Multi-Level Markets for Virtual Goods

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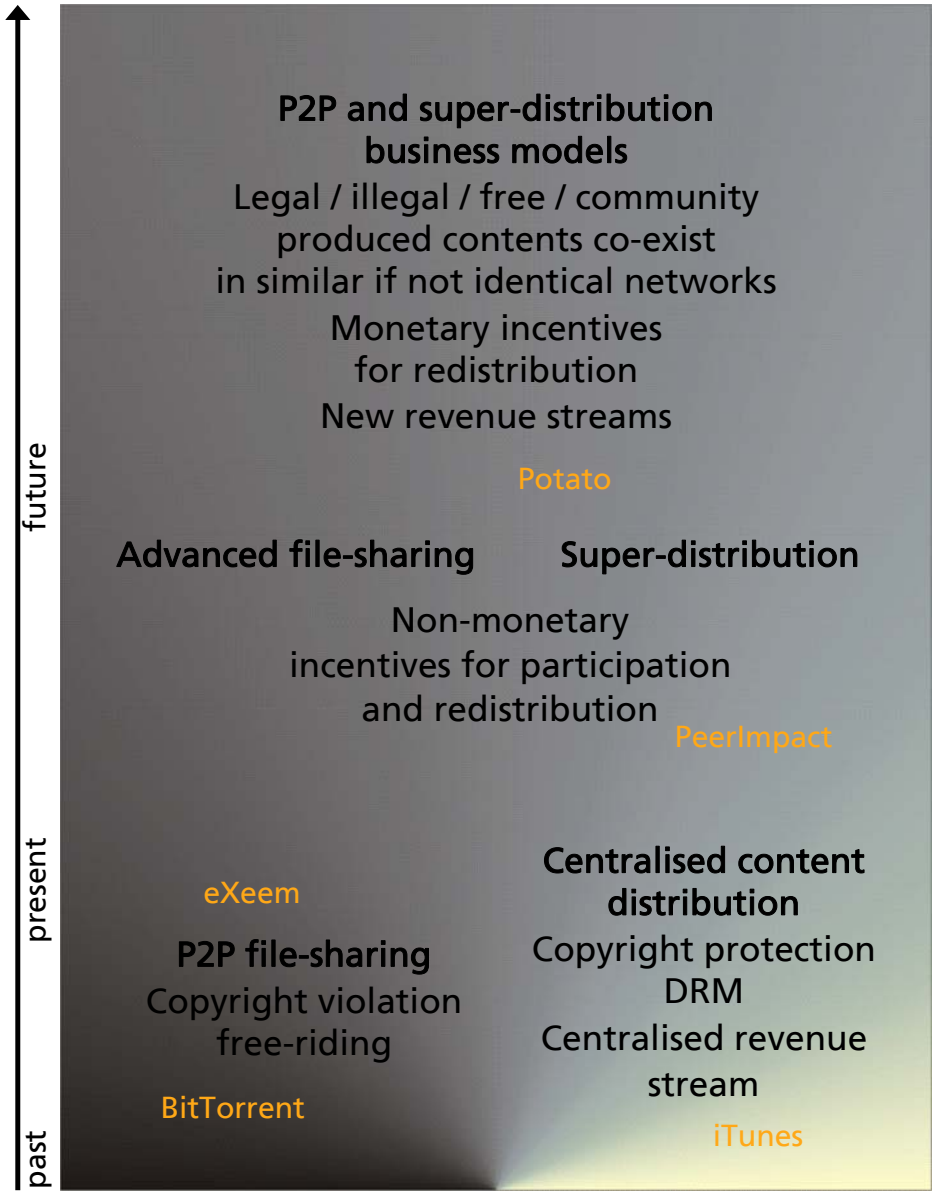
Evolution of online media distribution – Convergence of white and grey market



Why convergence?

