An agent-based simulation of lock-in dynamics in a duopoly

(Extended Abstract)

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ABSTRACT

We create an agent-based simulation to explore consumer lock-in in a duopoly of experience goods (goods with characteristics that are difficult to determine in advance, but ascertained upon consumption). We model heterogeneous agents using simple assumptions, where agents choose between products based upon personal experience and neighbours' decisions. We test strategies to break a lock-in through a free give-away and advertising. We find that, under our assumptions, breaking a lock-in required the formation of regions where the competitor product was adopted, likened to a niche in the market.

Categories and Subject Descriptors

J.4 [**Social and Behavioural Sciences**]: Economics, Sociology; I.6.5 [**Simulation and Modelling**]: Model Development, Modelling methodologies

General Terms

Experimentation, Human Factors, Economics

Keywords

Agent-based simulation, consumer behaviour, lock-in.

1. INTRODUCTION

Lock-in describes a situation where a single product dominates a market place over similar competing products. Examples found in literature are the QUERTY keyboard layout [3] and the VCR format "war"[1, 2]. Economists and psychologists have identified factors that may contribute to lock-in formation such as cognitive [4], where familiarity reduces cognitive load and impedes exploring alternatives; path dependency [1], where decisions may limit the proceeding choices (including bandwagon effect and network costs [6, 5]), and propriety lock-in, such as Apple iTunes proprietary format. Little literature is devoted to how a lock-in may be broken. We therefore create an agent-based model to explore the dynamics involved in breaking a lock-in.

Cite as: An agent-based simulation of lock-in dynamics in a duopoly (Extended Abstract), Michael Garlick and Maria Chli, *Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2010)*, van der Hoek, Kaminka, Lespérance, Luck and Sen (eds.), May, 10–14, 2010, Toronto, Canada, pp. 1545-1546

2. SIMULATION MODEL

The simulation revolves around two competing products in a market, where consumers decide which product to buy through selecting the product with the highest associated utility for the consumer (agent). The utility is calculated as shown in Eq.(1), which includes the extent to which consumers follow neighbours decisions (ft), individual experience of a product (Q) and the proportion of neighbours' purchasing the product N_i/N_P. N is the set of all neighbours, and P is the set of all products, with $i \in P$ being the product in consideration. Consumers are located in a grid, representing their social environment, where consumers consider all neighbours equal and have homogeneous network size. Local neighbourhood refers to the consumers Moore neighbourhood of radius one, whilst global refers to all consumers. The quality of each product has a normal distribution representing the product quality distribution, from which the consumer draws their experience upon first "purchase".

$$U_i = (1 - ft)Q_i + ft\frac{N_i}{N_p} \quad (1)$$

2.1 Model assumptions

We make the following assumptions: consumers assume all products are equal before consumption; product experience is gained upon first consuming the product; consumers differ in their strength of follower tendency ft, $U(0, 1)$; neighbouring consumers purchases are observable and every consumer regards the members of their network equally, with the network size homogeneous for all consumers.

2.2 Model behaviour

Initial tests of the model showed that lock-in may be global under global neighbourhood conditions, or localised in regions under a local neighbourhood. In a localised lock-in no product gains overall market dominance. However, well defined regions form which are locked-into a single product, bringing about an overall equilibrium in market share. We found that whilst maintaining an equal quality distribution it was not possible to break the lock-in. With alterations to the distribution of one product to yield a "better" product ($\mu_a = 0.5, \mu_b = 0.7$), but maintaining equality in the initial perceived quality ($\forall i \in P, Q_i = 0.5$), we found that the lock-in may still form in favour of the inferior product.

3. BREAKING A LOCK IN

We first simulate a lock-in to one of the products, e.g.

