

Agent based models: practical examples
people have paid money for

Paul Ormerod

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www.paulormerod.com

What is an Agent Based Model (ABM)?

- 'agent' = 'decision maker'
- 'model' = 'map'
- Tries to capture the behavioural rules of decision makers
- Like a map, simplifies dramatically: needs to reflect the most important features of a problem, and leaves out large amounts of small detail

Standard economics is an ABM!

- Mainstream economics is essentially a theory about how agents – individuals, firms, regulators – make decisions
- Like all theories, it makes simplifying assumptions to make sense of the world
- In the basic model, agents are assumed to gather *all* relevant information
- They then make the best possible decision – the ‘optimal’ one – given this information and their preferences
- It is not a completely empty box e.g. if the tax on beer goes up, less of it will be drunk
- Modern versions allow agents to have less than complete information – the basis for a lot of policy

But.....

- **Vernon Smith, Nobel Laureate 2002:** 'I urge students to read narrowly within economics, but widely in science. Within economics there is essentially only one model to be adapted to every application: optimization subject to constraints due to resource limitations, institutional rules and /or the behaviour of others, as in Cournot-Nash equilibria. *The economic literature is not the best place to find new inspiration beyond these traditional technical methods of modelling*'
- More realistic assumptions about behaviour are often needed
- **Daniel Khaneman, Nobel Laureate 2002:** 'Agents reason poorly and act intuitively'

ABMs are not new

- There is now a big academic literature in a wide range of disciplines
- A famous and early example is Thomas Schelling *Dynamic Models of Segregation*, 1971
- Standard software is available e.g. NetLogo, RePast
- There is a substantial literature on verification and validation of such models
- Mainstream economics essentially ignores them, but there are powerful applications to financial markets and the macro economy (no 'representative agent' in the financial crisis!)
- In short, agent based modelling is a well established technique based on a broad consensus on how it should be done

Some ABM clients

- Financial Services Authority
- Department of Health
- South West Regional Health Authority
- British Telecom
- Svenska Handelsbanken
- Advertising Association
- Water company consortium

What are the features?

- The model is designed to reflect the views of the client(s) on how the relevant agents really do behave in the particular context
- Decision makers usually have a 'mental map' – we synthesise these and try to produce a coherent narrative
- Need to specify the agents, how/what/when they decide, who their decisions affect, who they are affected by
- Like mainstream economics, we want the key features which enable us to construct a model which is useful to decision makers
- Pointless to have a 'model' which is so detailed that no-one can understand it
- Plausibility of the results to the client is a key part of validating the model – ideally, you want most results to be expected plus a few which are not!

Why do people want them?

- **To answer specific question(s) they may have e.g.**
- Why has our market/company evolved the way it has
- What happens if.....? *This is the single most frequent use*
- How do we persuade the regulator that.....?
- They are all practical questions to which practical answers are needed
- There are usually time (and resource) constraints

ABMs and policy modelling: elective surgery in the National Health Service

- Carried out for UK Department of Health: client actively involved
- Elective surgery in the NHS was essentially centrally planned: you have your operation in the hospital nearest to you
- What happens if consumers can choose where to go?
- Decision rules for consumers and providers

Agents in the model

- 3 types of motivation for hospitals
- 4 types of consumer
- The model features waiting times and quality of service
- Consumers decide which hospital to go to for their operation (or their doctor might, we do not distinguish the two)
- Hospitals decide whether to invest money in effort, quality and capacity
- There are potential new entrants who decide whether to enter the market

Summary of results

- Agents are myopic, use simple forecasting rules, exhibit inertia, have imperfect information, some producers are captured by producer interests in their motivations
- **But** in general:
 - average quality improves
 - - average wait time falls
 - - consumer utility increases
- averages are the appropriate weighted average by number of consumers