Status:

- Centralised distribution with copyright protection is not effective in ***mitigating free-riding***
- The economic effect of free-riding is disputed

Problems:

- In the presence of free versions of content on file-sharing networks, centralised content business models are lacking a ***sound economic foundation***, because
- Illegal and legal versions live in very different distribution nets and therefore
- It is not possible to model and asses the ***competition*** between the two

Consequences:

- Paid for and freely available versions of virtual goods should live in similar environments to
- allow for a sound ***market mechanism design*** to
- generate ***revenue streams for originators*** that
- make ***original creation and production economically viable***

Incentive systems by network marketing

The first-best approach to

- generate revenues for the originator and
- provide incentives to re-distribute the legal version of a virtual good

is a ***commission model***.

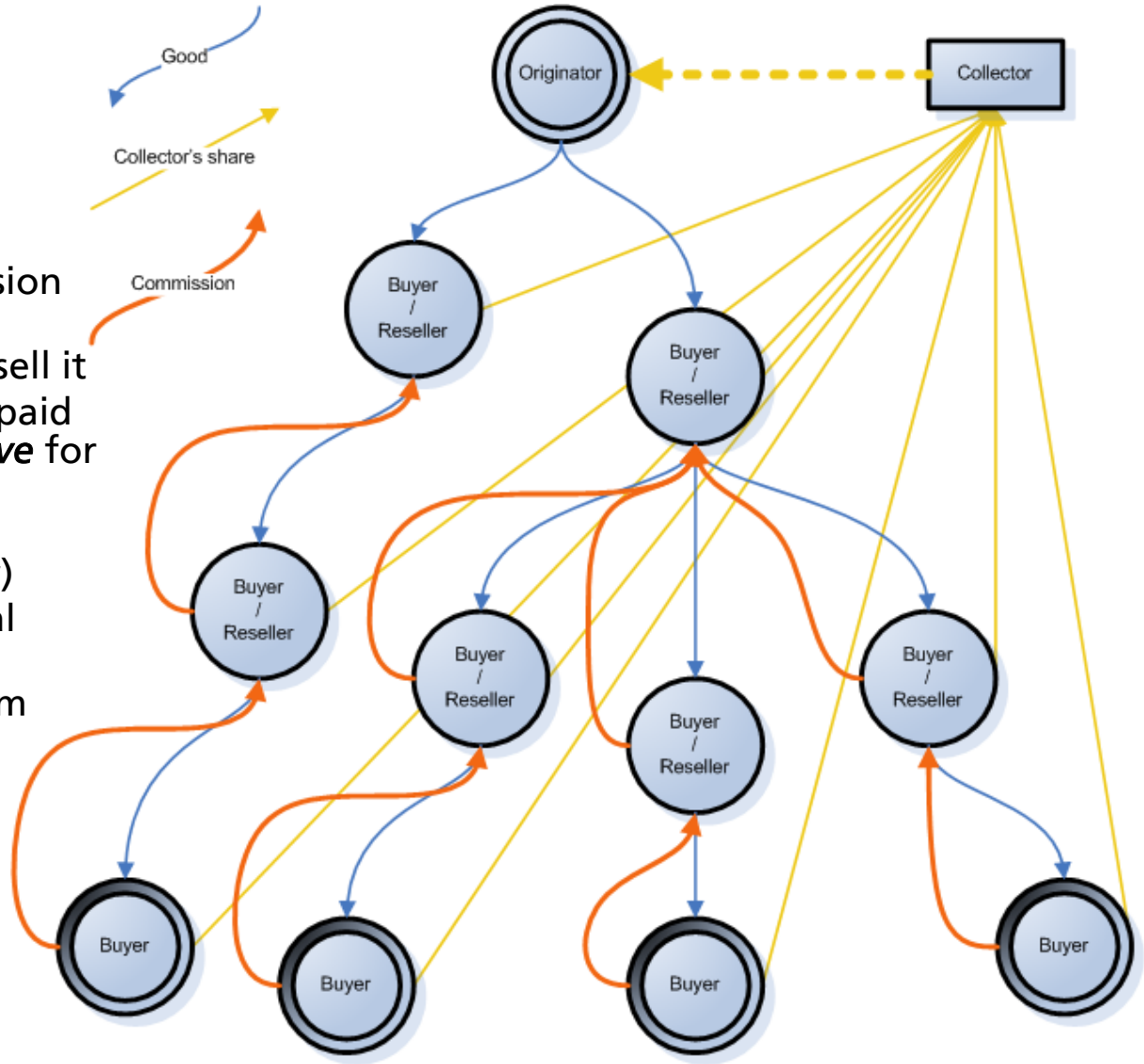
Specifically, consider **Multi-level incentive Mangament (MLIM) systems**:

