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The natural monopoly paradox: incumbent inefficiency and entry

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The natural monopoly paradox

- The intuitive definition of a natural monopoly: a productive activity in which entry will lead to increased costs
- The determination of whether a natural monopoly exists affects
  - Allocations of funds for
    - government support (eg state aid) (more than $20 b in post)
    - future investments (more than $300 b in energy)
  - Determining whether entry will be legally forbidden
  - Need for regulation of prices, costs, investments
- Getting the definition right *matters*
- The traditional definition is mostly spot on with intuitive definition but has one assumption that can lead to an industry being classified as a natural monopoly BUT entry could reduce costs
- I show that while most classifications of activities as natural monopoly have probably been fine, exceptions can arise for both infrastructure sectors and postal delivery
- A new definition is needed that will eliminate the counter-intuitive outcomes
- This paper provides such a definition and shows the relevance of the definition in changing outcomes in limited circumstances

The source of the paradox

- The traditional definition (Baumol 1977 and other papers with Bailey, Panzar and Willig) assumes that all firms have access to the same cost possibilities
- This assumption has the advantage of tractability
- However, there is significant research that shows:
  - Empirically, incumbents often do not operate on the cost frontier
  - Theoretically, incumbents may not be expected to operate on the cost frontier
    - X-inefficiency (Liebenstein (1966), Liebenstein and Maital (1992), Borenstein and Farrell (2000), Perelman (2011))
    - Labor seeks share of monopoly rents (Salinger (1984), Rose (1987), Hendricks (1977))
    - Managerial slack (Hart (1983), Holmstrom (1982), Machlup (1967) and Nalebuff and Stiglitz (1983))
- So the assumption of access to the same cost curve is likely not always the case
- The simplifying assumption is non-trivial: as incumbent costs can be >30% higher in monopoly industries

Thesis with respect to delivery

- With low-volume mail, delivery should not be classified as a natural monopoly
- Why?
  - The economy of scale/density in post is based largely on idea that, the marginal cost of delivering an extra letter, given that you are passing the address and may already deliver one letter to an address, is small
  - But with low volume countries, average address may not receive delivery on more than 1/3 of days (or less!)
  - Delivery routes are flexible and are designed to take account of probabilities of delivery
  - While there may be scale economies, substitution of volume to entrant will *often* mean no incumbent delivery on same day as entrant
  - Likelihood of receiving two letters on same day, one from incumbent and one from entrant, is low. So, taking price as given, addition to variable costs by an entrant delivery is likely to result in decline of variable costs for incumbent.

Relevance

- As postal services move away from a government-owned, statutory monopoly, regulatory and market design questions related to natural monopoly become more important
- If no part of the postal sector has natural monopoly characteristics and no other special circumstances are present, then competitors may not be handicapped compared to the incumbent postal services and no, or only transition, regulations may be needed.
- In contrast, if the postal service constitutes a “sustainable natural monopoly” then profitable entry will not be possible (Baumol, Panzar & Willig (1982))
- In either case, no entry restrictions (or protected areas) are necessary

