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Adjusting for Time Lags in a Yardstick Regulation Model – The Case of Electricity Networks in Norway

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Norwegian Power Market

- Deregulated since 1990
  - Nordic market for electricity (Nord Pool)
- Regulated transmission and distribution
  - Incentive regulation since 1997
    - Revenue caps
  - Third regulation period from 2007
    - Changes every 5 year
  - From 2007
    - Annual updates
    - VOLL part of benchmarking and cost norm
    - Calibration/normalization of benchmarking results
    - Adjustment parameter for time lags

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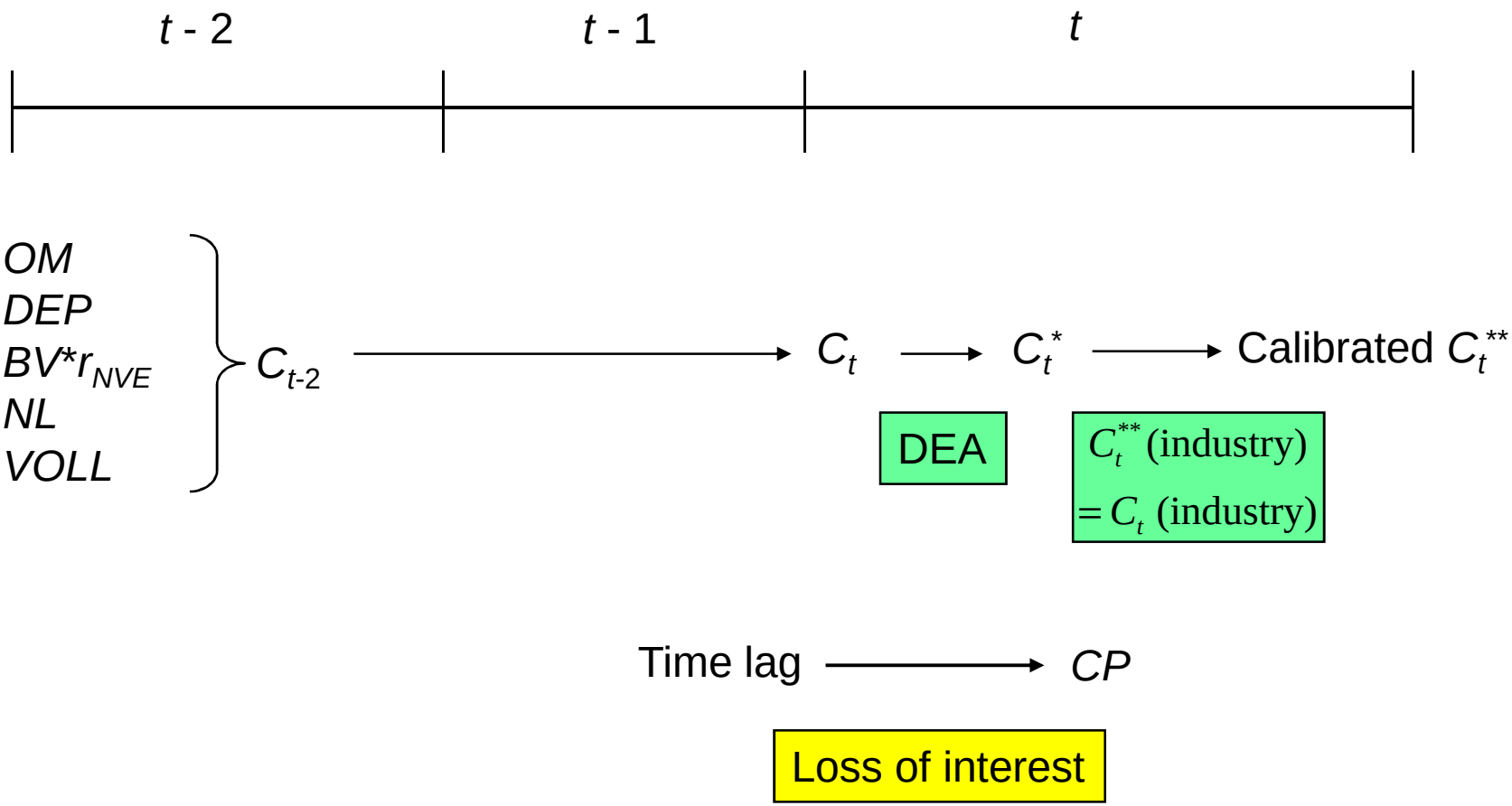
Yardstick Regulation Model from 2007



