Yield versus Pest - Can Monopolies in Seed Markets Increase Welfare?

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Content

Monopoly in a Hardin's world

What if the cattle was not freely available at a constant cost but rather supplied to farmers by a monopolist?
Would this prevent the tragedy of the commons?
Would the final outcome be closer to first best in presence of the monopolist?

$\Rightarrow$ Anti-pest innovations as a common pool resource

$\Rightarrow$ Can monopoly at the market for anti-pest be of some social value? Monsanto as cattler supplier is Hardin's world.

Anti-pest innovations

- necessity for safeguarding crop productivity against competition from pests
  - loss potential varying from less than 50% (on barley) to more than 80% (on sugar beet and cotton)
  - highest loss potential of weeds (32%), animal pests (18%) and pathogens (15%)
  - FAO predicts that by 2050 60% more food needs to be produced
- history of boom-and-bust of effective control (e.g. corn rotation)
  - evolutionary pressure on the pathogens
  - common pool character of the innovations and the associated externalities
- latest innovations - disease-resistant hybrids, genetically engineered seeds etc.

Assigning monopoly rights (e.g. through patents):

- protects the efficacy of the innovation
- drives up the prices
- is controversial (patents on life sciences).

Reserach goal:

- compare the welfare outcomes when the innovation is publicly supplied with innovation managed by a monopolist
  Could monopolistic regime be welfare-improving compared to perfect competition in the presence of anti-pest innovations?
- build a model that reflects the trade-offs connected to the monopoly power over an innovation in a seed market

Specificities of the necessary model:

- model of interconnected harvest and innovation market
- endogenous risk of innovation losing its efficacy
- innovation used preventively to boost yields.

Literature I

- **Weitzman** (QJE 2000) trade-off between concentrating on high-yielding varieties and maintaining diviersity to lower the risk of infection. Models the probability of an ultra-catastrophic mass extiction of all crops.
- **Brock and Xepapadeas** (AER 2003) - externality from using the most productive variety as speeding up the evolution of the pest; valuation of biodiversity.

Literature II

- first-best pest strategies in biological studies
- **Fischer and Laxminarayan** (JEEM 2006) how monopolist's incentives differ from those of a social planner in case of sequential exploitation of exhaustible resources.
- antibiotics literature
  - **Herrman** (JEEM 2009, J. Health Econ. 2010) compares first best paths with the perfect competition (and monopoly) paths,
  - **Mechoulan** (Can. J. Econ. 2007) compares welfare under monopoly and competition.

Assumptions

- N farmers with fields of size one
- farmers decide whether to allocate their field to HY seeds or natural varieties ($s_i = 1$ or $s_i = 0$)
- HY seeds have a resistance against a certain pest - yields from one seed α. When no protection offered the yields scaled down by R
- using more of the HY seed increases the probability τ that the resistance will be broken: $\tau = \frac{s}{m}$ if $s < m$, else $\tau = 1$
- farmers are so small that they disregard the influence of their own cropping decisions on τ and harvest price
- harvest is sold on a competetive market with $p = g - \beta Q$.

The model does not

- ask where the innovations come from in the first place
- take dynamic or spatial effects into account
- look at other aspect of monopolization (product bundling, predatory pricing).

Farmers' maximization problem

α	harvest from one field	intertemporal adjustment term	ρ
R	share of harvest lost to the pest	demand for harvest	$g - \beta Q$
τ	probability of innovation losing its efficacy	efficacy threshold	m

$$\max_{s_i} (1-\tau)\alpha p_G(s_i + (1-s_i)R) + \tau p_C \alpha R - s_i(1+\rho)r$$

We observe both farmers using HY and NV - the expected profits from both must be the same. NE is given by:

$$(1 - \tfrac{s}{m})\alpha[g - \beta N\alpha(s + (1-s)R)](1-R) = (1+\rho)r$$

(inverse demand function)