- Originator is a monopolist for the legal version and determines sales and resale price
- Buyers receive the good *and* the right to resell it
- Resellers receive a share of the resale price paid by buyers (both called ***agents***) as an ***incentive*** for redistribution
- Remaining revenue goes to a ***collector*** (e.g. originator, creating artist, collecting society)
- The incentives discriminates legal and illegal version

This model (++) is realised in the Potato system

Problems and questions:

- Closeness in concept to ***pyramid schemes*** – when is MLIM considered ***fair***?
- Lack of ***theoretical models*** for multi-level and network markets; required to examine quantitatively
- expected incentives,
- effectiveness against free-riding, and
- Competition between goods



A continuous (fluid) model

The ***number*** of agents $n(t)$ in the market increases continuously with time up to the ***saturation value*** n_∞

The ***incentive*** is the ***resale revenue*** minus the ***price*** paid (expectation values, commission, transaction costs etc. left aside)

$$v_i(t) = v_r(t) - \pi(t)$$

Price varies continuously

Ansatz $$v_r(t) = \int_t^\infty \frac{\pi(t')}{n(t')} \dot{n}(t')\,\mathrm{d}t'$$

Influx of agents

Revenues are gained from later market entrants

Expected revenue is diminished by competition

Re-parametrisation by the ***market saturation*** $s = n/n_\infty, 0 \le s \le 1$ yields

$$v_i(s) = \int_s^1 \frac{\pi(s')}{s'}\,\mathrm{d}s' - \pi(s)$$

- A flexible, generic model for the ***monetary flux*** multi-level markets
- Easily extended, by commission, transaction costs, and other features

Some rigorous results

- If the price is bounded then holds the conservation law (**zero-sum condition**)

$$\int_0^1 v_i(s)\,\mathrm{d}s = 0$$

- The incentive is scale-free, i.e., independent of the final market size, at given saturation
- The price is positive at all times if and only if

$$\frac{1}{s}\int_0^s v_i(\sigma)\,\mathrm{d}\sigma > v_i(s) \quad \textit{for all } s$$

Expected incentive before s on average

Expected incentive at s

- The **inversion formula**

$$\pi = -\frac{1}{s}\int_0^s \sigma \dot{v}_i(\sigma)\,\mathrm{d}\sigma$$

allows to calculate price from incentive target

- The error between discrete and continuous market model is bounded by

$$|v_i(s) - \overline{v}_i(sn_\infty)| \le \frac{\pi_{\max}}{2}\left[\frac{1+s}{sn_\infty} + \frac{1}{6}\frac{1+s^2}{(sn_\infty)^2} + O\left(\frac{1+s^4}{(sn_\infty)^4}\right)\right]$$

