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OF COMPETITION AND REGULATION INC.**

Vertically Integrated Electricity Generators – Villains, Victims or Heroes?

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Outline

- Background
- Motivation
- Related literature
- Model setup
- Key results
- Extensions
- Conclusions



Background

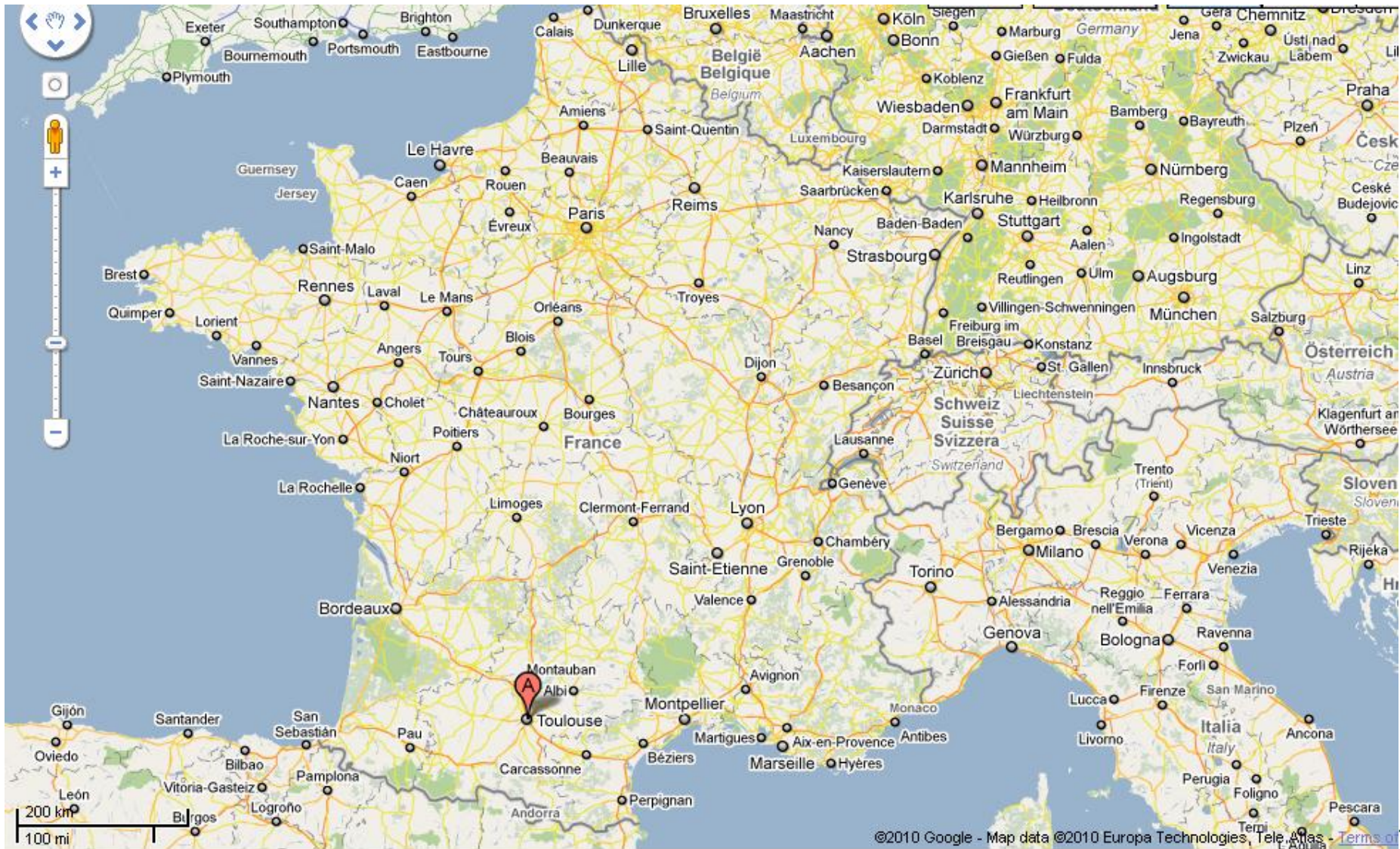
- Previous contributions on vertical integration (VI) in electricity:
 - Hogan and Meade (2007) – VI gentailers with balanced supply and load have no incentive to manipulate wholesale prices, while separated generators always price above cost
 - Meade and O'Connor (2009, 2010) – VI resolves contracting problems, and is superior to separation in terms of supporting retail competition and investment
- Just completed Masters degree at Toulouse School of Economics (TSE), with thesis formally modeling welfare consequences of VI – working paper version of the thesis is called:

Vertical Integration vs Vertical Separation in an Imperfectly Competitive Industry, such as Electricity, with Retail, Wholesale and Forward Markets