Sum Industry Revenue Cap

Yardstick revenue cap formula for each company

$$RCap = \rho \cdot C^{**} + (1-\rho) \cdot C + CP$$

	2007		2008	
	MNOK	**"Profitability"**	**MNOK**	**"Profitability"**
Revenue cap based on DEA eff. scores	12 986	6.54 %	13 848	6.37 %
Effect of adjusting eff. scores (step 2)	599	1.55 %	786	2.01 %
Revenue cap after step 2 adjustments	13 585	8.09 %	14 635	8.38 %
Compensation parameter (step 3)	328	0.85 %	371	0.95 %
Rev. cap before calibration (IR1)	13 913	8.94 %	15 006	9.33 %
Calibration effect (step 3)	-328	-0.85 %	-372	-0.95 %
Final revenue cap (IR2)	13 585	8.09 %	14 634	8.38 %

Summary

- A representative company
  - Averagely efficient
  - Revenue cap is equal to calculated cost, including the (NVE) normal rate of return on book value of capital
- Without lags = Rate of return (RoR)
  - Internal rate of return and accounting rate of return = NVE interest rate

Summary

- Compared to a standard RoR-regulation, the present regulation have revenues that are lagged
  - Depreciation: two years
  - Interest: one year
- Every investment of a representative company needs a compensation in order to give net present value equal to zero at a required rate of return equal to the NVE interest rate
  - Supplements a revenue cap that is calibrated according to calculated (lagged) cost
    - (≈) Up-front compensation parameter
    - Annual interest compensation of lagged cost elements

Simple Example

3-year investment with RoR revenue
Linear depreciation, 8 % cost of capital

Year	CapOB	Dep	8%·CapOB	Revenue cap	Profit	Profita-bility
1	100.0	33.3	8.0	**41.3**	8.0	8.0 %
2	66.7	33.3	5.3	**38.7**	5.3	8.0 %
3	33.3	33.3	2.7	**36.0**	2.7	8.0 %
Sum	200.0	100.0	16.0	**116.0**	16.0	8.0 %
PV(8%)		85.9	14.1	**100.0**	14.1	
IRR				**8.0 %**		

- Annual capital costs: $Rev0_t = Dep_t + 8\% \cdot CapOB_t$
- Profit: $Pro0_t = Rev0_t - Dep_t$
- Profitability: $Ret0_t = Pro0_t / CapOB_t$

Investment with lagged revenue from accounts t-2

$CP = - NPV1 \cdot 1{,}08^2$

$= \quad 13{,}3 \quad \cdot 1{,}1664$

					Uncompensated		
Year	CapOB	Dep	8%·CapOB	**Rev0**	CapOB	Dep	**Rev1**
1	100.0	33.3	8.0	41.3			
2	66.7	33.3	5.3	38.7	100.0		8.0
3	33.3	33.3	2.7	36.0	66.7	33.3	38.7
4					33.3	33.3	36.0
5						33.3	33.3
Sum	200	100		116.0	200.0	100.0	**116.0**
PV(8%)		85.9		100.0		73.6	**86.7**
IRR				8.0 %			**4.0 %**

- Uncomp. : $Rev1_2 = 8\% \cdot CapOB_1$; $Rev1_5 = Dep_3$

  $Rev1_t = Dep_{t-2} + 8\% \cdot CapOB_{t-1}$ (t = 3,4)

- Int. comp.: $Rev2_2 = 8\% \cdot CapOB_1 \cdot \mathbf{1{,}08}$; $Rev2_5 = Dep_3 \cdot \mathbf{1{,}08^2}$

  $Rev2_t = Dep_{t-2} \cdot \mathbf{1{,}08^2} + 8\% \cdot CapOB_{t-1} \cdot \mathbf{1{,}08}$ (t = 3,4)