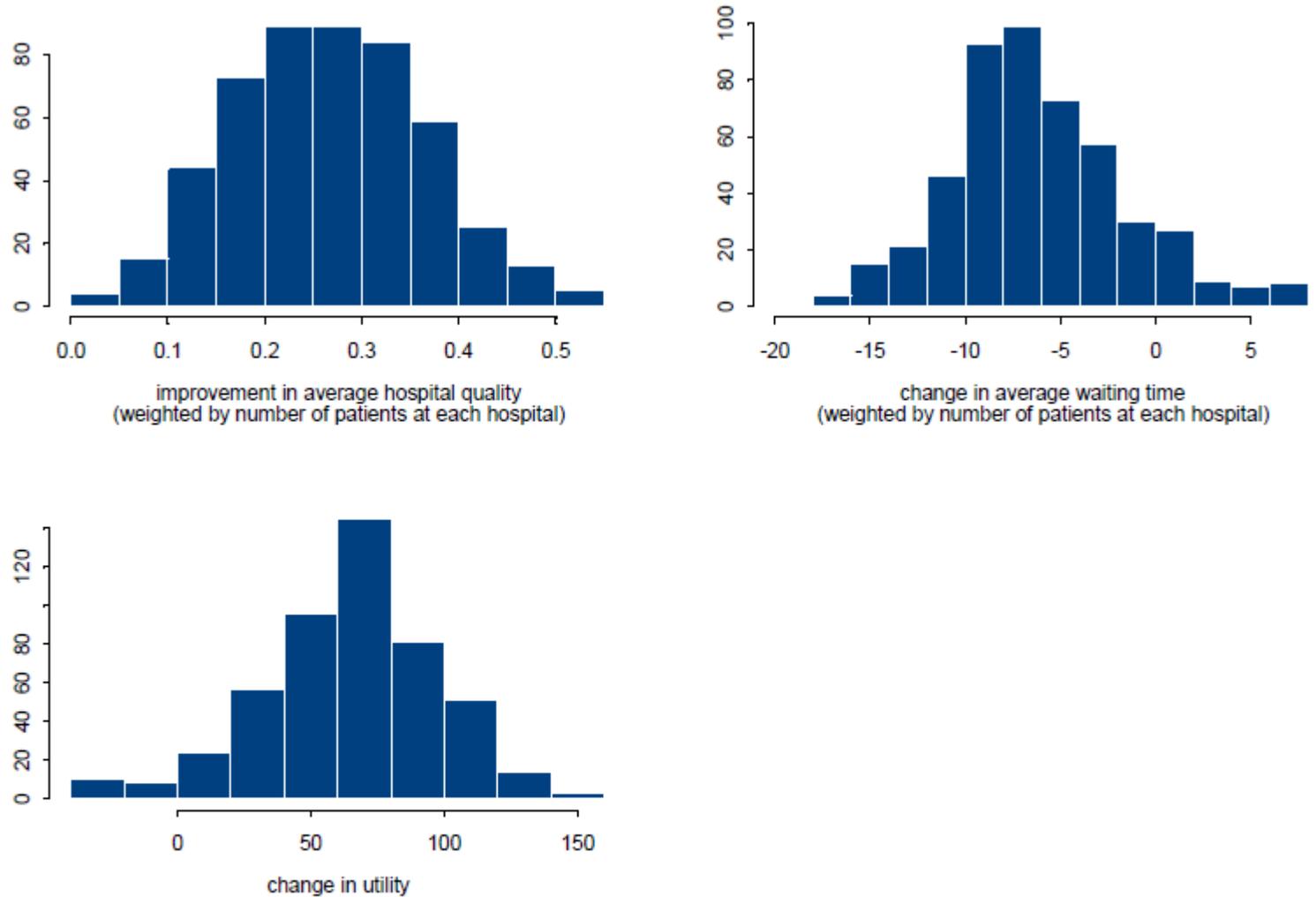
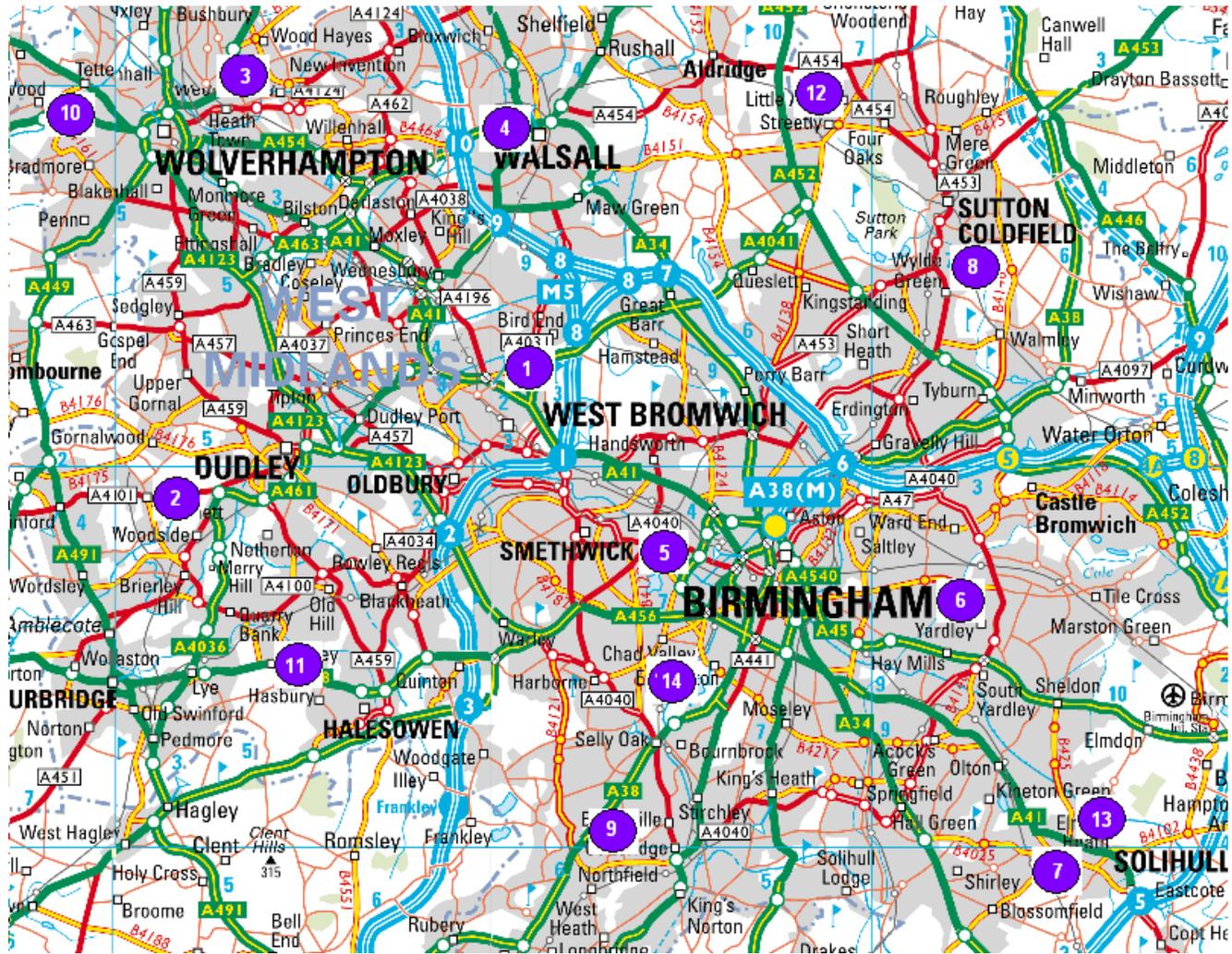


