The Role of Competition and Regulation in Stimulating Innovation - Telecommunications

ZEW SEEK Conference on *Overcoming the Crisis in Europe: How to Foster Innovation and Entrepreneurship in Europe?*

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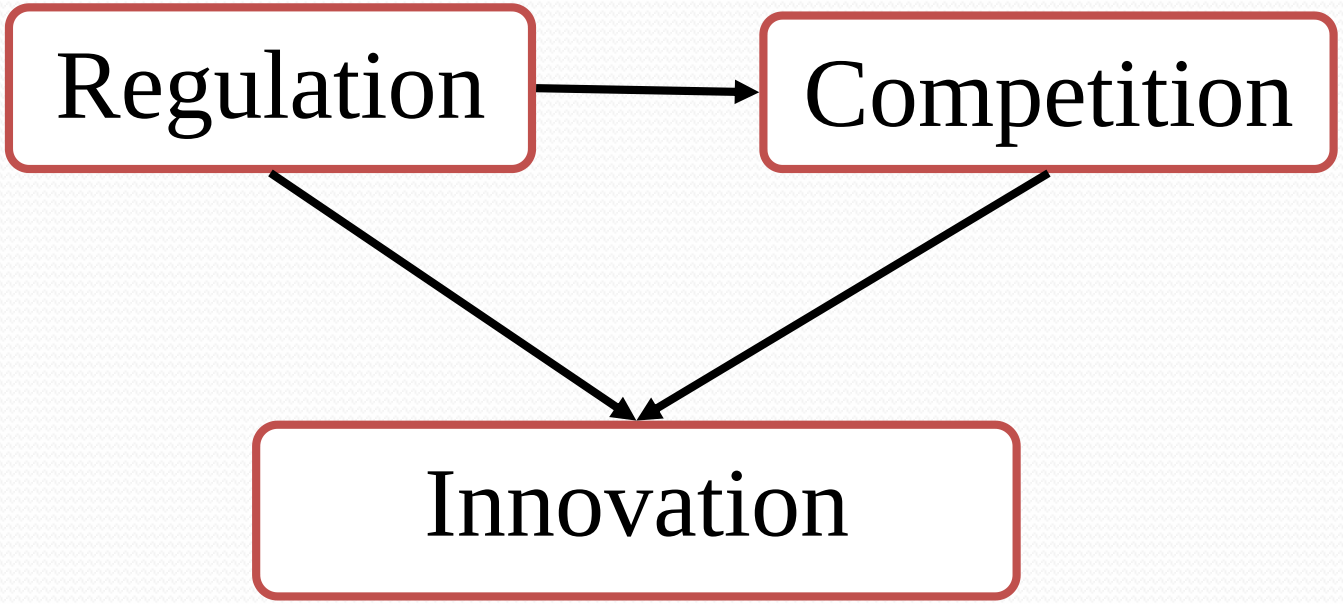
Ingo Vogelsang, Boston University

Motivation

- Since the mid-1990s European telecommunication regulation has emphasized competition. → Regulation as the enabler of competition
  - Starting in the early 2000s regulators followed the ladder-of-investment approach, which claimed that regulated competition would lead to innovative investments. However, in the last few years the emphasis of the European Commission has directly shifted to investments in next generation networks (= innovation).
  - What now is the relationship between regulation, competition and innovation in telecommunications?



Motivation

- The effect of competition on innovations has been studied a lot, starting at least with Schumpeter
  - Currently, most economists support the inverted "U" position on the relationship between the extent of competition and innovation
  - Accordingly, some competition is viewed as best for innovation
- In contrast, with a grain of salt one could paraphrase Larry White and say "*Regulation is the enemy of innovation, because innovation is the enemy of regulation*". Why?
  - Regulation is the enemy of innovation, because regulation prevents or retards innovative investments, for example, by disallowing appropriate rates of return.
  - Innovation is the enemy of regulation, because innovation destroys (cross-subsidized) regulatory price structures or regulatory entry barriers (example Uber).
  - → Ambiguous relationship between regulation and innovation

Motivation

- Telecommunications sector is viewed as particularly innovative
  - In its own right: Progress in fixed and mobile network technology
  - Empirically well-documented spillovers into other sectors throughout the economy could be reason for specific innovation-enhancing policies.
- However, empirical evidence on innovative effects of regulation in the telecommunications sector is largely negative
  - More regulation → less innovation
  - Grajek/Röller (2012): Consider access regulation effects on new investments
    - Get negative effect only when regulation is taken as endogenous: Suspicion that regulators increase regulation in response to innovation
  - Bauer/Shin (2012): Consider broad index of regulatory intervention
    - Generally find negative incremental effect with some nonlinearity: Incremental effect turns positive in already highly regulated countries