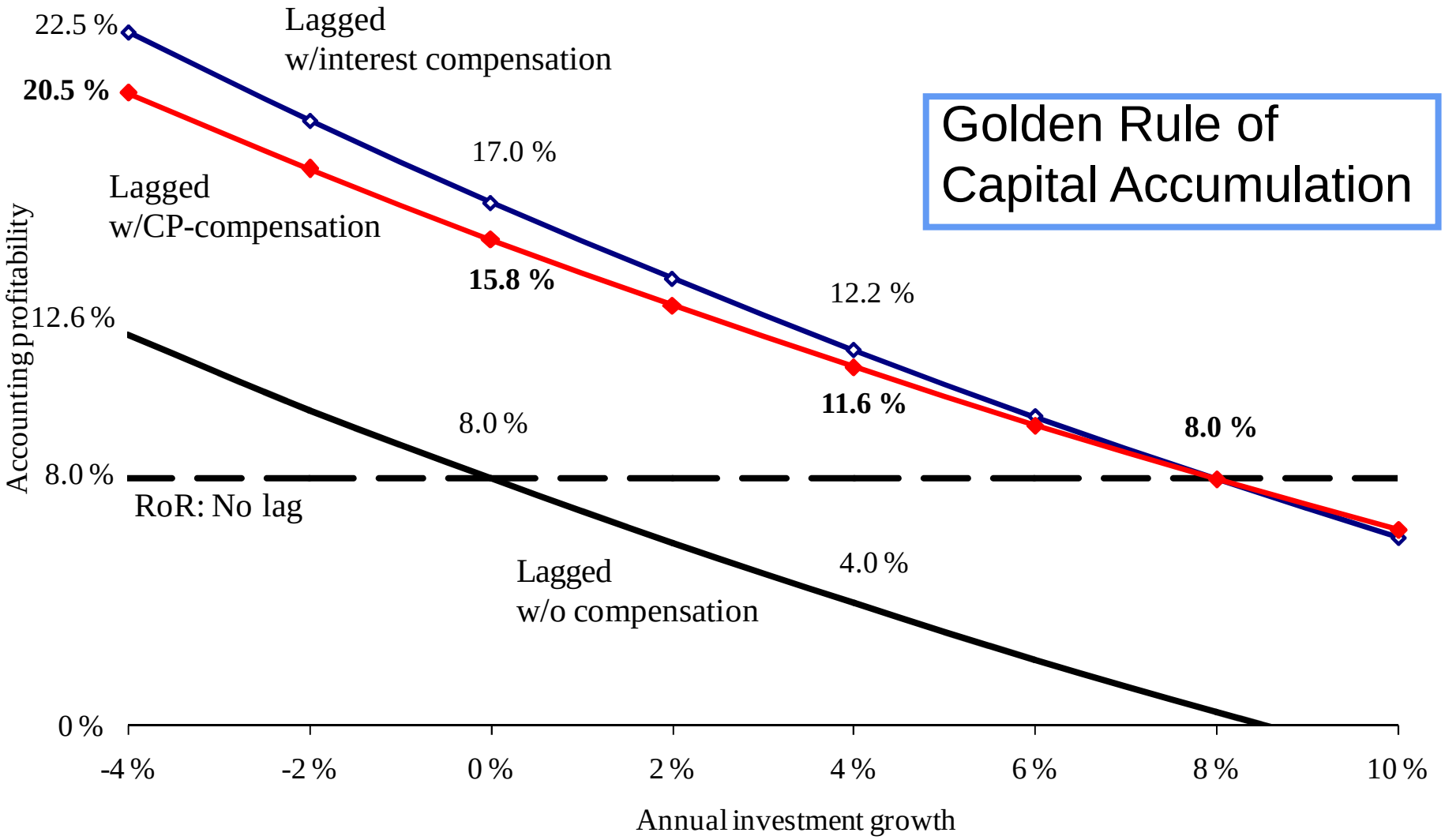
- CP-comp.: $Rev3_2 = Rev1_t + \mathbf{CP}$; $Rev3_t = Rev1_t$ (t = 3..5)

Company with 3 vintages, without capital growth

	Historical			Revenue cap			
Vintage	cost	CapOB	Dep	Rev0	Rev1	Rev2	Rev3
1	100	100.0	33.3	41.3			
2	100	66.7	33.3	38.7	8.0	8.6	23.5
3	100	33.3	33.3	36.0	38.7	44.6	38.7
4					36.0	41.8	36.0
5					33.3	38.9	33.3
Total	300.0	200.0	100.0	116.0	116.0	133.9	131.5
% CapOB			50.0 %	58.0 %	58.0 %	67.0 %	65.8 %