Figure 1 *Changes in average quality, average waiting times and total consumer utility. Summary of results from 500 separate solutions of the base model, at year 10*

Analysis of the model

- Interrogate the results statistically to find out why they happen (e.g. change in quality positively related to number of profit maximisers, negatively to the final number of hospitals)
- Check sensitivity to varying tariff, exit rule, profit threshold for maximisers, increase accuracy of quality perception, vary weights on consumer utility functions
- Calibrated it to actual data on 13 hospitals in the Birmingham area on elective hip replacement and had the results validated by presenting them to local decision makers



Hospitals with low probability of exit

- Royal Orthopaedic 9 per cent
- Walsall Manor 15
- Sandwell General 17

Svenska Handelsbanken

- In the early 1990s, Sweden had a recession worse than the 1930s
- Defaults on corporate loans rose sharply
- But SH did much better than its competitors
- It has a completely different process of granting and monitoring corporate loans
- Was it good luck, or was it their system?
- The board wanted to know
- The regulator wanted to know –pressing the bank to conform to industry norms

The model

- The bank does not have a centralised tick box approach to loans
- There are guidelines, but the decision is devolved to the branch officer
- The officers use both formal and informal networks across the bank to obtain up to date information on individuals/companies/industries
- We interviewed both board members and branch officers
- We designed a questionnaire with the bank to model the structure of the network, for example

The results

- We concluded that it is the bank's process of granting and monitoring corporate loans which is responsible for their good relative performance
- We presented to the board in July 2008
- The bank also did well in the 2009 recession – a good scientific test of the model!

Conclusion

- ABMs are open and transparent
- They try to capture how practitioners think their company/industry etc actually works
- They are a reality check on these perceptions
- They have a wide range of outputs which are useful to decision makers