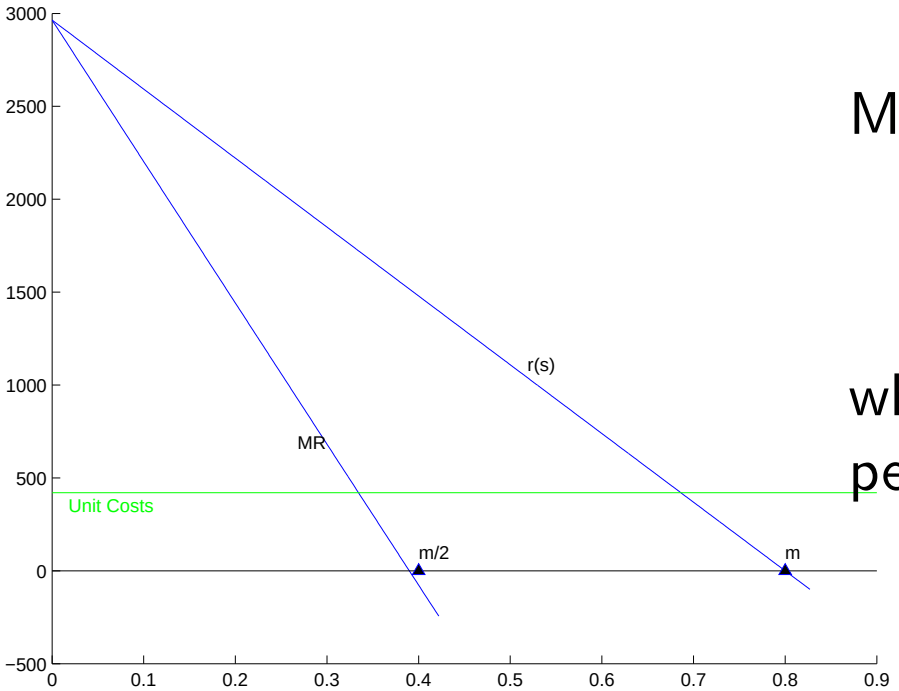


Figure: Demand schedule for HY seeds.

Monopolist producer maximizes:

$$\max_s r(s)sN - sNk$$

whereas for the perfectly competetive market in equilibrium:

$$r(s) = k.$$

Consequently, $s^M < s^{PC}$

Additionally , $s^M < \frac{m}{2}$.

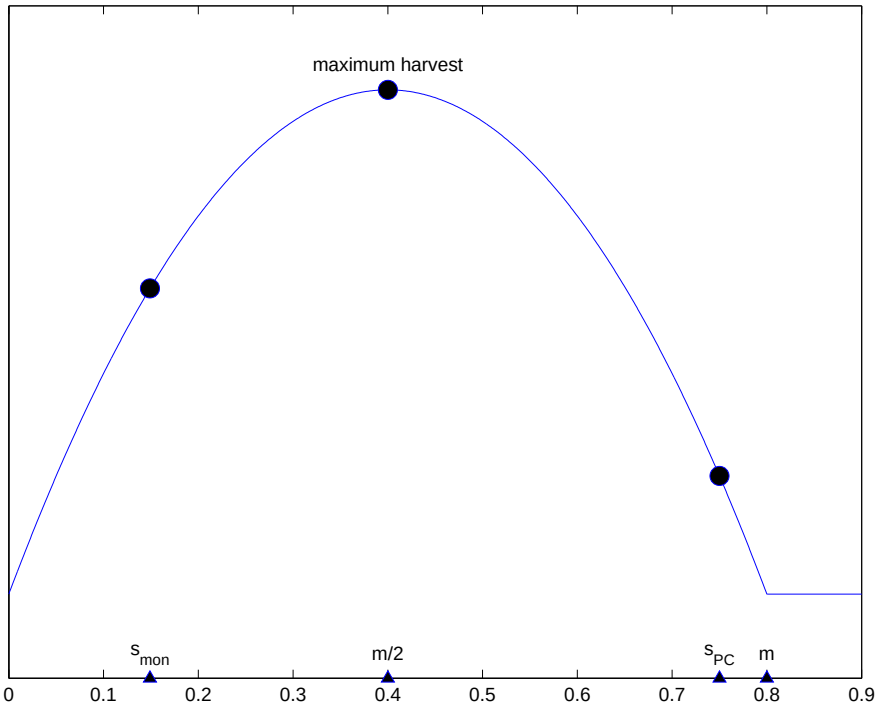


Figure: Relationship between share of HY and the total expected harvest

The share of HY, s, does not influence the outcome values for the disease case, just the p_G (through Q_G) and τ.
At a price p consumer welfare is $V = \frac{1}{2}[g - p]^2$, hence V is sitricly convex in prices .