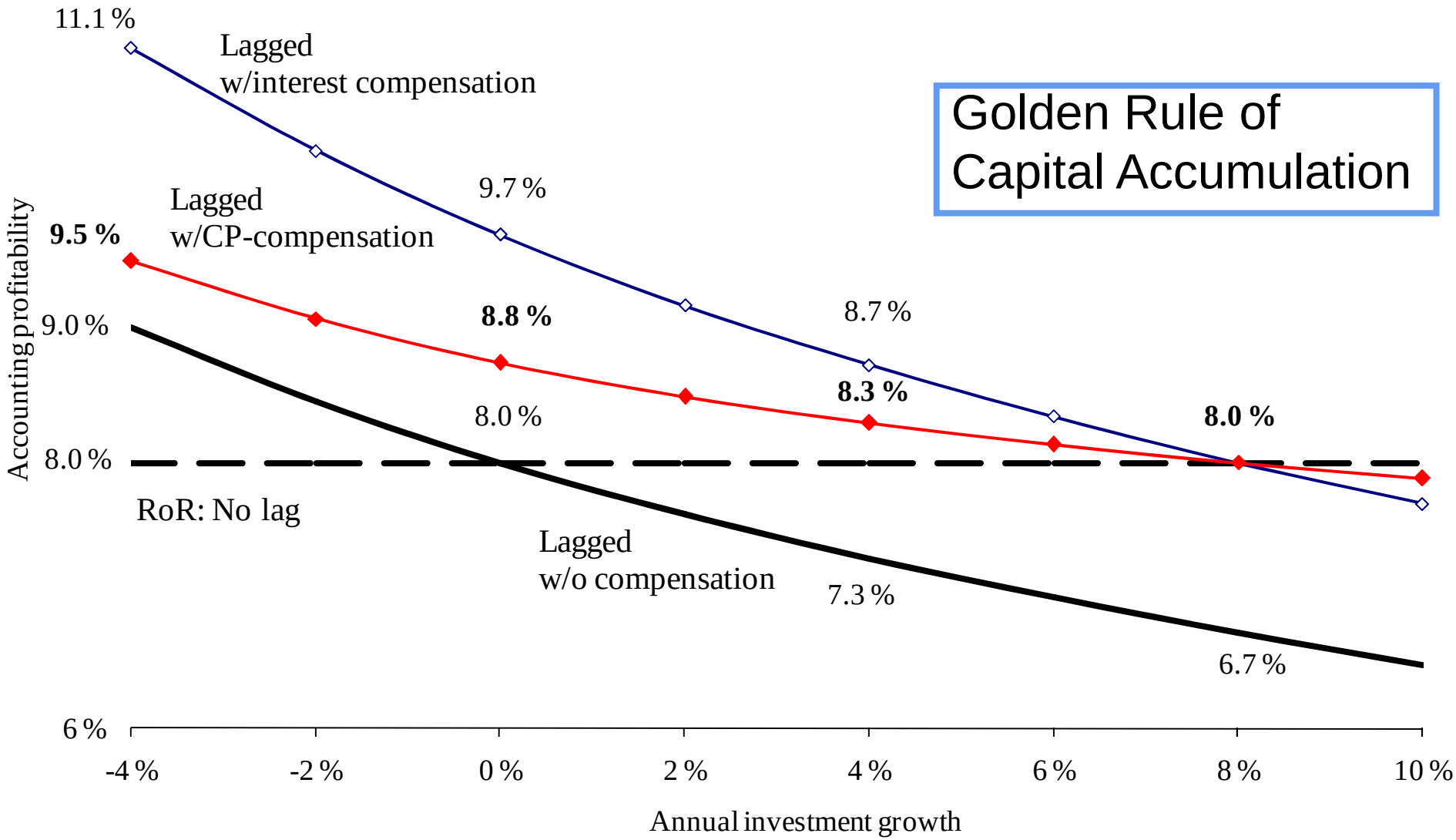
- Aggregated revenue cap is dramatically higher, including revenues for ”scrapped” vintages
- Higher accounting profitability
  - Large weight on depreciated vintages
- Additional revenue is compensation for loss of interests, it is NOT economic profit

