Individual Transferable Quotas: the role of Flexibility and Market power

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Overview

- Want to investigate a fishery «benchmark» case where a dominant firm is able to exert market power in the quota market, but is a price taker in the output market.
- Demand for flexibility, multispecies fisheries
- How to control fisheries with a convex tax,
  - 1. case full competition
  - *2. case market power*
- Illustrations

Optimal stock for sole owner – Gordon-Schaefer static model

- Stock size X in steady state: $\frac{\partial X}{\partial t} = F(X) - h = 0$
- Total harvest $h = e\,X$ where e is normalized effort
- Logistic natural growth function $F(X) = r\,X\,(1 - X/K)$
- For X(e) > 0, the stock-effort relationship becomes $X(e) = K - \frac{K}{r}\,e$
- Optimal profit: $\pi = \max_{e}[p\,e\,X(e) - \,C(e)]$ where p is a fixed output price &
- $C(e) = (c/2)e^2$ is a (quadratic) cost of effort function where c is a mean cost parameter

Optimal stock for sole owner – static model

- FOC: $p\,X(e) \;+\; p\,e\,X'(e) - c\,e \;= p\,K - \frac{2\,p\,K}{r}\,e - c\,e = 0$
- Optimal effort for sole owner $e_{so} \;= \frac{K\,p\,r}{2\,K\,p\,+c\,r}$
- MEY stock size $x = X(e_{SO}) = K - \frac{K}{r}\,e_{SO} \;= \frac{K(p\,K+c\,r)}{2\,p\,K+c\,r}$
- Individual harvest $h_i = e_i\,x \Leftrightarrow e_i = \frac{h_i}{x}$

Regulation introduced as follows:

1. Assume that the planner applies available historical data to estimate model parameters K, r and sole owner stock size $x = X(e_{SO})$ at MEY.
2. Before fishing starts, the parameters of the stock function are disclosed and become common knowledge. These parameter values will be used in the regulation scheme. The planner promises that these parameter values will not be changed during the forthcoming regulation period.
3. Subsequently, each firm i in the industry is informed that its revenue for landed fish will not be paid out through regular sale channels. Instead they will be compensated by the regulation authorities with a payment scheme build on the stock-effort relationship $X(e) = K - \frac{K}{r}\, e$

Efficient regulation I, Competitive share market

Like the stock-effort relationship $X(e) = K - \frac{K}{r}\ e$ the payment scheme consists of two parts.

- Benefits to i when harvesting the first fish: $B_i(h_i) = p\ \left(\frac{h_i}{x}\right) K - \left(\frac{c_i}{2}\right)\left(\frac{h_i}{x}\right)^2$ where individual effort e_i= $\frac{h_i}{x}$
- Quadratic tax equal to i's share of total catches $T(h_i, s_i) = s_i D(h) = s_i\ p\frac{K}{r}\left(\frac{h}{x}\right)^2$= $s_i\ p\ K/r\left(\frac{h_i}{x\ s_i}\right)^2$
- where we define a share quota holding as $s_i = \hat{h}_i/\ \hat{h}$ where $\hat{h}_i$ is the individual catch quota and $\hat{h}$ is TAC
- As indicated we want an outcome $h = h_i/s_i$ where $h = \sum h_i$ and $\sum s_i = 1$
- Maximising $\pi_i(h_i, s_i) = B_i(h_i) - s_i\ D(h_i/s_i)$ wrt h_i gives the necessary and sufficient first order condition for interior solutions $B_i'(h_i) = D'(h_i/s_i)$

Efficient regulation I, Competitive share market

This defines $h_i = h_i(\, s_i)$, which in the fishery case becomes

$$h_i(\, s_i) = \frac{p\, r\, s_i\, x^2}{2\, p\, K + c_i\, r\, s_i}$$

Through transferability heterogenous fishing firms can be individually induced to solve the same problem as a monopoly or a social planner.