$\rightarrow$ expected consumer increases if the expected price decreases (equivalently, if expected harvest increases):

$$|\frac{m}{2} - s^M| < |\frac{m}{2} - s^{PC}|$$

The effects of monopoly on farmers' profits.

z-axis: $|\frac{m}{2} - s^{PC}| - |\frac{m}{2} - s^{M}|$, x-axis: m, y-axis: R

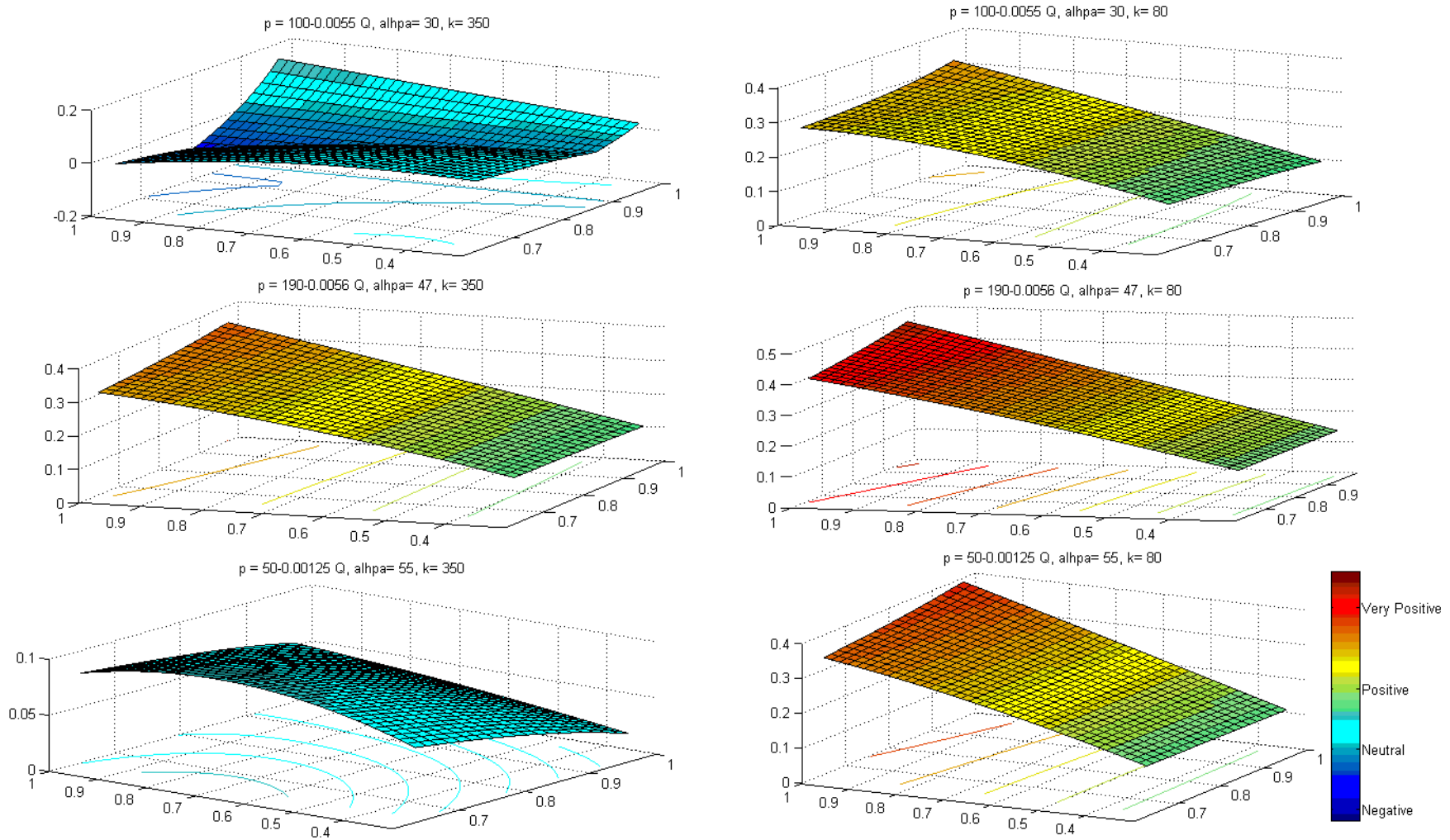


Figure: Effect of monopolistic seed producer as compared with perfectly competetive market for different parameter values.

