

The need

150 million times a day, someone somewhere chooses a Unilever product. Unilever is one of the largest consumer goods companies in the world. Its mission is to add vitality to life, meeting everyday needs for nutrition, hygiene and personal care. It manages around 400 brands spanning 14 product categories.

Modelling consumer behaviour is complicated and the data available is vast. Agent-based models are a style of computational modelling that focuses on modelling individuals or heterogeneous parts of a complex system. However, validation of such models (an essential step in model development) is extremely difficult. The aim of this project was to create an agent-based model that could be validated.

The outcomes

This internship project contributed to Unilever's aim of developing a holistic model of shoppers' behaviour, taking into account heterogeneity in their demographic profile, as well as past responses to pricing, promotion and marketing strategies. Using large disaggregated panel data sets of supermarket transactions, the intern developed, implemented and validated an agent-based model (ABM) of consumer choice.

A key challenge for Unilever's researchers has been to come up with a validation methodology using real-life data for the choice

models that they have been developing. Stephen's contribution as an Intern goes a long way in taking those very important first steps in the validation exercise. These are important steps, not only for this project, but also as a contribution to the growing literature on the use of ABMs to study consumer markets.

Unilever are not only more confident now of the use of the ABM methodology for business purposes, but will also benefit from the increased visibility of their research group within the ABM community.

"[The project] has played a key role in taking a step towards one of the challenges we were facing – i.e. validation of agent based consumer choice models. I found the experience extremely rewarding and I look forward to future collaborations and publications."

Abhijit Sengupta, Unilever

Technical summary

The project took an agent-based consumer choice model developed at Unilever and followed an iterative process of developing a simplified version of the model and implementing it as a computer simulation with the intention of applying validation techniques in order to assist the validation of the full model.

The advantage of agent-based models lies in their ability to model heterogeneity and emergence within populations. As such, validation needs to occur on multiple levels. Usually this happens at the macro/population and micro/individual levels. In this project, validation at the macro level involved examining overall market shares and at the micro level involved examining consumer choice in terms of product characteristics such as brand, flavour or carton volume, so enabling an examination of individual consumer preferences.

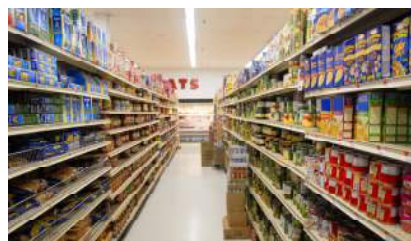
The final simplified model incorporated a weighted consumer choice function of net product price and product characteristics. Product characteristics refer to quantities or qualities of the product, such as brand or pack size, which are mapped to the interval $[0,1]$ based on the volume of sales of categories within each char-

acteristic. Each product was mapped to a point of the unit cube in a three-dimensional characteristics space.



Following the development of the computer simulation model, panel data of the sales of fruit juice in 2007 from an internet shop were used in the initialisation of agents' characteristic preferences, calibration of parameters and subsequent testing of predictions out of sample. Out of sample tests gave us greater confidence on the ability of our model to predict real life sales.

The current validation exercise involved statistical techniques comparing the outputs of the simulation for a three month period to the real data covering the same period. Related ideas on probability evolution are currently being explored in a partial differential equation framework as a means of comparison against the ABM model, with the hope of providing further validation.



"The project matched well with the original plans but was also allowed to veer a little in a constructive way. It benefited all and involved some new departure for all sides concerned. The venture has been very refreshing from my (academic) side."

Frank Smith
UCL

This project was part of the programme of industrial mathematics internships managed by the Knowledge Transfer Network (KTN) for Industrial Mathematics. The KTN works to exploit mathematics as an engine for innovation. It is supported by the Technology Strategy Board, in its role as the UK's national innovation agency, and the Engineering and Physical Sciences Research Council, in its role as the main UK government agency for funding research and training in engineering and the physical sciences.



Project Details

Partners

Unilever
UCL

Project investment

£12,000

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