Information Choice Technologies

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Neo- imperfect information

- Elements in the resurgence of research
  1. Strategic interactions. (Angeletos, Hellwig, Pavan, La'O, Paciello, ...)
  2. Focus on attention. (Reis, Sims, Mackowiack, Wiederholt...)
  3. Markets for information. (Veldkamp, ...)
  4. The forecasts of others. (Woodford, Lorenzoni, Sargent, ...)

- Already some surveys, all out in 2011:
  - Veldkamp, *Information Choice in Macroeconomics and Finance*,
  - Mankiw and Reis, *Handbook of Monetary Economics*,
  - Lorenzoni, *Annual Reviews*.

- This paper: focus on choice of acquiring information, synthesis of existing results and filling some holes.

The problem of information choice

Following somewhat the language of Sims, the equilibrium of a rational-expectations information-choice model is:

1. Each agent behaves optimally choosing actions p and information h to solve:

$$\max_{h(.)\in H} \left[\int \left(\max_{p(.)} \int U(p, s, \bar{p}) f(s|z) ds \right) h(z) dz - \lambda c(h(.)) \right]$$

   knowing that $\bar{p}(s, \mathbf{z})$.

2. In equilibrium, $\bar{p} = A(\mathbf{p})$.

In this paper

$$\max_{h(.)\in H}\left[\int\left(\max_{p(.)}\int U(p,s,\bar{p})f(s|z)ds\right)h(z)dz-\lambda c(h(.))\right]$$

- Static choice, continuum of agents i, aggregate is mean.
- Utility function:

  $$U(.)=-\left(p_i-r\bar{p}-(1-r)s\right)^2$$

  leading to indirect utility function:

  $$r^2\,\mathrm{var}(\bar{p})+(1-r)^2\,\mathrm{var}(s)+2r(1-r)\,\mathrm{cov}(\bar{p},s)$$

- Space H of signals is:

  $$z_j^i=s+a_j^i u_j+b_j^i v_j^i$$

- Agent chooses $\mathbf{a^i},\mathbf{b^i}$ facing $c(\mathbf{a^i},\mathbf{b^i})$

The four models

$$\mathbf{z} = \mathbf{1}s + \mathbf{a}u + \mathbf{b}v$$

1. Fixed costs, inattentiveness (Reis, 2006, Alvarez and Lippi, 2011)

   $(\mathbf{a}, \mathbf{b}) \in \{(0,0), (\infty, \infty)\}$ $\qquad$ $c(\mathbf{a}, \mathbf{b}) = \bar{c}(1 - I((\mathbf{a}, \mathbf{b}))$

2. Private signals, including rational inattention (Sims, 2003, Mackowick Wiederholt, 2011)

   $\mathbf{a} = 0$ $\qquad$ $c'(\mathbf{b}) < 0$

3. Public signals or information markets (Veldkamp, 2006)

   $\mathbf{b} = 0$ $\qquad$ $c'(\mathbf{a}) < 0$

4. Correlated signals (Myatt, Wallace, 2011)

   choose either $\mathbf{a}$ or $\mathbf{b}$ $\qquad$ $c(\mathbf{a})$ is convex

Results

1. Fixed costs
   - Fraction that pays attention is weakly monotonic in cost.
   - Multiple equilibria as long as strategic complementarity.

2. Private signals
   - Concavity of cost function in precision can generate multiple equilibrium.

3. Public signals
   - Discontinuity in marginal benefit of information, as go from public to private.
   - Multiple equilibrium around kink.

