Auctioning Annuities

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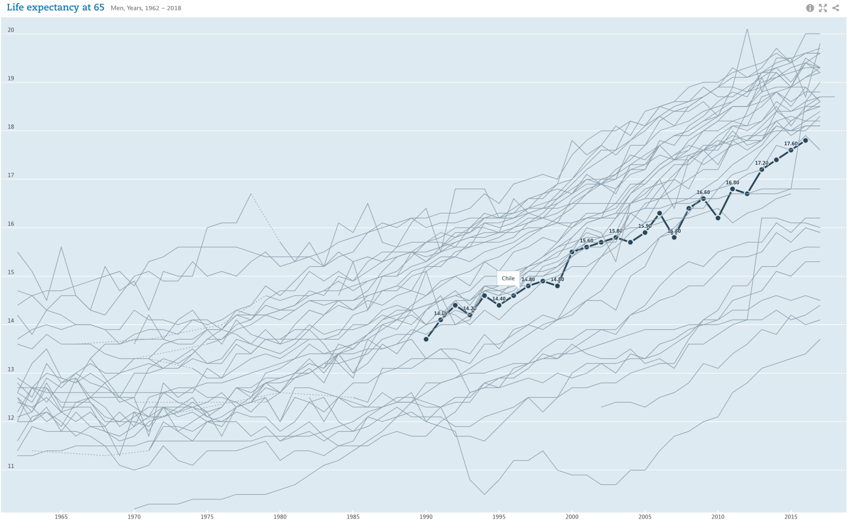
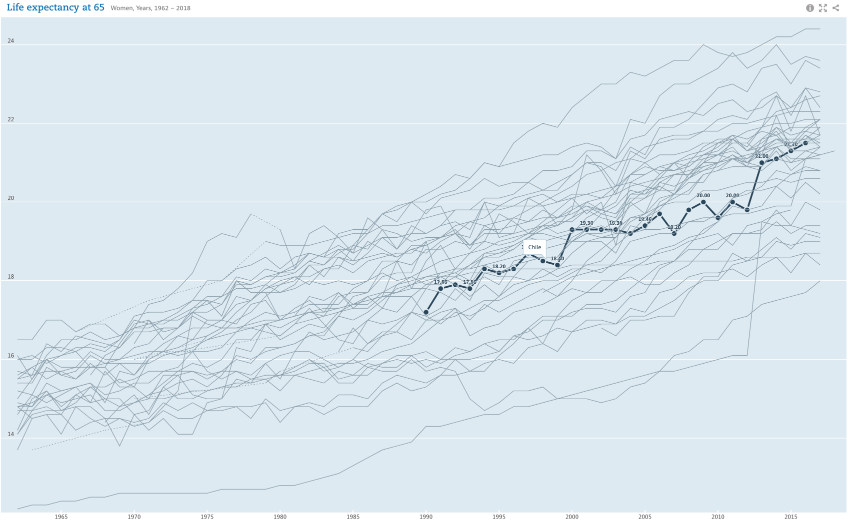
Life Expectancy at 65 for Male in Chile



Life Expectancy at 65 for Female in Chile



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What is an Annuity?

- A series of payments at fixed intervals, paid while the buyer is alive.
- The payment stream has an unknown duration based principally upon buyer's death.
- Upon death the contract terminates and the remainder of the fund is forfeited.
- Unless there are other beneficiaries in the contract.

Overarching Goal:

Design an efficient market to buy and sell annuities.

1. How can we tell if a market is efficient, when there is two-sided informational asymmetry
   - adverse selection: people who expect to live longer want to buy (more) annuity.
   - private info: insurance companies have private information about cost of annuitization.
2. And how to ensure a "thick" market when there is
   - Bequest motives;
   - Adverse selection;
   - Endogenous competition;
   - and when products are "complex" (leading to high markup)?

What do we do?

- Use rich data from Chile to answer these "market design" questions.
- Most papers focus only on demand and treat the supply as perfectly competitive.
- We estimate *rationally inattentive* demand <u>and</u> *strategic* supply with *endogenous entry*.

Goals

- We use the estimates for two main purposes:
  1. to empirically determine if the market in Chile is efficient or not;
  2. if not, to identify some policy changes that can improve market efficiency;
  3. to identify "markers/rules" that foster/hinder competition and welfare.

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- Q3: contribute to our understanding of how to design a new market for annuities.