The value of the fishery, expressed as a function of the share parameter s_i, is

$$V(s_i) = \max_{h_i} \{\pi_i(h_i, s_i) = B_i(h_i) - s_i\, D(h_i/s_i)\} = \frac{p^2\, r\, s_i\, x^2}{4\, p\, K\ + 2\, c_i\, r\, s_i}$$

Efficient regulation I, competitive share market

Proposition 1. *Suppose the constraint* $\sum s_i := 1$ *is perfectly enforced. Then, for all* i, *after trade* s_i *will be distributed among firms such that consistency is obtained. That is,*

$$h = \frac{h_i}{s_i} \ for\ all\ i.$$

where $h = \sum h_i$

Leading firm (L) excercises market power

- With traditional ITQs, market power can lead to inefficiencies. Losses due to market power can be subdued when quotas are more flexible.

- Rather than being exploited by the leading firm (L), the competitive fringe (F) might find it better to deviate from the 1:1 “quota — realised catches”- relationship that characterises competitive equilibrium

- In the first stage firm F trades quota shares in the market, solving the decision problem

$$\max_{s_F} \{ V(s_F) - \theta(s_F - s_F^0)\}$$

- where s_F^0 is the initial (grandfathered) share and price θ is the price per unit of s_F that may be manipulated by the leader. By the Envelope Theorem

$$\theta = V'(s_F) = \frac{p^3 K\, r\, x^2}{(2\, p\, K + c_F\, r\, s_F)^2}$$

- Since $V''(s_F) < 0$ the condition is both necessary and sufficient.

Leading firm (L) excercises market power

- The leading firm (with index i=L) has another formulation of its decision problem. It optimises its profit with s_L as the control variable, and as indicated, θ is a function of s_L. Additionally the formulation includes a condition that the market for share quotas must clear

$$\max_{s_L}\{V_L(s_L) - \theta(s_L)\left(s_L - s_L^0\right)\}\ s.t.\ s_L = 1 - s_F$$

- The first order condition is

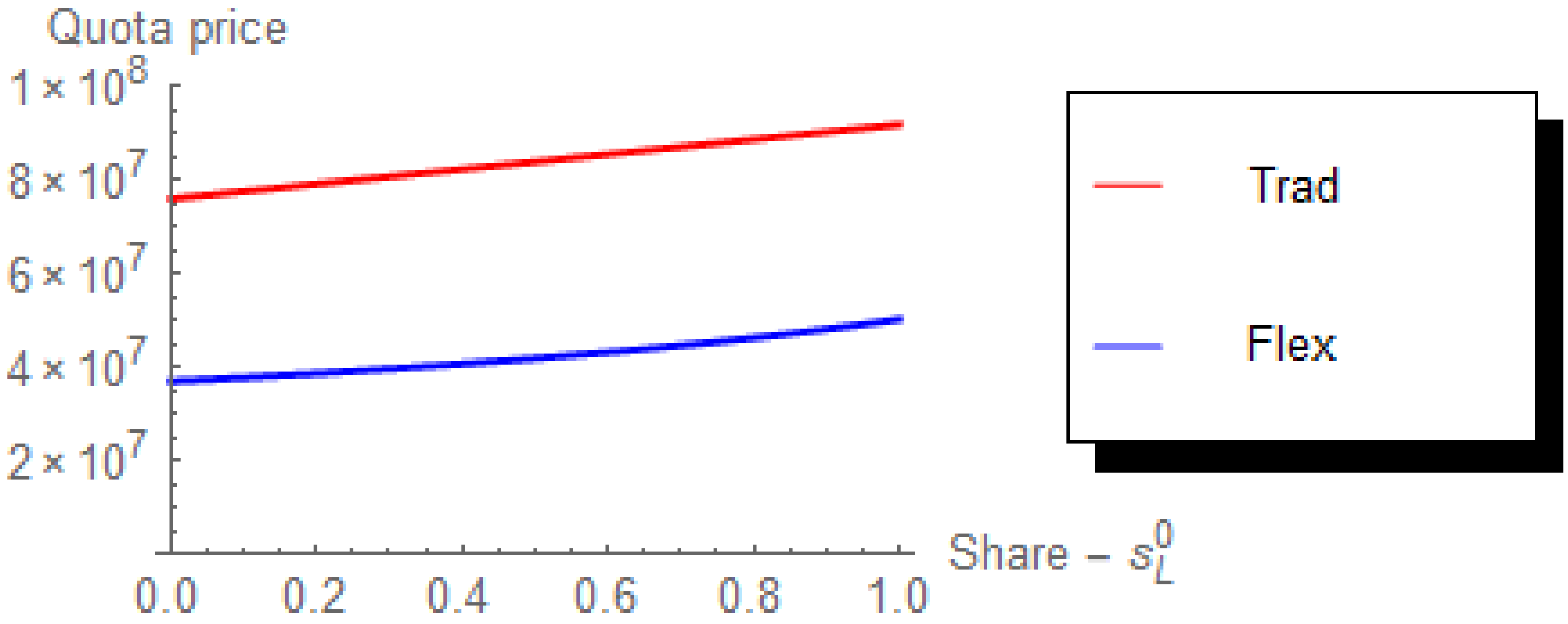
$$V_L'(s_L) - \theta'(s_L)\left(s_L - s_L^0\right) - \theta(s_L) = 0$$