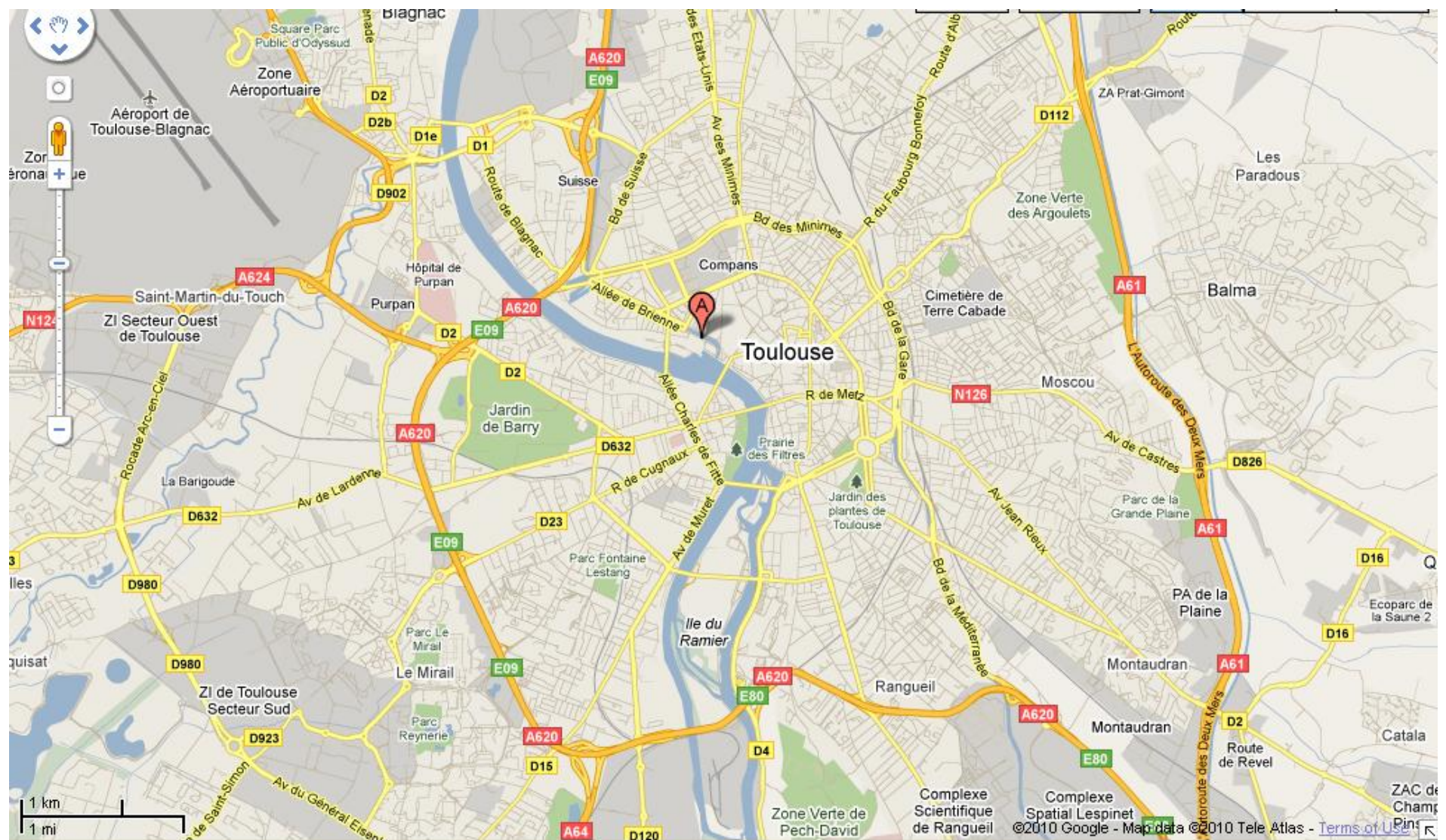
- Tonight's seminar is the 40 minute version of the 15 minute thesis defence ...



Background – TSE



Background – TSE (cont'd)



Background – TSE (cont'd)



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Motivation

- Unsettled question in electricity reforms:

Is vertical integration between generators and retailers good or bad, given its impacts on retail, wholesale and forward markets?

- Separation often mandated/required as part of reforms
- Endogenous rise of VI often viewed with suspicion → e.g. Wolak (2009) study for ComCom
- Some jurisdictions unwind VI through regulated contract sales → e.g. NZ regulations
- “My paper is the first to formally address this question, from a theoretical welfare perspective, in an oligopoly model with endogenous integration, and with a forward market”



Related literature

- Some authors model imperfect competition in upstream and downstream industries, e.g.:
 - Salinger (1988) – imposes level of VI, and no clear finding on welfare impacts
 - Gaudet and Van Long (1996) – assume firms choose whether to integrate/separate, but no welfare analysis
 - Neither allow for forward contracting
- Others model electricity with forward and wholesale markets, but without clear retail competition, e.g.:
 - Powell (1993) – shows that retailers can use forward contracts to constrain generator market power
 - Green (2004) – generators sell less energy forward when retailing is more competitive
 - Both allow for only two generators, and neither considers welfare



Related literature (cont'd)

- Aïd et al. (2009) model an electricity sector with forward, wholesale and spot markets:
 - Assume perfect competition
 - Focus on hedging (rather than strategic) motives for VI and contracting → opposite of my paper's strategic focus only
 - Find VI and contracting are imperfect substitutes for risk management
 - Only partial welfare analysis
- Allaz and Vila (1993) – the classic paper on forward contracting in a two firm industry:
 - Ignore VI
 - Contracts are bought by speculators rather than industry participants
 - Firms sell forward even though this toughens competition in the wholesale market and lowers profits