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- Q1 and Q2: directly address some debate in Chile about competition and waste.
- Q3: contribute to our understanding of how to design a new market for annuities.
- E.g., the Setting Every Community Up for Retirement Enhancement Act of 2019:
  - It incentivizes small businesses to band together to create retirement plans (annuities).
  - But how should these plans and markets be structured?
  - Should we use posted price or auctions or allow retirees to haggle?
  - What if buyers value companies' non-pecuniary features?
  - And they have limited information processing capacity?

Summary of (Preliminary) Results

- information processing cost:
  - decreases with income.
  - larger for those who use sales agents.
- credit rating:
  - bad rating is bad.
  - "disutility" it is lowest for those with the highest income.
  - those with sales agent tend to care more about ratings.
- Cost of offering annuity (relative Unitary Necessary Capital):
  - a lot of heterogeneity across firms
  - increases with income $\rightarrow$ adverse selection.

Outline

Institution

- The Chilean pension system was privatized in 1981 replacing a pay-as-you-go system.
- Workers in formal sectors are required to save 10% of their taxable income.
- This saving is in their "savings" account.
- Retirees use their savings to buy a guaranteed stream of income, either an annuity or Programmed Withdrawal (PW).
- Normal retirement ages are 60 (Female) and 65 (Male).

Timing

1. Initiate the process.
2. Chooses (randomly) a “channel” who can help:
   2.1 AFP (free)
   2.2 Insurance Company (free)
   2.3 Sales agent (fee)
   2.4 Independent advisor (fee)
3. Act as an “auctioneer” and requests bids (monthly pension) from firms in FPA.
4. Choose annuity/PW or go to second round English auction.
5. Make a final decision.

Data

- Every individual in the system: January 2007- December 2018.
- For each, we observe: gender, age at retirement and savings.
- Crucial: we observe everything the companies observe about a retiree at the offer stage.
- Set of all annuity products requested, all the offers made by all companies and final choices.
- We focus on: those without children, and retire within 10 years of normal retirement age.
- Sample size: 238,891 retirees.

Data

1. Mean savings US $ 112,471 and median $74, 515.
2. Mean pensions: $570 (immediate annuity) and $446 (deferred).
3. Programmed Withdrawal comprise of 33% (we ignore them for now).

Round/Choice	**PW**	1^{st} **round**	2^{nd} **round**	**Total**
1^{st} round	76,690	18,001	0	94,691
2^{nd} round	1,471	(2,979)	139,407	143,857
Total	78,161	20,980	139,407	238,548

Stylized Data Features

1. Many retirees make poor decisions (around 29%), they don't choose the best offer. MLT
2. Sales agents are responsible for poor decisions. More
3. Total of 19 unique firms. But not all participate in all auctions. Participation 73%.

The Model: Timing

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5. Retiree i decides how much information to acquire (about his/her own preferences).
6. Retiree i chooses one from J offers, or opts the second-round.
7. In the second-round, companies participate in a modified English auction.

The Model: Demand

Utility

$$\tilde{U}_{ij} = \underbrace{\beta_i^\top \tilde{Z}_{ij}}_{\texttt{firms}} + \underbrace{\mathbf{A}_{ij}}_{\texttt{NEPV of pension}} + \underbrace{\theta_i}_{\texttt{bequest motive}} \mathbf{B}_{ij} - S_i, \tag{1}$$

- $\mathbf{A}_{ij} \equiv P_j \times UNC_i$, where UNC_i is the (known) unitary necessary capital.

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Normalized Utility

$$U_{ij} \equiv \frac{\tilde{U}_{ij}}{S_i} = \beta_i^\top Z_{ij} + \rho_{ij} + \theta_i \times b_{ij} - 1. \quad (2)$$

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- Retirees are *rationally inattentive* decision makers Sims (2003, JME).
- Follow Matejka and McKay (2015, AER): posit that i has a prior belief $\beta_i \sim^{i.i.d} F_\beta(\cdot)$.

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- But has to incur some cost to update.
- Let $\lambda > 0$ be the per unit information processing cost of reducing uncertainty about β.
- In empirical setting we allow λ depend on:
  - income: $\uparrow$ savings $\quad\leftrightarrow\quad$ $\uparrow$ education $\rightarrow$ $\downarrow \lambda$.
  - channel: possiblee steering by sales agent.