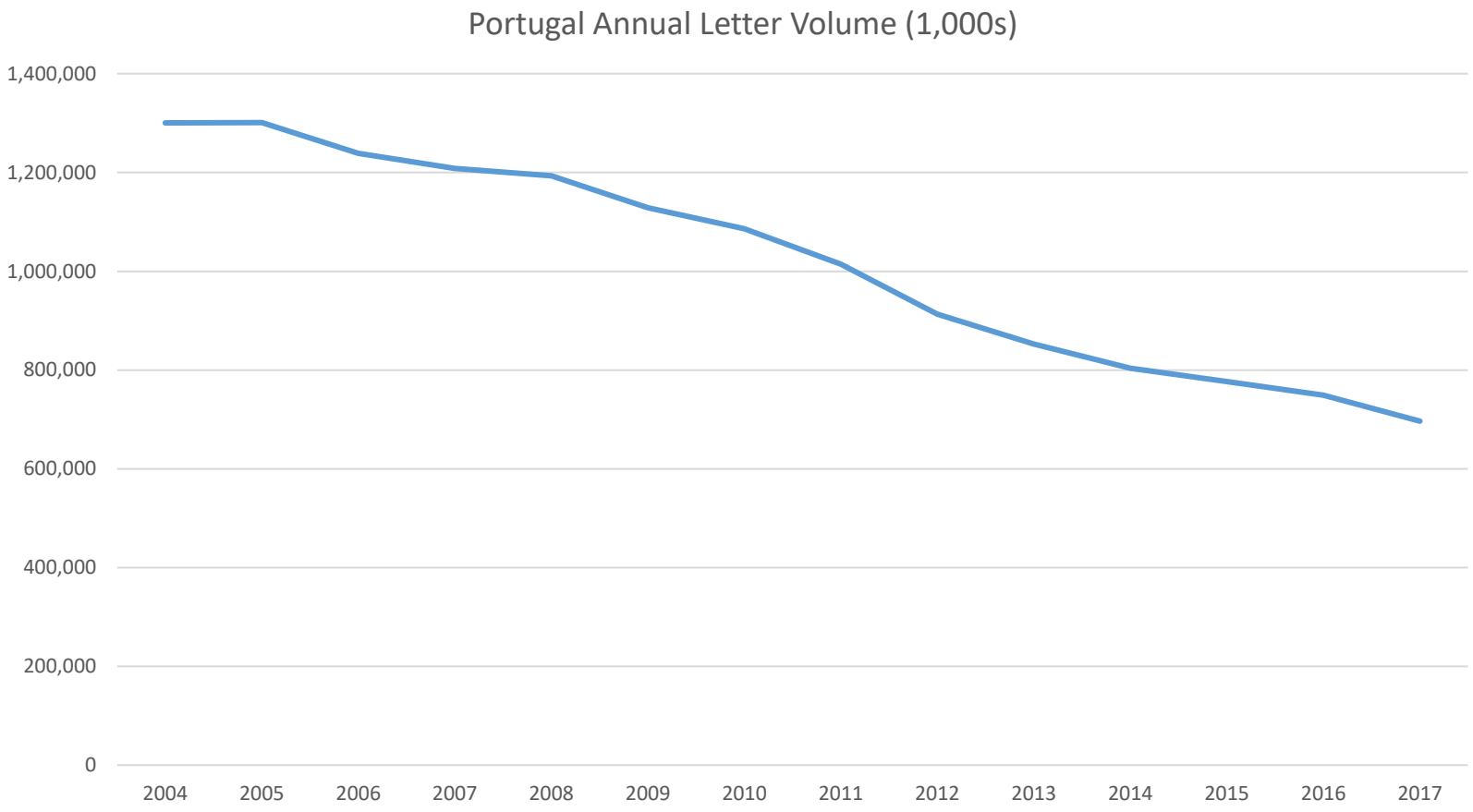
Focus of this paper

- Costs, not retail prices
  - Question is not: will competition benefit consumers?
  - Question is not: will social welfare increase as a result of competition in delivery
  - Question is: will competition raise or lower costs?
- Key variables
  - Efficiency of incumbent compared to entrant
  - Volume of mail per capita
- Theoretical with consideration of empirical relevance

Why "natural monopoly" in delivery matters

- Digitalisation: domestic letter volumes decreasing 4.2 % per year over 2013-2016 (Copenhagen Economics, 2018), differing widely between countries, with some maintaining steady volume
- Postal services in EU have moved progressively to more competitive environment
  - Increasingly regulators are being set up with at least nominal independence from postal service, political pressure
  - Legal monopolies permitted for "standard" letter. Exemptions from competition requirement:
    - Weighing less than 100 gm and costing 3x basic tariff from 1/1/2003
    - Weighing less than 50 gm and costing 2.5x basic tariff from 1/1/2006
    - Liberalised: 2008/6/EC resulted in full market opening from 2013 (with possibility for USP to request compensation)
  - Some countries are moving faster in permitting competition than others, e.g. Sweden, UK
  - Only 2 countries with letter delivery companies *in EU data*: Cyprus, Norway
- Many postal services and governments resist increased competition,
  - arguing that the postal services are natural monopolies /unsustainable natural monopolies
  - universal services will be placed in jeopardy by competition
  - compensation mechanisms developed, permitting support (subsidies) for universal service, lowest volume areas (e.g., rural) often considered the most in need of such support, with possibility to tax entrants
  - USPS has arguably received subsidies of $10b + in the last decade
- To the extent natural monopoly features are present, they influence the most desirable market structures and regulations

Example of declining letter volume



Natural monopoly assessment affects…

- Retail price regulation
- Access regulation
- Assessing “essential facilities”
- Structural separation
- Privatisation
- Entry limits

Outline of remainder of talk

- Definition of natural monopoly
- Delivery services
- Model of costs
- Impact of one entrant
- Impact of multiple entrants
- Simulation of entry effects
- Conclusion

