Comments on Sims *et al.*, "Discrete Behavior in Information-Constrained Tracking Problems"

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Discrete Behavior

- A puzzle for models of optimizing behavior: movement among a discrete set of options when

  - available actions are continuous

  - determinants of payoffs from action also continuous

  - and should vary continuously over time

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- Example: pricing by retailers

WEEKLY PRICE OF FROZEN JUICE (Dominick's)
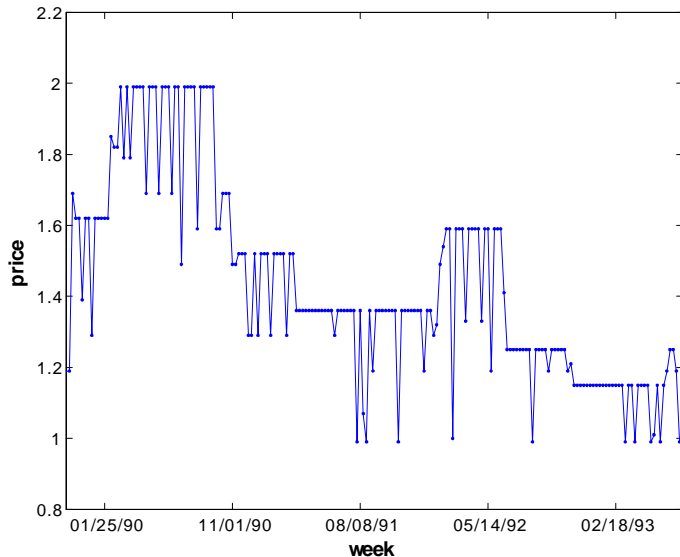
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- A possible interpretation: really only a discrete set of (convenient) price options: only prices ending in 9

- But this doesn't explain the observed jumps in prices:

  - frequent jumps over gaps that include prices ending in 9 (and that are charged on other occasions)

  - alternation between a small set of prices for a period of a few months, with intermediate prices never charged, though in a later period those intermediate prices may be used

The Proposed Explanation

- Explanation offered here (following Matejka, 2011): seller chooses one of a discrete set of prices, even though profit-maximizing price is (randomly) drawn from a continuous distribution of possibilities, in order to economize on cost of more precise information about current conditions

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- Limit on more precise information: upper bound on mutual information between true state and subjective representation of market conditions (on which pricing decision is based)

  - under fairly general conditions, optimal information structure involves discrete set of possible representations, even though true state drawn from continuous distribution (Fix, 1978; Rose, 1994)

  - conditions further clarified in this paper

Some Doubts

- In a dynamic model of price-setting: if a finite-valued signal is received each period, and price can be based on complete history of past signals (as in Sims, 2003), then the set of prices that can be observed over time is infinite

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- Assumption of inherent discreteness in action set (only prices that end in 9) can explain exact repetition of prices

    - but still, probability of charging any given price should continuously rise and fall, rather than there being abrupt changes in the set of prices seller alternates among

Example: Frozen Juice Price Series

Frozen Juice
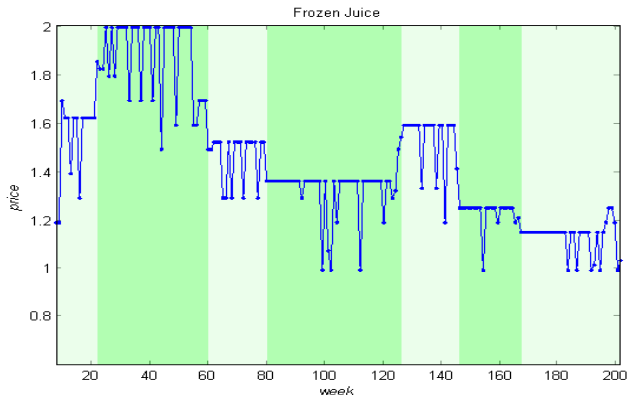
- Note the existence of successive "regimes", each involving only a few prices (Stevens, 2011; cf. Eichenbaum *et al.,* 2011)

The Model of Stevens (2012)

- Firms reconsider their pricing policy only on discrete occasions (not each week)

