Equilibrium effects of price updating: evidence from a centralized marketplace for annuities

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October 19, 2025

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Motivation

- In several markets consumers receive initial offers, then they can request revised offers. Examples:
  - Loans: consumers get a loan estimate (LE) and showing a LE to another lender could lead to a revised offer. Loan Estimate
  - Auto dealerships: buyers can shop around and dealers are willing to revise their initial offers
- What is the welfare impact of allowing consumers to request revised offers?
- Effects of prohibiting revised offers:
  - Direct impact: buyer can no longer improve initial offer.
  - Indirect effect: buyers improve their initial offers

This research

- Studies a centralized marketplace for annuities in Chile (SCOMP)
- A recent law eliminated the possibility of requesting revised offers.
  - Before: consumers receive initial offers, then can request revised offers from one firm.
  - After: consumers can only accept/reject initial offers.
  - Rationale for elimination: "firms will not make their best efforts in the initial phase"

Literature

- Search in selection markets: Allen et al. (2019)
- Competition in selection markets: Cosconati et al. (2025), Crawford et al. (2018), Cuesta and Sepulveda (2018), and Mahoney and Weyl (2017)
- Centralized marketplaces in selection markets : Abaluck and Gruber (2023) and Tebaldi (2025)
- SCOMP specific: Alcalde and Vial (2021), Boehm (2024), and Illanes and Padi (2019, September)

Outline

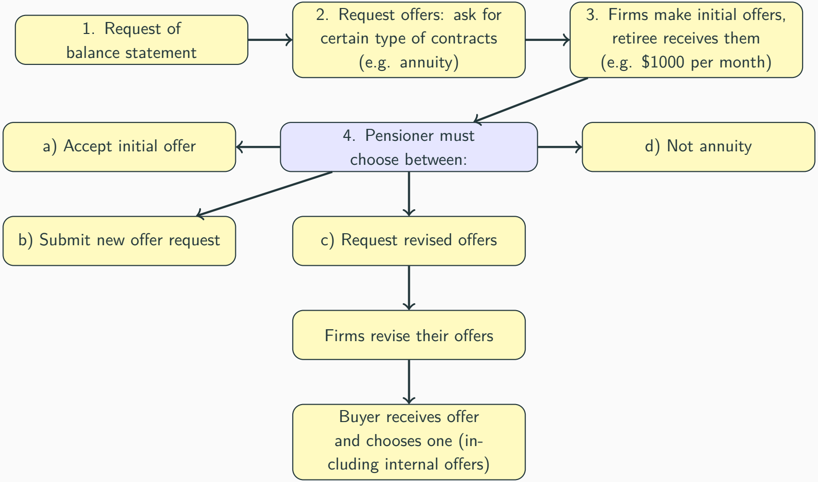
Setting: annuities

- Annuities: transform a stock of savings into a stream of payments until death.
- Reasons to buy: insure against overlife risk
- Profits of firm j:

$$\pi_{ji}(F) = S_i - \mathbb{E}_T^j \left[\sum_{t=1}^{T} \frac{F}{(1+r_j)^t} | x_i \right]$$

  S: stock of savings, F: per period annuity payment, x_i: buyer mortality factors
- Firm heterogeneity: algorithm (mortality tables), financing costs (r_j) and risk ratings.

SCOMP Process



Offer Certificate

Data

- SCOMP data at the individual level
  - Posted and revised offers, consumer acceptance. **Not** requests
  - Total savings
  - Demographics: age and gender Certificate with initial offers
- Retirement insurance companies: risk ratings

Particularities of the data/setting:

- One observes all the offers received by the buyers
- One observes the same information as the firms (gender, age, savings)

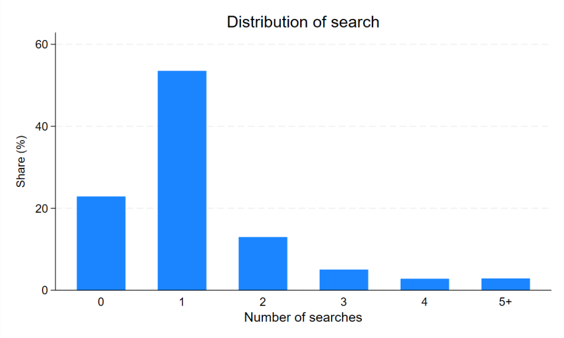
[best way of leveraging this particularities?]

