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The Potential Impact of Open-Access on Prices and Investment
The Case of the U.S. Rail Freight Industry

Marc Ivaldi

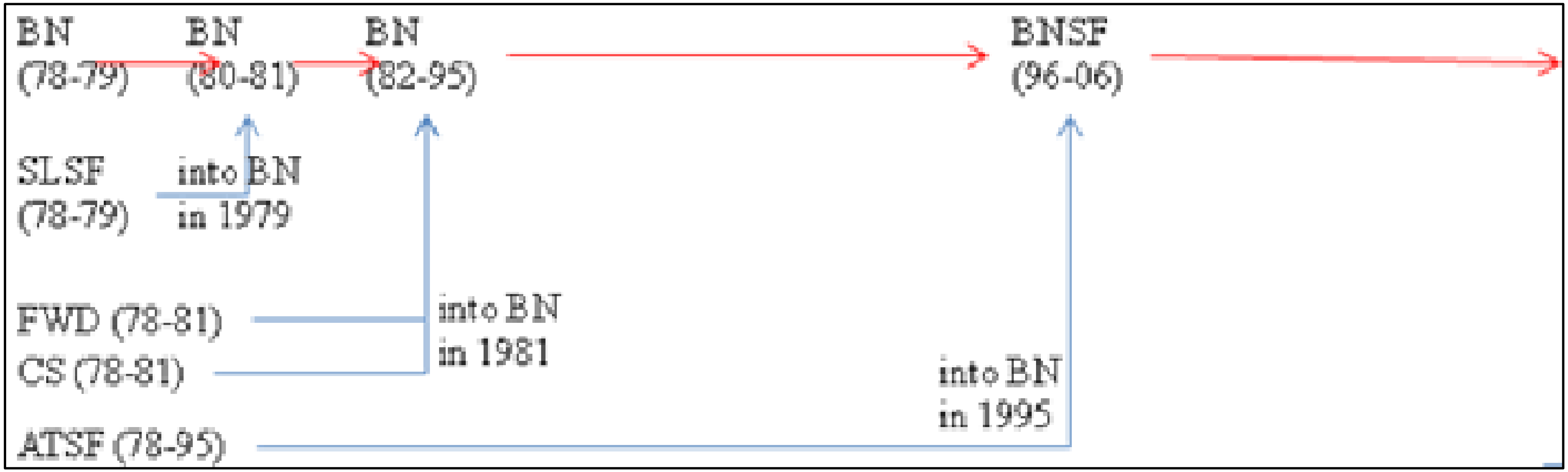
Toulouse School of Economics

Daniel Coublucq, Toulouse School of Economics

Gerard McCullough, University of Minnesota

The US railroad industry

- Deregulation since the Staggers Act in 1980
  ⇨ Major restructuring: exit of firms and takeovers
- 26 firms (integrated Class 1 railroads) in 1980, 7 in 2006



Concern about competition

- Recent concern about competition: 7 integrated firms
- Law proposal: open-access (GAO, 2006, 2008)
- A (very) hot debate at the Congress
- Definition of open-access: the incumbent must provide access to competitors over (portions of) its network facilities
  ⇨ Entry of a new firm on the network of an existing firm.
- Price competition will increase

Drawback 1: cost-efficiency argument

- Importance of economies of density
  ⇨ Ivaldi and McCullough (2001, 2008)
- Open-access ⇨ Sharing of traffic ⇨ increase cost, and thus price

Drawback 2: Investment

- The main argument ⇨ focus of this paper
- Idea: track infrastructures is the result of previous costly investment
- Open-access: entrant benefits from good infrastructures by not bearing the cost of investment
  ⇨ prospect to be expropriated (infringement of property rights)
  ⇨ discourage investment in the future
- Motta (2004), OECD (1997, 2006), Christensen (2008)
- Rail infrastructures: key for performance

More on investment

- In the data: investment in ways and structure capital
- Argument 1: some prospects of profits necessary to motivate firms to make costly investment in rail infrastructures
  ⇨ obtained through above marginal cost pricing
- Argument 2: smaller proportion of rail traffic, weaker incentives to carry out investment
- Open-access ⇨ increase competition (static efficiency)
  ⇨ decrease rates and market share for the owner
  ⇨ decrease anticipated revenues
  ⇨ decrease investment and rail infrastucture quality (dynamic inefficiency)
- Final impact on consumer welfare?