which is a complicated expression of order 3 in s_L and s_L^0. The equation solves into three roots, of which only one root is real.

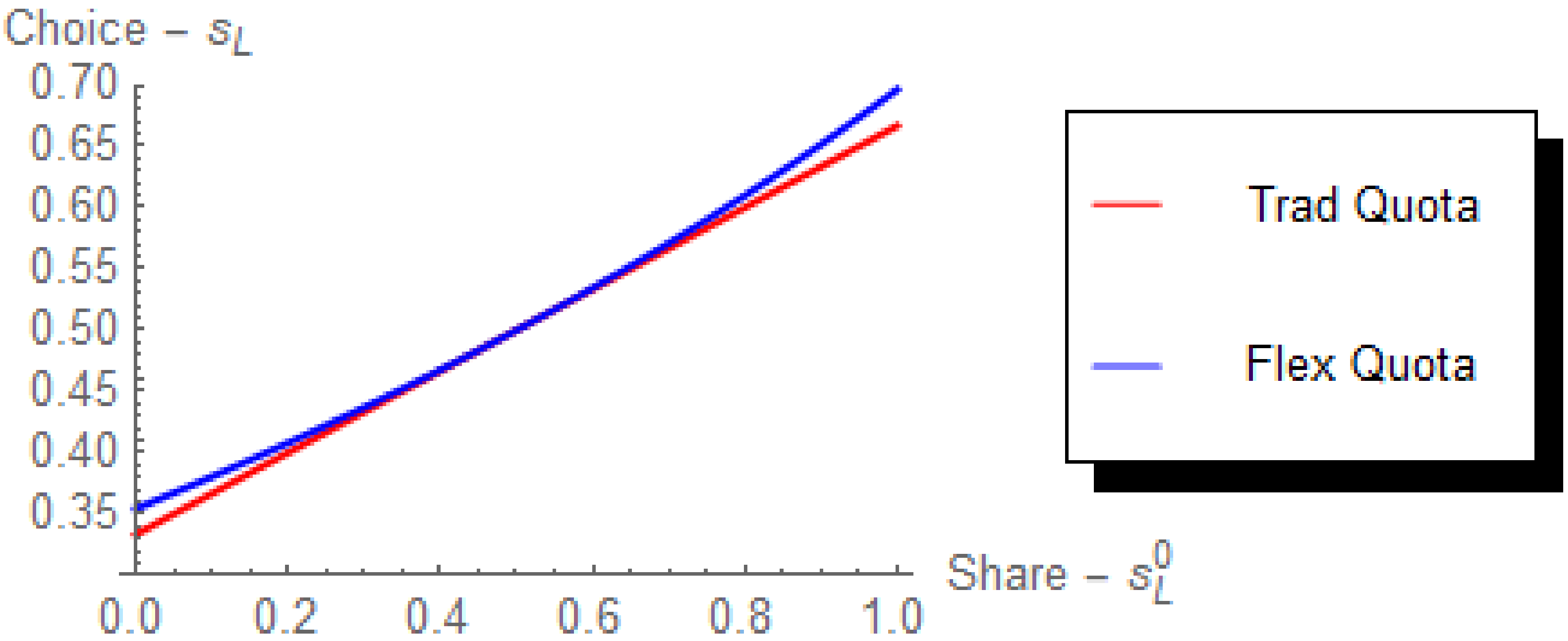
A case study: the NW Mediterranean demersal fishery