Examples

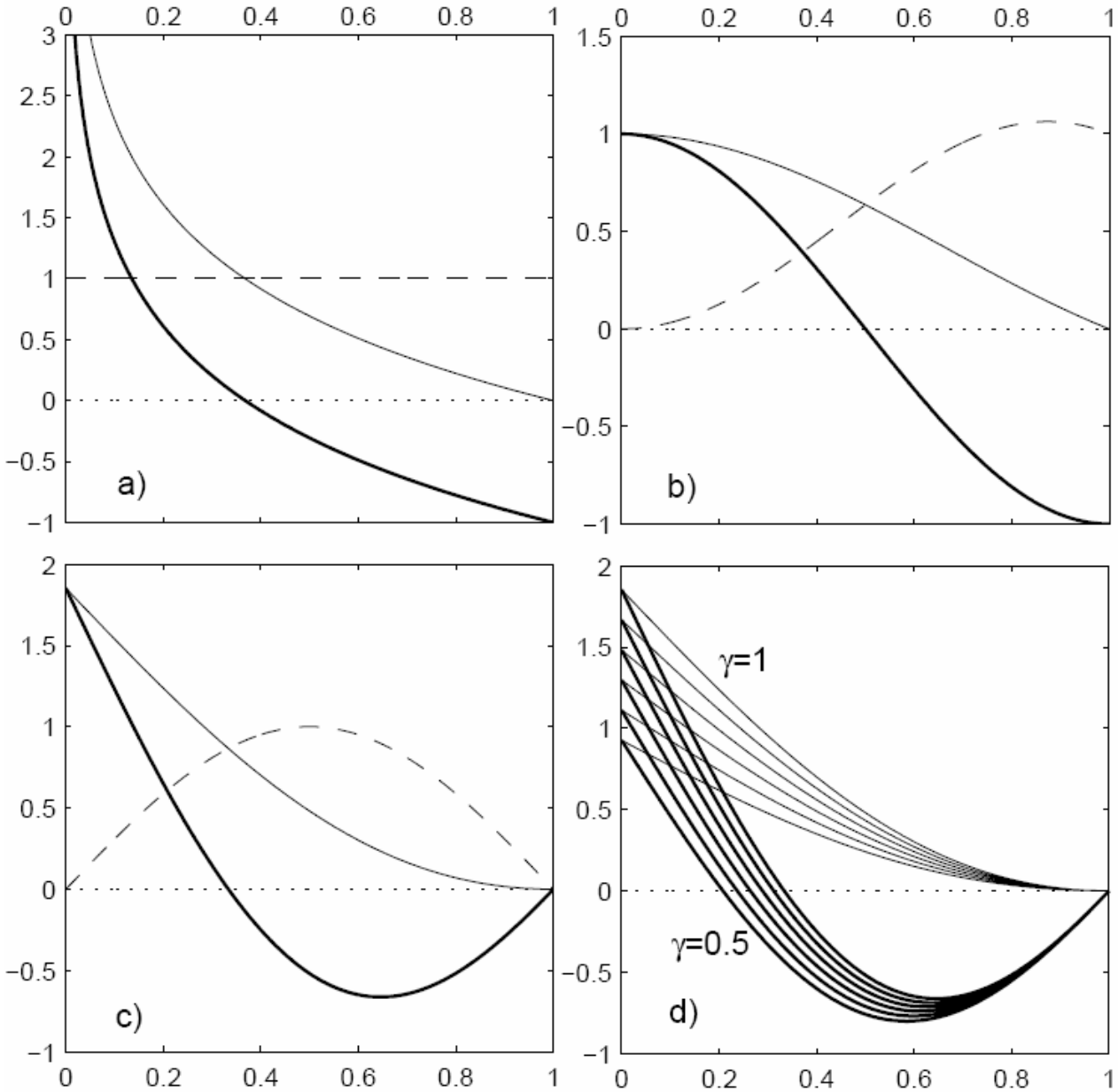
Dashed: prices, thin solid: expected resale revenues, thick solid: incentives

a) - Constant, non-zero prices entail a ***logarithmic singularity*** at low saturations
- Strong ***favouritism of early buyers***, later market entrants are increasingly penalised

b) - An ***early subscriber discount*** avoids the singularity
- Can provide an initial ***invitation to enter*** to counter slow start-up

c) - Early subscriber discount plus late-comer rebate
- Effective ***closure of the market*** at a predetermined size
- price peaks during an interme-diate period, perhaps when demand is high

d) - The effect of a collector (com-mission factor) is rather limited



A simple model for competition in an MLIM system

Assume two goods **A** and **B** compete in the same MLIM market as ***substitute goods***

Their ***market shares*** are $(\bullet = A \text{ or } B)$

$$s^\bullet = s^\bullet(s) \quad s^A + s^B = s$$

The ***decision probability*** governs the evolution of market shares by

Probability to decide for A at saturation s

$$s^A(s) = \int_0^s \rho^A(s')\mathrm{d}s'$$

The decision probability is determined by the distribution of individual utilities of A, B across the agent population. Three main contributions:

1. ***Popularities*** are probability distributions

$$\mu^\bullet(u^\bullet) = \mu(p^\bullet, u^\bullet) \qquad p^\bullet \geq 0$$

Popularity distribution PDF | Popularity parameter

and satisfy principle of ***stochastic dominance***

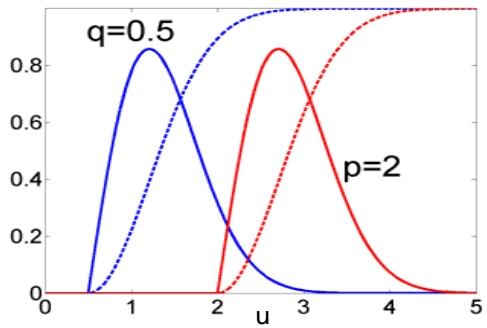
CDF

$$\mathcal{M}(q,x) \geq \mathcal{M}(p,x) \quad \text{for } p \geq q$$

If pop. is generated by ***translation***, only the ***popularity bias***

$$\Delta p = p^A - p^B$$

contributes



2. ***Incentive bias*** "I choose A over B because I *expect* to obtain a larger incentive from it"

$$\Delta u_i = \Delta u_r - \Delta\pi \qquad \Delta x \stackrel{\text{def}}{=} x^A - x^B$$

Exp. resale revenue difference | price difference

Bounded knowledge estimation of resale revenue

$$u_r^\bullet(s) \stackrel{\text{def}}{=} v_r^\bullet(s) \cdot \rho^\bullet(s)$$

Expected resale revenue difference

$$v_r^\bullet(s) = \int_s^1 \pi^\bullet / s' \mathrm{d}s'$$

Decision probability ***by popularity only***

3. ***Multiplier bias*** (a largely unknown factor) accounts for positive network effects on competition

$$u_m^\bullet \stackrel{\text{def}}{=} \varepsilon s^\bullet / s$$

Complete specification

$$\rho^A(\Delta) \stackrel{\text{def}}{=} \Pr(\Delta u + \Delta > 0)$$

Individual popularity bias | Incentive & multiplier bias

Simplified (distributions of translation form)

$$\rho^A(p^A, p^B; \Delta) = \int_0^\infty \mathrm{d}\mu(u)\mathcal{M}(u + \Delta + \Delta p)$$

With the total decision bias

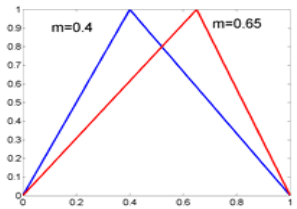
$$\Delta \stackrel{\text{def}}{=} \Delta u_i + \Delta u_m = v_r^A \rho^A - v_r^B \rho^B - (\pi^A - \pi^B) + \varepsilon\left(\frac{2s^A}{s} - 1\right)$$

