Behavioral models of demand and IO

Industrial Organization

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Bounded rationality models in IO

Dominant paradigm in IO today relies on Game Theory, to formlize firms' behavior, and fully rational models for competitive concumers, to determine demand in equilibrium.

Two weaknesses at the heart of this approach:

1. Do firms (know how to) play Nash ? Evidence of deviations (lab and field)
2. Are consumers fully rational ? Evidence of deviations from full rationality

Always been attempts to propose alternative approaches to IO, based on one of these 2 criticisms.

Bounded rationality models in IO

Ellison's survey (2006): nice and useful reading

Before the advent of Game Theory to formalize strategic interactions among firms: stress on deviations from profit-maximization by firms, e.g. in their pricing rules

Influence of Simon's work (50s - 60s), with applications to IO by Cyert and March

Late 70s - 80s: Domination of Game Theory

90s: Dissatisfaction wrt to fully rational / game theoretic models begins

Bounded rationality models in IO

Dominant approach: firms are fully bayesian players, they play a Nash (even refined) equilibrium that may rely on very sophisticated strategies

Consumers form demand understanding this rich environment:

- Inference from prices, place on shelf, popularity,...
- based on prior over quality, costs, information of others,...
- and considerations of signalling, of social learning,...

Possible but is that really plausible ? Often unable to explain observed puzzles.

Moreover, very sophisticated models become untractable, do not allow clear predictions (and work becomes more difficult within the dominant paradigm...)

Bounded rationality models in IO

Deviate from Nash equilibrium, on the firms side : rules of thumb in pricing, learning theories, explicit bounded rationality ...

Focus on deviation from consumers' full rationality assumption. Posit behavioral rules that consumers follow, key is believable rules (instead of utility function !?), and perform robustness analysis (usually simpler than under full rationality)

Benefits from development of psychology imported in economics:

- Starting with Kahneman - Tversky EMA79
- Changing preferences and time inconsistency: quasi-hyperbolic preferences with Strotz RES56 and Phelps-Pollack RES68
- Basic psychology biases imported in economic modelling: over-confidence, loss aversion, framing effects,...

Roadmap for today

Presentations of key papers that have launched a strand in research, without aiming for exhausitivity:

- Inattentive / unaware / non-Bayesian consumers: (**Spiegler**, 2006, **Gabaix-Laibson**, 2006, Armstrong-Chen, 2009, Piccione-Spiegler, 2012)
- Changing preferences and time inconsistency (**DellaVigna-Malmendier**, 2004 and 2006, Eliaz-Spiegler, 2006)
- Overconfidence (Grubb, 2009, Sandroni-Squintani, 2007)
- Loss aversion and psychological bias (**Heidhues-Koszegi**, 2005, 2008 and 2014, Spiegler's book, 2011)

Certainly a field that will prove to be fertile in the future

Spiegler (2006) investigates a model with **non-bayesian consumers** and **how firms exploit the uncorrect inferences** / how a market exists inefficiently.

- Markets where difficult to get hard evidence on quality and on which, consequently, suspicion of quacks (charlatans)
- E.g. psychotherapy, management consulting, forecasting, alternative medicines
- Interaction skill / luck typically difficult to disentangle in these markets
- Moreover consumers enter while facing unexpected (and possibly urgent) problems, hence without long learning phase and without much time to figure out how the market works

Non-bayesian consumers

- n healers that provide a valueless service to a continuum of patients + "natural default" option, equally valuable
- Consumers' payoffs: $x - p$, with success (healed) $x = 1$ with probability α, failure $x = 0$ otherwise, for all healers and natural option
- Price competition among fully rational healers
- Patients choice rule exhibits bounded rationality: sample $x_i \in \{0, 1\}$ of one patient - healer anecdote (and one for default option), and choose i that maximizes $x_i - p_i$
- Hence, **take realization as expected value**
- Formalizes stories like: "A friend took this pill and he got much better", "this forecaster has correctly predicted the collapse of the USSR"...

