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# A Model of Endogenous Market Structure, Innovation, and Licensing in Agricultural Biotechnology

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May 2010

*Poster prepared for presentation at the Agricultural & Applied Economics Association 2010  
AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010*

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by Benjamin Anderson\* and Ian Sheldon\*\*

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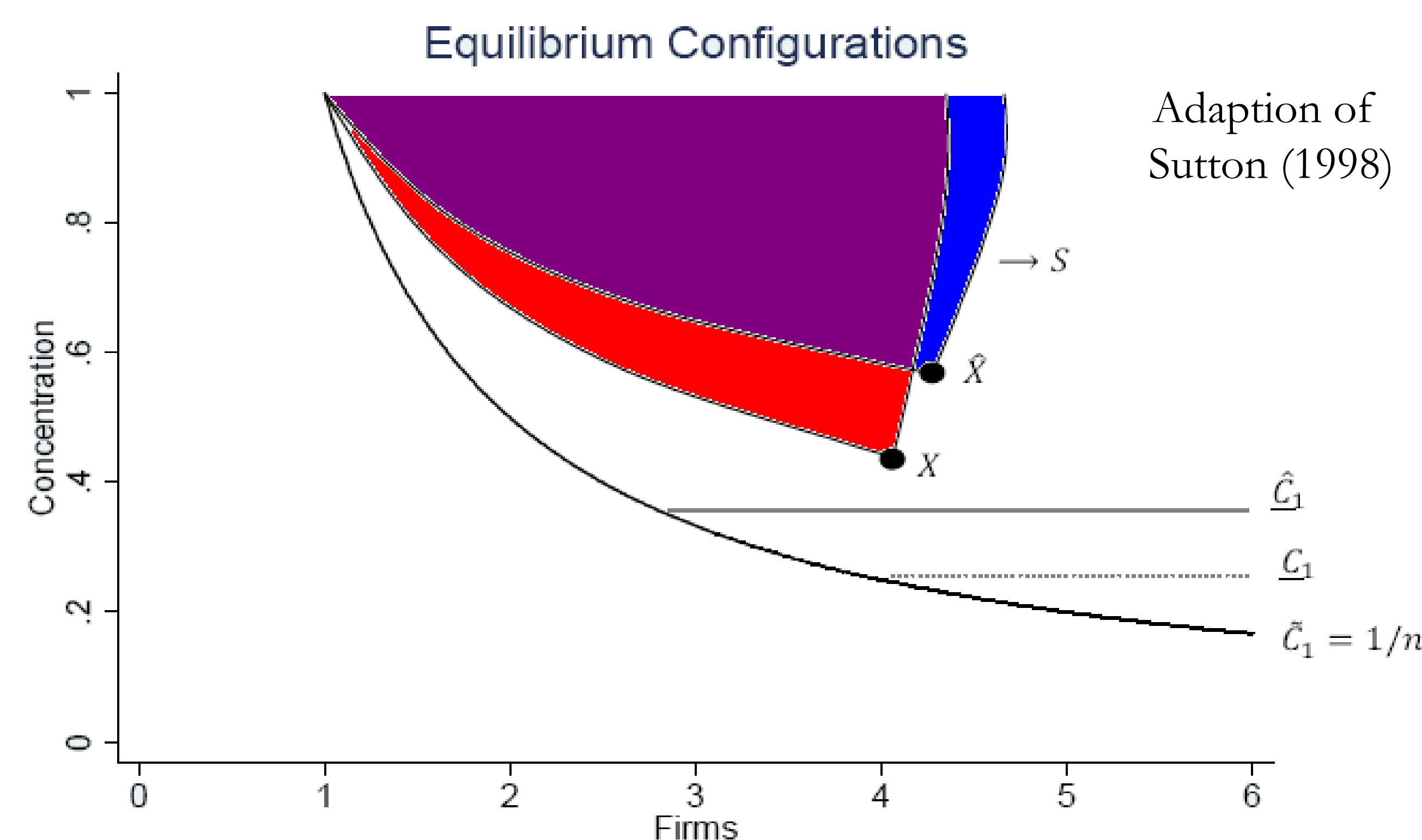
## Abstract

We develop a model of endogenous market structure and sunk cost R&D investment that allows for the licensing of technology among competitors. Our theoretical model predicts both a greater lower bound to market concentration and higher levels of quality compared to the case without licensing. These results imply that in markets in which licensing and asymmetric R&D costs are prevalent, such as the agricultural biotechnology sector, the ability to license technology generates more concentration among firms but also improves consumer welfare by incentivizing the production of higher quality.