Company with 3 vintages
Accounting profitability versus capital growth



Golden Rule of
Capital Accumulation

Company with 30 vintages
Accounting profitability versus capital growth



Company accounts and historical growth
15 versus 30 years depreciation

Growth	Dep/ CapOB	Revenue cap / CapOB				Profitability			
		Rev0	Rev1	Rev2	Rev3	Ret0	Ret1	Ret2	Ret3
15 years life span									
-4 %	13.8	21.8	23.3	26.5	24.7	8.0	9.5	12.7	10.9
0 %	12.5	20.5	20.5	23.2	22.2	8.0	8.0	10.7	9.7
4 %	11.5	19.5	18.3	20.7	20.2	8.0	6.8	9.2	8.7
8 %	10.6	18.6	16.5	18.6	18.6	8.0	5.9	8.0	8.0
12 %	10.0	18.0	15.1	17.0	17.4	8.0	5.1	7.0	7.4
IRR						*8.0*	*6.3*	*8.0*	*8.0*
30 years life span									
-4 %	8.0	16.0	17.0	19.1	17.5	8.0	9.0	11.1	9.5
0 %	6.5	14.5	14.5	16.2	15.2	8.0	8.0	9.7	8.8
4 %	5.4	13.4	12.7	14.2	13.7	8.0	7.3	8.7	8.3
8 %	4.8	12.8	11.5	12.8	12.8	8.0	6.7	8.0	8.0
12 %	4.4	12.4	10.7	11.8	12.2	8.0	6.2	7.4	7.8
IRR						*8.0*	*6.9*	*8.0*	*8.0*

Exact Compensation Parameter

$$CP = CP^* \cdot r_{NVE} \cdot Investment_{t-2}$$

$PV0 = 1 = \mathbf{a} + (1-\mathbf{a})$

$a \equiv PV(dep)$

$PV1 = a/(1+r)^2 + (1-a)/(1+r)$

$CP = [PV0 - PV1]\cdot(1+r)^2$

$$CP^* \equiv [PV0 - PV1] \cdot (1+r)^2 / r$$

$$CP^* = 1 + r + \mathbf{a}$$

$$\text{where } \mathbf{a} \equiv Ann[T;r]/T = \frac{1-(1+r)^{-T}}{r \cdot T}$$

Life span	Rate of return 6 %	7 %	8 %	9 %	10 %
Percentage of capital invested					
10	10.8 %	12.4 %	14.0 %	15.6 %	17.1 %
20	9.8 %	11.2 %	12.6 %	13.9 %	15.3 %
30	9.1 %	10.4 %	11.6 %	12.9 %	14.1 %
40	10.0 %	10.9 %	11.8 %	12.8 %	13.9 %
Relative to rate of return					
10	1.80	1.77	1.75	1.73	1.71
20	1.63	1.60	1.57	1.55	1.53
30	1.52	1.48	1.46	1.43	1.41
40	1.67	1.56	1.48	1.43	1.39