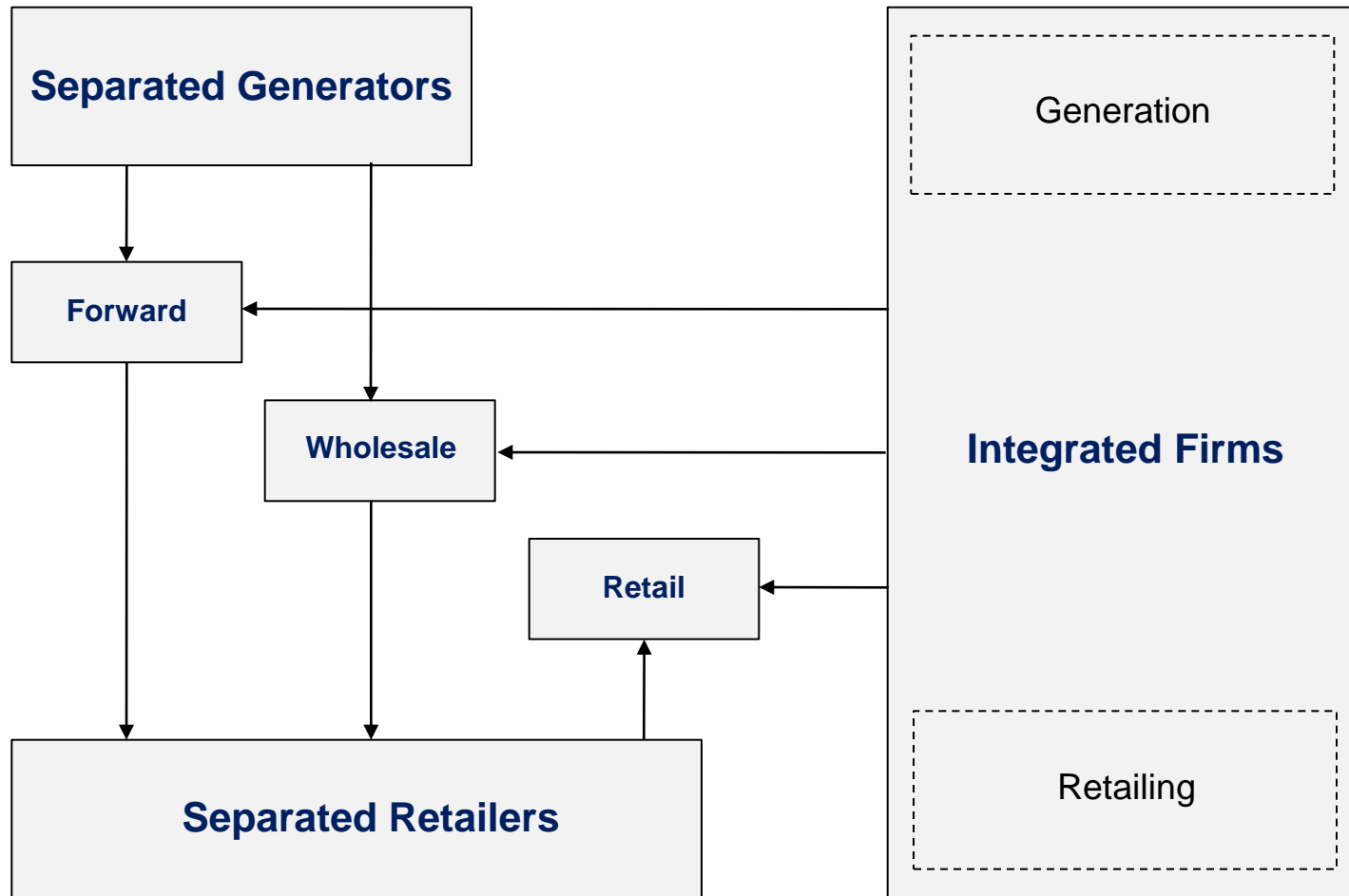


Model setup – Assumptions

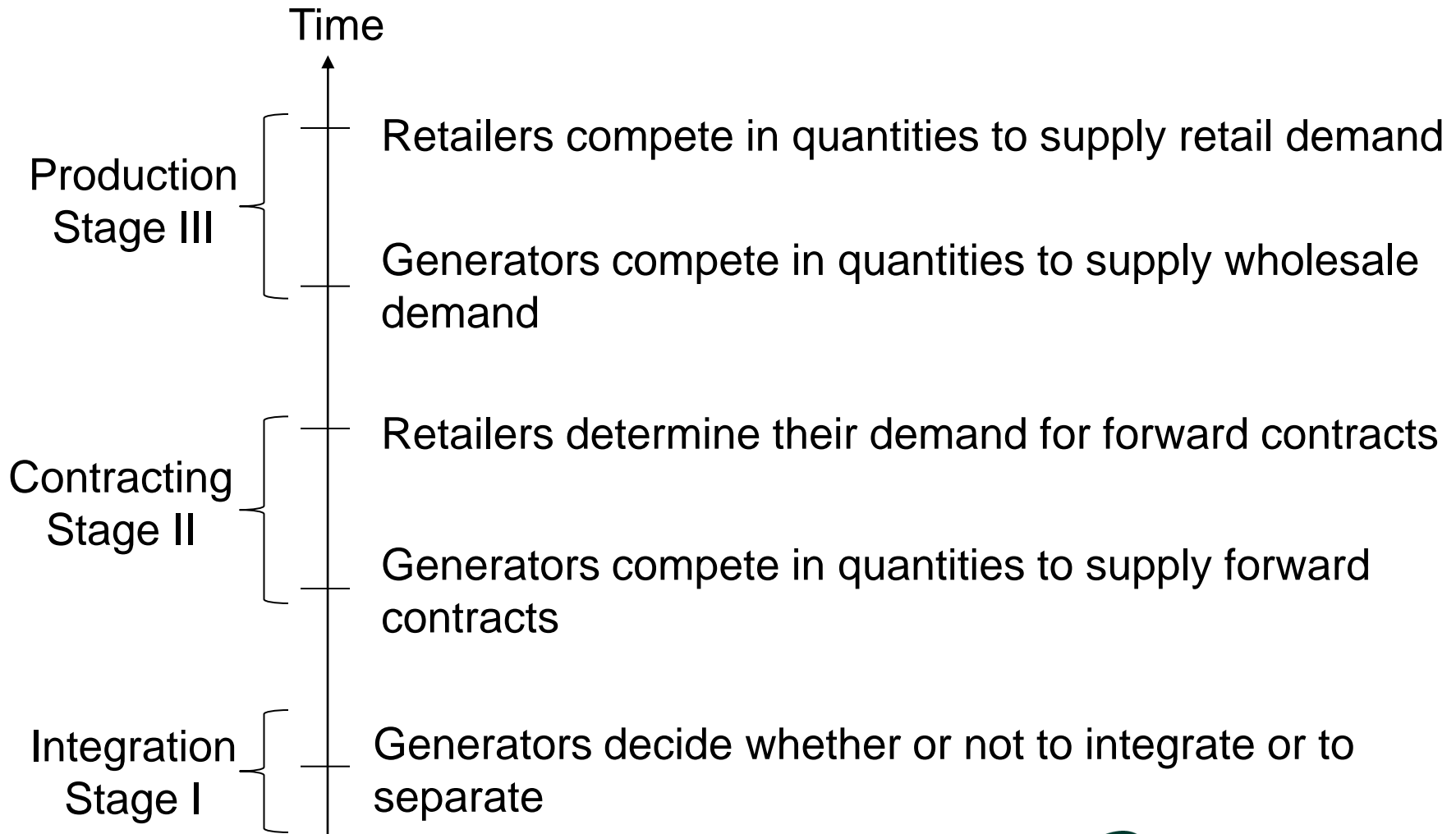
- Static, deterministic setting with full information
- No spatial considerations (e.g. no grid congestion) or capacity constraints
- Homogenous good – e.g. electricity – with linear retail inverse demand
- Imperfectly competitive (i.e. “oligopolistic”) industry:
 - n_g generators
 - n_r retailers } m vertically integrated (with m endogenous)
- No costs of generation, or of retailing (other than energy purchase costs) → convenient, and should leave strategic stories unchanged
- Generators choose whether to integrate or separate, and do so irrespective of scale differences between generators and retailers



Model setup – Institutional setting



Model setup – Timing



Model setup – A taste of the results ...



In equilibrium, wholesale price can be shown to be ...

$$\begin{aligned}
 & \left(1 - 4m^3 n_r + 6m - n_r + 2m^3 n_r n_g - 7m n_r n_g + 9m^2 - 3n_r^2 + 4m^3 \right. \\
 & \quad + m n_r - m n_g - 3n_r n_g + 3m^2 n_g - n_r^3 + m n_r^3 - m^2 n_r^2 + 4m^4 \\
 & \quad - 2n_g n_r m^2 - n_g n_r^3 - 4n_g n_r^2 - 3n_g m n_r^2 + n_g^2 + 2n_g m^3 - m^2 \\
 & \quad \left. n_r^2 n_g - n_g m n_r^3 - n_r^2 n_g^2 + m n_g^2 - m n_r^2 n_g^2 \right) / \left(\left(m n_r n_g + m n_g \right. \right. \\