Price equilibrium in Spiegler

There exists a unique Nash Equilibrium: it is symmetric and in mixed strategies with support $[(1-\alpha)^{n-1}, 1]$

- Look for a symmetric ms equilibrium $G(.)$; monopoly price $p = 1$ is in support
- Healer 1 sells to the consumer if $x_1 = 1$ (probability α), if $1-p_1 \geq x_0$ (probability $1-\alpha$) and if for any j, $1-p_1 \geq x_j - p_j$ (probability $[1-\alpha G(p_1)]^{n-1}$)

$$p\alpha(1-\alpha)[1-\alpha G(p_1)]^{n-1} = \alpha(1-\alpha)^n$$

- **Expected price decreases in α, from 1 to 0, when α goes from 0 to 1**: when more incurable (α decreases), the sample contains less success, hence less competitive pressure (more erroneously perceived differentiation among healers)

Non-bayesian consumers

Industry profits $n\alpha(1-\alpha)^n$ (= welfare loss on patients) is non-monotonic in n, as two forces at work:

- Standard competitive effect: higher n means more pressure on prices
- Perverse effect: higher n increases sample size, hence the probability of at least one success, i.e. increases aggregate demand for charlatans; this can hurt consumers

If one healer is a true expert ($\alpha_e > \alpha$), nothing changes in equilibrium price and welfare loss

- Indifference for the true healer between monopoly price and the lower bound p_L of support of price distribution means: $\alpha_e(1-\alpha)^n = p_L\alpha_e(1-\alpha)$
- Hence again: $p_L = (1-\alpha)^{n-1}$ and quacks' profits: $\alpha(1-\alpha)^n$

Non-bayesian consumers

If healers have different qualities α_i and can disclose their success rates, none of them choose to disclose

Policy measures (allowing disclosure) ineffective, as long as rationality of consumers is not improved

Interesting extension with forecasters without any forecasting ability, who choose forecasting fees and a rule for predicting outcome (which horse wins in various races)

- Consumers recall a random race and picks the cheapest among those who predicted right
- Hence, possibility to avoid competition by differentiating one's predictions from others': in equilibrium, predictions are as diffused as possible (maximal differentiation)
- Cf proliferation of therapeutic methods in alternative medecines

Inattentive or unaware consumers

Instead of deviation from bayesian updating, some type of consumers are simply not fully aware of market conditions

- Fully rational search cost models (Varian)
- Or unawareness, lack of understanding of the market game or misperception, although the information is available at (almost) no cost: bounded rationality flavor

Low attentiveness in financial retail markets

- 43% consumers do not know at all interest rate on overdraft on current account
- 23% do not know at all the charges for withdrawals from saving account
- 10% do not read at all the terms and conditions when buying financial product

Inattentive or unaware consumers

Model of add-on pricing: shrouding of add-on prices (Gabaix-Laibson, 2005)

- E.g. price of ink cartridges is shrouded to consumers, or add charges in hotels, low-cost airline tickets,...
- With rational consumers, firms should show what is favorable to them, hence shrouding means unfavorable information to consumers
- Cf unraveling result (a la Milgrom): all firms disclose all information with rational consumers
- With inattentive consumers, firms could "educate" consumers to conquer consumers if other firms shroud; is it profitable?
- May be no: debiasing / educating a customer may make him substitute away from the add-on, and not change supplier

Inattentive or unaware consumers

Firms choose shrouding or not (no cost) and prices $(p, \hat{p})$ for base good and add-on, $\hat{p} \leq \bar{p}$ ($\bar{p}$ exogenous)

Consumers choose a firm, and possilbly effort e to substitute away from add-on ($e < \bar{p}$)

- Under shrouded attributes, sophisticated consumers $(1 - \alpha)$ form Bayesian posteriors on $\hat{p}$; inattentive consumers (α) do not take add-on price into account
- Under no shrouding, sophisticated and λ of the inattentive consumers take add-on price into account
- NB: when an inattentive is "educated" (unshrouding), he becomes sophisticated

Then add-on purchase if no substitution effort

Inattentive or unaware consumers

Look for a symmetric equilibrium $(p^*, \hat{p^*})$

- Substitution away from add-on iff: $e < \mathbf{E}\hat{p}$
- Consider deviation $(p_i, \hat{p}_i)$; sophisticated or informed inattentive demand depends on x_i, the anticipated net surplus from firm i compared to others

$$x_i = (-p_i - min\{e; \mathbf{E}\hat{p}_i\}) - (-p^* - min\{e; \mathbf{E}\hat{p^*}\})$$

- For uninformed inattentive, $x_i = -p_i + p^*$ and they do not invest in substitution
- Let $D(x_i)$ denote probability that consumer goes to deviating firm i, corresponds to a (smoothed out) demand function;
- Parametrization of competition: $\mu = D(0)/D'(0)$, with perfect competition corresponding to $\mu = 0$

Equilibrium in Gabaix-Laibson

Equilibrium with shrouded add-on prices: if $\alpha > \frac{e}{\bar{p}}$, exists a symmetric equilibrium with shrouded add-on prices, $p^* = \mu - \alpha\bar{p}$ and $\hat{p} = \bar{p}$; only inattentive purchase the add-on. It is inefficient (cost of e for sophisticated).