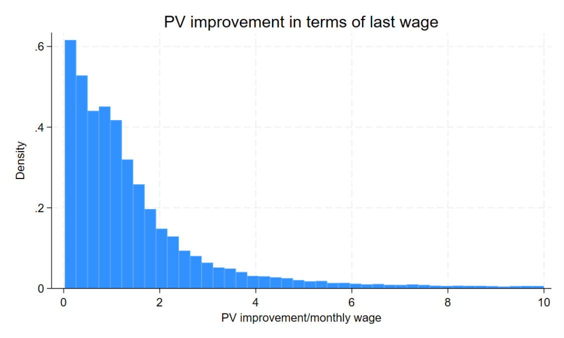
Outline

Descriptive Evidence

1. Most buyers request revised offers and the improvement is sizeable. Revised offers
2. Products are differentiated Foregone value
3. Selection into companies Heterogeneity in algorithm precision
4. Firms learn about other firms' prices Learning

Prevalence of revisions

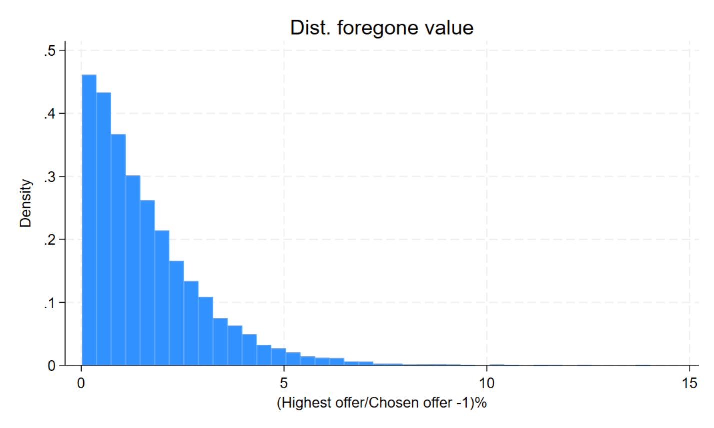




- 75% of the purchases are through revised offers. Go back
- Not everyone requests revised offers $\rightarrow$ search costs.

Differentiation

Buyers do not always buy highest annuity. Average foregone value is 1.57 monthly wages.



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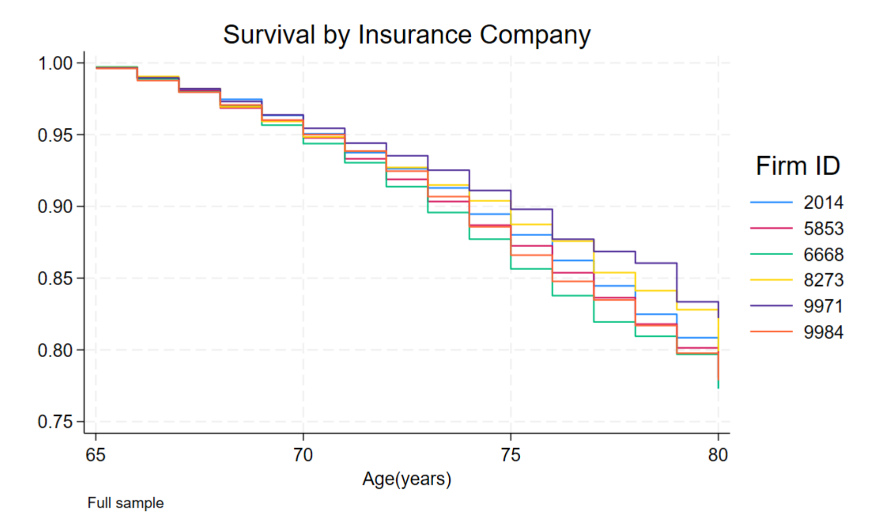
Heterogeneity in algorithm precision



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Learning

If firms do not know competitors' prices one expects them to increase their offers more when the competitors' prices are higher.