This paper

- To propose an econometric framework to analyse this issue of investment and static/dyncamic efficiency
- A structural approach
  - Policy change not in the data
  - Estimate a structural model and counterfactual
  - Policy change = entry of a new firm on an existing network (open-access)
- High potential for competition policy:
  - Merger (CRAI, 2007)
  - Essential facilities (RBB, 2010, Australian Rail industry)

Methodology

- Estimation of a demand model
  - Coublucq (2011): issue of panel attrition
  - Counterfactual: increase in price competition
- Estimation of investment model
  - Parameter of interest: cost of investment
  - Important for counterfactual
- Counterfactual: simulation of entry
  - Price competiton and investment behavior
  - Impact on consumer welfare

Simulation of an open-access policy

- Entry on BN's network (market share = 36%)

An open-access policy: presentation

- Simulate the impact on price competition and investment
- BN's (denoted j) network opened to competition
  - New firm denoted n
  - Mean-utility of entrant: $\delta_{n,t_0} = \theta k_{j,t_0} - \alpha p_{n,t_0} + \xi_{n,t_0}$
  - ξ_{n,t_0} : fixed to average efficiency
- Assumptions:

	Network	Services	Total marginal cost
BN	$s \times mc_{j,t_0}$	$(1-s) \times mc_{j,t_0}$	mc_{j,t_0}
Entrant	$a = s \times mc_{j,t_0}$	$(1-s) \times mc_{j,t_0}$	$a + (1-s) mc_{j,t_0} = mc_{j,t_0}$

  - Null profit from access for the incumbent BN

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An open-access policy: price competition

- Price competition:
  - Spot profit for entrant: $\pi_{n,t_0} = (p_{n,t_0} - \underbrace{\text{cost}_{n,t_0}}_{mc_{j,t_0}}) s_{n,t_0}(\boldsymbol{p}_{t_0}) M_{t_0}$
  - FOC: $(p_{n,t_0} - mc_{n,t_0}) \dfrac{\partial s_{n,t_0}}{\partial p_{n,t_0}} + s_{n,t_0} = 0$
- Using the other 7 FOCs from incumbents, we get a new equilibrium prices vector at date t_0 : $\boldsymbol{p}_{t_0}$
  -

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An open-access policy: investment

- Using FOC for BN investment:

$$i_{j,t_0} = \frac{\delta}{\hat{b}} \frac{\partial V_{j,t_0+1}}{\partial K_{j,t_0+1}}$$

$$\Rightarrow i_{j,t_0} = \frac{\delta}{\hat{b}} \left(\frac{\partial \pi_{j,t_0+1}}{\partial K_{j,t_0+1}} + \delta(1-d) \frac{\partial \pi_{j,t_0+2}}{\partial K_{j,t_0+2}} + (\delta(1-d))^2 \frac{\partial \pi_{j,t_0+3}}{\partial K_{j,t_0+3}} + \dots \right)$$

- Where: $\frac{\partial \pi_{j,t_0+1}}{\partial K_{j,t_0+1}} = M(p_{j,t_0+1} - mc_j) \frac{\partial s_{j,t_0+1}}{\partial K_{j,t_0+1}}$

- Open-Access:
  - more competition: decrease of anticipated prices and revenues
  - Less incentives to invest in network infrastructures

An open-access policy: results (1)