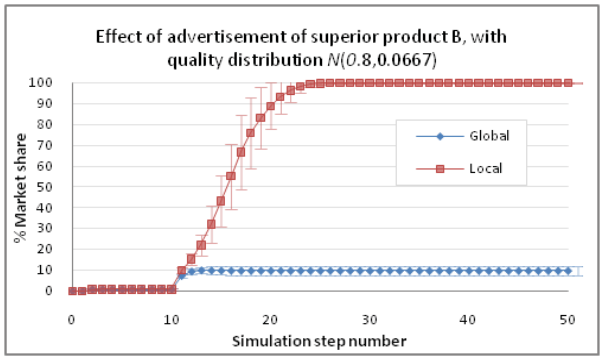

Figure 1: Market share of superior product B after advertising occurs in the 10th step. The trend shows local networks may reverse a lock-in.

Figure 2: The spatial representation of consumer choice for product A (light) and product B (dark) during the advertising scenario with local neighbourhood at steps 5, 10 (after advertisement) and termination respectively.

product A, before introducing a new superior product B. We then test two different strategies to break a lock-in:

- **Free give-away:** where a percentage of the population, selected at random, are given product B once during a single step.
- **Advertising:** where every consumer receives notification of product B's mean quality ($Q_b = \mu_b$) during a simulation step. A consumer's view of the quality may differ upon purchasing B.

Product B is available from the start of the simulation; advertising or free give-away occurs during the tenth step.

3.1 Advertising

Fig. (1) shows the resulting market shares from advertising product B in the 10th step of a simulation. Under global neighbourhood, it fails to capture any market share despite advertising, whilst under local neighbourhood the lock-in is reversed. Fig. (2) shows the spatial representation of the local neighbourhood interactions "growing" to break, and reverse, the lock-in of product A.

3.2 Free give away

Fig. (3) shows the resulting market shares of product B during free give-away's when consumers consider their local neighbourhood. The results show it is possible to break a lock-in as the amount of product B given-away increases. Fig. (4) shows that within a global neighbourhood, the same strategy is unsuccessful in breaking a lock-in. Spatial representations showed that with local neighbourhood, local regions locked into product B perpetuated or grew. In the global neighbourhood the consideration radius is so large that the "region" remains globally locked into product A.

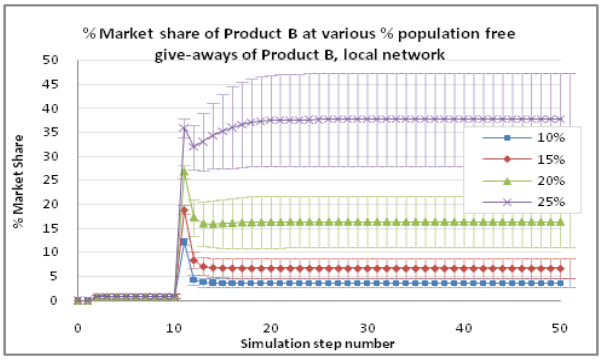

Figure 3: Market share of product B after free give-away in local neighbourhood. The trend shows that market share may be captured with increasing proportions of the consumers given the product.

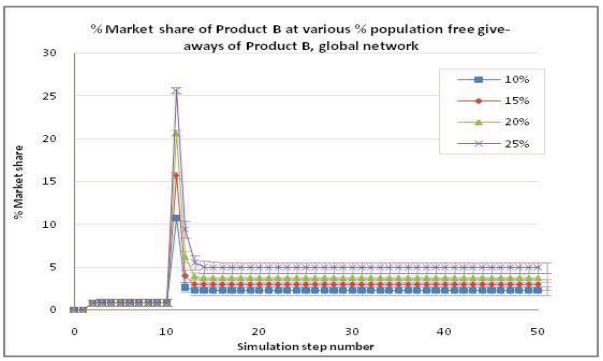

Figure 4: Market share of product B after free give-away in global neighbourhood. The trend shows that no significant market share is captured.

4. CONCLUSION

Using simple assumptions with regards to a consumer purchase decision being based only upon the perceived quality of the products and conformity with their neighbours, we observed that methods which overcame a lock-in exhibited similar patterns. Lock-in was only successfully overcome if spatial regions of the superior product are formed within the population locked into the inferior product. Future work may focus upon targeting specific regions related to consumers, and different network topologies.

5. REFERENCES

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