- $$F_{ij}^{R} - F_{ij}^{I} = \beta_0 + \beta_1 \text{Avg. gap}_{ij} + \beta_2 \text{Max. gap}_{ij} + \epsilon_{ij}$$
- $$1(F_{ij}^{R} - F_{ij}^{I}) = \alpha_0 + \alpha_1 \text{Avg. gap}_{ij} + \alpha_2 \text{Max. gap}_{ij} + \epsilon_{ij}$$

where

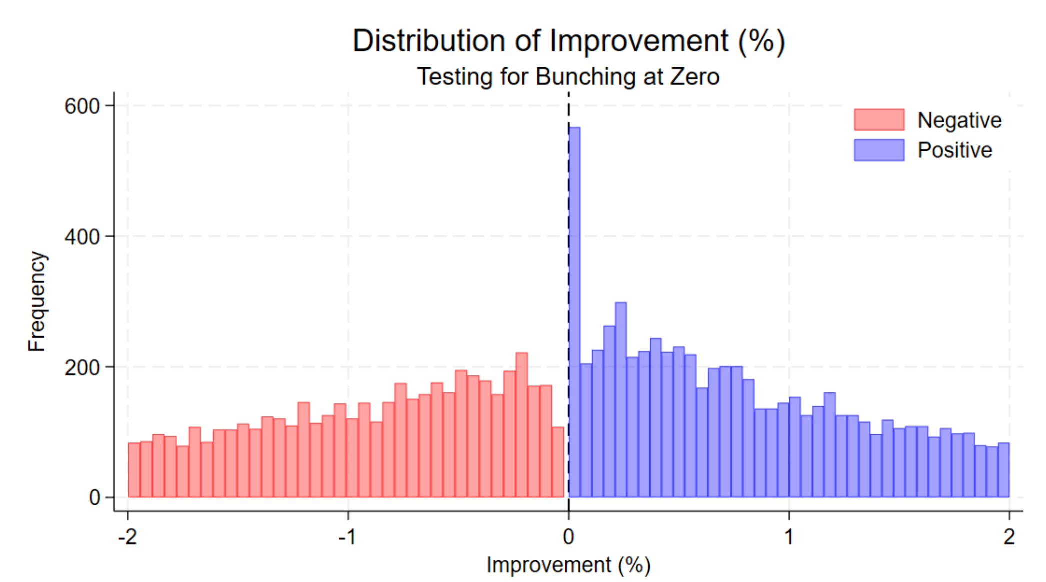
$$\text{Avg. gap}_{ij} = \left(\frac{1}{J-1} \sum_{k \neq j} F_{ik}^{I} - F_{ij}^{I} \right) \quad \text{Max. gap} = \left(\max_{k \neq j} F_{ik}^{I} - F_{ij}^{I} \right)$$

Learning(1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Increase	Increase	Increase	Increase	Increase	Increase	Has External Offer
Avg. Gap	0.316***	0.202***	0.155***	0.139***	0.147***	0.071***	
	(0.006)	(0.010)	(0.010)	(0.016)	(0.019)	(0.020)	
Max. Gap		0.128***	0.110***		-0.021	-0.006	
		(0.009)	(0.009)		(0.029)	(0.028)	
gap_from_avg							-0.191***
							(0.032)
Constant	1.893***	1.606***	1.375***	1.381***	1.387***	1.511***	-2.012***
	(0.010)	(0.022)	(0.082)	(0.045)	(0.046)	(0.121)	(0.028)
Sample	Not highest	Not highest	Not highest	Highest	Highest	Highest	All
Firm FE	No	No	Yes	No	No	Yes	No
Observations	14,133	14,133	14,133	2,046	2,046	2,046	16,164

Go back

Learning(2)


Distribution of Improvement (%)
Testing for Bunching at Zero
Frequency
600
400
200
0
-2
-1
0
1
2
Improvement (%)
Negative
Positive

Outline

Learning Model: Overview

- **Goal:** Rationalize the increase in offers between initial and revised offers
- **Key mechanism:** Firms learn competitors' offers when consumer requests revised offers
- **Incorporate:**
  - Search cost [not today]
  - Product Differentiation [today]
  - Prediction precision [not today]
  - Learning [today]

Two-Stage Game: Timeline

1. **Stage 1 (Initial offers):** Connection with setting
   - Firms draw costs c_j from distribution $F(c_j|c_{-j})$ they only observe their own cost.
   - Firms simultaneously post initial prices p_j^{T1}
   - Consumer observes all offers