Definition of natural monopoly

Traditional definition of natural monopoly

- A natural monopoly exists when there is subadditivity of costs.
- Intuitively this means that the cheapest way to produce a given set of outputs is via one producer; adding one or more producers raises the cost of production of that set of outputs.
- Technically:
- William Sharkey (Theory of Natural Monopoly, 1982) following work by Bailey, Baumol, Panzar, Willig:
- If $q^1, q^2, \ldots, q^k$ are output bundles that sum to q, then a single firm is superior on efficiency grounds to a multi-firm industry if the following condition holds:
- $C(q) < C(q^1) + C(q^2) + \ldots + C(q^k)$ (1)

  $C(q^1)$ can be interpreted as the cost of producing commodity bundle q^1. If inequality (1) holds, then a single firm can **jointly** *produce bundles* $q^1, q^2, \ldots, q^k$ more cheaply than if the bundles were produced separately, or if they were produced by two or more firms.
- This is a *traditional* natural monopoly. Monopolies may arise for other reasons (e.g., unique control of necessary inputs)
- Monopolist costs often include x-inefficiency. So cost functions should not be identical.

Proposed definition of natural monopolist

- A producer I is a y^m-natural monopolist at a positive vector of outputs y^m if and only if,

  $CI(y^m) < CI(y^1) + C(y^2) + \ldots + C(y^k)$

For all $y^1,\ldots,y^k$ such that y^1 exhibits non-zero production of all outputs;

At least one $y^i \neq 0$, $i>1$;

$$\sum_{i=1}^{k} y^i = y^m$$

C(y) is the minimum cost of producing y (i.e., entry at minimum production cost)

- The producer is a natural monopolist if this condition holds throughout the relevant range, i.e. for all y^m which are consistent with (at least) zero economic profits for the producer.
- Benefits of this definition will be shown with a delivery cost model

Incumbents can punish entrants who do not provide end-to-end service

- Liberalization challenge: alleged anti-competitive actions by incumbent
  - Sweden
  - UK
  - Germany
- When abuses stem from access to natural monopoly part of post service, consider structural separation
- Common suggestion: Separate delivery function from other part of postal service
  - Economies of scale considered most significant in delivery
  - Nov 2, 2004: chair of UK post regulator (POSTCOMM) discussed possibility of structural separation if Royal Mail engages in anti-competitive behaviour
  - More recent developments? 2019 Ofcom case in postal services. Others?
- Economic arguments for separation depend on nature of cost function

Delivery services

Fixed/Variable cost by function

Function	Fixed (%)	Variable (%)	Total b USD
Delivery	52	48	22.1
Processing	4	96	21.4
Transport	8	92	4.3
Window Service	54	46	3.1

Source: US Postal Rate Commission Docket No. R2000-1

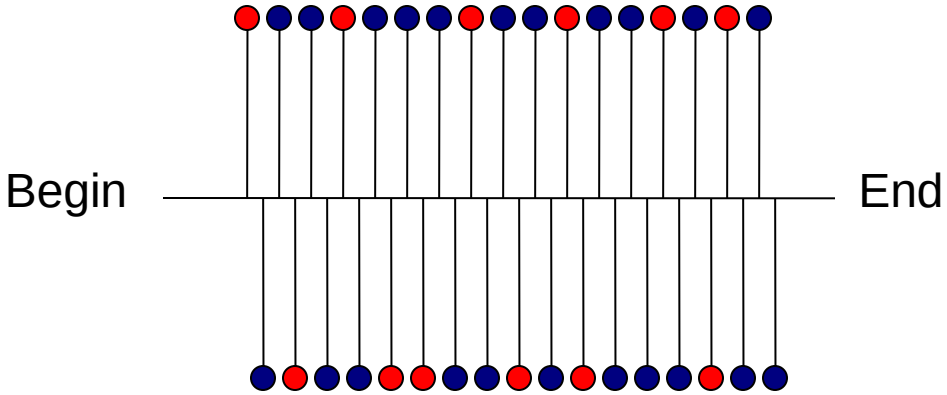
Delivery: natural monopoly?

- Often argued that postal delivery is the “natural monopoly” area of postal services
  - Some debate about what precisely counts as postal delivery, e.g. final sorting by postal delivery person
- Common view: low-volume markets are the ones most in need of protection from entry
  - Their services are already insolvent or close to it
  - It is in low-volume markets that the graveyard spiral could have most dramatic effects. (Cohen (2004), European Commission reports in last decade)
- Key point: The presence of inefficiency is a key factor for the question of whether delivery is a natural monopoly

Model of costs

Stylized delivery model

Delivery person starts at center, moves along black line in middle and goes to red addresses, but not blue addresses.