- Overall price decrease: -6% per year (more competition)
- Less traffic for the incumbent (-10%;-13%)
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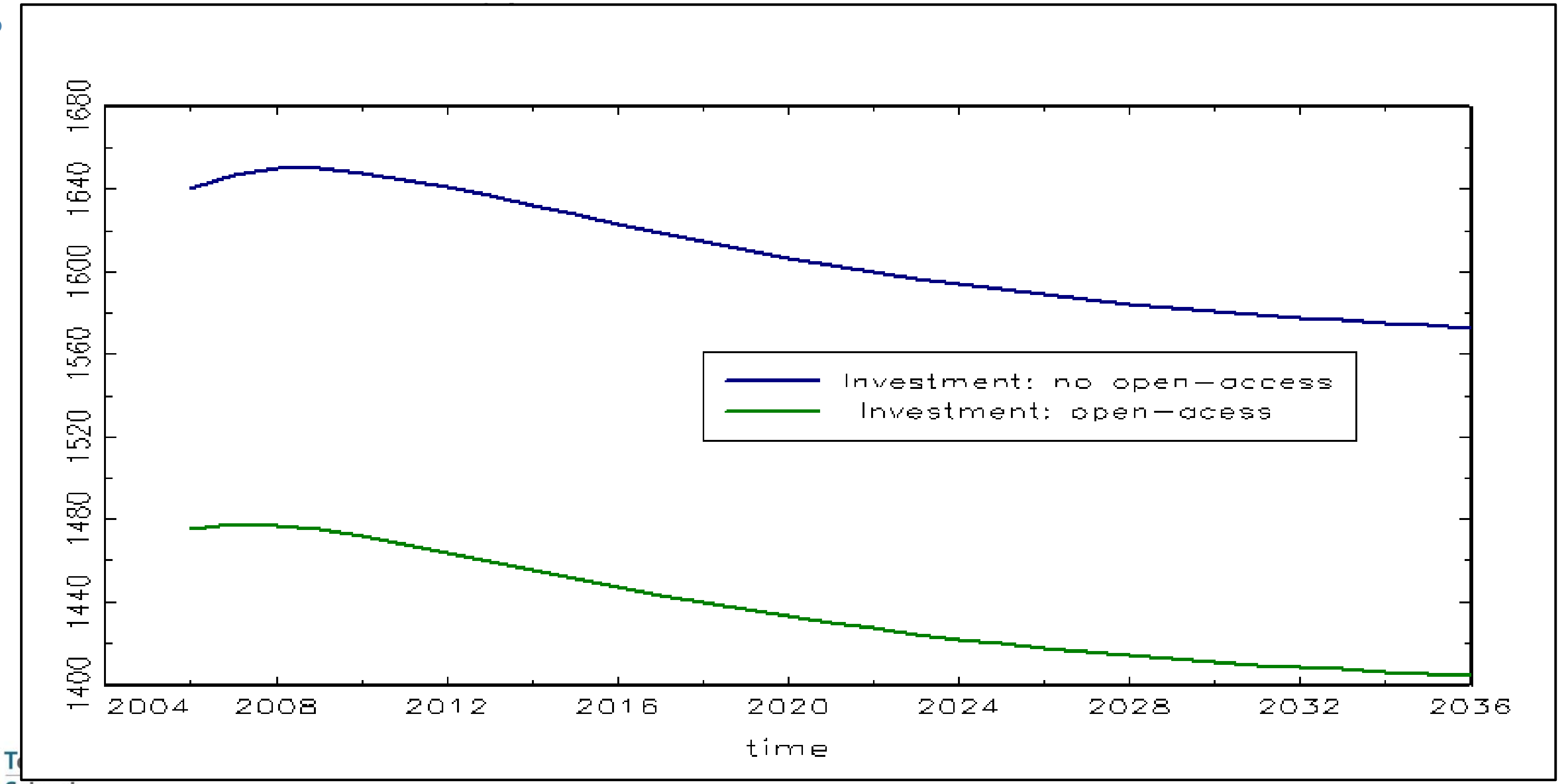
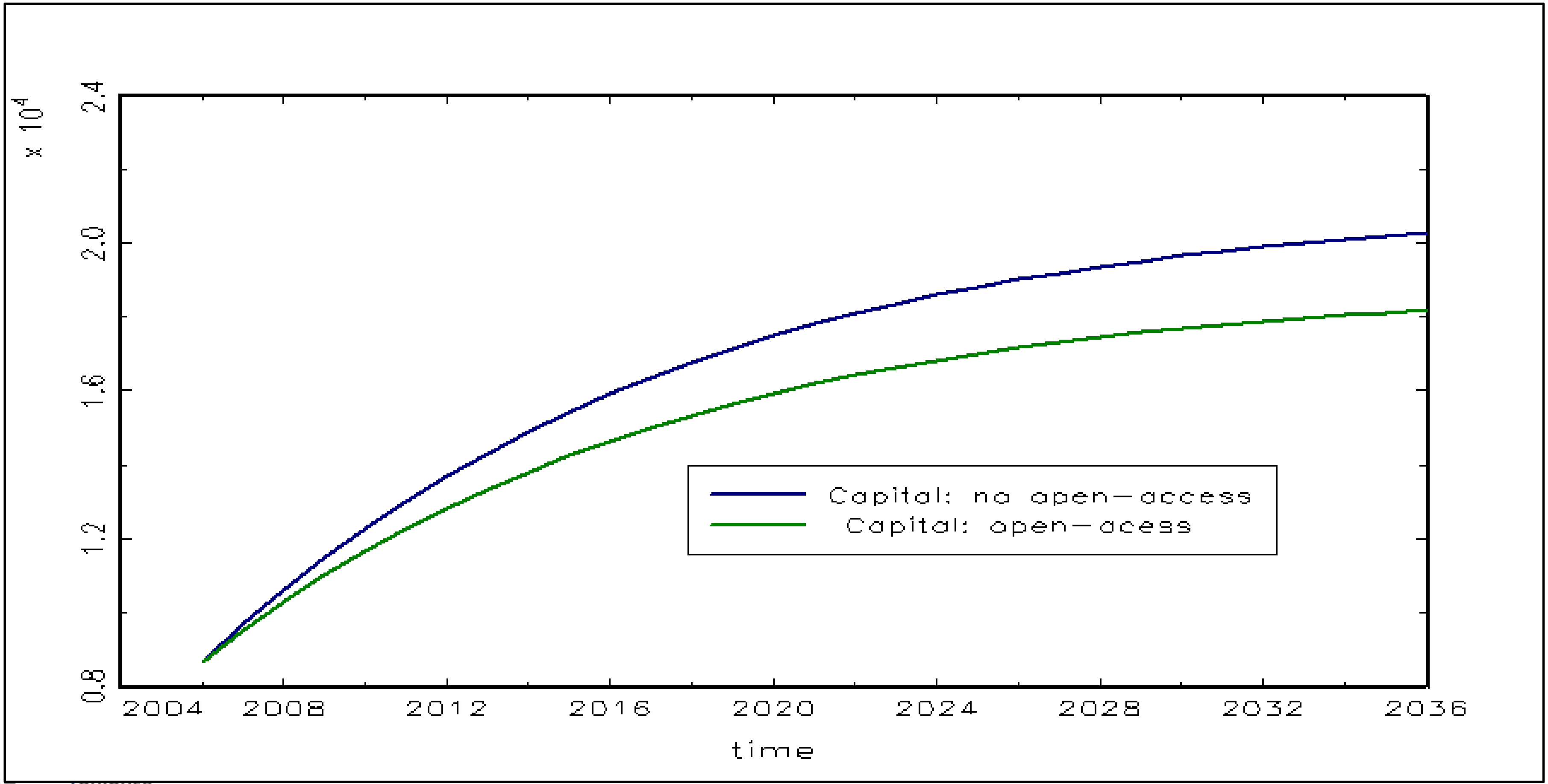