2. **Consumer decision:**
   - With probability $1 - \lambda$: accepts one of the initial offers
   - With probability λ: requests a revised offer from a randomly chosen firms

3. **Stage 2 (Revised offers):**
   - Selected firm observes all initial offers p^{T1}
   - Can update its offer: $p_j^{T2}(c_j, p^{T1}) = \min(p_j^{T1}, p^*)$
   - Consumer chooses among all available offers

Second Stage: Optimal Pricing with Learning

When selected for revised offer, firm observes competitors' initial prices

Optimal updated offer:

$$p_j^{T2}(c_j, p^{T1}) = \min(p_j^{T1}, p^*)$$

where

$$p^* = \arg\max_{p_j} (p_j - c_j) D_j(p_j, p_{-j}^{T1})$$

After observing competitors, firm best-responds to known prices rather than expected prices

Expected Profits in Second Stage

When consumer searches, firm j faces two scenarios:

1. **Selected for revised offer ($\frac{1}{J}$ probability):**

$$\pi_j^{(j)}(p^{T1}, c_j) = (p_j^{T2}(c_j, p^{T1}) - c_j)D_j(p_j^{T2}(c_j, p^{T1}), p_{-j}^{T1})$$

2. **Competitor j' selected ($\frac{1}{J}$ probability):**

$$\pi_j^{(j')}(p^{T1}, c_j, c_{j'}) = (p_j^{T1} - c_j)D_j(p_{-j'}^{T1}, p_{j'}^{T2}(c_{j'}, p^{T1}))$$

Expected second stage profits:

$$\pi_j^{T2}(p^{T1}, c_j, c_{-j}) = \frac{1}{J}\left[\pi_j^{(j)}(p^{T1}, c_j) + \sum_{j' \neq j} \pi_j^{(j')}(p^{T1}, c_j, c_{j'})\right]$$

First Stage: Strategic Pricing

Firms anticipate the second stage when setting initial prices

Expected profits in first stage:

$$\pi_j^{T1}(p^{T1}, c_j, c_{-j}) = (1-\lambda)\underbrace{(p_j^{T1} - c_j)D_j(p^{T1})}_{\text{Immediate acceptance}} + \lambda\underbrace{\pi_j^{T2}(p^{T1}, c_j, c_{-j})}_{\text{Search occurs}}$$

Equilibrium condition:

$$p_j^{T1}(c_j) = \arg\max_{p_j} \int \pi_j^{T1}(p_j, p_{-j}^{T1}(c_{-j}), c_j)dF(c_{-j}|c_j)$$

Trade-off: higher initial price (if accepted) vs. competitive position if search occurs

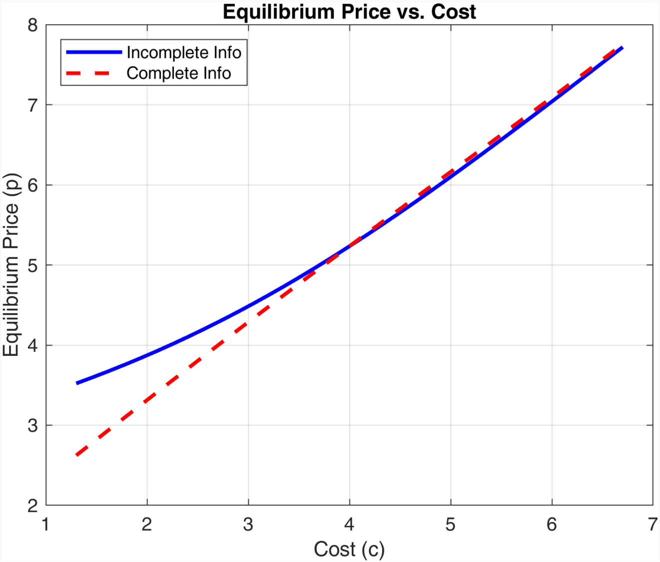
How to compute equilibrium?