Delivers to red addresses

Costless bypass of blue addresses

Cost of incumbent

Probability of 0 arrivals is $e^{-\lambda(p)}$

$$C_I = F_I + nd(1-e^{-\lambda(p)})c_I$$

- F_I fixed cost for incumbent
- n number of addresses
- d days of delivery per year
- λ mean daily arrival rate of letters (Poisson process)
  Where $\lambda(p) = D(p)/d$
- c_I cost per address with delivery (for incumbent)

Impact of one entrant

Entry

- Creates two extra costs
  - Fixed cost of entrant
  - Increased variable cost based on overlapping delivery on same day
- Creates saving
  - Substitution of high variable cost incumbent deliveries to low variable cost entrant deliveries (assuming entrant has lower variable costs)
- Lower prices may increase volume and change economies of scale…

Costs after entry

$$C_{IE} = F_I + nd(1-e^{-s\lambda(p)})c_I + F_E + nd(1-e^{-(1-s)\lambda(p)})c_E$$

- s share of letters for postal operator I
- different fixed cost and variable cost for entrant E

Are incumbents inefficient?

- Efficiency has undoubtedly increased in many respects in last twnety years.
- Still, labour costs have been estimated at more than 30% above comparable benefits for comparable skills
- Informal comments suggest that avoidable costs from worksharing can be 5 times greater than incurred cost by mailer/processors

Sufficient condition for entry to lower costs

$$\left(1-e^{(1-s)\lambda}\right)\left(e^{-s\lambda}\right)\left(c_I-c_E\right) \geq \frac{F_E}{nd} + \left(1-e^{-s\lambda}\right)\left(1-e^{(1-s)\lambda}\right)c_E$$

- Efficiency gain from substituting deliveries from incumbent to entrant> Entrant fixed costs + duplicative delivery costs

Suppose incumbent delivery operates on cost function frontier

- There may be reason to provide “protected” status to incumbents delivery system
- Given efficient incumbent delivery system may give lower quality service to entrants
- Duplication of delivery system (vs. pure access) may then still be desired by entrant because of
  - ease of discrimination against entrant
  - difficulty of monitoring discrimination
- Structural separation may eliminate incentive of entrant to duplicate an efficient delivery system

Natural monopoly reappears

- Suppose prices are flexible after entry.
- Low prices from entrant will stimulate demand, increase volume per capita.
- For sufficiently large reduction in prices, it is possible that postal delivery will not be a natural monopoly in presence of an incumbent but will be a natural monopoly after entry
- Could one reach a “flip-flop equilibrium” with entry creating natural monopoly leading to re-monopolization?