Motivation

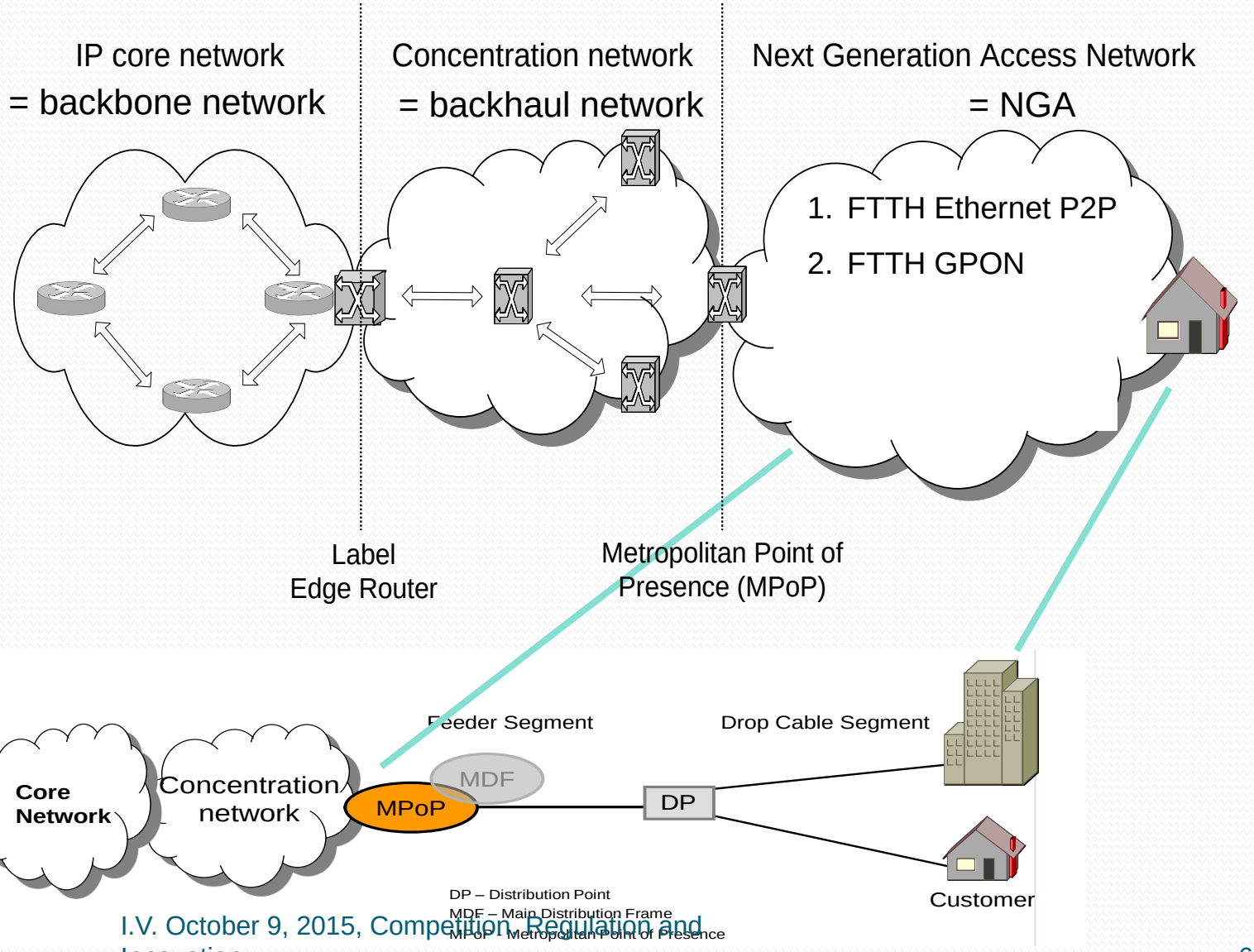
- There are two main reasons for potential conflicts between regulation and innovation:
  - **Pricing/profit reason:** Innovation incentives may require larger profit opportunities than regulators can grant or want to grant. → *Consumer protection issue*
  - **Political economy reason:** Entrenched regulation of legacy industry conflicts with helping create a new industry that may or may not be regulated. → Bias against innovation: *Regulatory neutrality issue*
- Today, I will address the relationship between competition and innovation in the regulatory context of next generation access (NGA) investments and wholesale access regulation.