The Model: Demand

The probability i chooses j is

$$\sigma_{ij}(\boldsymbol{\beta}, \boldsymbol{\rho}, \mathbf{b}) = \begin{cases} \dfrac{\exp\left(\log \sigma_j^0 + \frac{U_{ij}}{\lambda}\right)}{\sum_{k=1}^{J} \exp\left(\log \sigma_k^0 + \frac{U_{ik}}{\lambda}\right) + \exp\left(\frac{\mathbb{E}U_i}{\lambda}\right)}, & j = 1, \ldots, J \\ \\ \dfrac{\exp\left(\frac{\mathbb{E}U_i}{\lambda}\right)}{\sum_{k=1}^{J} \exp\left(\log \sigma_k^0 + \frac{U_{ik}}{\lambda}\right) + \exp\left(\frac{\mathbb{E}U_i}{\lambda}\right)}, & j = J + 1. \end{cases} \tag{3}$$

where U_{ij} is defined in Equation (2) and σ_k^0 is the prior probability of selecting k.

The Model: Supply - First Stage

- Insurance company j's would choose monthly pension P_j to maximize:

$$\mathbb{E}\Pi_{ij} = (S_i - P_j \times UNC_j) \times \Pr(\texttt{j wins offering } P_j | \mathbf{P}_{-j})$$

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&\equiv S_i(1 - \underbrace{\rho_{ij}}_{\texttt{MWR}} \times \underbrace{r_{ij}}_{\texttt{relative UNC or cost}}) \times \underbrace{\sigma_j(\rho_j, \boldsymbol{\rho}_{-j})}_{\texttt{demand}},
\end{aligned}
$$

- Recall $r_{ij} := \frac{UNC_j}{UNC_i} \sim W_r(\cdot|X)$ be j's private information.
- The CDF $W_r(\cdot|X)$ is a model primitive and unknown to the researcher.

The Model: Supply

- Now i requests to go to the second-round and initiate English auction.
- Under a symmetric equilibrium, j solves

$$\max_{\rho_j \geq 0, \tilde{\rho}_j \geq \rho_j} \left\{ \underbrace{\mathbb{E}\Pi_{ij}}_{\texttt{First-Price Auction}} + \underbrace{\sigma_{J+1}(\boldsymbol{\rho})}_{\texttt{second-round probability}} \times \underbrace{\mathbb{E}\Pi_j^{II}(\tilde{\rho}_j | r_j, \boldsymbol{\rho})}_{\texttt{English Auction}} \right\}.$$

The Model: Supply - Example with $J = 2$

- $J = 2$ firms with strictly positive returns r_1 and r_2, and suppose r_1 and r_2 are also known.
- All else equal, the retiree prefers 1, $\Delta_{12} > 0$, commonly known.

SPNE

- If $r_2 \leq r_1 + \Delta_{12}$, 1 wins, and 2 pushes bid up to r_2, 1 pushes bid up to $r_2 - \Delta_{12}$.

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SPNE

- If $r_2 \leq r_1 + \Delta_{12}$, 1 wins, and 2 pushes bid up to r_2, 1 pushes bid up to $r_2 - \Delta_{12}$.
- If $r_2 > r_1 + \Delta_{12}$, 2 wins, and 1 pushes up to r_1, and 2 pushes up to $r_1 + \Delta_{12}$.

Similarly, we can adapt to cost of providing annuity.

The Model: Supply - Weak Perfect Bayesian Nash Equilibrium

Extending this argument to $J > 2$ we see that if j_i^* is the chosen firm by retiree i, then

$$\beta_i^\top Z_{ij_i^*} + \theta_i b_{ij_i^*} + \tilde{\rho}_{j_i^*} = \max_{k \neq j} \Big\{ \beta_i^\top Z_{ik} + \theta_i b_{ik} + \underbrace{1/{\color{red}r}_k}_{\texttt{reciprocal of k's true cost}} \Big\}, \tag{4}$$

Equation (4) is the heart of our identification and estimation equation.

Identification

- Information processing cost λ (by channel): use the elasticity of choice w.r.t pension
- Distribution of preferences $F_\beta(\cdot)$: variation in top two firm's characteristics.
- Distribution of returns $W_r(\cdot|X)$: English auction

Identification of W_r and F_β

- Assumption: the two-most competitive firms in the first-round are also the two most competitive firms in the second-round,

Identification of W_r and F_β

$$
\begin{aligned}
\underbrace{\tilde{\rho}_{j_i^*}}_{\texttt{chosen pension}} &= \max_{k \neq j_i^*, k \in J_i} \{\beta_i^\top Z_{ik} + \theta_i b_k + 1/r_k\} - \beta_i^\top Z_{ij_i^*} - \theta_i b_{j_i^*} \\
&= \frac{\beta_i^\top}{1 + \alpha_i \theta_i}(Z_{ik_i^*} - Z_{ij_i^*}) + 1/r_{k_i^*} \qquad (\because b = \alpha \times \rho) \\
&= \tilde{\beta}_i^\top (Z_{ik_i^*} - Z_{ij_i^*}) + 1/r_{k_i^*} \\
&\equiv [(Z_{ik_i^*} - Z_{ij_i^*}), 1] \times [\tilde{\beta}_i, 1/r_{k_i^*}]^\top = Q_i \times \tilde{\delta}_i^\top
\end{aligned}
$$