Equilibrium without shrouding: if $\alpha < \frac{e}{\bar{p}}$, exists a symmetric equilibrium without shrouding, $p^* = \mu - e$ and $\hat{p} = e$, all consumers purchase the add-on. It is efficient

Beliefs are that $\hat{p} = \bar{p}$ for a firm that shrouds in both cases. Total industry profits are μ.

Inattentive or unaware consumers

Discussion:

- When highly competitive, $\mu \approx 0$, base good is a loss-leader ($p^* = -\alpha\bar{p} < 0$), add-on a profit center
- Is there an incentive for a firm to educate consumers and capture the efficiency gain (by prices more in line with costs)?
- No, "curse of debiasing": educated consumers prefer to stay with high add-on prices firm and substitute away from the add-on (surplus with almost perfect competition $-p^* - e = \alpha\bar{p} - e > 0$), rather than to swith to the "educating" firm (surplus 0)
- Educated consumers take benefit from pricing policy aimed in the first place at exploiting inattentive consumers !

Inattention to quality

Model of inattention to quality by Armstrong-Chen 08

- $N > 2$ identical firms supply an homogenous good in one of 2 possible qualities: L or H
- Each firm chooses one quality
- L-quality yields consumers' surplus 0 at production cost 0
- H-quality yields surplus v at production cost $0 < c < v$
- $\lambda \in [0, 1]$ consumers observe all qualities, $1 - \lambda$ do not and buy only on basis of prices, mistakenly believing all qualities are H
- Bounded rationality: (a) inattentive consumers do not acquire information about quality; (b) and do not figure out quality by price observation (Bayesian rationality)

Inattention to quality

Pure strategy symmetric equilibria in Armstrong-Chen

- When $\lambda = 1$, mc pricing with H-quality and $p = c$
- When $\lambda = 0$, mc pricing with L-quality and $p = 0$
- When $\lambda \in (0, 1)$, no pure strategy symmetric equilibrium: if H-quality, then $p = c$ candidate, but profitable deviation at L-quality and $p = c - \epsilon$; if L-quality, then $p = 0$ candidate, but profitable deviation at H-quality and $p = v$.

Pure strategy asymmetric equilibria in Armstrong-Chen

When $N \geq 4$, asymmetric equilibria with at least 2 firms producing L-quality at price 0 and at least 2 firms producing H-quality at price c; zero equilibrium profits and welfare equal to: $\lambda(v - c)$

Inattention to quality

Mixed strategy symmetric equilibrium in Armstrong-Chen

When $N \geq 4$, ms equilibrium with $F(.)$ on 2 sub-intervals:

- L-quality and $p \in [p_0, p_1)$
- H-quality and $p \in [p_1, v]$
- Expected profits are positive: $\lambda(v-c)F(p_1)^{N-1}$

- On $[p_0, p_1]$, $(1-\lambda)p[1-F(p)]^{N-1}$ (with L-quality) is constant, hence $F(.)$
- On $[p_1, v]$, $(p-c)\{(1-\lambda)[1-F(p)]^{N-1} + \lambda[F(p_1)+1-F(p)]^{N-1}\}$ is constant, equal to $\lambda(v-c)F(p_1)^{N-1}$ as charging $p = v$ is a possible move
- And p_1 characterized by:

$$p_1(1-\lambda)[1-F(p_1)]^{N-1} = (p_1-c)\{\lambda+(1-\lambda)[1-F(p_1)]^{N-1}\}$$

Inattention to quality

- Firms cannot price-discriminate among consumers (otherwise, separate competition on both markets), e.g. published offers to all consumers
- Inattentive consumers enable firms to produce L-quality at low prices, hence to charge high prices on H-quality
- Monopoly profits on attentive consumers when all rivals serve L-quality on inattentive;
- Social welfare increases in λ (more often H-quality); profits increase (decrease) when λ is small (large) (differentiation largest for moderate λ)
- For λ small, increase in λ reduces probability of L-quality but also increase prices: consumers' surplus reduced. For λ large, effect on prices reverse and consumers' surplus improved
- For N large, convergence towards asymmetric ps equilibrium (L-quality with probability 1/2), profits drop in N and consumers' surplus increases in N (ambiguous on welfare)