 & \quad \left. \left. + 2m^2 + n_r n_g + n_g - m n_r + m + n_r + 1 \right) \left(-n_r^2 + 2n_g m n_r^2 - \right. \right. \\
 & \quad \left. \left. n_r^2 n_g^2 - m n_r^2 n_g^2 - m n_r^2 + m^2 n_r n_g^2 + m^2 n_r - 4n_g n_r m^2 + m n_r \right. \right. \\
 & \quad \left. \left. - 2n_r n_g^2 - 2n_r - 2n_r n_g - m n_r n_g^2 + 1 + 4m + m^2 + m^2 n_g^2 - n_g^2 \right. \right. \\
 & \quad \left. \left. + 2m n_g + 2n_g m^3 \right) \right)
 \end{aligned}$$



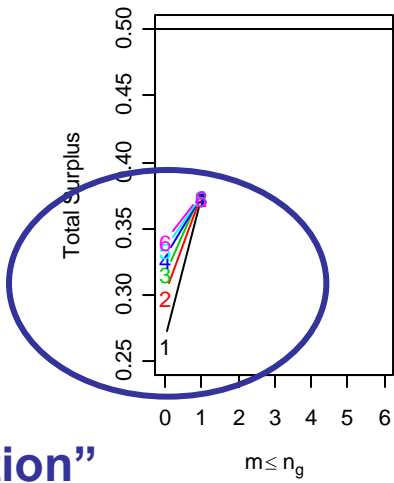
Key results

- Vertical integration is superior to separation:
 - Two key welfare measures - Total surplus and Consumer surplus – increase as the level of integration rises
 - Retail price falls as the level of integration rises
- “Four is enough” – with four or more generators there are diminishing returns from adding extra generators:
 - Total surplus attains almost first best levels
 - Consumer surplus attains almost maximal levels
- Full integration is a form of “synthetic generation” – i.e. is comparable in welfare terms to having one extra generator under full separation
- In the case with two generators, full VI is the only choice of generators (even though this can result in lower profits)