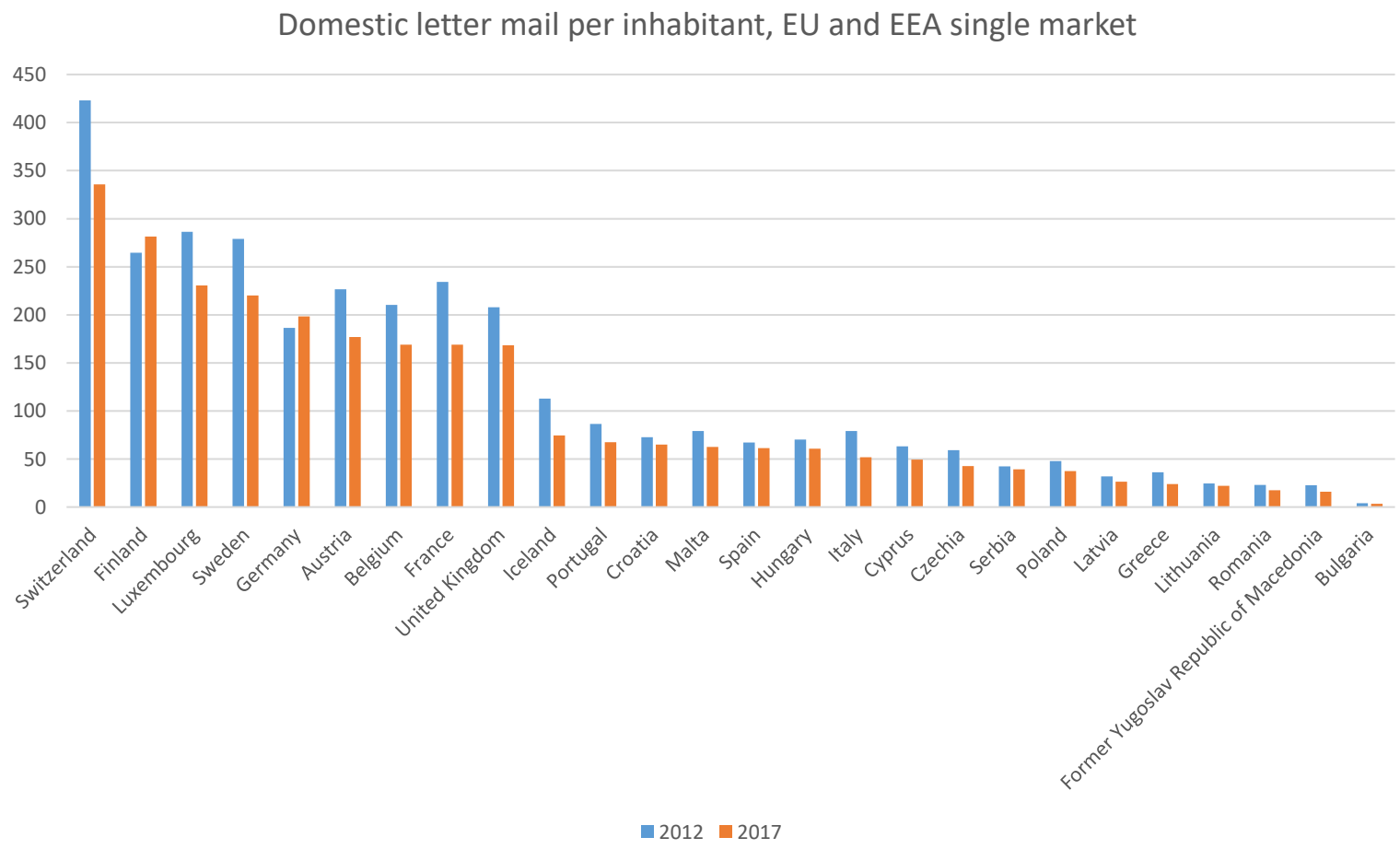
Impact of multiple entrants

More competitors = higher costs than one entrant scenario

- Let there be n entrants.
- Assume they all operate on cost frontier.
- To the extent that fixed costs are important, these will increase (over one entrant scenario) by a factor of n.
- Economies of delivery scale by entrant will be reduced by presence of additional entrants, though this effect will be smaller in low volume countries.

In practice, when would entry lower costs?

