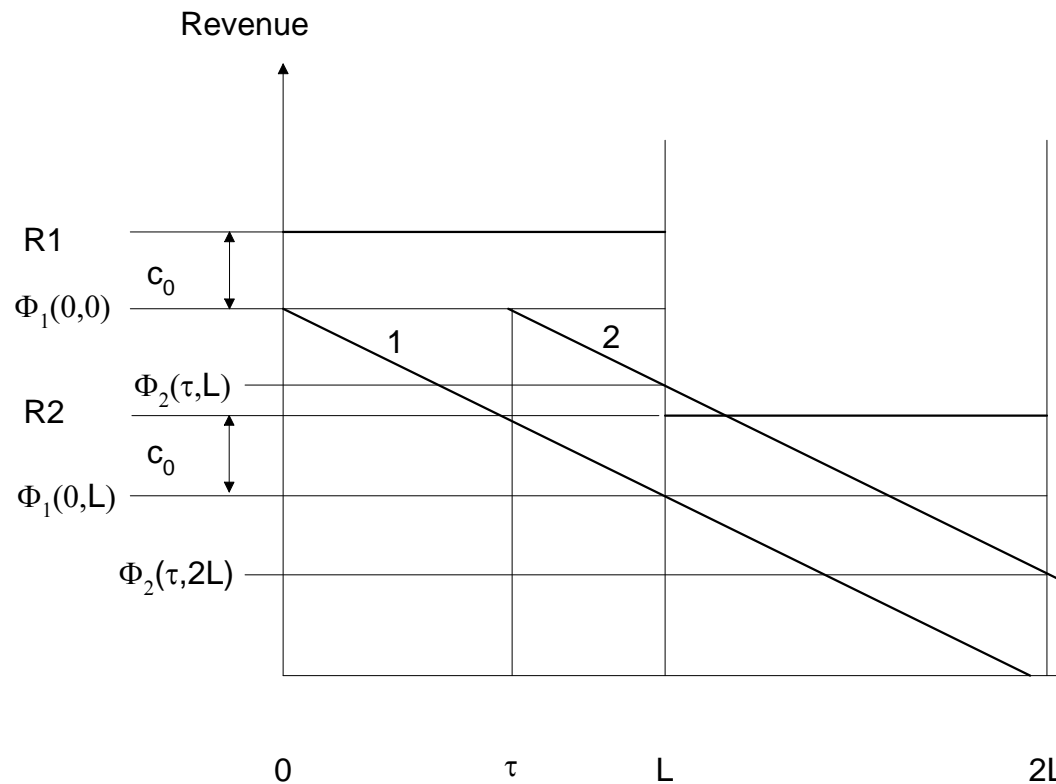
# Regulatory revenue from capital

- Combines depreciation and a return on the depreciated value of capital

$$\Phi(\tau, t) = rB(\tau, t) + \delta(\tau, t)$$

- For straight line depreciation this schedule is a slightly falling straight line
- It is possible to calculate an annuity giving a constant sum of depreciation and return on the remaining value