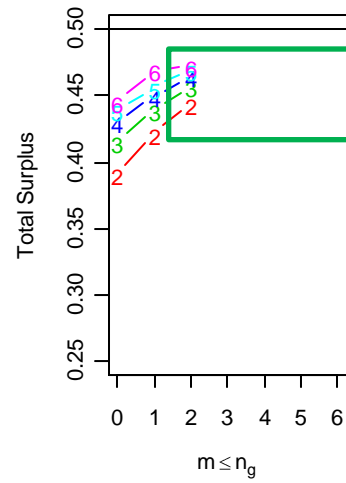
Key results – Total surplus

$n_g = 1$

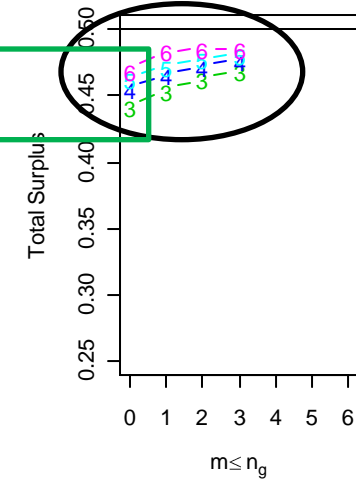


No “double marginalisation”

$n_g = 2$



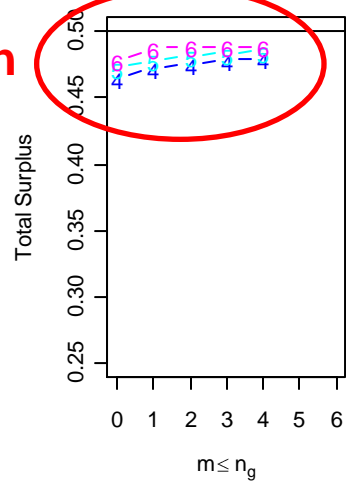
$n_g = 3$



TS rising with integration

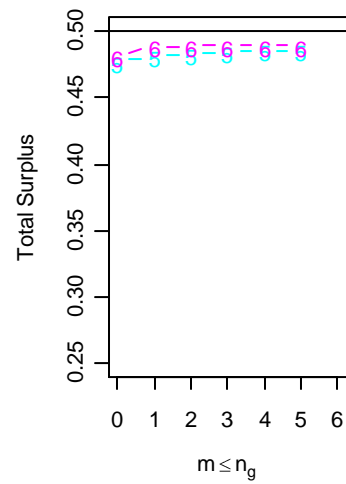
Synthetic generation

$n_g = 4$

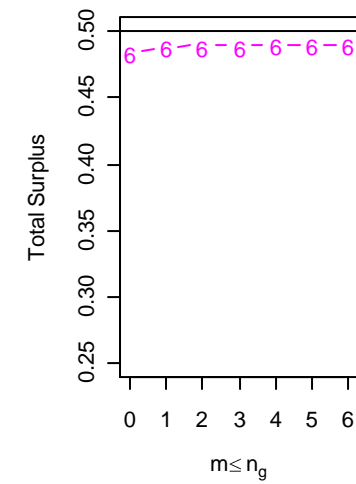


Four is enough

$n_g = 5$



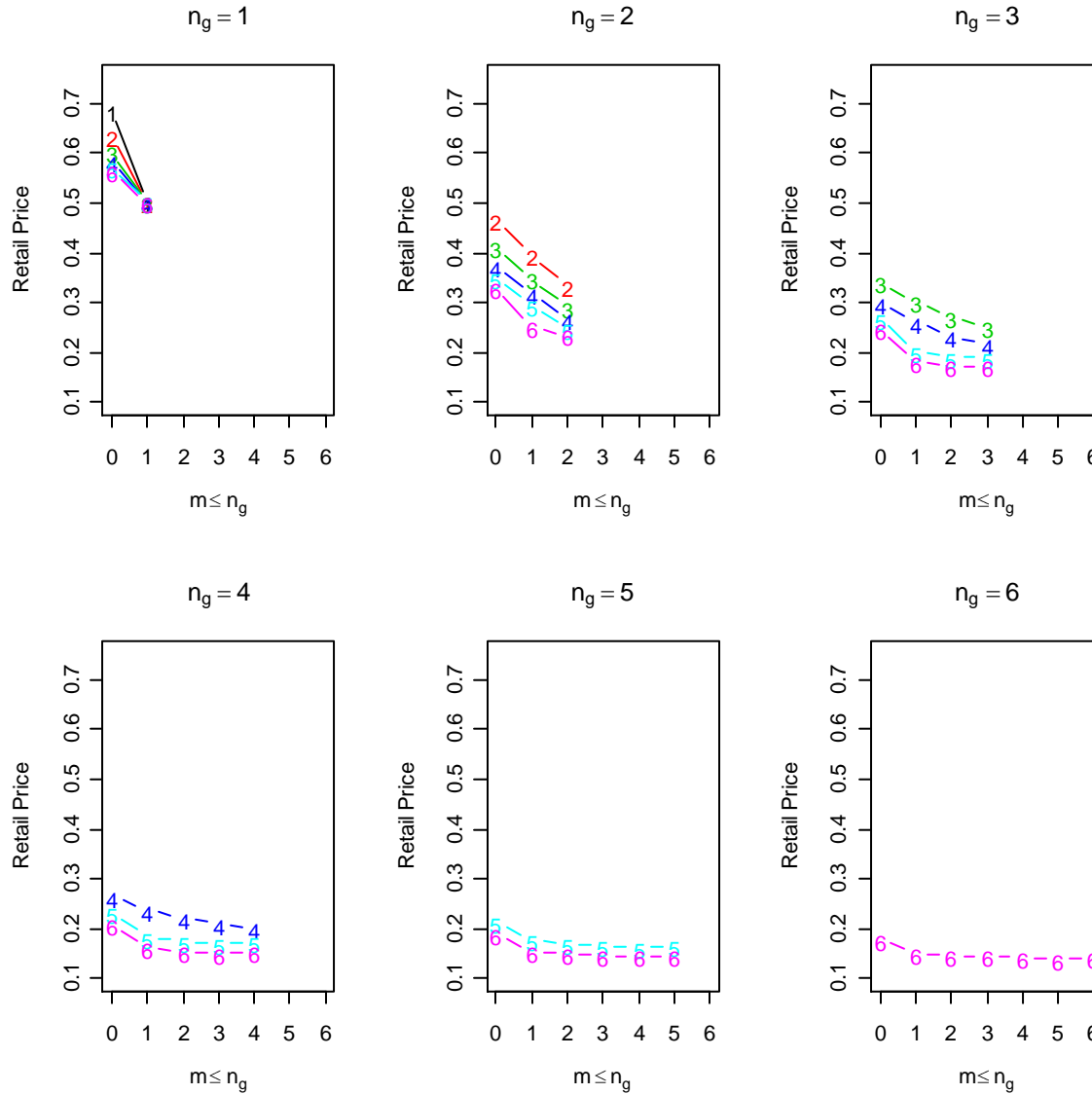
$n_g = 6$



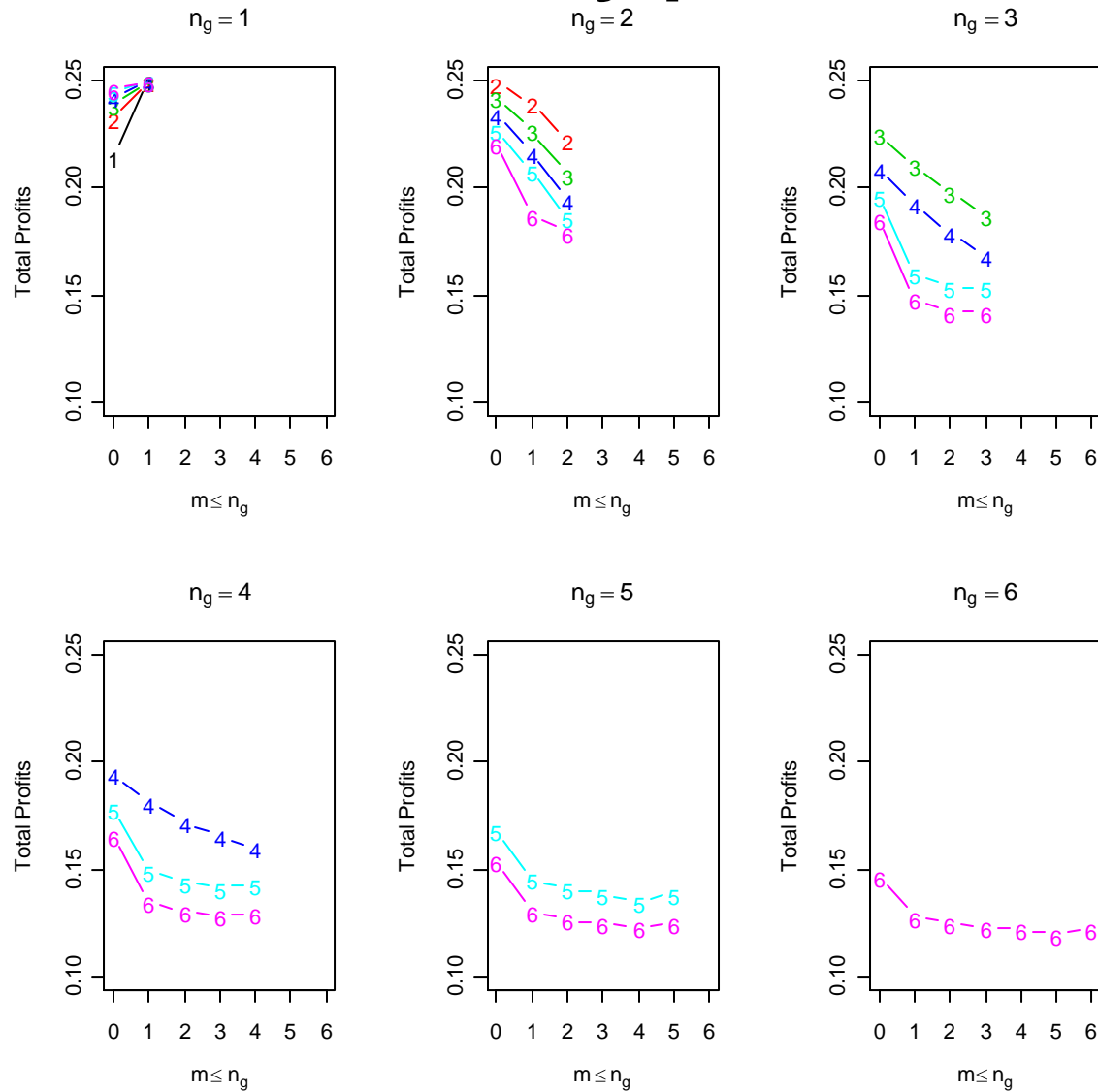
First Best TS



Key results – Retail price



Key results – Industry profits



Key results – Contradictions

- Monopoly generation is unusual case:
 - Full integration raises Total (and Consumer) surplus while lowering retail price
 - It does this despite wiping out independent retailing, increasing profit, and increasing retail market concentration
- Duopoly generation (i.e. two generators) is also quirky:
 - Retail concentration is often higher under partial integration than under either full separation or full integration
 - But welfare is still increasing with integration