Domestic letter post volume per capita



Source: EC GROWTH, postal services data

Table 1: Domestic letter mail service volumes

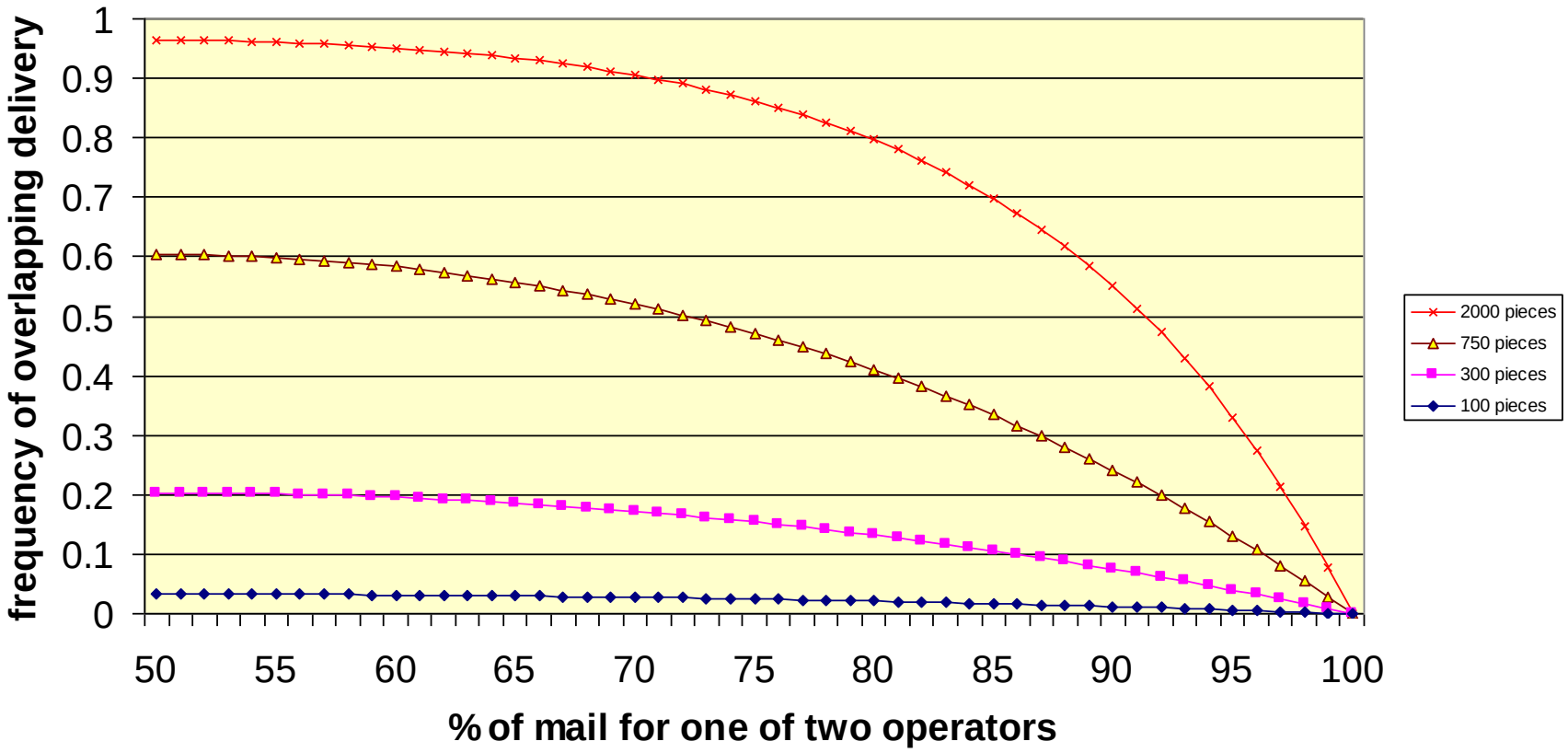
Country	(1) letters per capita 2012	(2) letters per capita 2020	(3) HH Size	(4) letters per HH 2020	(5) % Δ letters per HH 2012-2020	(6) 2030 (proj) HH 2030 (proj)
United States	474.8	354.8	3.1	1099.9	-26.0%	755.1
Switzerland	423**	335.7***	2.2	738.5	-24.1%	523.3
Finland	264.6	227.7	2.0	455.5	-18.0%	355.3
Luxembourg	286.3	186.7	2.2	410.7	-40.2%	215.9
Belgium	210.5	169***	2.3	388.7	-19.7%	295.4
United Kingdom	207.9	168.4***	2.3	387.3	-19.0%	297.6
Canada	272.7	154.3	2.5††	385.8	-43.4%	189.3
Germany	186.4	155.0	2.0	309.9	-16.9%	246.1
Austria	226.6*	140.3	2.2	308.6	-40.8%	160.2
Sweden	278.9	154.2	2.0	308.4	-47.3%	138.3
France	234.4	113.8	2.2	250.3	-51.5%	101.4
Iceland	112.8	74.6***	2.3†	171.6	-36.6%	97.0
Spain	67.3*	63.77****	2.5	159.4	-8.9%	141.9
Portugal	86.6	55.8	2.5	139.6	-38.0%	76.8
Croatia	72.8	50.5	2.7	136.4	-33.1%	82.5
Malta	79.3	49.2	2.4	118.0	-44.9%	56.0
Hungary	70.2	49.6	2.3	114.1	-32.3%	70.1
Cyprus	63.4	37.0	2.6	96.3	-45.8%	44.8
Serbia	42.3	32.2	2.9	93.5	-23.8%	66.6
Czech Republic	59.3*	39.3***	2.3	90.4	-36.5%	51.2
Poland	47.8	30.1	2.8	84.3	-37.1%	47.2
Italy	79.2	35.7	2.3	82.2	-56.8%	28.8
FYR Macedonia	22.9	16.2***	3.6	58.3	-31.2%	36.6
Romania	23.1	18.8	2.6	48.8	-21.7%	36.0
Greece	36.2	18.3	2.6	47.5	-49.6%	20.2
Latvia	32.0	19.8	2.3	45.6	-40.7%	23.7
Lithuania	24.6	17.5	2.2	38.5	-32.0%	23.8