- Flexible regulation will be compared with traditional transferable quota regulation (Helgesen 2022).
- We use data from an effort regulated bottom trawl fishery in the North Mediterranean Coast.
- Assume that the fleet will be quantity regulated and that individual vessels are owned by two firms (firm L and F), having homogeneous cost functions.
- In one case there is no market power present, while in the other case firm *L* ha market power while firm *F* is the competitive fringe.

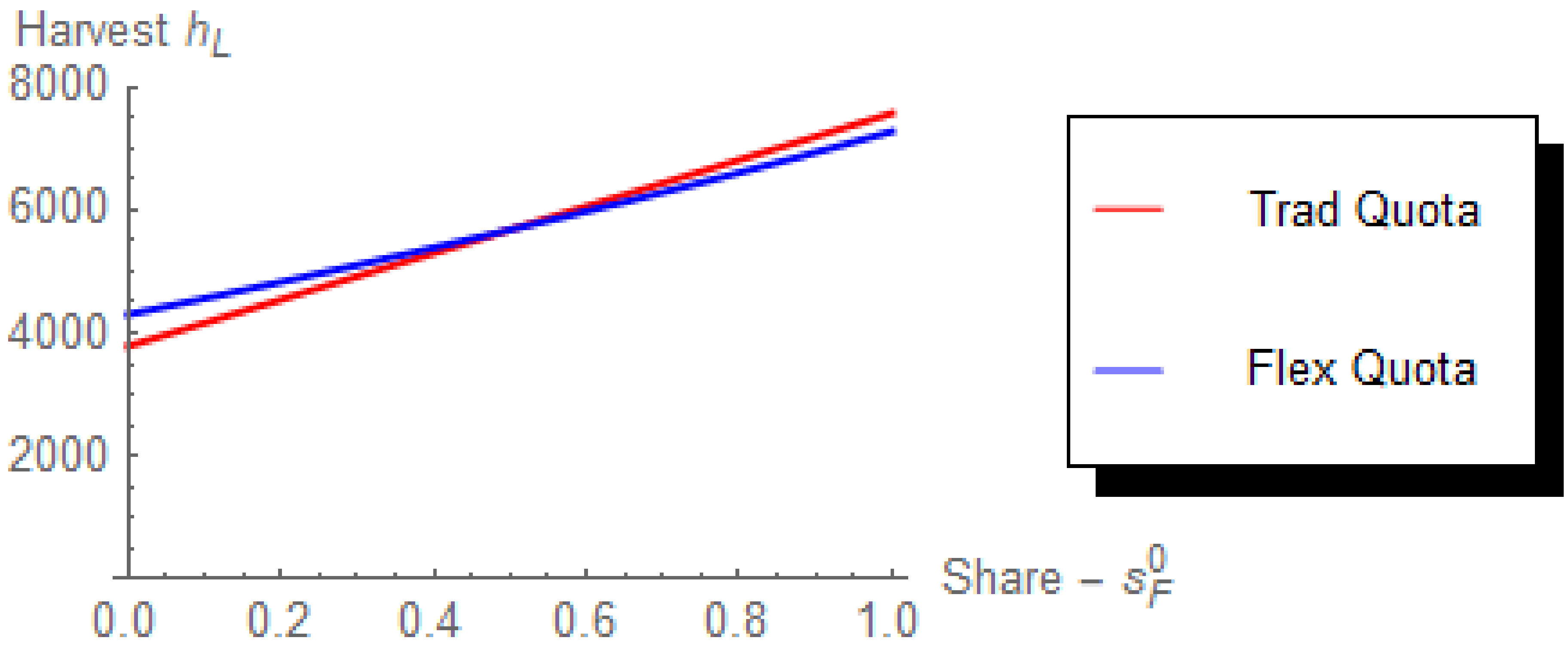
Share quota price as a function of initial share of the leading firm. Difference due to tax payment