Experimental results on the free-rider phenomenon

Goods A and B enjoy the ***same popularity*** and B is freely available

$$p^A = p^B \quad \pi^B = 0$$

Price of A is determined by spike functions, parameterised by maximum ***m***

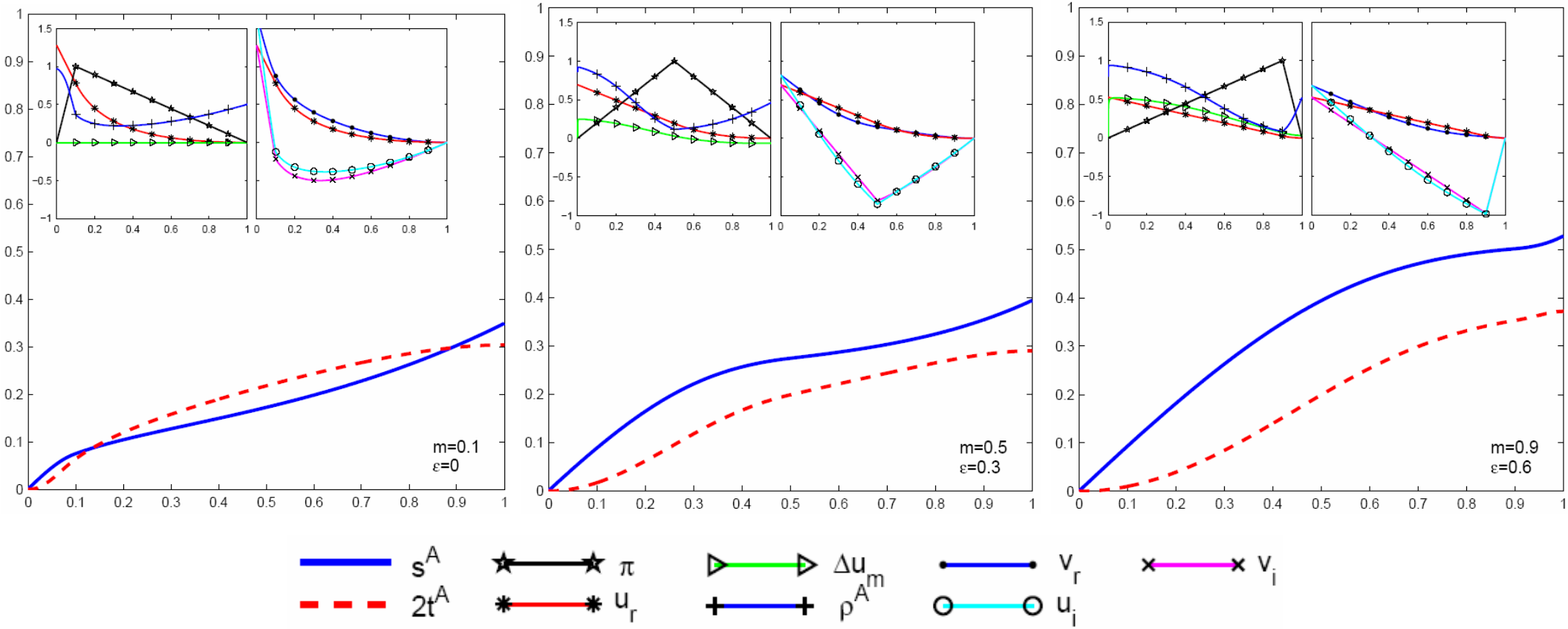


Main observables are ***final shares***

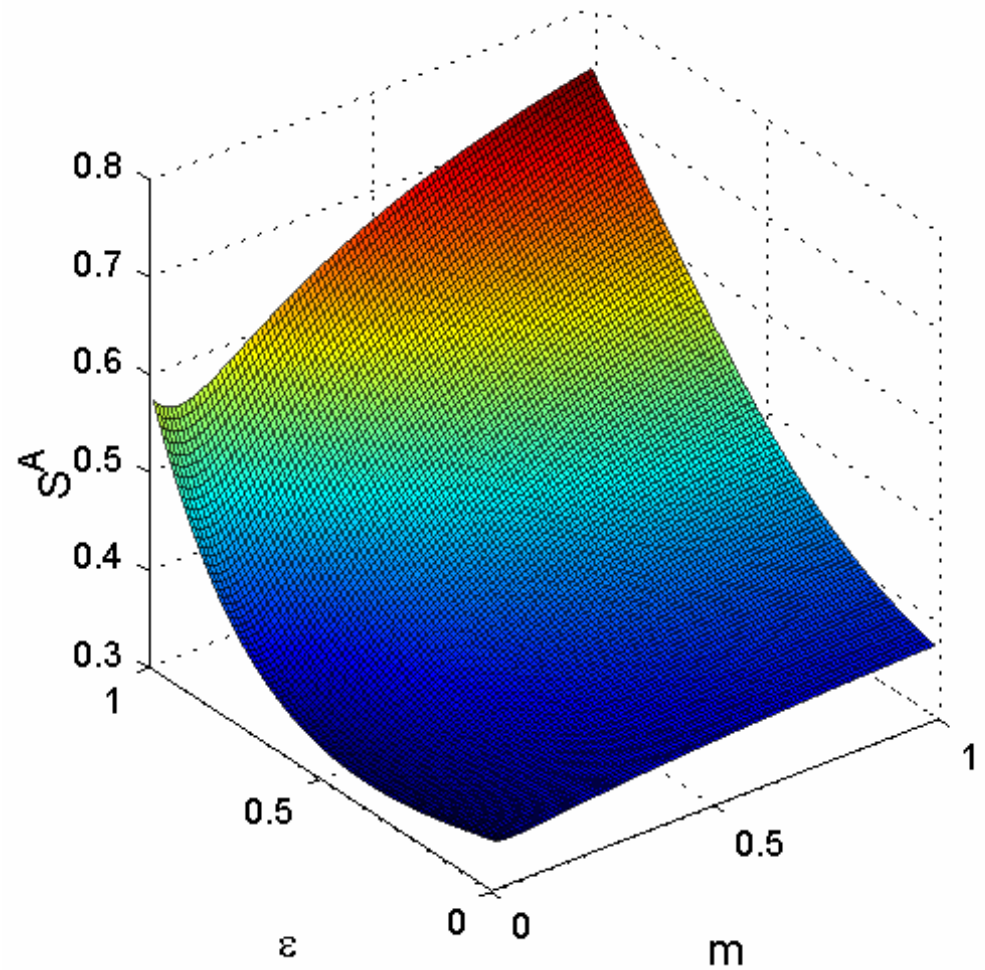
$$S^\bullet \stackrel{\text{def}}{=} s^\bullet(1)$$