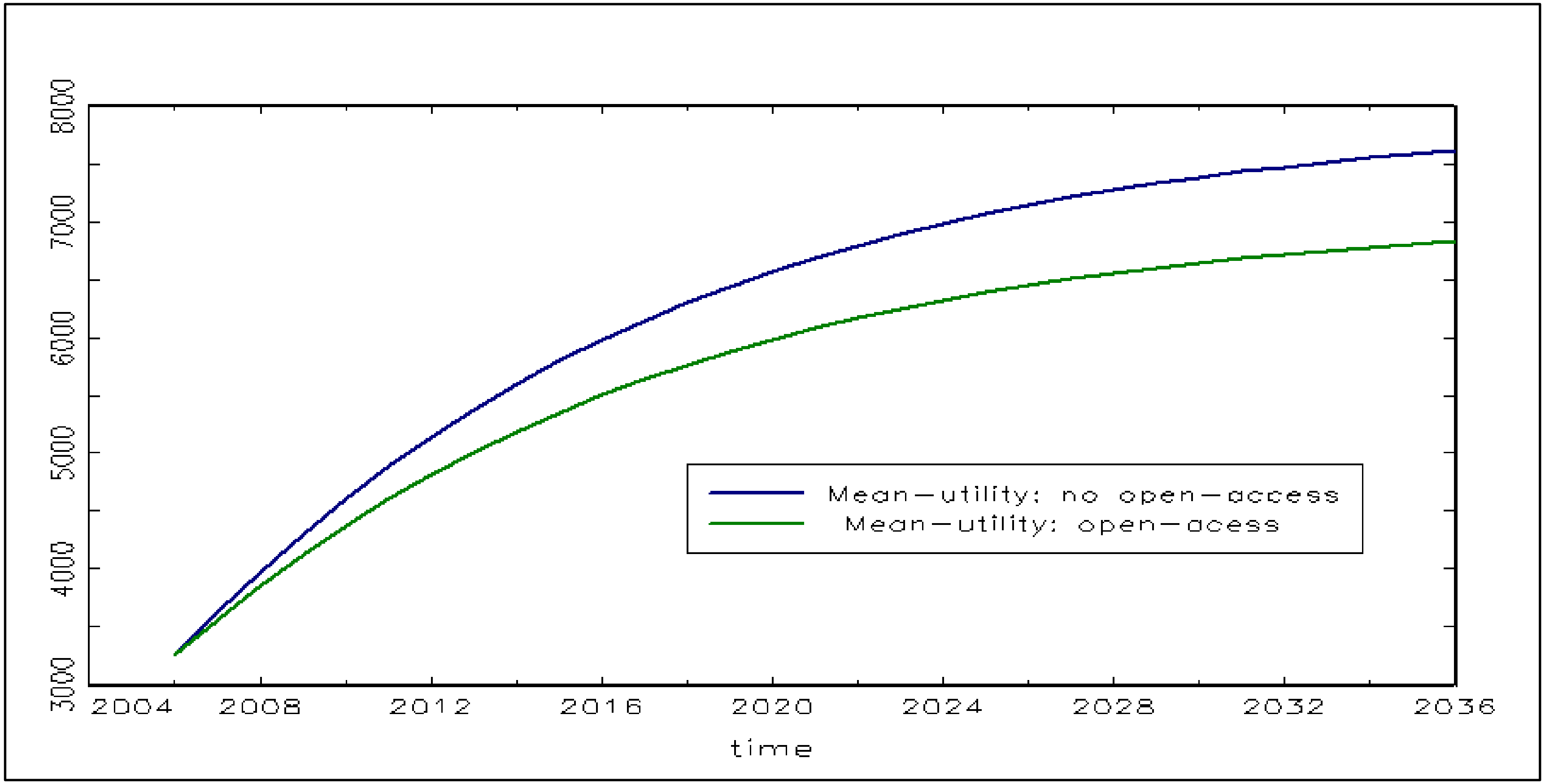
An open-access policy: results (2)

- Exponential loss in network value (10% after 30 years)