Changing preferences and time inconsistency

Dominant model of changing preferences (Strotz, Phelps-Pollack): discount factor between today and tomorrow is different from the discount factor between two subsequent dates: hence, inconsistency and need for commitment

Moreover, consumers may be more or less aware of their time inconsistency: sophisticated vs naive (cf work by Rabin)

- Industry of investment goods: today's cost in exchange of future benefits (health / fitness clubs)
- Leisure industry: today's enjoyment but later costs (credit card borrowing)

DellaVigna - Malmendier (2004) focus on a monopolist's exploiting these characteristics

- 3 periods, time-inconsistent consumer
- $t = 0$: monopolist offers two-part tariff (L, p), consumer accepts or refuses
- $t = 1$: if refused u, if accepted $(-L)$, consumer learns personal cost of consumption c and decides to visit $(-c-p)$ or not (0)
- $t = 2$: long term benefits (b) if there has been consumption; no benefit otherwise
- Consumer's preferences: $U_t + \beta \sum_{s=t+1}^{\infty} \delta^{s-t} U_s$ with $\beta \leq 1$
- Consumer expects his inconsistency parameter to be $\widehat{\beta} \in [\beta, 1]$: $\widehat{\beta} - \beta$ degree of overconfidence, $\widehat{\beta} = \beta < 1$ sophisticated consumer, $\beta < \widehat{\beta} = 1$ naive consumer

Changing preferences and time inconsistency

- Firm maximizes discounted profits with δ, with cost per consumption a and setup cost K
- Firm knows the consumer's type
- Consumption value from t=0 viewpoint: $\beta\delta(\delta b - p - c)$, non-consumption has value 0
- But, at t=1, consumption value: $\beta\delta b - p - c$.
- Consumer expects he will consume with probability: $F(\widehat{\beta}\delta b - p) \geq F(\beta\delta b - p)$, i.e. overconfidence
- Net expected benefits from contract:

$$-\widehat{\beta}\delta L + \widehat{\beta}\delta \int_{-\infty}^{\widehat{\beta}\delta b - p} (\delta b - p - c) dF(c)$$

have to be at least $\widehat{\beta}\delta u$ (IR)

The monopolist maximizes its expected profits

$$\delta\{L - K + F(\beta\delta b - p)(p - a)\}$$

subject to IR. Saturating IR, the objectives can be written as:

actual social surplus + fictitious consumer's surplus

where the fictitious surplus is taken for c such that

$$\beta\delta b - p \leq c \leq \widehat{\beta}\delta b - p$$

Optimal monopoly pricing in DellaVigna - Malmendier

The optimal pricing exists. With time-consistent consumer, $p = a$; with $\beta < 1$, $p < a$; and surplus extracted by L.

Changing preferences and time inconsistency

With time-consistent preferences, perfect price discrimination with marginal cost pricing for consumption

With time-inconsistent preferences, below-marginal cost pricing so as to provide commitment device to consume (even if $\widehat{\beta} = \beta$, in which case $p = p^{FB} = a - (1 - \beta)\delta b$)

But also, to exploit consumer's overconfidence (for partially naive):

- Increase fictitious surplus by $p < a$ so as to increase upfront payment L
- Consumer is indifferent with a contract with a higher price per visit (and lower L)
- But he will benefit from the price discount less often than he expects; firm makes gain on consumer's overconfidence

Changing preferences and time inconsistency

In case $b < 0$, i.e. leisure good, $p > a$ if inconsistency

In case of competition, same deviation from mc-pricing. The level of IR u depends on other firms' two-part tariffs: additive way in the program, so only affects L in equilibrium

Also robust to certainty of cost of consumption c

Welfare analysis:

- Time-consistent agents consume whenever $c \leq \delta b - a$
- Sophisticated time-inconsistent: $c \leq \beta\delta b - p^{FB} = \delta b - a$ agents also, perfect commitment through firm's pricing
- But naive time-inconsistent consume less than FB-optimal !
- Hence, firm's profit and loss in consumer's welfare increase with naiveness $\widehat{\beta} - \beta$
- Under competition, there is still also a loss from naiveness, but smaller than under monopoly

Changing preferences and time inconsistency

Testable: price below marginal cost

Health club industry in Boston area 2001-2002, 3 types of contracts:

1. monthly contract: 129USD initial and 55USD/month
2. annual contract: 64USD initial and 625USD/year
3. per-visit: 11USD

Contracts with no fee per visit are largely prevalent. Yet, marginal cost between 3 and 6USD (apart congestion costs) ! And retracing history, consumers would save money by choosing per visit contract !