Overview

- Features of telecommunications regulation
- The consumer protection issue
- The regulatory neutrality issue
- Innovation incentives under regulation vs. competition?
- Some implications and conclusions

Example of Next Generation Telecom Network

(Source: WIK)



Wholesale access regulation: Bottleneck local loop

- **EU**
  - Unbundled local loop (ULL) and bitstream access regulation dominate for copper-based access
    - ULL gives an entrant access to the incumbent's loop at the customer side of the first central office, regulated at cost-based prices.
    - Bitstream access provides somewhat similar functionality as ULL but is accessed at a more remote location, also regulated at cost-based prices.
  - Bitstream access required for Fiber-to-the-Home (FTTH) with non-discrimination provision, but no price regulation
  - Three-criteria test for deregulation
- **US**
  - Partial deregulation, due to dominance of (unregulated) cable in broadband markets.
  - Deregulation based on
    - Information service vs. telecommunications service
    - Lack of essential facility property of local loops

Empirical results on effects of wholesale access regulation and competition on innovative investments

- No full ladder of investment:
  - Access-seeking networks are incentivized to invest, but not in local loops (Nardotto et al., 2013; Bacache et al., 2014).
  - This may have more to do with incumbency advantages and scale economies than with regulation (Cave, 2014).
- ULL and/or bitstream regulation of legacy network and/or a high level of DSL penetration → less follow-up investments in NGA networks (Briglauer et al., 2013; Briglauer, 2014).
  - Effect of regulation of old networks suggests that regulation of NGA is expected.
  - Effects of existing DSL base suggests cannibalization/sunk costs.
- Briglauer et al. (2013) find that infrastructure competition has inverted "U"-shaped effect on innovation (subject to interpretation).

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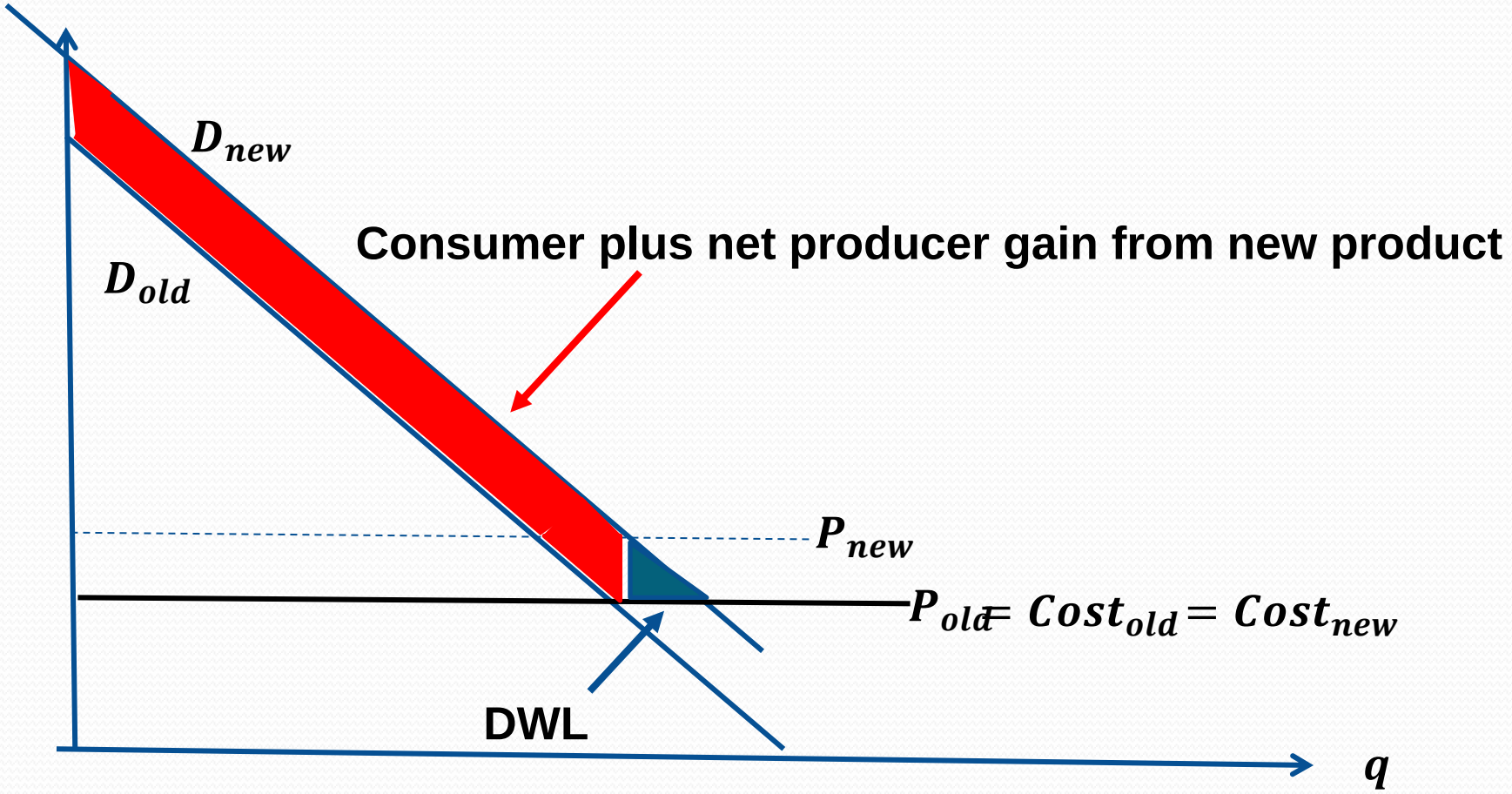
The Consumer Protection Issue