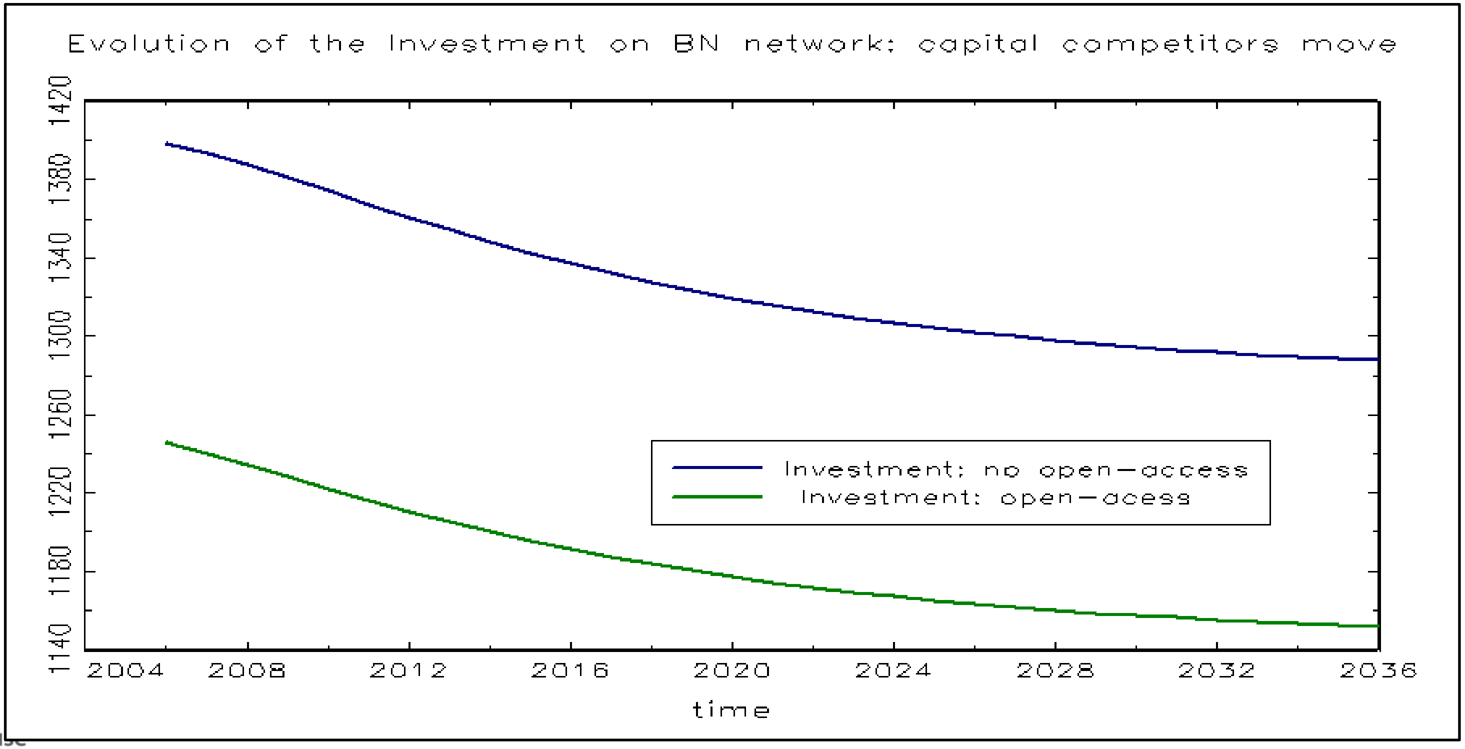
An open-access policy: results (3)

- Welfare of shippers who use BN's network
  - Sensitive to prices and network value