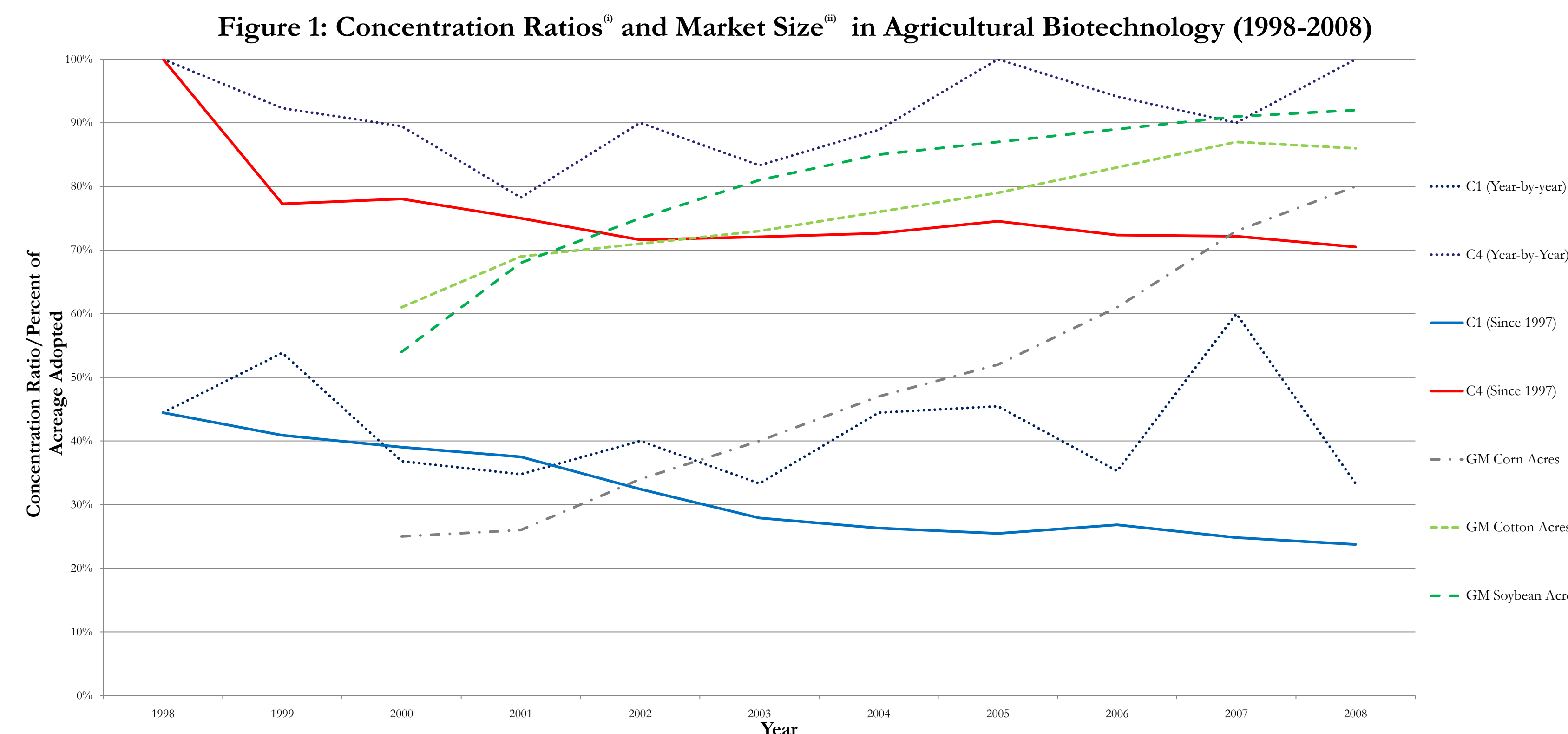
## The Question

How does the endogenous formation of market structure change if we allow for strategic alliances between firms?

## Equilibrium Configurations



## Motivation



Source: (i) Author's calculations (Data retrieved from the Field Tests Database, Biotechnology Regulatory Services, APHIS, USDA); (ii) Retrieved from calculations of Fernandez-Cornejo (2009) "Adoption of Genetically Engineered Crops in the U.S." (Source data from NASS June Agricultural Survey, NASS, USDA).

## Model

Three stage entry game in which market structure is determined endogenously by the levels of sunk cost R&D investments by firms.

Firms first choose to enter the market and upon entry make a deterministic fixed (sunk) investments in quality along some set of research trajectories. In the final stage, firms compete in quantity in the product market.

Consumers get utility from both the amount of the good they consume as well as the quality associated with the good.

Firms can attain a given level of quality by pursuing their own R&D and incurring a sunk cost which is increasing in the level of quality. Alternatively, firms can license quality from a rival, incurring a minimum setup cost, a transactions cost, and a fixed-fee royalty payment, expressed as a percentage of sales from the associated product.