# Regulatory revenue and investment time



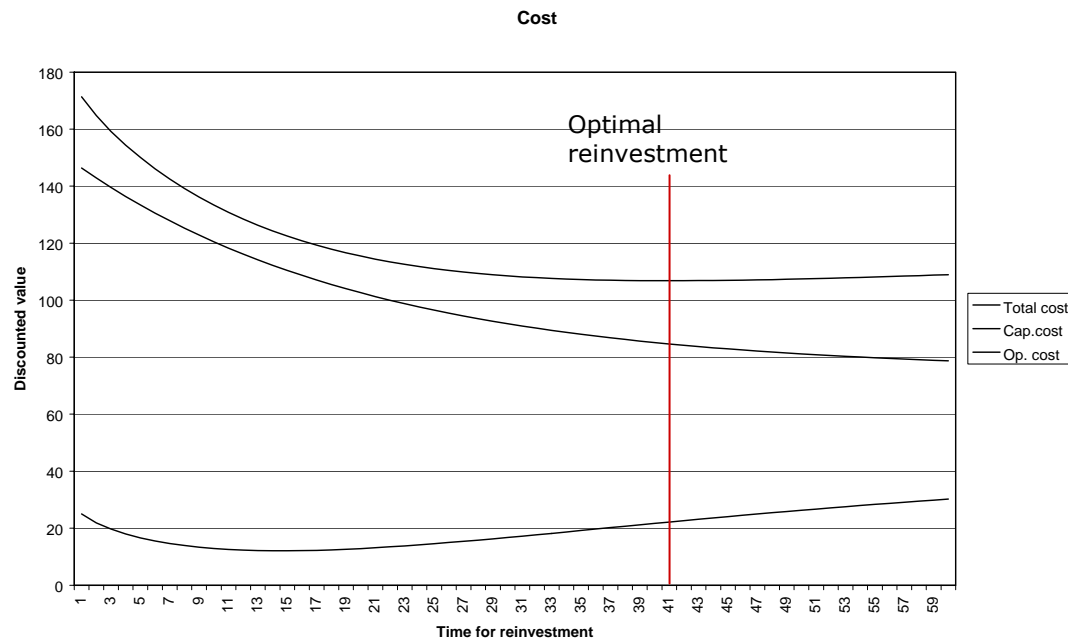
# Regulatory revenue

- Constant over a regulatory period – no efficiency parameter
- Depend on inclusion time
- The form of the depreciation schedule
  - Linearity
  - Statutory lifetime of equipment
- To evaluate the revenue effect of investment we must consider several periods
  - But the pattern over a given regulatory period will be identical for other periods