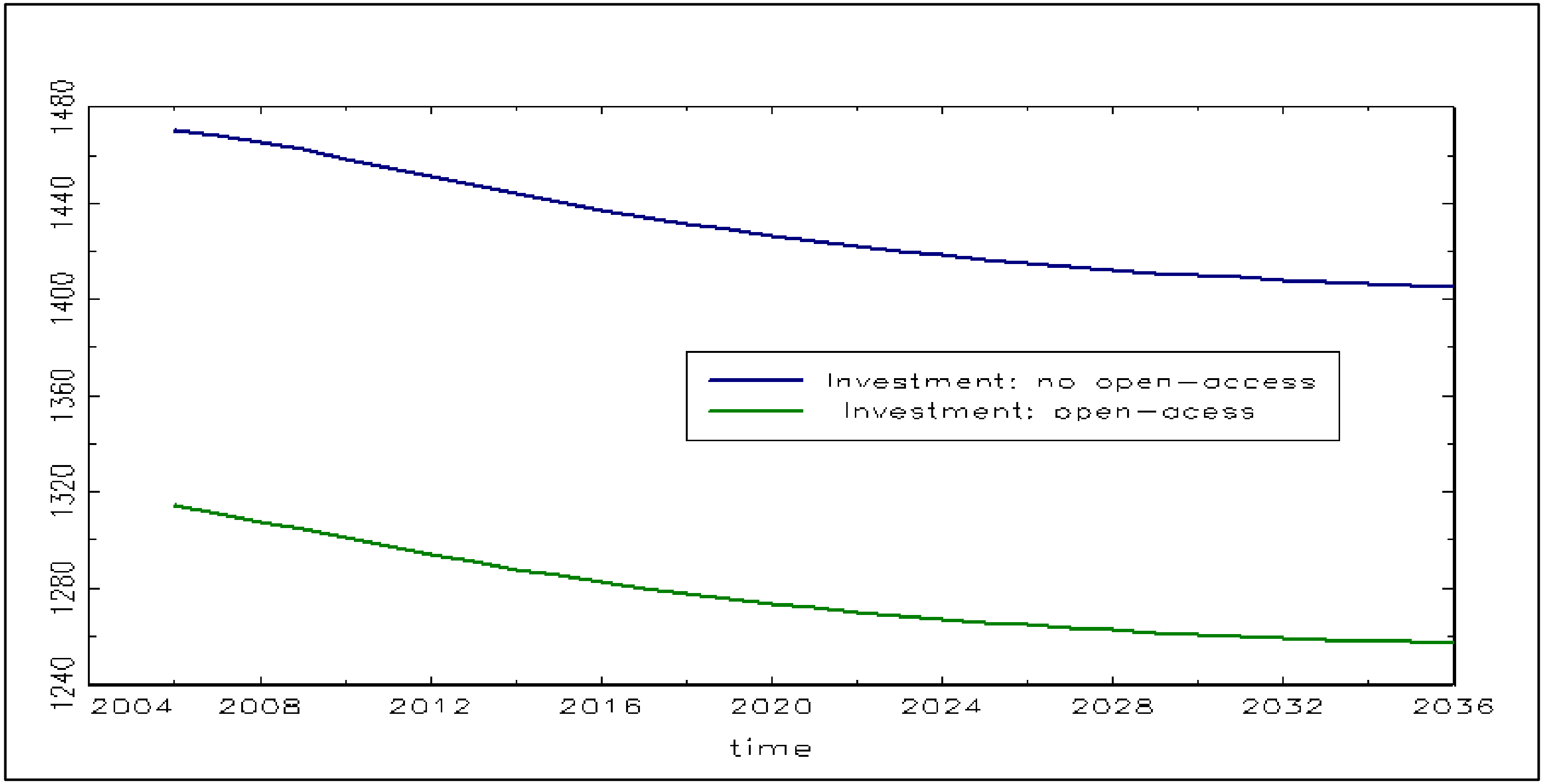
An open-access policy: robustness

- Capital stocks of competitors fixed over time in previous algorithm
  - Similar results if capital stocks of competitors increase



An open-access policy: robustness (2)

- Same simulation with opening of UP's network



Findings

- Entry on BN's network (market share = 36%)
  - Average price: -6%
  - Investment of BN: -10%
  - Consumers on BN's network loses at the end: lower prices, but lower infrastructure quality
- Robust to different specifications of investment policy function
- Similar result for UP
- Message: preserve investment incentives = key for success of open-access

  ⇨ Simulations show it is not easy (need future research)

Conclusion: contribution

- An empirical framework to analyze the trade-off between static efficiency and dynamic efficiency
- Application to a recent debate in US rail industry
  - Open-Access and the expropriation argument
  - To sustain innovation (dynamic efficiency), investment requires a RoR obtained through above marginal cost pricing (static inefficiency)
    ⇨ Prospects of profits necessary to motivate costly investment
  - The smaller the proportion of traffic operated, the smaller the incentives to invest as the benefits are shared by other firms

Conclusion: An example

- Entry on BN's network
  - Decrease in prices, but also in investment
  - Bad for consumer's welfare (decrease in the quality of network, tracks, facilities)
- General message: regulator careful with the implementation of open-access policy
  - Key: investment incentives

Conclusion: extensions

- Marginal costs:
  - Constant marginal costs
  - With economies of density: sharing traffic ⇨ increase cost
    ⇨ anticipated margins decrease more
    ⇨ higher (negative) impact on investment
- Design of the access charge (needs further research):
  - Framework: linear access charge, with null profit from access
    ⇨ Standard way of thinking for regulator
  - Quid if higher level of access charge
    - Preserve investment incentives, but no impact on competition
  - Quid if 2-part access charge: might work, but complicated in practice

APPENDIX

An open-access policy: simulation

- Forward-simulation procedure (Judd, 1998)
- An investment policy function for BN: $I_{j,t_0} = \gamma K_{j,t_0}$
- Results robust to different policy functions
- Find γ such that investment policy function compatible with the FOC for investment
  - Then compute I_{j,t_0}

An open-access policy: simulation (2)