4. Correlated signals
   - Marginal benefit continuous again, uniqueness is re-established.

Beyond this paper

The long-reaching influence of Chris Sims...

$$\max_{h(.)\in H}\left[\int\left(\max_{p(.)}\int U(p,s,\bar{p})f(s|z)ds\right)h(z)dz-\lambda c(h(.))\right]$$

1. What is *the* right cost function $c(h(.))$?

   - Shannon (1948) showed that the only measure of uncertainty that is: (i) continuous in probabilities, (ii) symmetric across outcomes, (iii) maximal for the uniform, and (iv) additive, is entropy:

   $$H(s)=-\int\log(f(s))f(s)ds$$

   - The information gained from the signal z is $H(s)-H(s|z)$, agents can only get so much. Sims('98, '03, '05, '06, '11)
   - James Gleick (2011) *The Information*

Beyond this paper

The long-reaching influence of Chris Sims...

$$\max_{h(.)\in H}\left[\int\left(\max_{p(.)}\int U(p,s,\bar{p})f(s|z)ds\right)h(z)dz-\lambda c(h(.))\right]$$

2. Using survey data on expectations to measure $f(s,z)$

- Mankiw, Reis and Wolfers (2004): use time-series for dispersion of beliefs.
- Increase in dispersion of beliefs is *not* necessarily a result of increased uncertainty.
- Coibion and Gorodnichenko (2011): use time series for how forecast errors get eliminated.

Beyond this paper

The long-reaching influence of Chris Sims...

$$\max_{h(.)\in H}\left[\int\left(\max_{p(.)}\int U(p,s,\bar{p})f(s|z)ds\right)h(z)dz-\lambda c(h(.))\right]$$

3. Imperfect information is a theory of random choice

$$\max_{f(p,s)\in F}\left[\int\int U(p,s,\bar{p})f(p,s)dsdp-\lambda c(f(.))\right]$$

- Woodford (2008) randomized discrete adjustment.
- McKay and Matejka (2011) on multinomial logit model
- Woodford (2012) can explain prospect theory and other forms of reference-dependent choice.

Beyond this paper

The long-reaching influence of Chris Sims...

$$\max_{h(.)\in H}\left[\int\left(\max_{p(.)}\int U(p,s,\bar{p})f(s|z)ds\right)h(z)dz-\lambda c(h(.))\right]$$

4. What is *the* right structure for the signals, H?

- With non-quadratic objectives (Sims, Tutino, Lewis, ...)
- Discrete and continuous (Matejka, Sims, Stevens, ...)
- Impulses (Woodford, ...)

Beyond this paper

The long-reaching influence of Tom Sargent...

$$\max_{h_t(.)\in H} \sum_t \beta^t \left[\int \left(\max_{p(.)} \int U(p_t, s_t, \bar{p}_t) f(s_t|z^t) ds \right) h(z^t) dz^t - \lambda c(h_t(.)) \right]$$

5. *When*, rather than what, to pay attention to

- The *Bellmanization* of the information acquisition problem
- Time at which to get signals (Reis, Woodford, Stevens, ...)
- Synchronized or staggering (Hellwig, Veldkamp, ...)
- When to release information (Bolton, Faure-Grimaud, Reis, ...)

Looking beyond this paper

The long-reaching influence of Tom Sargent...

$$\max_{h_t(.)\in H} \sum_t \beta^t \left[\int \left(\max_{p(.)} \int U(p_t, s_t, \bar{p}_t) f(s_t|z^t) ds \right) h(z^t) dz^t - \lambda c(h_t(.)) \right]$$

6. Markets and communication policy

- Another agent(s) releases signals, markets or Ramsey.
- Private firms. (Veldkamp, Kurlat, Sketra ...)
- Ramsey-type policymaker. (Reis, Chahrour, ...)
- Work in micro theory and IO (Prat, Gentzkow, Shleifer, ...)

Conclusion

- This paper provides a wonderful concise synthesis of the insights from asking what signals should agents look at.

- I tried to provide you a flavor of what the literature has been busy with in information choice on
  1. How to measure information?
  2. Using survey data to measure information choice
  3. Understanding random choice
  4. Optimal structure of signals
  5. When to acquire the information
  6. Markets and communication policy

- And to tell you how Sargent and Sims have been at the forefront in all of these.