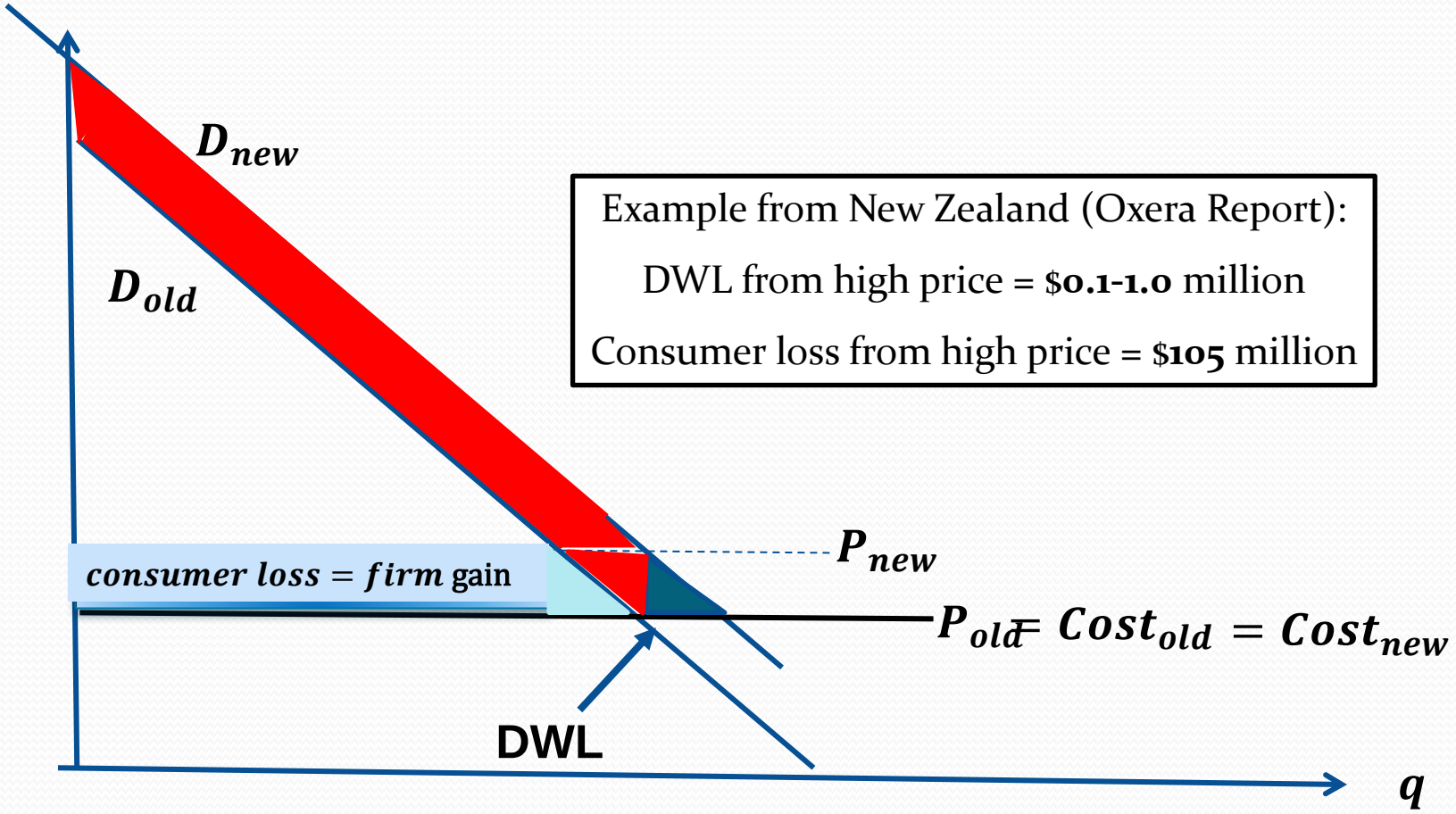
- High price for new investment that shifts demand outwards: Social surplus approach → No doubt that high price is beneficial



- Consumer welfare standard reduces emphasis on innovation incentives.