Price discrimination and/or transaction costs ? PD would predict frequent users should pay more ! And transaction costs low with electronic card for attendance

Screening agents wrt time-inconsistency

Eliaz-Spiegler (2006): Second-degree price discrimination by a monopolist when unknown type is how aware consumer is of his time inconsistency !

- Monopolist interacts with agents with changing tastes: monopolist chooses a price schedule $t(.) : X \to \mathbf{R}$ in period 1, agent chooses his consumption x at period 2
- Period 1 utility $u(.)$, period 2 utility $v(.)$, outside option is null; monopolist's cost $c(.)$. (assume $u(.) - c(.)$, $v(.) - c(.)$ and $u(.) - v(.)$ have unique maximum
- Two types: Some know their taste will change (sophisticated), some are unaware of this (naive)
- E.g. entering a casino, buying a cable TV package, credit card extension of credit line,...

Screening agents wrt time-inconsistency

For sophisticated type:

- $\max(T - c(x))$ such that $u(x) - T \geq 0$ and $v(x) - t(x) \geq v(x') - t(x')$
- Hence, $x^* = \arg\max(u(x) - c(x))$, i.e. efficiency, $T^* = u(x^*)$ for IR, and $t(x)$ for $x \neq x^*$ such that: $v(x) - t(x) \leq v(x^*) - T^*$

For naive type:

- (x_u, T_u) if utility turns out to be u (what consumer believes) and (x_v, T_v) if utility is v (what firm knows)
- For naive type, firm offers a "bet" (conflicting priors):

$$\begin{aligned} \max(T_v - c(x_v)) \\ u(x_u) - T_u \geq 0 \\ u(x_u) - T_u \geq u(x_v) - T_v \\ v(x_v) - T_v \geq v(x_u) - T_u \end{aligned}$$

and infinite penalty for other values of x

Screening agents wrt time-inconsistency

$$\max(T_v - c(x_v))$$
$$u(x_u) - T_u \geq 0$$
$$u(x_u) - T_u \geq u(x_v) - T_v$$
$$v(x_v) - T_v \geq v(x_u) - T_u$$

- Immediate that IR_u is binding (otherwise, increase both T)
- And IC for (x_v, T_v) binds (otherwise increase T_v): consumer 2nd period willingness to pay for real consumption relative to imaginary is fully extracted

Optimal discriminatory pricing of naive in Eliaz-Spiegler

Optimal consumptions are $x_u = \arg\max(u(x) - v(x))$ and $x_v = \arg\max(v(x) - c(x))$, $T_u = u(x_u)$ and $T_v = v(x_v) + u(x_u) - v(x_u)$

Screening agents wrt time-inconsistency

- If forced $x_u = x_v$, same problem as for sophisticated
- As soon as $\arg\max(u(x) - v(x)) \neq \arg\max(v(x) - c(x))$,

$$\max(v(x_v) - c(x_v)) + (u(x_u) - v(x_u)) > \max(u(x) - c(x))$$

  contract facing naive is different and more profitable than contract facing sophisticated
- v-efficient consumption induced, while facing sophisticated it is the u-efficient consumption
- Naive end up paying T_v which is larger than $u(x_v)$ and than $v(x_v)$: **exploitative contract**, but naive thinks he'll consume x_u !

Costless screening in heterogeneous population

Monopolist can perfectly screen consumer's type at no cost

- All types agree that (x^*, T^*) provides perfect commitment and yields zero surplus
- Naives evaluate surplus from (x_u, T_u, x_v, T_v) to 0
- But (x_u, T_u, x_v, T_v) is exploitative (yields negative surplus) for sophisticated, since it yields higher profit for firm than any acceptable contract for sophisticated
- So natural screening

Screening agents wrt time-inconsistency

Duopolistic discriminary pricing and heterogeneous population

There exists a symmetric equilibrium with:

- x^* and $T_s = c(x^*)$ aimed at sophisticated
- x_v, x_u and $\tilde{T}_v = c(x_v)$ and $\tilde{T}_u = c(x_v) + v(x_u) - v(x_v)$ aimed at naive
- Firms make zero profits