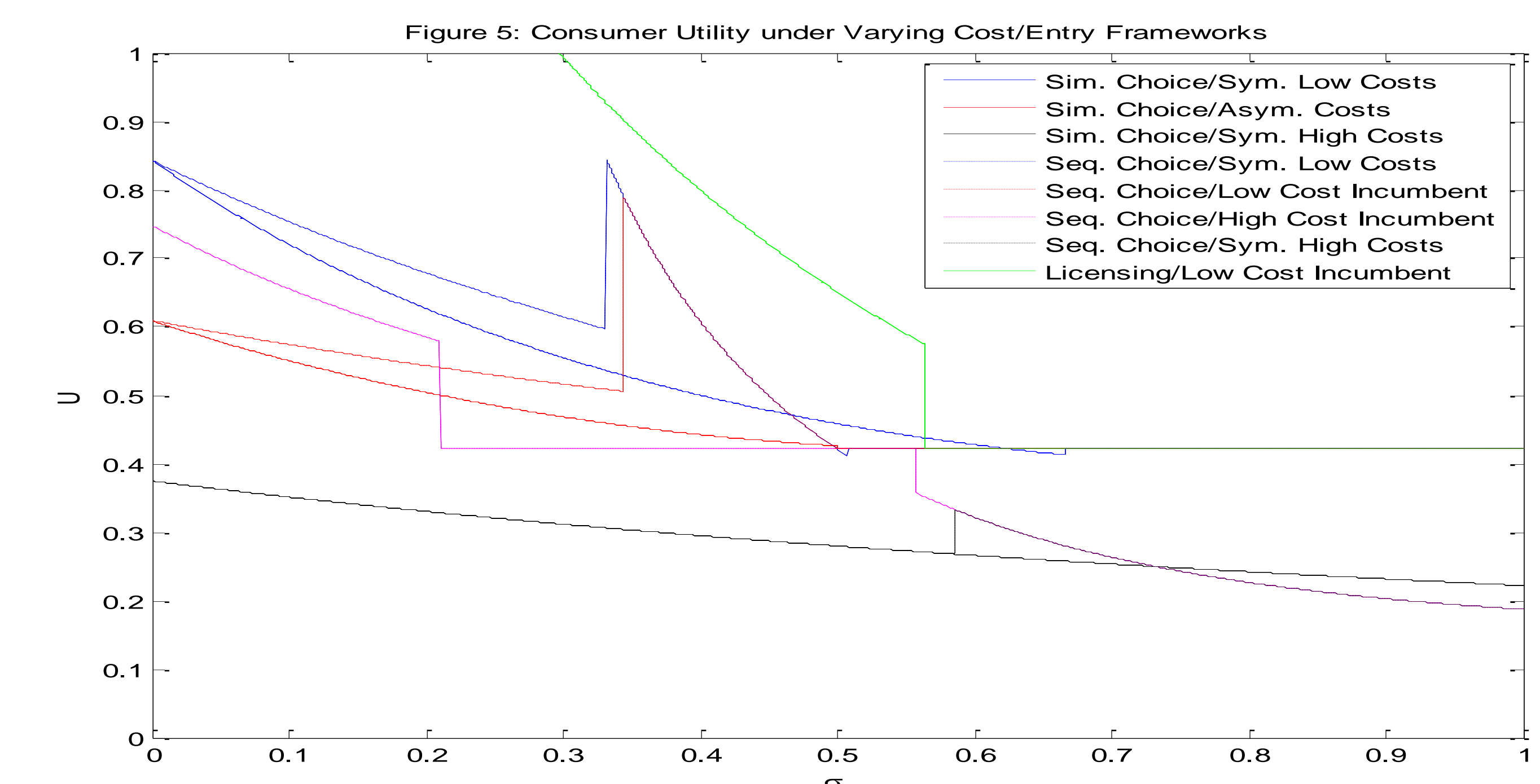
Market structure is determined endogenously by solving for a configuration of qualities under which all active firms, both licensors and licensees, earn positive profits net of sunk R&D investments such that all profitable entry opportunities are realized.

Despite increasing adoption rates and market size, an increase in firm entry has not been observed in the agricultural biotechnology sector.

Concentration ratios have decreased only gradually even though the domestic market has been growing steadily.

The relaxation of "anti-stacking" provisions has led to an increase in the observed number of licensing and cross-licensing agreements among agricultural input firms.

## Illustrative Example



Results from a duopoly quality-quantity choice model imply that consumer welfare is greatest if firms with asymmetric costs are able to license their technology.

## Conclusions

The introduction of licensing raises the lower bound to market concentration in an endogenous sunk cost industry.

There are incentives for a firm with R&D cost advantages to escalate its levels of quality and recoup the costs via royalty payments from licensees.

The effect of licensing on consumer welfare is ambiguous: decreasing in concentration, but increasing in the quality.