The Consumer Protection Issue

- High price for new investment that shifts demand outwards : Consumer welfare approach → Lots of doubts about high price



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The regulatory neutrality issue

- Regulation can be troubled by innovation in the form of:
  - Emergence of new end-user products: Over-the-top internet telephony against plain old telephone service (POTS)
  - Emergence of new technologies, causing
    - Emergence of unregulated competition for the same end-user product (Cable TV)
    - Decline in demand for wholesale services: Copper access network replaced by fiber access network in telecommunications
- Reasons for regulatory concerns in the face of innovation:
  - Stranded assets arising from past sunk investments in the legacy network threaten viability of incumbent.
  - Loss of labor rents: Less important for telecommunications than for other industries, such as postal service
  - Loss of services by captive customers: Important for shutdown of POTS (two-way effect of cross subsidization)
  - Regulators threatened by deregulation

The regulatory neutrality issue

- Stranded assets
  - Sunk assets may no longer be recoverable, once the new service arrives.
  - Long-lived tradable assets may be overvalued because of slow depreciation policy or because of sudden switch from expanding to shrinking demand (Pindyck, RNE 2007)
  - Sunk costs can lead to excess capacity, as demand declines
  - Stranding raises the issue of regulatory commitment.

The regulatory neutrality issue of stranding and regulatory commitment

- Kolbe/Tye (1995): Cost of capital does not compensate for stranded-cost risk
  - Cost of capital = expected return. If regulated firm is allowed to earn cost of capital in expanding market and less in contracting market it is not fully compensated.
- → Option 1: Avoid the commitment issue by compensating above cost of capital before stranding occurs → Cannibalization issue early in the game
  - Hausman (1997), Pindyck (2007): Real option approach
- Option 2: Commit by compensating for stranded costs ex post
  - Sidak/Spulber (1997): Make regulated firm whole through remedies against breach of regulatory contract. → Can lead to high ex post prices, but may still not make the firm whole → May prevent innovation by incumbent (cannibalization) but incentivizes innovation by competitors (which can defeat commitment)
- On balance Option 1 is more innovation-friendly than Option 2

The regulatory neutrality issue

- Regulatory neutrality issue has a long history in the U.S..
  - Example: FCC disallowed Hush-a-phone, but was over-ruled by court; FCC then allowed Carterphone.
- Today, the regulatory neutrality issue appears to be less pronounced for telecommunications than for other industries.
  - Sunk assets may be re-used for new services (ducts).
  - Regulated incumbent may be the innovator, trading off stranding of old assets against profits from new assets.
  - Few labor issues; few expensive specialized consumer appliances

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Innovation incentives under regulation vs. competition?

- The main (political) problems caused by innovations for regulators relate to some form of sunkness of capital or labor costs or of consumer appliances. ***However, sunkness works against innovation with or without regulation.*** For example, a large installed base for one technology (e.g., 2G) retards the introduction of a new technology (e.g., 3G).

- Effects of sunk assets on innovation in unregulated industries:
  - Cannibalization argument: The incumbent will only innovate if expected profit under innovation is greater than quasi-rents from sunk legacy network.
  - Due to sunkness incumbent can lower its price in response to innovation by others.
  - }→ Sunkness of legacy network can present large innovation hurdle.
  - Thus, in the presence of sunkness the question is if innovation incentives under regulation are smaller or larger than under unregulated competition.
  - We take the example of NGA networks against legacy copper access networks (ADSL), assuming that they are substitutes.

Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Innovation/investment game with two firms
  - Firm 1 = incumbent, firm 2 = entrant
  - Investment costs of the incumbent's old network are sunk. Investment costs for the new network are I_k for firm k. Firm 1 grants firm 2 wholesale access.
- Three main assumptions:
  - Quasi-rents (gross profits) increase if firm k invests and fall if competitor invests.
  - Quasi-rents of firm k decrease for service j if its service j is regulated, while they increase for firm l.
  - Quasi-rents of firm k increase and of firm l decrease for service j if the regulated price of service j is increased.
- Payoff matrix for static investment game:

	$d_2 = 0$	$d_2 = 1$
$d_1 = 0$	$\pi_1(0,0), \pi_2(0,0)$	$\pi_1(0,1), \pi_2(0,1) - I_2$
$d_1 = 1$	$\pi_1(1,0) - I_1, \pi_2(1,0)$	$\pi_1(1,1) - I_1, \pi_2(1,1) - I_2$

Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Inderst/Peitz characterize potential investment equilibria of the static one-shot game via critical investment levels
  - Critical investment level for firm k to invest if its competitor does not invest is given for firm 1 by $I_1^* = \pi_1(1,0) - \pi_1(0,0)$ and for firm 2 by $I_2^* = \pi_2(0,1) - \pi_2(0,0)$.
  - Exactly one firm invests in equilibrium in the interval $[\min\{I_1^*, I_2^*\}, \max\{I_1^*, I_2^*\}]$. It is firm 1 if $I_1^* > I_2^*$ and firm 2 if $I_2^* > I_1^*$.
  - In the interval $[\max\{I_1^*, I_2^*\}, \infty)$ investment in the new technology is unprofitable for either firm.
- Assuming perfectly foreseeable outcomes Inderst and Peitz characterize the effects of different types of regulation on the resulting equilibria. We take up some of their cases and add some, with an emphasis on the effects of regulation on innovation. Duplicate investments will be excluded.

Matrix of innovation incentives normalized to '0' for $R^1 = R^2 = 0$

	$R^2 = 0$	$R^2 = 1$
$R^1 = 0$	$i_1(0,0) = 0, i_2(0,0) = 0$ Case III: Rank 1-2	$i_1(0,1) < 0, i_2(0,1) < 0$ Case IV: Rank 3-4
$R^1 = 1$	$i_1(1,0) > 0, i_2(1,0) < 0$ Case I: Rank 1-2	$i_1(1,1) > 0, i_2(1,1) < 0$ Case II: Rank 3-4

- Case III dominates case IV, because regulation of service 2 reduces quasi-rents of investor.
- For the same reason case I dominates case II.
- Case II has higher innovation incentives for the incumbent but lower incentives for the entrant than case IV.
- Case I has higher innovation incentives for the incumbent but lower incentives for the entrant than case III.
- The cross-rankings are ambiguous. However, for drastic innovations Cases II and IV should always provide inferior innovation incentives than Cases I and III because of the high profit potential cut short by regulation of the new service.
- } → ***Whether regulation of the old service is good or bad for innovation of new service depends on parameter values. However, not regulating the new service provides unambiguously positive innovation incentives for both firms.***

Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- How general are these results?
  - Static, simultaneous one-time game precludes analysis of strategic preemption of firm 2's investment by firm 1.
    - The opportunity cost of investing is reduced if firm 1 foresees firm 2's investment (Stackelberg):
    - Compared to the simultaneous Nash case the additional investment range for firm 1 is then given by $\Delta I_1^* = \pi_1(0,1) - \pi_1(0,0)$.
    - Thus, Stackelberg leadership makes the incumbent more investment prone, while the investment incentives of the entrant do not change.
    - Stackelberg effect depends on size of threat of entrant's investment and the size of the opportunity cost of the incumbent's investment in the simultaneous move game. → Effect likely to be larger if legacy service is not regulated.

Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- How general are these results?
  - Co-existence of old and new network after investment raises migration issues
    - Bourreau/Cambini/Dogan (2012) identify three relevant effects:
      - The *replacement effect* calls for a large enough copper access charge so that independent NGA investors have incentives to invest.
      - The *wholesale revenue effect* calls for a large enough difference between the copper and fiber access charge so that profits from copper alone are lower than profits from operating both a copper and a fiber access network. Replacing copper with fiber needs to be sufficiently profitable in order to induce fiber investment.
      - The *migration effect* calls for small enough price differences between copper and fiber access so that end-users have incentives to switch from copper to fiber, once fiber is offered.
    - Inderst/Peitz model only captures first two effects.
      - ***Including migration effect suggests increase of regulated price of old technology in order to spur innovation.***

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Innovation incentives under regulation vs. competition? Conclusions from cases of simple economics

- Depending on parameter values regulation can lead to more or less innovation than unregulated competition.
- Not regulating the new service leads to more innovation than regulating the new service. → Commit not to regulate the new service. That was always superior to regulating the new service.
- Allowing or helping entry competition increases the innovation incentives of the incumbent (even more so if the incumbent acts as a Stackelberg leader in the innovation game).
  - Regulation of old services reduces cannibalization effect for incumbent's innovation.
  - Regulation facilitates race for innovation between incumbent and entrants (by creating entrants with less cannibalization problem).
  - If both firms invest there is an ambiguity, because the new technology will be offered in duopoly.