- Perfect screening again: when lowering price to attract one type, firms don't care if another type comes, as all types consume identically, conditional on committing to a contract
- Contract for naives is not v-exploitative, but if $u(x_v) < c(x_v)$, it is exploitative for 1st period preferences
- Not profitable for the firms to educate consumers

Overconfidence

Documented biases (in experiments and in the field):

- Individuals overestimate the degree to which their future tastes will resemble their current ones, hence underestimate the variance of their future demand
- Individual are overconfident about the precision of their own predictions

Use these well-documented biases to formalize deviations from full rationality by consumers in specific IO situations:'

- Insurance market and compulsory insurance policy (Sandroni-Squintani, 2007)

Motivation: well documented underestimate of one's own risk in insurance market, e.g. for driving

- In Rothschild-Stiglitz insurance model with asymmetric information: compulsory insurance improves all agents' welfare, as it relaxes the IC constraint
- If agents are overconfident, they may underinsure, hence compulsory insurance by paternalistic argument
- Both rationales do not reinforce each other ! Compulsory insurance may make low risk agents worse off !
- Fundamental reason: presence of overconfident agents changes the nature of the equilibrium, as it may make the IC constraints non-binding !

Overconfidence

- Wealth is W (no accident) with probability $1 - p_i$ or $W - d$ (accident) with probability p_i, $p_L < p_H$
- 3 types of agents: H-risk, L-risk (fraction λ), and overconfident O-agents (κ) (H-risk who think they're L-risk)
- Perfectly competitive equilibrium is a set of contracts (of the form (premium, gross coverage)) such that no contract yields negative expected profits and no non-included contract would make a positive profit (focus on locally competitive equilibrium, cf existence problems)
- Key insight: insurance cannot screen between O-agents and L-agents: agents are screened according to their beliefs
- The IC constraint may not be binding when enough overconfident agents