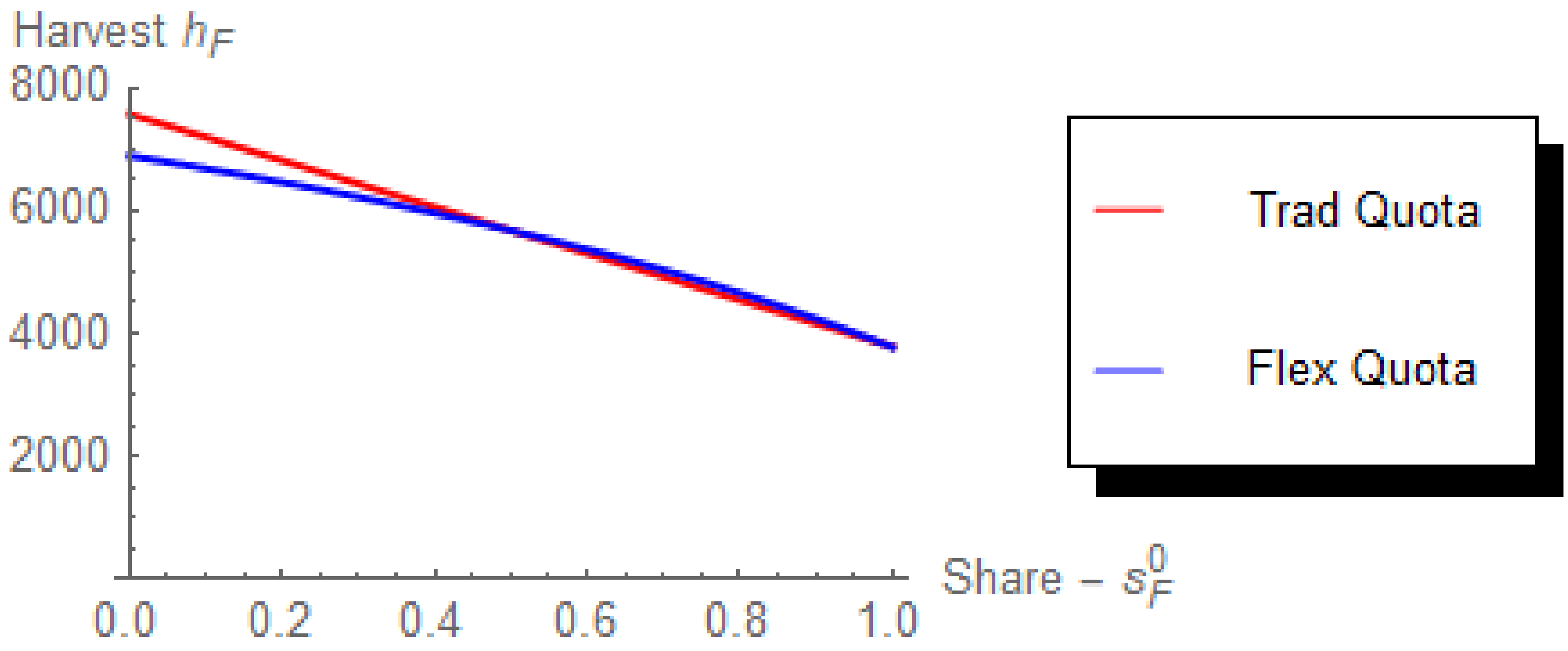
Final choices of shares s_L as a function of leader's initial (grandfathered) allocation.