Innovation incentives under regulation vs. competition? Conclusions from cases of simple economics

- Low regulated price of old service can foreclose entry of new services (migration argument)
  - → Commit not to lower the price of the regulated legacy product in response to launching of the new product will increase the rate of penetration of the new product and be more profitable for the entrant as the innovator.
- Incumbent often has investment advantages from owning old network.
  - Relative advantage of incumbent vs. entrant for innovation depends on amount of re-use of existing capacity (to overcome sunkness problem).
    - Generally, incumbent can re-use larger amount of existing capacity and has larger customer base (with switching costs). → Explanation why ladder-of-investment has not been successful.

Different regulation for innovative vs. legacy networks?

- The simple model suggested that new services should not be regulated. But that may not always be possible. An alternative could be a regulatory holiday*)
  - Regulation begins with a lag after regulatory requirement has been met.
  - Lag has to be short enough so that commitment is feasible.
  - Holiday has to be long enough for financing large sunk investments
    - Very similar to patent issue but not such an established institution
- Regulatory holiday could also be justified by inherent differences between innovative and legacy networks.
  - Legacy infrastructure: Known costs and demands
  - New type of infrastructure
    - Costs highly uncertain and risk of low penetration
    - Unbundling and access regulation inherently difficult

*) *Peruvian regulator Thornberry: What is that? I have not had a holiday in 2 ½ years!*

Insights from the U.S. experience?

- Last year at this spot Christopher Yoo demonstrated the lead of the U.S. over Europe in NGA investment.
- Over ten years ago the U.S. has deregulated next generation investments. The U.S experience would therefore be in line with our simple modeling. Could the experience of the U.S. travel to Europe?
- I am skeptical because the U.S. success in NGA was mostly due to cable: 81% coverage from cable vs. 82% from all sources. → Path dependence of policy success. However, the deregulation factor probably explains Verizon's FTTH investments (FIOS) and more recent investments by AT&T (also chased by Google).
- Importance of relevant counter-factual, e.g., infrastructure duopoly vs. infrastructure monopoly.
  - US vs. EU: Pre-existing cable TV infrastructure (Cave, 2014)
  - White vs. gray vs. black regions (Briglauer et al., 2015): Best policy for innovation depends on geographic circumstances.

Final Conclusions

- A consumer welfare standard applied by regulators is less innovation-friendly than a social surplus standard.
- The regulatory neutrality issue plays less of a role in telecommunications than in other regulated industries.
- Our main finding has been that a regulated industry could actually be more innovative than a similar industry that has not been regulated.
- However, in a regulated legacy setting more innovation will be induced if new, innovative products are not regulated. That, however, can generally only occur once, because after the old product vanishes there will be no more regulation.
  - The Grajek/Röller (2012) results suggest that, on average, regulators in the past have extended regulation to new networks.
- An open question is if a regulatory holiday can do the same as the absence of regulation of the new product.

Backup 1: Cited Literature

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Backup 3: The regulatory neutrality issue

- The labor issue contains two variants:
  - Due to contracts, labor laws or moral obligations the regulated firm may be unable to reduce employment or wages and salaries.
    - This raises issues fairly similar to stranded sunk assets.
    - It may be cheaper for the firm to pay severance etc. in order to adapt employment, wages and salaries
  - Employees may lose their labor rents because of diminished wages and salaries in the regulated firm or because they are laid off.
- Loss of services by captive customers
  - This issue again comes in two variants.
    - If declining demand forces the regulated firm to curtail services or increase prices customers may lose the value of their sunk investments in appliances (Biggar, 2009).
    - Even without sunk appliances customers may face higher costs when switching to substitute services.
  - Cost of shutdown to captives vs. cost of continuation to regulated firm

Backup 4: OTTs versus ISPs

- DO OTTs interfere with wholesale access regulation of ISPs?
  - OTTs compete with services offered by ISPs.
  - OTTs offer complementary services to those of ISPs but do so in 2-sided markets.
  - As a result, OTTs increase competition for ISPs' services and lower their returns. ISPs may then be unable to earn the returns envisaged in their access regulation.
  - Thus, even if competition measured by market shares does not increase deregulation may be in order.
  - Problem of balancing innovation incentives for ISPs and OTTs
    - OTTs have an interest in innovation by ISPs but may free-ride on other OTTs (externality issue increases with competition).