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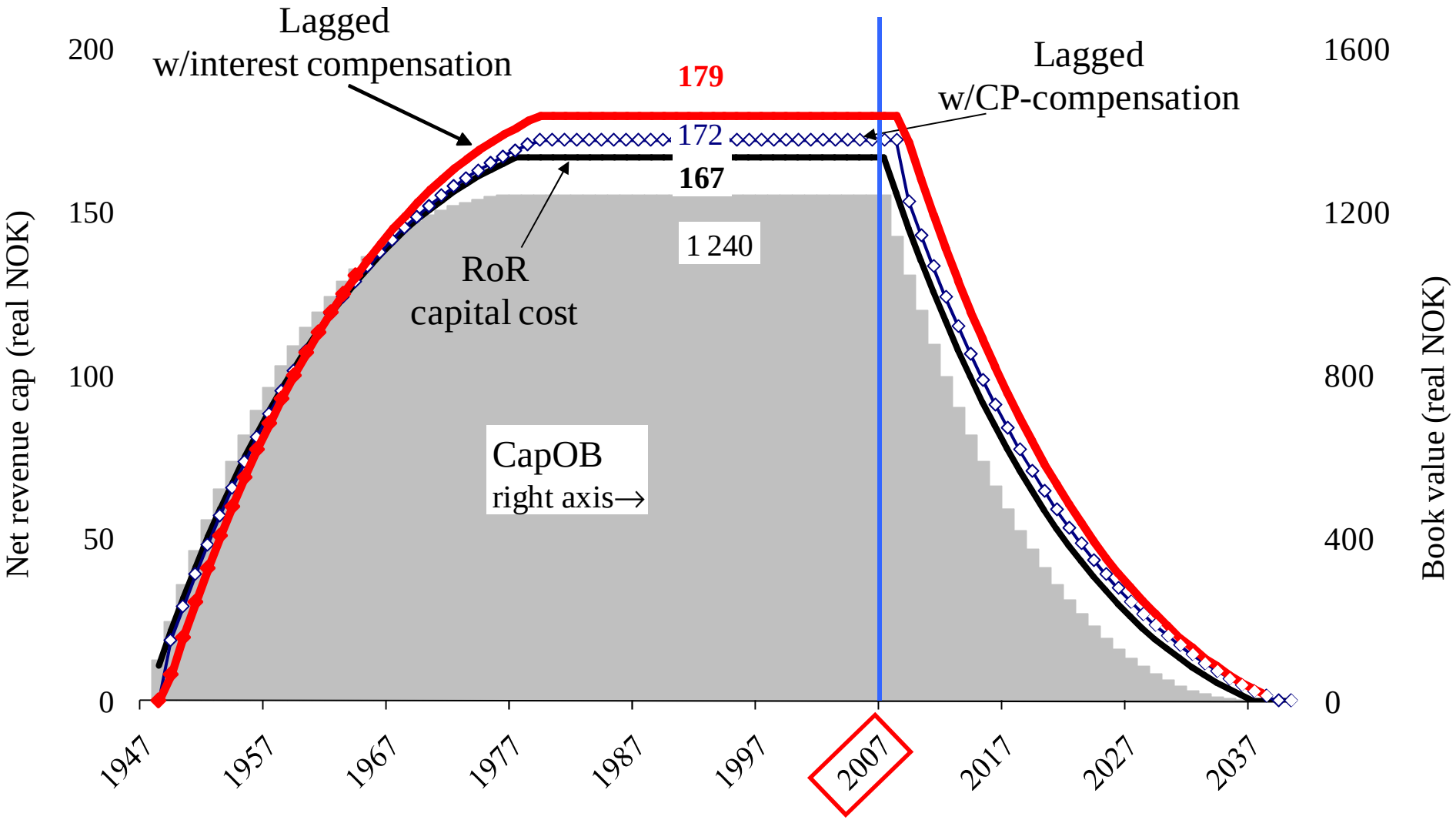
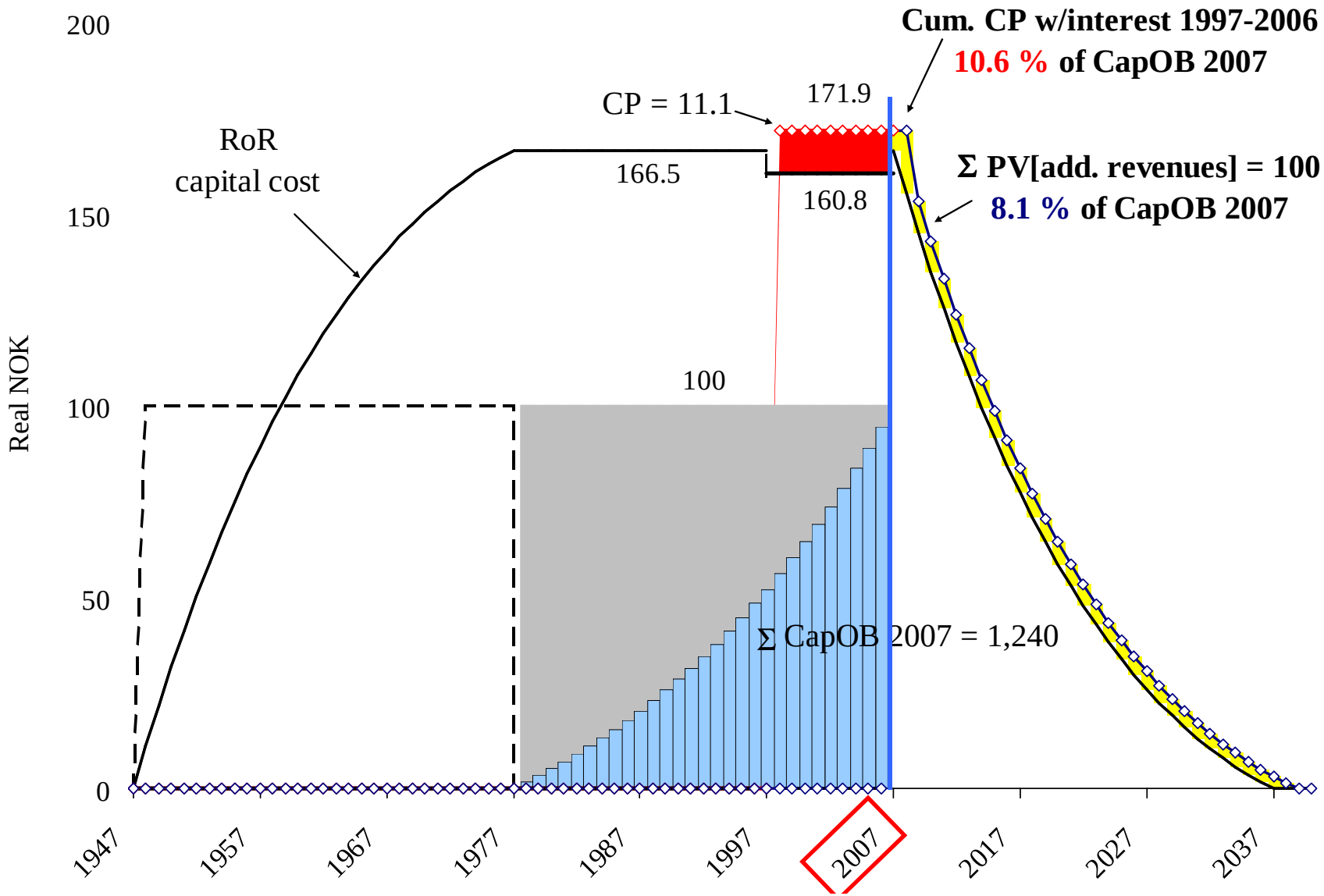
Transition from one system to another: Double compensation?