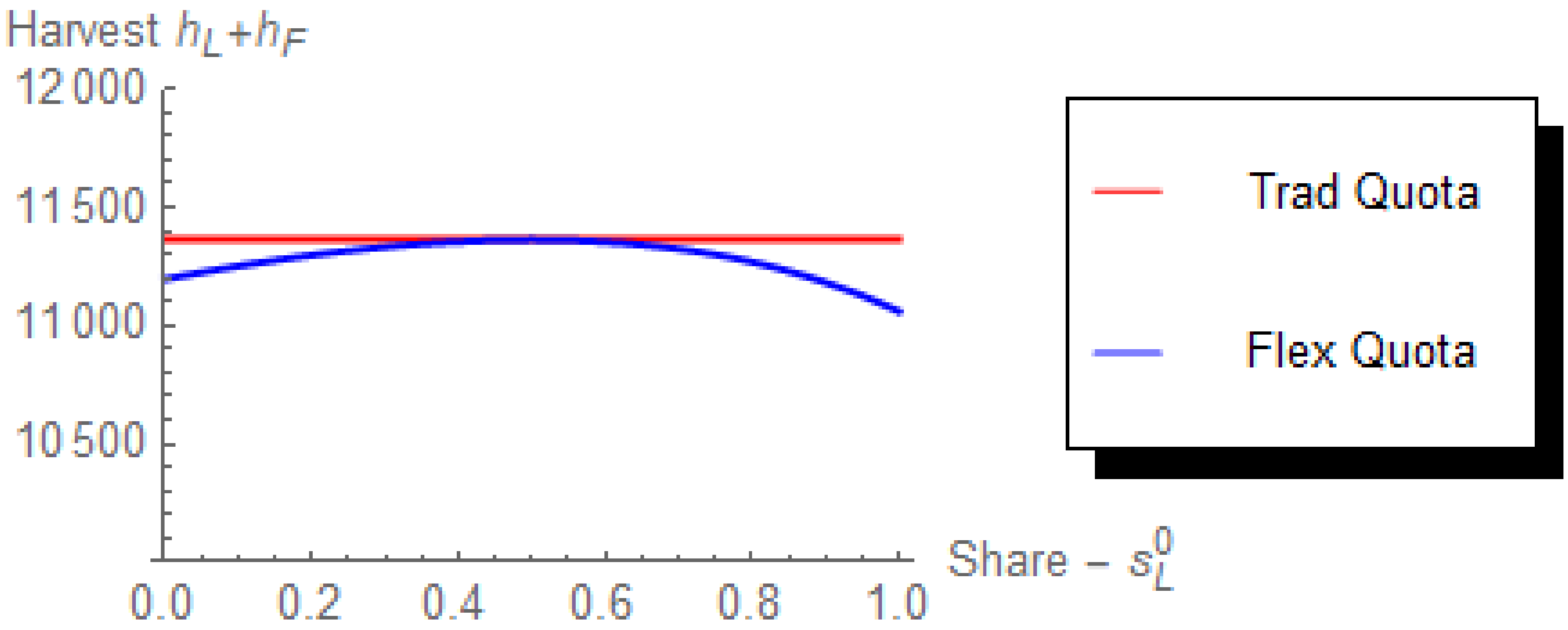
The leader's final choice of harvest h_L as a function of its initial (grandfathered) allocation. Crossing at the full competition point $(\mathbf{0.5}, \mathbf{5681})$.