Overconfidence

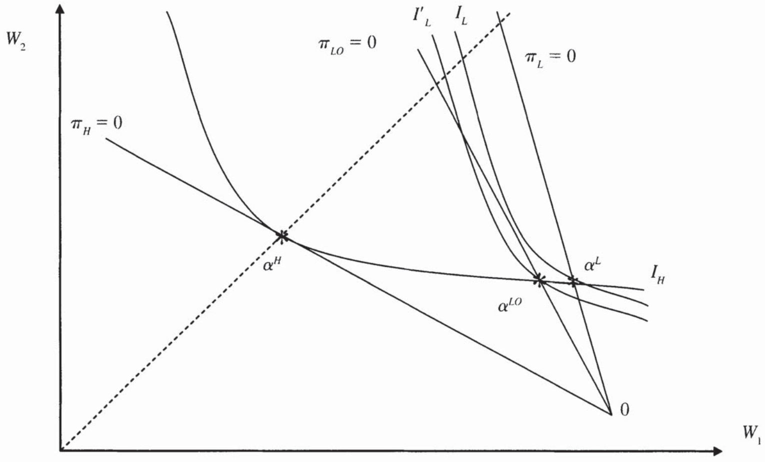

FIGURE 1. EQUILIBRIUM WITHOUT OVERCONFIDENCE, AND WITH A SMALL FRACTION OF OVERCONFIDENT AGENTS

Overconfidence

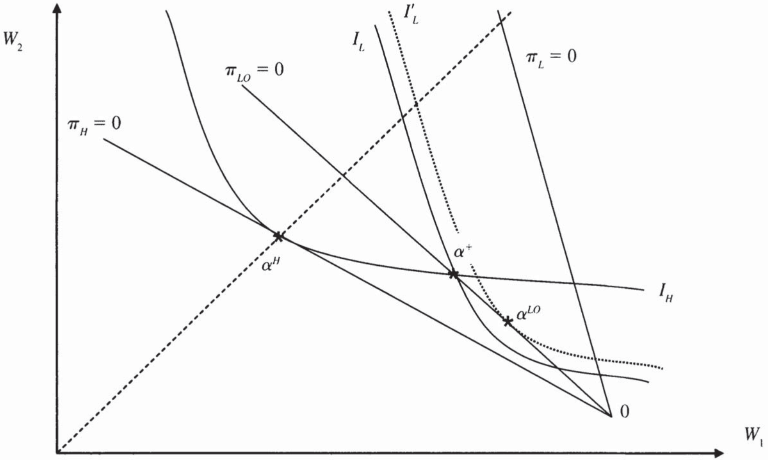

FIGURE 2. EQUILIBRIUM WITH INTERMEDIATE OVERCONFIDENCE

Overconfidence

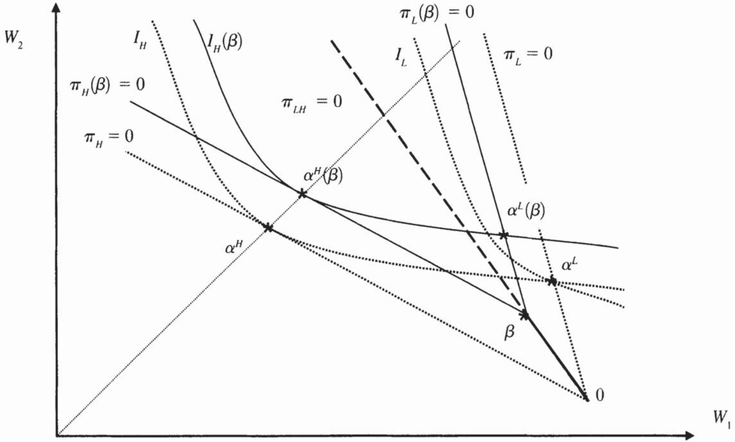

FIGURE 3. COMPULSORY INSURANCE WITHOUT OVERCONFIDENCE

Overconfidence

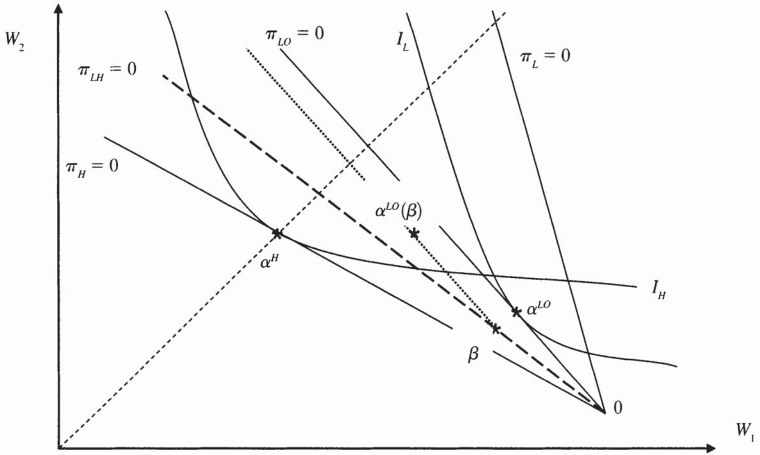

FIGURE 4. COMPULSORY INSURANCE WITH OVERCONFIDENCE

Loss aversion

Documented psychological bias: agents are sensitive to reference points, i.e. actions or consequences that act as a "frame" of a choice problem and affect choice in unconventional way

As reference points can change and be manipulated by firms, induce unstable preferences

- Default options, or status quo options
- Past realization of uncertainty
- Exogenous expectations
- Anchoring, i.e. choice of a quantity close to one suggested by a third party
- Loss aversion: outcomes as gains / losses wrt reference point, losses register more powerfully than gains (Heidhues-Koszegi, 2005, Spiegler's book)

Price sample as a reference point for a monopoly

- Price above an expected price p^e viewed as loss, reduces willingness to pay
- More natural in markets with simple products, no obfuscation / shrouding by firms, price easy to observe and recall
- One unit sold by monopolist (cost c distributed uniformly over finite C, $\mid C \mid = m$, lower bound $0 < c_l$, upper bound $c_h < 1$, mean $\bar{c}$)
- Monopolist commits to pricing strategy $P : C \to \mathbf{R}$, that implies probability measure on possible prices $\mu_P(p)$

Loss aversion

- One consumer with reference point p^e drawn from one sample according to $\mu_P(.)$: market experience (alternative would be: mean according to $\mu_P(.)$)
- Buys iff: $p \leq v - L(p, p^e)$, $L(.)$ loss function non-decreasing in p, non-increasing in p^e, $L(p, p^e) = 0$ whenever $p \leq p^e$, v uniformly on $[0, 1]$
- Demand: $D_P(p) = \mathbf{E}_{c'}[max\{0, 1 - p - L(p, P(c'))\}]$, as a function of whole price distribution
- **Changing one price affects demand for all prices, through change in reference points**
- $\max_{P(.)} \mathbf{E}_c[(P(c) - c) D_P(P(c))]$ (non-separability)
- Restricted to one price: $\bar{p} = \frac{1+\bar{c}}{2}$, independent of $L(.)$
- Without loss aversion: $P^0(c) = \frac{1+c}{2}$