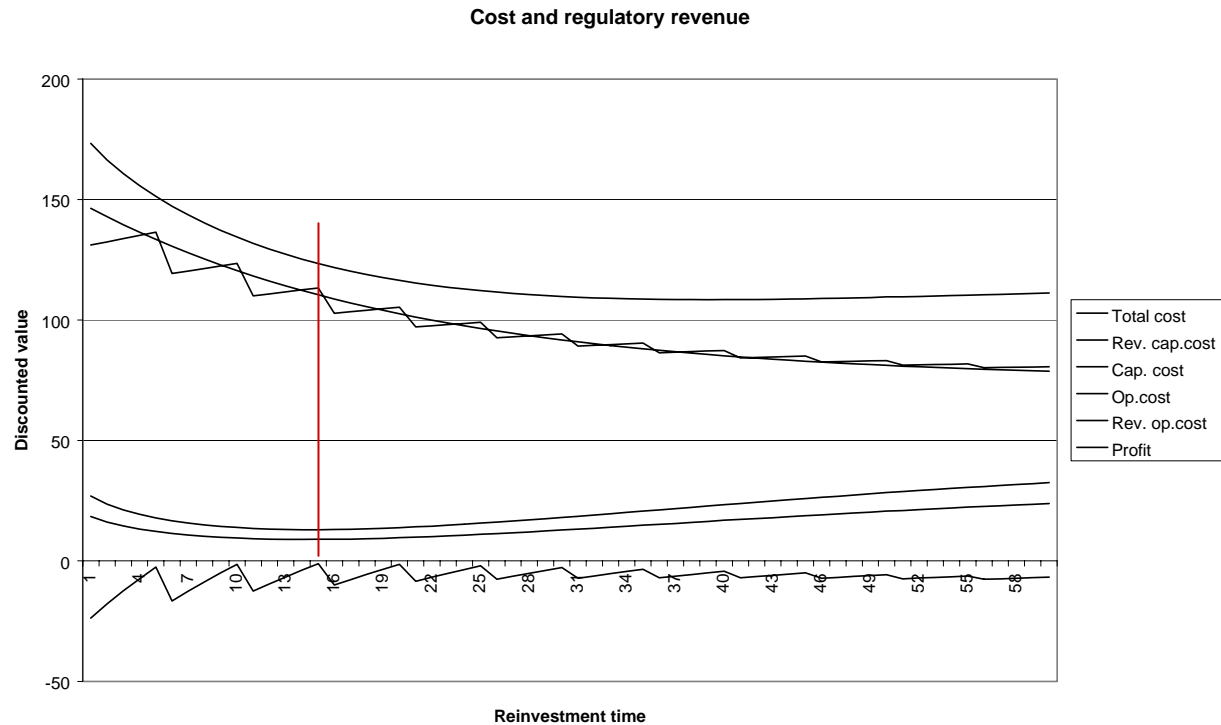
## Numerical calculations

- Operation of the system for 60 periods
- Regulatory periods of 5 years
- Linear depreciation schedule
- Statutory lifetime 35 years
- Regulatory rate of return identical to the firms rate of return

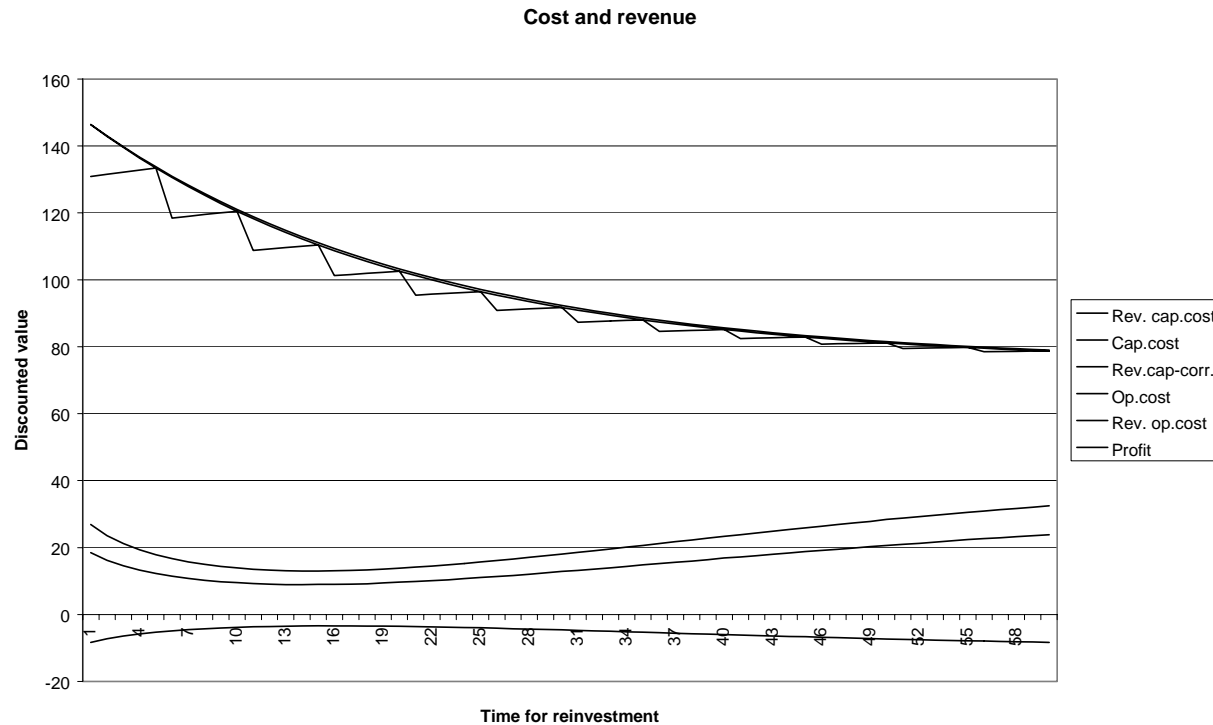
# Total cost discounted to $t=0$ for different reinvestment times



# Cost and regulatory revenue



# Annuity schedule and correction for the inclusion effect



## Conclusion

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- The inclusion effect causes an important within period effect but can be corrected
- Minor variations in the statutory lifetime are not important, but annuity schedules can have an effect