Backup 5: Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Innovation/investment game
  - π_1 = profit of firm 1 (incumbent), π_2 = profit of firm 2 (entrant), each gross of investment costs
  - Profit function $\pi_k(d_1, d_2)$ with $d_k = 0$ means firm k does not invest and $d_k = 1$ means that it invests.
  - Investment costs of the incumbent's old network are sunk. Investment costs for the new network are I_k for firm k. Firm 1 grants firm 2 wholesale access to the old network at marginal costs (normalized to 0).
- Payoff matrix for static investment game:

	$d_2 = 0$	$d_2 = 1$
$d_1 = 0$	$\pi_1(0,0), \pi_2(0,0)$	$\pi_1(0,1), \pi_2(0,1) - I_2$
$d_1 = 1$	$\pi_1(1,0) - I_1, \pi_2(1,0)$	$\pi_1(1,1) - I_1, \pi_2(1,1) - I_2$

- Assumptions on profits (ceteris paribus):
  - Profits increase if firm k invests: $\pi_1(1,0) > \pi_1(0,0)$; $\pi_1(1,1) > \pi_1(0,1)$; $\pi_2(0,1) > \pi_2(0,0)$; $\pi_2(1,1) > \pi_2(1,0)$
  - Profits fall if competitor invests: $\pi_1(1,0) > \pi_1(1,1)$; $\pi_1(0,0) > \pi_1(0,1)$; $\pi_2(0,1) > \pi_2(1,1)$; $\pi_2(0,0) > \pi_2(1,0)$

Backup 6: Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Case I of linear regulated access charges for the old technology, but no access regulation for new technology
  - If the access charge exceeds marginal cost and if total demand is price-dependent we get two main results:
    - If the innovation is drastic (i.e., if it leads to a monopoly and totally replaces the old technology) firm 2 has a stronger incentive to invest than firm 1, because firm 1 loses the profit from the old technology (wholesale revenue effect ≈ cannibalization argument).
    - If the innovation is non-drastic firm 1 will enjoy profits from the old technology whether it invests or not (smaller wholesale revenue effect). Thus, it is not clear that firm 2 will have a higher incentive to invest than firm 1. However, firm 2's investment incentive relative to firm 1 increases if the access charge for the old technology is increased.

Backup 7: Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Case II of linear access charges for the old technology, but now also access regulation for new technology
  - If access regulation for the new technology is symmetric and binding then, compared to case I, the innovation incentives for both firms are reduced by this regulation, because the new technology becomes less profitable for the investor and becomes more profitable for the non-investor.
  - If only firm 1 is subject to access regulation for the new service firm 2's investment incentives are enhanced relative to firm 1's.

Backup 8: Innovation incentives under regulation vs. competition? Answers from simple economics (based on Inderst/Peitz, RNE 2012)

- Case III where neither access to the old technology nor to the new technology is regulated
  - Now π_1 (o, d_2) is increased relative to the Inderst/Peitz cases and π_2(o, d_2) is reduced. This reduces firm 1's innovation incentives and increases firm 2's innovation incentives.
  - Thus, deregulation of the old service would have countervailing effects on the innovation incentives of the two firms.
    - Innovation incentives for firm 1 are decreased.
    - Innovation incentives for firm 2 are increased.
- In Case IV where both technologies are regulated regulation of the new product unambiguously hinders innovation.

Backup 9: Innovation incentives under regulation vs. competition? Summary of results (based on Inderst/Peitz, RNE 2012)

- Innovation/investment incentives for variation of regulation of old and new product
  - i_1 = innovation incentive of firm 1 (incumbent), i_2 = innovation incentive of firm 2 (entrant), each measured by the profit differential between investing and not investing
  - Innovation incentive $i_k(R^1, R^2)$ for firm k with $R^j = 0$ means service j is not regulated and $R^j = 1$ means that it is regulated.
- Matrix of innovation incentives normalized to '0' for $R^1 = R^2 = 0$

	$R^2 = 0$	$R^2 = 1$
$R^1 = 0$	$i_1(0,0) = 0$, $i_2(0,0) = 0$ Case III: Rank 1-2	$i_1(0,1) < 0$, $i_2(0,1) < 0$ Case IV: Rank 4
$R^1 = 1$	$i_1(1,0) > 0$, $i_2(1,0) < 0$ Case I: Rank 1-2	$i_1(1,1) >/< 0$, $i_2(1,1) << 0$ Case II: Rank 3