Source: EC GROW, domestic postal data; EU Labour Force Survey; US Postal Service; Canadapost; WEO.
Individual-country geometric compounding applied for 2030 projections. EU states excluded if not present in EC GROW for relevant time period.
* 2013 ** 2014 *** 2017 ****2019
Average household (HH) size from official postal statistics, official government statistics or, where missing, † EU-28 average †† 2016 Census data

Stylised facts

- High variation in letter volume
- Average EU volume is below 200
- 14 EU countries have letter volumes below 100
- 7 EU countries have letter volumes below 50

Overlap on a given day, by market share of postal incumbent

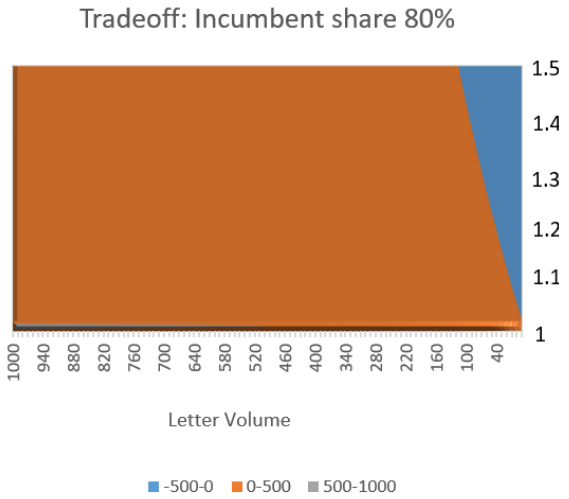


When would entry lower costs?

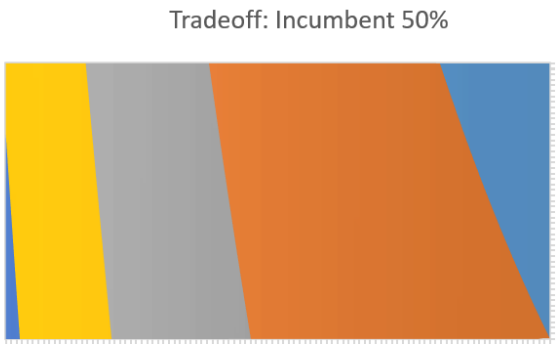
- Assume fixed costs for entrant are 0
- 200 letters per address and 50% penetration by entrant implies entry would reduce costs for a 50% or more productivity premium
- 100 letters per address and 20% penetration by entrant, entry would reduce costs for productivity premiums of 38% or more
- 50 letters per address and a 10% penetration by the entrant implies entry would reduce costs for productivity premiums of 20% or more

Efficiency – volume tradeoff

Entrant takes 20%



Entrant takes 50%



Entrant takes 80%

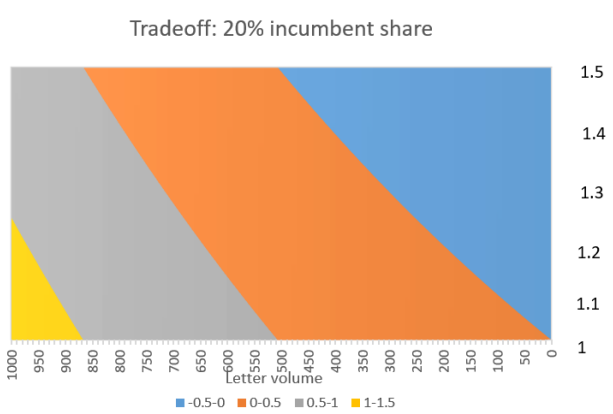


Table 2: Minimum productivity improvement required for cost-reducing entry

Country	(1) 2020	(2) 2030 (projected)	(3) letters ≥ 1 (2020)	(4) letters ≥ 2 (2020)
United States	97.0%	91.1%	98.8%	93.4%
Switzerland	90.6%	81.3%	94.8%	79.4%
Finland	76.7%	67.9%	83.8%	54.4%
Luxembourg	73.1%	49.9%	80.7%	48.9%
Belgium	71.2%	61.1%	78.9%	46.0%
United Kingdom	71.0%	61.4%	78.8%	45.9%
Canada	70.9%	45.4%	78.6%	45.6%
Germany	62.9%	54.5%	71.1%	35.2%
Austria	62.7%	40.1%	70.9%	35.0%
Sweden	62.7%	35.8%	70.9%	34.9%
France	55.1%	27.7%	63.3%	26.5%
Iceland	42.3%	26.7%	49.7%	15.1%
Spain	40.0%	36.5%	47.1%	13.4%
Portugal	36.0%	21.8%	42.8%	10.8%
Croatia	35.4%	23.2%	42.0%	10.4%
Malta	31.4%	16.4%	37.6%	8.2%
Hungary	30.6%	20.1%	36.6%	7.7%
Cyprus	26.5%	13.4%	32.0%	5.8%
Serbia	25.9%	19.2%	31.2%	5.5%
Czech Republic	25.1%	15.1%	30.3%	5.2%
Poland	23.6%	14.0%	28.6%	4.6%
Italy	23.1%	8.8%	28.0%	4.4%
FYR Macedonia	17.0%	11.0%	20.8%	2.3%
Romania	14.5%	10.9%	17.7%	1.7%
Greece	14.1%	6.2%	17.3%	1.6%
Latvia	13.6%	7.3%	16.7%	1.5%
Lithuania	11.6%	7.3%	14.3%	1.1%