- Increased time lag
  - –Double compensation for depreciation
  - –Double compensation for interest
  - –E.g. RoR → 2 years lag
    - Two years extra depreciation
    - One year extra interest
- What was the system before 2007?
  - – RoR or lagged w/o compensation

Simulation of a company's life cycle: investment (30 yrs) / reinvestment (30 yrs) / harvesting (32 yrs) (*no real growth*)



Transition from uncompensated to CP-compensated lag in year 60, RoR-regulation in t=1 ... 50



Double Compensation

- Changes can lead to over- or undercompensation
  - –Depends on what we change from and what we change to
  - –Change in length of lag
  - –Change in form of compensation
- Fairness versus efficiency (incentives)
- Other costs fully covered in previous regulation models?

Conclusions

- With compensated lag
  - (combined with low or negative growth)
  - Accounting depreciation comes earlier than the corresponding revenue element
  - Accounting rate of return will be higher than the reference rate set by NVE
  - However, investment analyses for individual assets will show IRRs equal to the reference rate
- In lagged regulatory systems, evaluating economic returns using historical profitability measures from the accounts, can be very problematic!

Conclusions

- The compensation parameter should come as an addition to a revenue cap that is normalized to calculated (lagged) costs
  - Exact formula depends on interest rate and asset life span
  - Alternative: interest compensation
- Any revenue reductions because of double compensation should not be linked to the size of the (industry) compensation parameter (i.e the amount of new investments)

Suggested procedure

1. Calculate cost base using data from year *t*-2
2. Determine efficiency scores / cost norms via efficiency analyses
3. Calibrate efficiency scores / cost norms in order to give the average company the normal rate of return
   - Different calibration methods are possible
4. Add compensation parameters to revenue caps
   - Exact formula depends on interest rate and assumed asset life span
5. Adjust revenue caps in order to take into account under-/ overcompensation related to previous regulation regimes

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Alternative procedure

1. Calculate cost base using data from year *t*-2
2. Determine efficiency scores / cost norms via efficiency analyses
3. Calibrate efficiency scores / cost norms in order to give the average company a normal rate of return
    - Different calibration methods are possible
4. Determine final cost base using data from year *t-1* and *t*
5. Determine final revenue cap from efficiency score and final cost base