  — costly to reconsider more frequently
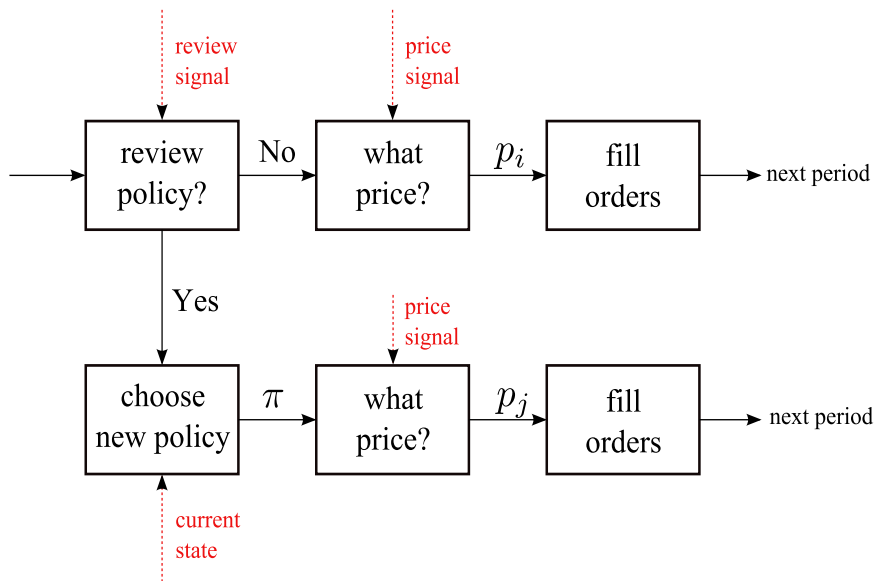
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- Policy also specifies signalling mechanism that will be used (until next review) to determine when to review the policy

The Model of Stevens (2012)

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- Policy chosen to maximize

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \left[\pi(p_t - x_t) - \kappa \delta_t^r - \theta^r I_t^r - \theta^p I_t^p \right]$$

where

$$p_t = \text{ price}$$

$$x_t = \text{ current profit-max price}$$

$$\kappa = \text{ fixed cost of policy review}$$

$$\theta^r = \text{ unit info cost of review signal}$$

$$\theta^p = \text{ unit info cost of price signal}$$

$$I_t^r = \text{ information flow from review signal}$$

$$I_t^p = \text{ information flow from price signal}$$

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  - assume that memory of past signals also accessed only through costly signal:
    — then finite set of price signals $\Rightarrow$ only that many prices ever charged under a given "regime"

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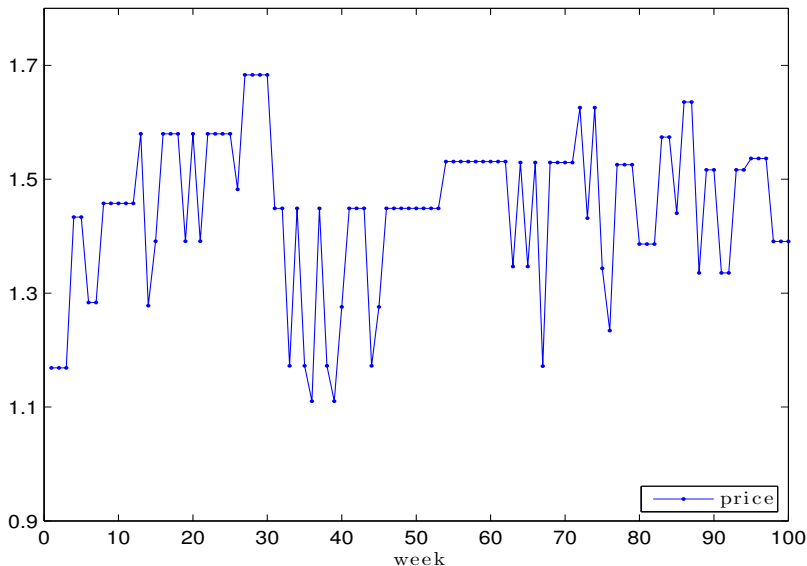
- Example of a simulated price series

Implications of this Interpretation

- Rate at which prices reflect changes in market conditions not determined solely by either the frequency of price changes or the frequency of changes in "regular" (or "reference") prices

  - change in entire price set on occasion of policy review reflects changed conditions since last review

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- Large shocks should be reflected in prices more rapidly than similar shocks of smaller magnitude

    - efficient for both review signal and price signal to be more sensitive to large shocks