Loss aversion

Reduced price variability

For all optimal pricing strategies

$$P^0(c_l) \le P(c_l) \le P(c_h) \le P^0(c_h)$$

- Monopolist does not want consumer to suffer large losses, hence reduces price range
- Extent of price rigidity depends on distribution of c: small frequent shocks in c induce rigid price (gain in adapting to cost small compared to consumers' disappointment)
- With continuum of costs, can get finite number of possible prices (stickiness)

Loss aversion

To investigate impact on expected price, assume $L(p - p^e)$, and the demand is strictly positive for all cost and reference points

Lower expected prices

For any optimal price strategy, the expected price is not larger than $\bar{p}$

Loss aversion induces a reduction in aggregate demand, hence in expected price

But not monotonic ! With very large loss aversion, optimal to charge $\bar{p}$ for all c.

Loss aversion

Same force to rigidity implies that firms are reluctant to charge higher prices than competitors: price uniformity across firms

- Hotelling-type model of firm specific raw utility
- Asymmetric firms: say $c_1 > c_2$, deterministic
- Reference point: if consumers expect firms to charge the same price p, that is $p^e = p$
- Without loss aversion, $p_1^* > p_2^*$
- With strong enough loss aversion (and small cost difference), there exist uniform price equilibria, both firms charging the same price (equal to reference point), below the Nash prices
- "Kinked demand curves"

Loss aversion

Attachment effect and own expected consumption as reference point (Heidhues-Koszegi 05)

- When consumer expects to buy and does not buy: disappointment
- Expectation to get hold on a product makes the consumer emotionally attached and more willing to pay for it
- For durable goods, or service to enjoy in the long run
- Related to endowment effect: ask more to give up a good once you have it than what you're willing to pay to get it

Methodological novelty: willingness to pay depends on one's own consumption decision (not on the expectation of variable beyond control), hence choice comes out of some "internal equilibrium"

Personal equilibrium (Koszegi-Rabin, QJE 06), used in Heidhues-Koszegi (05)

- Define utility with consumption reference point as: $u(x, x^e, p)$
- x^* is a personal equilibrium for p if for all x,

$$u(x^*, x^*, p) \geq u(x, x^*, p)$$

- Multiplicity quite natural
- Existence problems as well

Loss aversion

- Consumer's preferences for consuming $x \in \{0, 1\}$ as before with $\tilde{v}$, shock observed before decision:

$$\mathbf{E}_{(x^e, p^e)}[\tilde{v}x - p + G(vx, vx^e) + G(-p, -p^e)]$$

$$G(y, y^e) = y - y^e \text{ if } y \geq y^e, = \lambda(y - y^e) \text{ if } y < y^e \text{ and } \lambda > 1$$

- Reference point (x^e, p^e): lagged probabilistic beliefs (formed before seeing current price), hence expectations
- Personal equilibrium:
  - Given price distribution $F(.)$ and references, consumption strategy yields probability of purchase: $\sigma(p, v) \in [0, 1]$
  - $F(.)$, σ and distribution of $\tilde{v}$ induce a distribution of (x, p) that is the distribution of reference points
  - This distribution is the one used in determining σ

Strategy of analysis

- Firm commits (long run, reputation) to price decision as function of cost realization; consumers form expectations; costs and prices realized; shock $\widetilde{v}$; purchase decision
- A consumption strategy determines (expectations over $\tilde{v}$) a demand (probability of purchase as a function of price p)
- Market equilibrium: pricing strategy $P(.)$ maximizes expected (over realizations of c) profits given demand, and demand comes from a personal equilibrium given the distribution of prices induced by $P(.)$
- Assumption to ensure existence and uniqueness

Results:

- Continuum of cost yet possibly finite set of prices (stickiness)
- Consumption negatively affected by comparison with lower prices: with continuum, close-by prices decrease demand locally, hence incentive to lump nearby prices in single one
- Lowering price in low-cost state profitable in this state, but losses in higher-cost states: hence no aggressive price cuts in low-cost states
- NB: counter-effect to take into account: increasing demand in one state, increases the consumption reference, hence demand for all states
- Overall, reduced price variability (mark-up counter-cyclical)

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