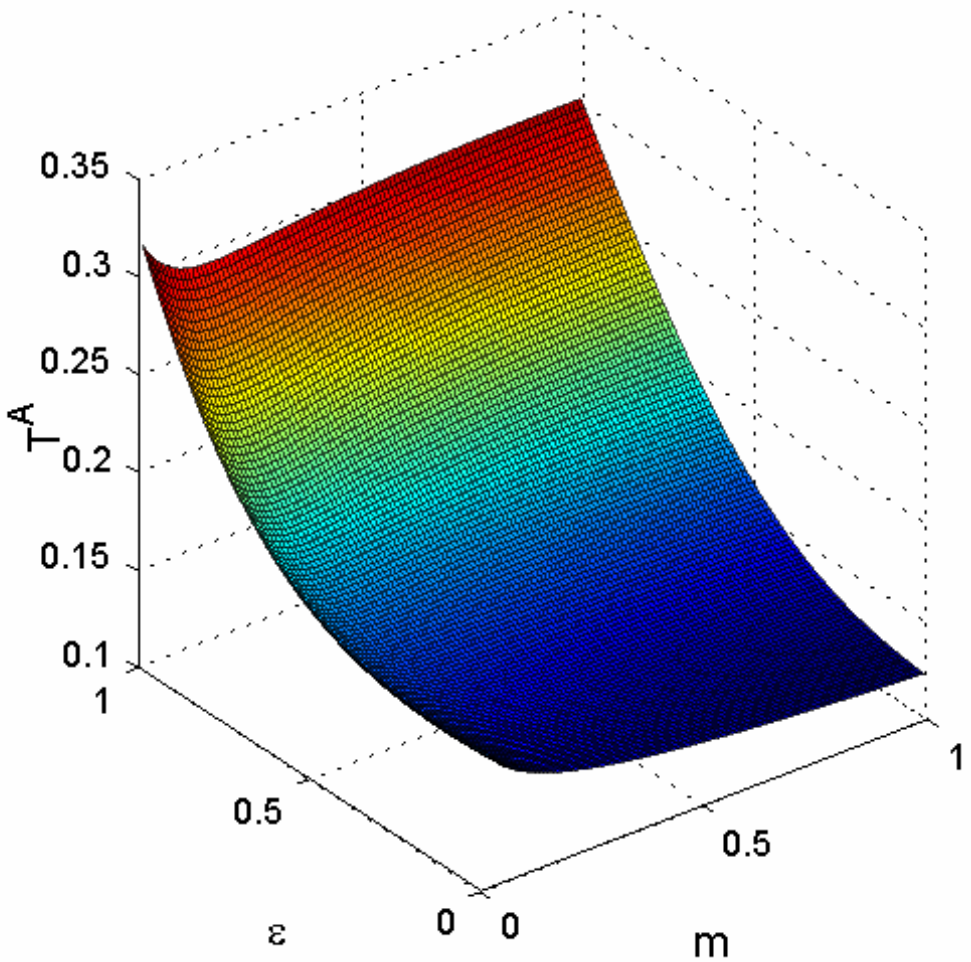
and ***turnovers***

$$T^\bullet \stackrel{\text{def}}{=} t^\bullet(1) \quad t^\bullet(s) \stackrel{\text{def}}{=} \int_0^s \pi^\bullet(s')\rho^\bullet(s')\mathrm{d}s'$$



Experimental results on the free-rider phenomenon – final shares and turnovers





- To optimally align incentives with market evolution is generally difficult
- Maximising shares viz. turnovers are conflicting goals

Discussion I

(Dis)similarity to illicit schemes

- MLM carries negative connotations special forms (pyramid selling, snowball systems, chain-letters,…) are illegal under many jurisdictions
- Micklitz *et al.* present criteria to discriminate legitimate schemes from illicit ones
- Applied to MLIM they yield five main arguments in its favour:

1. **Inventory loading** (large, non-returnable stocks) is irrelevant for virtual goods
2. **Marginal costs** for replication and redistribution are negligible, transaction costs insignificant.
3. **Incentives result from individual sales** of a virtual good of positive pecuniary value, not favouring recruitment over resale
4. **Down-line payments** (more than one level) are excluded – would only increase the advantage of early subscribers and punish late-comers
5. **Information** about mechanism and incentive schedule can be made public in MLIM

Effectiveness of MLIM in the free-rider problem

- By the zero-sum condition, buyers of the legal good are not worse off on average than free riders
- However will an equilibrium S>0 evolve dynamically?
- The competition model gives some positive indication

- **But**
  - **if** the price schedule is ***common knowledge***
  - **then** late-comers will know by the z.-s. cond., that their incentive is negative and
  - **not** buy the legal version
  - **By induction**, no one buys the legal version
- **On the other hand**
  - **If** the price schedule is merely ***public knowledge*** or even only ***private knowledge*** (of the originator, say)
  - **then** some agents know that others will have negative incentive
  - **but** expect those to buy the legal good (from them) nonetheless

- Success of MLIM against free-riding is a genuine question of ***information economy***
- This has to be taken account in mechanism design
- A multi-factor discrimination of the legal version is likely (watermarking, added value, etc.)

Discussion II

Dynamical forward pricing

- To **dynamically** control the incentive by the price is a salient, new possibility of MLIM
- **Enables new mechanism** design options, such as
  - market closure
  - early subscriber discount
  - late adopter rebate
- **Information** is crucial to successful operation – required to implement a price schedule is knowledge of
  - n(t) – possible if, e.g., a central server counts every acquisition
  - the final market size n_∞ – hard to estimate, in particular in a competitive situation
  - forced market closure, e.g., by setting the price to zero after a certain time or at a given market size, suggests itself
- **Mixed forms** seem reasonable
  - correlate price with buying frequency
  - frequency or price thresholds for market closure

Market (In)homogeneity

- Present model is ***structureless***, i.e.,
  - the market looks the same everywhere
  - all agents have equal probability to trade with each other
  - no topological assumptions on the underlying communication and transaction network
- The ***homogeneity assumption*** breaks down if
  - There is a (group of) agent(s) with higher marketing and trading capacity and/or
  - Small inhomogeneities are amplified by multiplier or other network effects
- **Cannibalisation** of the market can occur if a strong reseller obtains a quasi-monopoly at an early stage
- Other buyers' incentives are negatively affected
- Can and should the MLIM system homogenise the market, e.g., by
  - limiting resale volumes or frequencies
  - providing an equal marketing platform to all

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