

Modelling the pricing behavior of retail firms

A MathSys Masters Project Proposal by Gian Lorenzo Spisso & M. S Turner

Outline

An open question in the economics literature is how to model the price setting decisions of firms. Classical economic theory postulates that prices are set in a flexible manner. New Keynesian arguments have been advanced to explain the price stickiness observed in real data: the role of information cost, heterogeneity and interactions. The existing literature contains several different possible price setting rules (Calvo pricing, Taylor pricing, rule-of-thumb, indexing [1, 2]) in the context of representative agents and extends to the interaction of a few agents with different pricing rules on a complete graph [3]. The interaction between many agents has been explored through analogies to Statistical Mechanics and Game Theory but has only been concerned with generic decisions on complete graphs [4, 5]. Other possible studies have been suggested [6, 7], but have not yet been explored.

The project aims to explore the gap by proposing a model of many interacting agents making price-setting decisions on incomplete graphs. In particular, we plan to take seriously the observation in [8] and references therein, on the practice of imitation as a mean of competition between retailers, by introducing a price update rule grounded in observation of nearest neighbors' choices. Furthermore, we aim at exploring different possible forms of nearest neighbors' interaction by embedding agents on graphs different from the complete one. Neither of these features has been explored so far.

The general setup will feature agents facing a discrete choice . They can revise their current price up or down $\sigma_i = \pm 1$, or leave it unchanged $\sigma_i = 0$. The agents' objective is to maximize the payoff function V that in turn depends on:

- a private utility component, which is a function of the agent choice σ_i ;
- an interaction component, which is function of the agent's choice and all nearest neighbors choices indicated by $\sigma_{\langle i,j \rangle}$;
- a stochastic variation $\epsilon(\sigma_i)$, intended to represent other economy-wide aspects such as monetary policy choices (i.e. interest rates) or demand conditions.

The problem faced by the agents is then summarized as follows:

$$\underset{\sigma_i \in \{+1, -1, 0\}}{\text{Max}} V[\sigma_i, \sigma_{\langle i,j \rangle}, \epsilon(\sigma_i)] = \underbrace{U(\sigma_i)}_{\text{private utility}} + \underbrace{S(\sigma_{\langle i,j \rangle})}_{\text{interaction component}} + \underbrace{\epsilon(\sigma_i)}_{\text{stochastic variation}}$$

Aggregation of choices under this description leads to models that are reminiscent of approaches from Statistical Mechanics, as described in [5, 6, 9, 10]. The choice of the functional forms of U and S is part of the scope of the project, as well as the choice of the distribution for the stochastic component.

Objectives

The aim of the project is to propose a testable, theoretical model of pricing choices made by many interacting agents under different pattern of interactions, with the ultimate goal being to make prediction for the short-term behavior of average inflation/deflation at the country level.

Intermediate objectives and deliverables:

- Define appropriate functional form for private utility and the interactions
- Define the form of the stochastic component
- Select a class of appropriate (i.e. realistic) graphs on which the interactions take place
- Investigate the model analytically or by mean of Monte Carlo simulations.
- Formulate testable hypothesis, indicating what data can be used to calibrate and test the model

Impact

The model will address relevant gaps in the literature by investigating the effects different pattern of interactions have on price setting decision and therefore on average inflation/deflation and transmission of monetary policy. One key contribution is the use of a more realistic price staggered adjustment mechanism grounded in nearest neighbors interactions. Contributions will pertain both to the field of Macroeconomics and to that of Game Theoretic applications of Statistical Mechanics.

Matthew Turner 14/2/15 16:20

Comment [1]: OK?

Gian Lorenzo Spisso 14/2/15 16:41

Comment [2]: Sure

The project aims to take a few first steps towards capturing real world feature of price setting decisions. A fully developed working model will be of interest to both policy makers (especially those involved in monetary policy decisions such as central banks) and to firms offering consulting services on pricing strategy.

Required background

Knowledge of Macroeconomics, Game Theory, in particular Discrete Choice Theory, and Statistical Mechanics are required, together with computational skills necessary to carry out simulations.

Data analysis

Two major datasets constitute a reference for development and possible empirical tests, they are:

- Nielsen's dataset of Retail Scanner Data collected by the University of Chicago, Booth School of Business.
- The Billion Price Project started in 2007 at MIT, Sloan collects daily prices 'scraped' from online stores from all over the world

However, due to possible delays in obtaining access to the data and in pre-processing we decided to forego data analysis from the Masters project.

PhD and funding Not applicable

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