- Algorithm for a given γ :
  - 1) Compute I_{j,t_0}
  - 2) Update next period capital stock at date t_1
  - 3) Solve for next period equilibrium prices at date t_1
  - 4) Compute next period profit derivative at date t_1
  - 5) Compute I_{j,t_1}
  - 6) Iterate steps 2-5 for T periods
  - 7) Compute RHS of FOC for investment
  - 8) Build function

$$f(\gamma) = i_{j,t_0} - \frac{\delta}{b}\left(\sum_{\tau=1}^{T}(\delta(1-d))^{\tau-1}\frac{\partial \pi_{j,t+\tau}}{\partial K_{j,t+\tau}}\right)$$

  - Solve for $f(\gamma)=0$, and compute $I_{j,t_0} = \gamma K_{j,t_0}$

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Data

- Demand model: $\delta = \theta k - \alpha p + \xi$
- Main sources: “Analysis of Class1 Railroads: 1980-2006”
- US national freight market: air, truck, railroad, water, pipeline
- In 2007, more than 41% of freight ton-miles (20% in 1980)
  ⇨ Total size of freight market: from DoT
- Construction of a price index for each firm
  ⇨ Match of the industry price index with the price index of STB (2009)

Network infrastructures

- Demand model: $\delta = \theta k - \alpha p + \xi$
- Ways and structure capital: tunnels, bridges, ties, tracks and rail materials, ballasts, fences, signaling materials
  ⇨ Schedule 350 of R1 report
- Construction of the network value: PIM
  — $K_t = K_{t-1}(1-d) + I_{t-1}$
- Capital adjustment: Berndt et al. (1993)
  — cost savings from increments in ways and structure capital not enough to justify observed levels
  — cost savings might not fully reflect the benefit of investment
  — capital might affect service quality and then the demand

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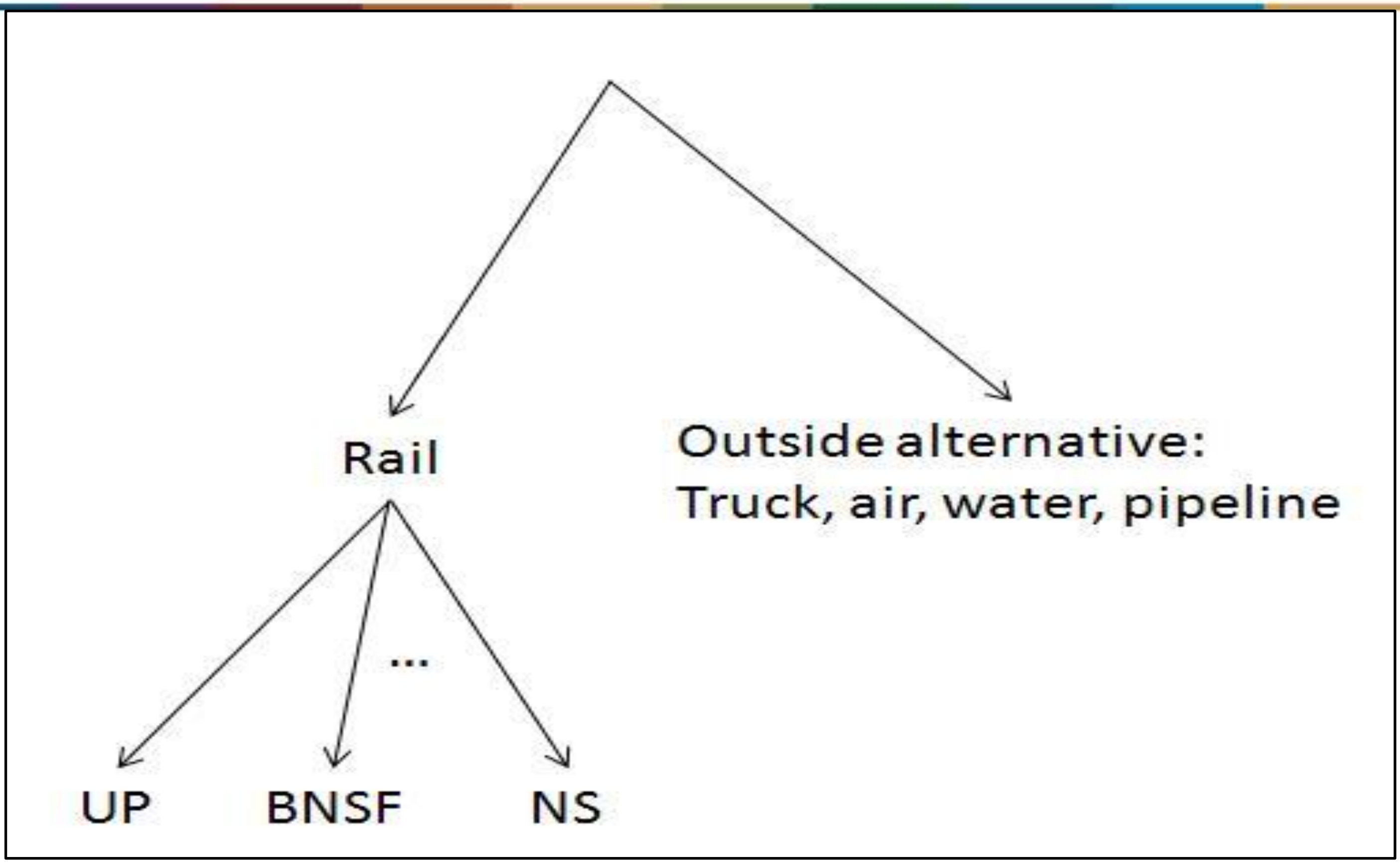
Demand model