Strategic considerations

Define $g(p_j, p_{-j}) = D_j + (p_j - c_j)\frac{\partial D_j}{\partial p_j}$

$$
\begin{aligned}
\frac{\partial \pi_j^{T1}(p^{T1}, c_j, c_{-j})}{\partial p_j^{T1}} = (1-\lambda) g(p_j^{T1}, p_{-j}^{T1}) + \frac{\lambda}{J}\Bigg(& \underbrace{\frac{\partial p_j^{T2}}{\partial p_j^{T1}} g(p_j^{T2}, p_{-j}^{T1})}_{\text{Option value}} \\
& + \sum_{j' \neq j} \left[D_j(p_{-j'}^{T1}, p_{j'}^{T2}) + (p_j^{T1} - c_j)\left(\frac{\partial D_j(p_{-j'}^{T1}, p_{j'}^{T2})}{\partial p_j^{T1}} + \underbrace{\frac{\partial D_j(p_{-j'}^{T1}, p_{j'}^{T2})}{\partial p_{j'}^{T2}} \frac{\partial p_{j'}^{T2}}{\partial p_j^{T1}}}_{\text{Strategic complementarity}} \right) \right] \Bigg)
\end{aligned}
$$

Simulations



Extensions

Possible extensions

- To add search costs
- Allow for more than one search
- Model prediction precision

Outline

Setting and Data

Empirical Evidence

Model and Simulations

Appendix

Loan estimate

FICUS BANK

4321 Random Boulevard • Somecity, ST 12340

Save this Loan Estimate to compare with your Closing Disclosure.

Loan Estimate

DATE ISSUED	2/15/2013
APPLICANTS	Michael Jones and Mary Stone 123 Anywhere Street Anytown, ST 12345
PROPERTY	456 Somewhere Avenue Anytown, ST 12345
SALE PRICE	$180,000

LOAN TERM	30 years
PURPOSE	Purchase
PRODUCT	Fixed Rate
LOAN TYPE	☒ Conventional ☐ FHA ☐ VA ☐ ___________
LOAN ID #	123456789
RATE LOCK	☐ NO ☒ YES, until 4/16/2013 at 5:00 p.m. EDT *Before closing, your interest rate, points, and lender credits can change unless you lock the interest rate. All other estimated closing costs expire on* ***3/4/2013*** *at 5:00 p.m. EDT*

Loan Terms		Can this amount increase after closing?
Loan Amount	$162,000	**NO**
Interest Rate	3.875%	**NO**
Monthly Principal & Interest *See Projected Payments below for your Estimated Total Monthly Payment*	$761.78	**NO**
		Does the loan have these features?
Prepayment Penalty		**YES** • **As high as $3,240** if you pay off the loan during the first 2 years
Balloon Payment		**NO**

Go back: Motivation

Initial prices

MODALIDAD RENTA VITALICIA INMEDIATA

RENTA VITALICIA INMEDIATA SIMPLE

Annuitize full wealth, 0 guarantee, 0 deferral

Nº Oferta	Compañia de Seguros de Vida Brand Name	Pensión final Mensual sin Retiro de Excedente UF	Pensión final Mensual en UF Considerando un retiro de excedente de 0,00 UF	Pensión con retiro de Excedente Máximo		Clasificación de riesgo de la Compañía de Seguros (2)
				Pensión final Mensual UF	Excedente UF	
43872093	CRUZ DEL SUR	26,61	<- Monthly payment		Risk rating ->	AA-
43872099	RENTA NACIONAL	26,58				BBB-
43872083	METLIFE	26,52				AA
43872100	CORPSEGUROS	26,34				AA-
43872094	PRINCIPAL	26,28				AA
43872097	CORPVIDA	26,26				AA-
43872084	EUROAMERICA VIDA	26,25				AA-
43872090	PENTA VIDA	26,25				AA-
43872091	OHIO NATIONAL	26,24				AA
43872098	SURA	26,21				AA
43872095	CN LIFE	25,90				AA
43872092	BICE VIDA	25,86				AA+
43872085	CHILENA CONSOLIDADA	25,59				AA
43872086	CONSORCIO VIDA	25,36				AA+

Go back: Diagram Go back: Data

Connection model with setting

- Firms cost:

$$c_{ij} = \mathbb{E}^{j}_{T}\left[\sum_{t=1}^{T} \frac{1}{(1+r_j)^t} | x_i\right]$$

- Firm prices: $p_j = S_i / F_{ij}$
- Firm profits:

$$\pi_{ij}(F) = (p_j - c_{ij})D_{ij} = \frac{S}{4}$$

Go back: Timeline [STILL WORK ON THIS SLIDE]