Key results – Strategic interactions

- Gaudet and Van Long model only integration and production stages
- They find:
 - Integrated firms “raise rivals’ costs” – i.e. *purchase* wholesale energy to increase wholesale price and hence raise separated retailers’ input cost
 - Strategy works provided number of separated retailers is large relative to number of integrated firms (so profits from reduced retail competition outweigh cost of buying at greater than own production cost)
 - Firms’ integration choice: either full integration ($n_r = 2, 3$), partial integration ($n_r = 4$), or full separation ($n_r \geq 5$)

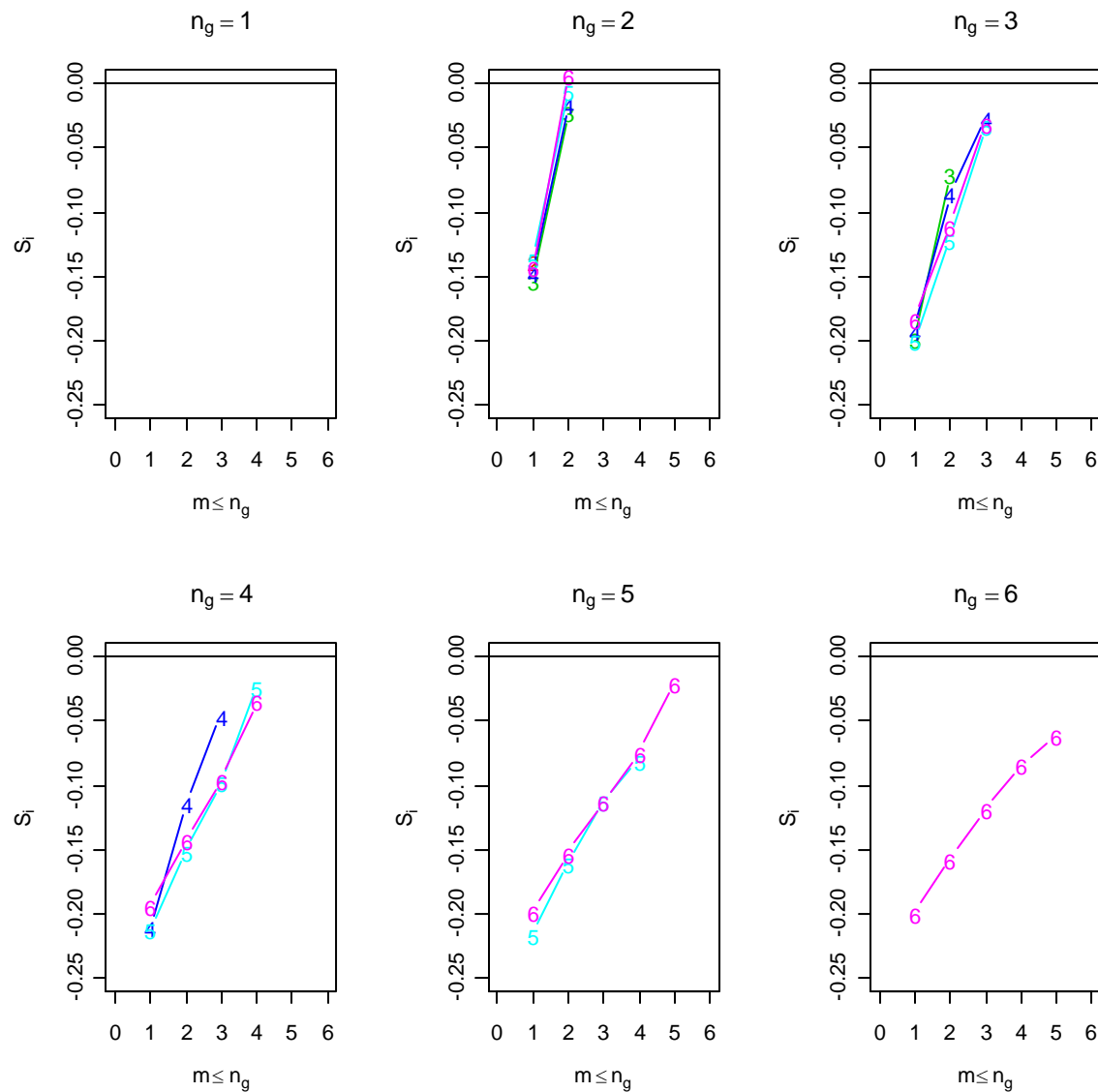


Key results – Strategic interactions (cont'd)