- Mean-utility: $\delta_{j,t} = \theta k_{j,t} - \alpha p_{j,t} + \xi_{j,t}$

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Demand estimation: selection issue

- Coublucq (2011)
- Standard estimating equation

$$\ln s_{j,t} - \ln s_{0,t} = \theta k_{j,t} - \alpha p_{j,t} + \sigma \ln s_{j,t|g} + \xi_{j,t}, \text{ where } E(\xi_{j,t} \mid z_{j,t}) = 0$$

- With attrition:
  - firm observed: $r_{j,t} = 1$
  - $E(\xi_{j,t} \mid z_{j,t}, r_{j,t} = 1) = 0$
- Control function approach:

$$\ln s_{j,t} - \ln s_{0,t} = \theta k_{j,t} - \alpha p_{j,t} + \sigma \ln s_{j,t|g} + E(\xi_{j,t} \mid z_{j,t}, r_{j,t} = 1) + e_{j,t},$$

where $E(e_{j,t} \mid z_{j,t}, r_{j,t} = 1) = 0$

Investment model

- Idea: investment is a dynamic decision
  ⇨ Depends on anticipated future profits
- State of the industry:
  $\mathbf{w}_t = (J_t; K_{1,t}, \ldots, K_{j,t}, \ldots, K_{J_t,t}; \xi_{1,t}, \ldots, \xi_{j,t}, \ldots, \xi_{J_t,t})$
- Adjustment cost function: $c(I_{j,t}) = bI_{j,t}^2$
- Bellman equation:

$$V_{j,t}(\mathbf{w}_t) = \sup_{i_{j,t}(\mathbf{w}_t)} \pi_{j,t}(\mathbf{w}_t) - c(I_{j,t}(\mathbf{w}_t)) + \delta E\left\{V_{j,t+1}(\mathbf{w}_{t+1} \mid \mathbf{w}_t)\right\}$$

-
- Estimation: $\hat{b}$ such that observed investment maximizes the firm's value

Investment: estimating equation

- FOC: $\frac{\partial c(I_{j,t})}{\partial I_{j,t}} = \delta E\left[\frac{\partial V_{j,t+1}(w_{t+1} \mid w_t)}{\partial I_{j,t}}\right]$
- Rewrite as: $\frac{\partial c(I_{j,t})}{\partial I_{j,t}} = \delta E\left[\frac{\partial V_{j,t+1}(K_{j,t+1}, K_{-j,t+1}, \xi_{j,t+1}, \xi_{-j,t+1} \mid w_t)}{\partial K_{j,t+1}}\right]$
- Using ET, we obtain:

$$E_{|t}\left[\delta \frac{\partial \pi_{j,t+1}}{\partial K_{j,t+1}} + \delta(1-d)bI_{j,t+1} - bI_{j,t} \mid \boldsymbol{w}_t\right] = 0$$

- Hansen and Singleton (1982): orthogonality conditions
  - $\boldsymbol{z}_{j,t}$: vector of variables in agent's information set at date t

Investment: estimating equation (2)

- Denote $h(b)=\delta\frac{\partial\pi_{j,t+1}}{\partial K_{j,t+1}}+b\left[\delta(1-d)I_{j,t+1}-I_{j,t}\right]$
- Build the function $g(b)=\mathbf{z}'_{j,t}h_{j,t}(b)$
- GMM: $Q(b)=g(b)'Wg(b),\ \text{where } W=\sum_{j,t}(z_{j,t}'z_{j,t})^{-1}$
- Instruments: information available at date t
  - Price, markups, number of active firms, HAUL

Estimation results: demand side

Impact on mean-utility	
Variables	Coeff.
price	-67.467719*** (21.600007)
Capital	.37583955 (.25605218)
Correction	.6281165** (.27461166)
Time	-.09278938** (.04115243)
Time squared	.00225597*** (.00086429)
Nobs	353
Sargan ($\chi^2(7)$)	6.12689 (p = 0.5250)

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Estimation results: investment side

- Adjustment cost function $c(I_{j,t}) = bI_{j,t}^{2}$

	Coeff.
Adjustment cost (b)	1.970873 (1.2239)
Nobs	291
Sargan	2.9446 (p=0.4002)

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