Innovations are usually marketed not as one homogenous product but rather as a whole lineup of products (seeds) differing in terms of their maturity time, tolerance for drought etc. $\longleftarrow$ farmers are endowed with fields varying in terms of the soil fertility, climatic conditions...

Assumption of perfectly competitive market for the production of innovative seeds may be too strong.

Model the market in form of the Salop circle with horizontally differentiated seeds located on the perimeter. Inside the circle natural varieties are available for free.

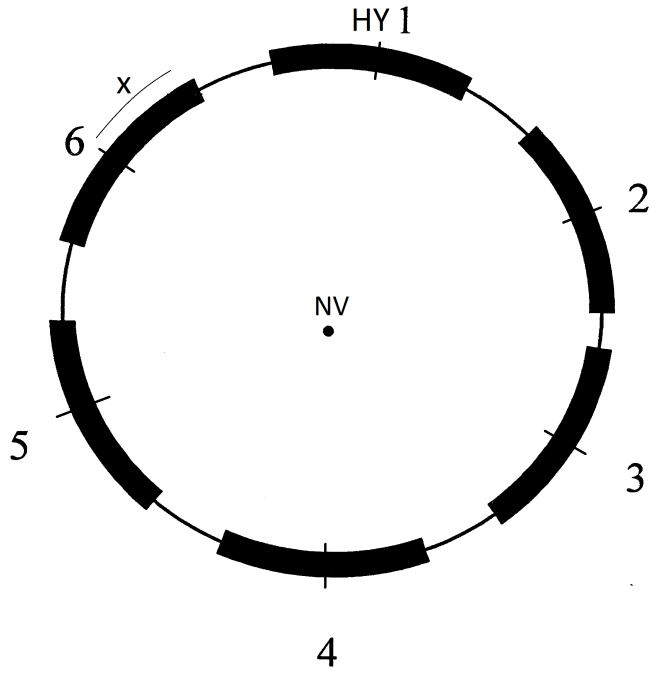
All parimeter products based on the same innovation but some R&D required for the product differentiation (cost of R&D-c).

Two cases:

Innovation patented by a monopolist who applies it to his own (differentiated) seeds after some R&D.

Open-access innovation. Firms use the innovation to develop own (differentiated) seeds using R&D - monopolistic competition.

N farmers are located uniformly on a circle and decide whether to buy one of the L varieties offered by the HY producers for price p_i (and incur the associated adjustment costs, $T(x) = tx_{ij}$) or get the natural variety for free.



The maximum price r_i that a farmer located at a distance x_{ij} is willing to pay for the variety is defined by:

$$(1-\tau)p_{ND}\alpha(1-R) = tx_{ij} + r(1+\tau)$$

The *monopolist* solves the maximization problem

$$\max_{x,L} 2NLx[r(x,L) - k] - cL.$$

For *monopolistic competition* the outcome is SPNE of a following four stage game:

1. L perimeter firms locate equidistantly on the circle, incurring fixed cost of c
2. the L firms choose simultaneously how much market to serve $(x_i,\ i = 1...L)$ taking into consideration the existence of natural varieties
3. farmers choose the preferred seed given the prices determined by the shares picked by the firms
4. harvest takes place with yields dependent on whether or not the innovation kept its efficacy. The harvest is sold on the competetive market to the final consumers at prices determined by the demand schedule: $p = g - \beta Q$.

Profits made by farmers depend on their location on the circle, especially on whether they are close to the one of the products (within the distance $x_{ij} < x$ for some i): The total sum of "extra" profiits that farmers obtaining HY make is given by:

$$0.5Ltx^2$$

As monopoly regime gives different expected havest and tends to choose higher x (but much lower L) than monopolistic competition, moving from one regime to another will not affect the level of their profits but also their distribution.

Monopolies protect the efficacy of innovations and prevent the tragedy of the commons.

Potential for monopolies to increase the consumer surplus - information about which world we live in necessary

Framework offers the possibility to investigate mixed market structures (e.g. the optimal length of a patent)