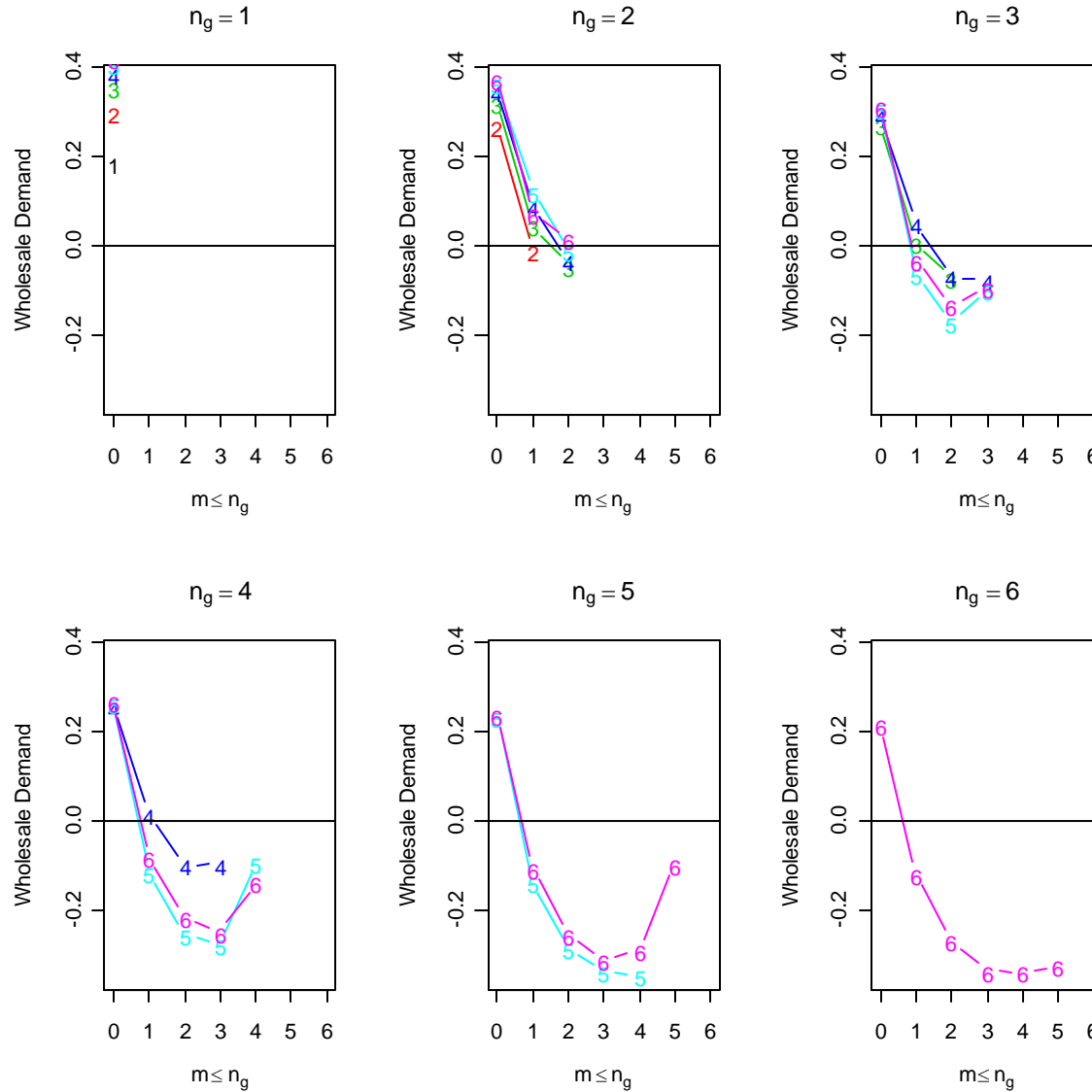
- Adding a forward market, I find both “raising rivals’ costs” *and* an additional and countervailing “over-buy and recycle” strategy of separated retailers:
 - They actively buy forward to pre-commit generators to supply, thereby toughening wholesale competition and restraining wholesale price
 - In fact they forward buy *more* than their retail supply commitment, and sell their excess to generators on the wholesale market
 - Hence, to protect themselves, generators *must* integrate
- This extra strategy underlies my finding that full integration is the *only* outcome in a model with forward trading



Key results – VI firm wholesale output



Key results – Total wholesale demand



Extensions

- Deeper analysis of existing model (e.g. solve Stage I for more than two generators)
- Numerous technical improvements possible – e.g. modeling costs, capacity constraints, etc
- More material innovations:
 - Introduce uncertainty (e.g. re demand and/or costs)
 - Introduce asymmetric information (e.g. re costs)
- Main future direction:
 - Model entry and investment in multi-period context
 - Test hypothesis of Meade and O'Connor (2010) that excessive retail entry curtails investment because it creates retail – and hence wholesale – hold-up risks, with VI predicted to be more robust than (i.e. superior to) separation



Conclusions

- Within the limitations of the model's assumptions, some clear messages emerge for regulators, competition authorities and policymakers
- Vertical integration offers welfare benefits over vertical separation in an imperfectly competitive industry comprising forward, wholesale and retail markets
- Although integration is predicted to emerge naturally as a consequence of generator decisions, this does not mean consumers suffer (the reverse is true)
- While integrated firms can indeed engage in apparently anti-competitive strategies ("raising rivals' costs"), consumers are still better off under integration
- Although imperfectly competitive generators are often seen as villains, in fact they can fall victim to retailers' forward market strategies ("overbuying and recycling")
- Integration can substitute for structural reform ("synthetic generation") and lowers the optimal number of generators ("four is enough")



Thank you – any questions?



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