Numerical simulations reveal complexity of outcomes in digital markets

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Bundling is a key feature for information goods. These goods include many of the services like music streaming, gaming and subscription television or video streaming services that make up a substantial share of the modern economy. Consumption of these services takes up an ever larger share of many consumers' leisure time. Firms are faced with the challenge of how to price their offerings since a cost-plus model is no longer appropriate.

We have constructed a computer simulation model of markets for information goods that allows us to explore outcomes and strategies under the assumption that firms offer differentiated products and price at discrete price points (not on a theoretical mathematical continuum) and that the consumers are a finite (set of individuals and/or groups). Our simulations demonstrate the degree to which outcomes depends, in more than one way, on chance.

We are currently considering two firms, both of which have two highly similar (possibly, digital content) products. It is assumed the firms can bundle arbitrarily, the consumers' willingness-to-pay is known to the firms who then collude in making pricing decisions so as to maximise their revenue. This amounts to the firms maximising joint profit since these are information goods. The model incorporates a principle of bounded rationality by limiting the ability of the firms to determine exact revenue-maximising pricing strategies.

Our simulations consist of rounds that involve a scenario of random customer willingness-to-pay (WTP) values, determining profit-maximising prices in each round for the two firms under the assumption that consumers maximise their surplus. In each round, the firms are allowed to examine a fixed number (iterations) of randomly sampled prices and determine what their revenue would have been, had prices been set like that.

Consumers may purchase any combination of products or bundles. In the initial work, we illustrate the diversity of outcomes based on 100 consumers. We assume that the individual products (two per firm) have integer prices (but not the bundles, the prices of which are determined by a fixed formula). This appears to be a realistic aspect of the model and it has the additional advantage of side-stepping the Bertrand paradox.

All the calculations for initial research were able to run in under 24 hours of total computer time, on a good but standard laptop computer using Python, Excel and LibreOffice Calc. They suggest the following.

- There are relatively modest incentives for firms to engage in high-effort maximisation of revenue.
- It is not uniformly the case that firm's effort to extract revenue necessarily harms consumers.
- High prices sometimes coincide with high firm revenue but often do not.
- The underlying WTP scenarios and the (bad) luck of lazy firms both influence the outcomes we observe.
- Strong market dominance by one firm often arises purely through chance.

Our model illustrates, to both firms and regulators, the complexity of underlying market forces in very simple scenarios. Future work will include examining outcomes with regard to the characteristics of the underlying willingness to pay instances and also considering higher customer valuations for the differentiated products.

We do not exaggerate the extent to which our model reflects marker reality but propose that the assumption that firms always find optima, very common in the literatur, is far from realistic. A model with integer prices and a finite number of consumers (as a proxy for groups of consumers) offers many insights.

Preliminary numerical results will be presented at the ITS 2018 biannual conference in Seoul during June.

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