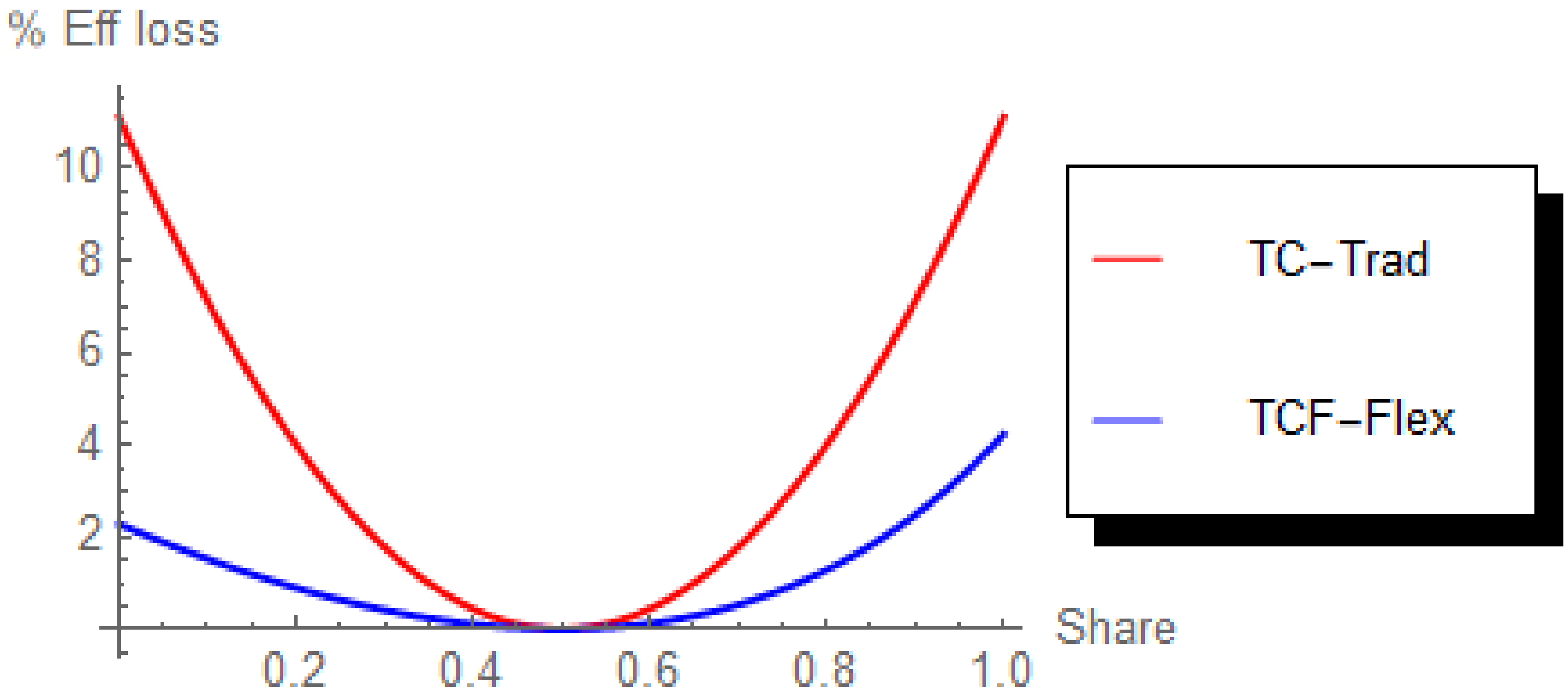
The fringe's final choice of harvest h_F as a function of the leaders initial (grandfathered) allocation. Crossing at the full competition point $(\mathbf{0.5, 5681})$.



Total choice of harvest $h_L + h_F$ as a function of the leaders initial (grandfathered) allocation. The full competition point $(\mathbf{0.5, 11363})$.



$$\Delta TC = 100 * \frac{TC^{**} - TC^{*}}{TC^{*}}$$



Thank you for your attention