Source: EC GROW, domestic postal traffic data; EU Labour Force Survey; USPS; Canadapost; WEO.
Individual-country geometric compounding applied for 2030 projections.

Conclusion

Natural monopoly definition

- The standard natural monopoly definition is not fit for purpose
  - in low capital costs special case of postal letter delivery and certain other cases
  - in infrastructure markets requiring new investment
- This paper proposes an alternative definition of ”natural monopolist” that can be applied and that capture weaknesses of existing definition with respect to efficiencies
- When applied to postal services, the proposed new definition has results that are more in keeping with intuition and avoids classifying activities as natural monopolies for which entry can reduce costs of operation.

Policy implications

- Identify natural monopolies
  - Low-volume postal services may not have natural monopoly in delivery
  - High-volume postal services likely do have natural monopoly in delivery
- If no long-run natural monopoly in delivery, entry may lower costs of providing postal service
  - Caveat: if entry lowers prices sufficiently, delivery may again be classified as a natural monopoly
  - State support (state aid) to incumbent may not be desireable for routes that are not natural monopoly routes
- If long-run natural monopoly in delivery, structural separation may be considered
  - Critical factor would be efficiencies that can arise from vertical integration

Conclusion

- Argument for structural separation would be greatest when natural monopoly element in delivery
- Where incumbent inefficient and economies of scale weak, as in some small post operators, simply permitting competition may result in substantial efficiency gains
- State aid may be least justified where low volumes and inefficiencies
- Twist: (Inefficient) incumbent may not operate natural monopoly but (efficient) entrant may be natural monopolist
- Relevance of these results is increasing with reduction in volumes from digitalisation.

Further work

- Account for cost differences among route types (apartments, purely linear roads, lone houses, need for signatures)
- Enhance pricing analysis so it is not exogenous
- Changing days of delivery
- Empirical estimates of economies of scale
  - Finding substantial economies of scale does not imply incumbent is a natural monopolist
  - E.g. if worker benefits are uniformly 35% higher than necessary in a postal service, empirical work will not necessarily pull this out
  - A firm that faces such wages will likely over-invest in capital
- Vertical economies
  - Relation between collection and delivery
  - Relation between sorting and delivery
- Energy sector implications (distribution and transmission)

Extra slides

Unsustainable natural monopoly

- However, if the natural monopoly is "unsustainable," then entry restrictions may be desirable
- In an unsustainable natural monopoly,
  - Production cost of a set of products is lowest when produced by one firm
  - However, entry can be profitable
  - This entry increases the average cost of production for the incumbent natural monopolist
  - Thus total production costs, across incumbent and entrant(s) may be increased by entry

Graveyard spiral

- Economic research has focused on the possibility of unsustainable natural monopoly (e.g. Crew and Kleindorfer (2000, 2001))
- Model
  - Routes have a distribution of costs
  - Prices are fixed and route-invariant
  - Incumbent has a break-even constraint such that revenues=costs
  - No cross subsidy across routes
- Analysis
  - Entry will lead to cherry picking where entrants take profitable routes (e.g. urban routes) and charge lower price than incumbent
  - Incumbent will then have to raise prices to cover higher per-letter costs of remaining letters
  - Entrant will then take on some more routes where $P_{incumbent}$>cost
  - Incumbent must raise prices yet again…
  - Conclusion: it is possible that costly routes will end up not being served
- Cohen (2003, 2004) finds that, as an empirical matter, the graveyard spiral is not likely to occur in U.S..
  - But U.S. has high volume postal service (measured in letters per capita)
  - In contrast, for lower volume postal services, graveyard spiral is more plausible
- I am not aware of more recent or European evidence on this point