A Computational Model of Bounded Rationality that Studies the Agency Problem: The Case of 'Physician-Induced Demand'

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Introduction

Rational Choice Theory (**RCT**) deficiencies have been debated by cognitive scientists, philosophers, computers scientists, economists and psychologists over the last 60 years. Yet, with the exception of some important instances, the great majority of economists have only taking into consideration either partial account of such deficiencies or have completely ignored them altogether. RCT is rooted in the notion of utility maximization and revealed preferences which purports to be neutral in terms of psychological assumptions or philosophies of mind. Herbert Simon, against some of the basic tenets of RCT that are rooted in behaviorism and positivism, argued for the need to take into account the inner workings of the mind and its computational limitations to better understand how human beings make decisions. Cognitive scientists have been working on this approach for many years, but their influence on economics has been marginal. Daniel Kahneman's work on behavioral economics has been crucial to remedy such neglect, but many behavioral economists are not willing to give up utility functions and the rather particular kind of analytical tractability that can be found in economic theory. In this paper we try to show, through an applied and specific case of health economics, that a model of computational rule-based procedures seems to provide better tools to understand human decisions, than RCT models.

Method

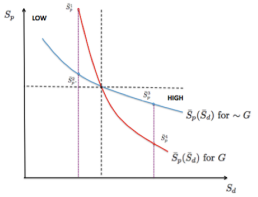
Our goal is to compare one "classic" RCT model, with another model based on computational rule-based procedures. Both models explain the physician agency problem, more specifically demand inducement, under similar circumstances. The comparison helps to illustrate how some of the deficiencies that are found in economic RCT models can be overcome by computational architectures that are similar to the ones used by cognitive scientists. The computational model we used is constructed on a simulation platform called GALATEA: **G**lider with **A**utonomous, **L**ogic-based **A**gents, **TE**mporal reasoning, and **A**bduction. This platform is a software that allows to model and simulate multi-agent systems, which are similar to cognitive science Rule-based models. The model from RCT that we use for this paper is Dranove's classical model of demand inducement (1988). The alternative model we are developing is derived from Herbert Simon's work on Bounded Rationality and cognitive science computational models. The main computational language used in this paper to define the behavior of the agents within GALATEA is Prolog.

Dranove's model in a nutshell

Patient: $-\int_{-\infty}^{\infty} \pi(Z) j(Z; S_p) dZ + \mu(E) \leq \mu(E - P)$

Doctor: $\int_{0}^{\infty} U(Y) j(Y \mid \bar{S}_d P) dY + \int_{0}^{\infty} U(W) j(W \mid \bar{S}_d P) dY$

$\partial \bar{S}_p / \partial \bar{S}_d < 0.$



First round of Results and what's next

Although Dranove's main goal was to study the physician induced demand for the overall market, we focused on the interaction of only two agents: the patient and the physician. We were able to replicate Dranove's model using a computational model based on GALATEA. This was an important result for us because it helps to show that utility maximization models can be taken as a subset of a larger and richer structure for modeling human decisions. The main structure of Dranove's model on a computational model looks as follows:

For the Patient:

```
1  if s_d_hat(Sd), greedyness(HowGreedy),
2     my_s_p(MySp), endowment(E), price(P),
3     integral(Sd, HowGreedy, MySp, Sum),
4     miu(E, MiuE), miu(E-P, MiuEMP),
5     Left is MiuE - Sum, Left < MiuEMP then get_treatment(P).
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For the Physician:

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1  if s_p_hat(Sp), endowment(E) then compute_Sd(Sp, E).
2
3  to compute_Sd(Sp, E) do
4     get_patient_satisfiable_set(Sp, E, Set),
5     max_list(Set, P),
6     pricing(Sd, P), s_d_hat(Sd), price(P).
```

A computer model like this allows to simulate many different shapes of utility functions and many different probability distributions, which provides some obvious advantages over the analytical structure commonly used in economic theory. Nevertheless, this is not why the computational model is considered to be better suited for the study of human behavior. Its advantage lies on the possibility of adding computational limitations from the part of the agents (i.e. heuristics, satisficing, cognitive bias etc.) and psychological elements into the model. Such psychological inputs must come from empirical work and not from the mind of the economist seated comfortably in their chairs (what Simon called armchair economics: a practice that he criticized during most of his academic life).

We are currently working on a bounded rational model that takes into consideration both the cognitive and computational limitations of the agents as well as the psychological elements that play a role in the process of decision making (i.e. what Simon called procedural rationality). Our goal is to make key comparisons between the two models and trace their respective implications for a better understanding of the problem of physician induced demand.

The first part of our work, namely that of converting Dranove's model into a computational structure, showed us that many of Dranove's behavioral assumptions mentioned in his 1988 paper do not find any real effect or translation on his own analytical model. In other words, those variables that are taken to operate implicitly in the different functions of the model, cannot be disaggregated in the analysis if we want to understand their specific effects. The computational model, on the other hand, allows us to explicitly model all the behavioral assumptions taken as implicit in Dranove's model, and more.

Conclusions

- The first part of our work already shows that the use of computational rule-based procedures seems to provide greater flexibility in understanding how people make decisions, when compared with the more traditional bayesian RCT models used in economics.

- Because of the impositions made by the analytical structure of utility functions and the use of equilibrium conditions for analyzing the interactions between the two agents, many of the assumptions used in Dranove (1988) are problematic. That is to say, they do not seem to correspond with how people actually behave under the circumstances described in the model. The computational model we are using allows us to overcome such restrictions and add the possibility of using a set of assumptions that better describes how people actually make decisions.

Main References

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Further Information

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For information about GALATEA please visit:
http://galatea.sourceforge.net/Home.htm