Identification of W_r and F_β

- Our second stage pricing equation has random coefficient form:

$$\tilde{\rho}_{j_i^*} = Q_i \times \delta_i^\top, \qquad \delta_i \perp Q_i, 1 \leq i \leq N_J. \tag{5}$$

- From Hoderlein Klemela and Mammen (2010) $\rightarrow$ identify F_β and $F_{r_{k_i^*}}$.
- Equation (5) is second-order statistic of $(\tilde{\beta} Z + 1/r)$. More
- We need some work to get W_r from this.

Selective Entry

- The identification strategy above side stepped the problem of selective entry.
- The threshold crossing equilibrium of Samuelson (1985): entry iff $r_j \leq r^*$.
- So we have identified: $W_r^*(r|S) := W_r(r|S; r \leq r^*) = \frac{W_r(r) - W_r(r^*)}{W_r(r^*)}$.
- Use $J \sim \texttt{Binomial}(\tilde{J}, p)$ to estimate the probability p that $r_j \leq r^*$.
- This helps us identify $W_r(\cdot|\texttt{Savings})$.

Semi-Parametric Estimation

- $\tilde{\beta}_i$ varies only by $\{\texttt{Age, Gender, Channel}\}$.
- $W_r(\cdot|X_i) \equiv W_r(\cdot|S_q)$, where S_q is the quintile of savings.
- Use Local Polynomial to estimate CDF of 2nd order statistics of $W_r^*(\cdot|S_q; \texttt{Signal} < s^*)$.
- Then estimate $W_r(\cdot|S_q)$ by following selective entry model of Samuelson (1985).

Results: (Median) Information Processing Cost, by Savings and Channel

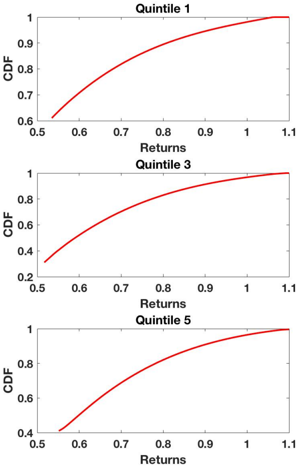
Savings Quintiles/Channel	**PFA**	**Agent**	**Advisor**	**Overall**
Q1	0.009	0.027	0.006	0.021
Q2	0.006	0.019	0.004	0.016
Q3	0.005	0.013	0.003	0.013
Q4	0.005	0.012	0.003	0.005
Q5	0.005	0.012	0.003	0.006
Overall	0.005	0.013	0.003	0.009

"Agent" includes Sales Agents and Insurance Company

Preliminary Results: Random Coefficient Estimations: if Z is credit rating

	Retirement Age	Gender	Q1	Q2	Q3	Q4	Q5
AFP	Pre-NRA	M	-243	-195	-20	-25	-1541
		F	n.a.	-204	-169	-137	-649
	At-NRA	M	-185	-83	-2	-482	-1852
		F	-202	-90	-99	-611	-788
	Post-NRA	M	-160	-66	-207	-581	-2102
		F	-202	-156	-319	-597	-1131
Agent	Pre-NRA	M	-375	-194	-178	-553	-1260
		F	-574	-254	-327	-726	-1183
	At-NRA	M	-278	-150	-322	-833	-1938
		F	-412	-336	-591	-982	-1223
	Post-NRA	M	-265	-212	-363	-1090	-2523
		F	-379	-365	-669	-1064	-1568
Advisor	Pre-NRA	M	-296	-251	-207	-317	-765
		F	-465	-321	-373	-584	-431
	At-NRA	M	-335	-213	-202	-249	-1055
		F	-555	-354	-455	-651	-878
	Post-NRA	M	-331	-219	-302	-592	-1405
		F	-493	-385	-472	-564	-925

Estimated conditional CDF of reciprocal cost, given Savings Quintiles



Summary of Results

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- credit rating:
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- Unitary Necessary Capital:
  - a lot of heterogeneity across firms
  - increases with income.
  - most $1/r < 1$.

To Do

1. Identify the bequest motive.
2. Determine the value of middle men. Why do they exist?
3. What happens if the second stage is removed?
4. Can we improve competition and consumer welfare by:
    4.1 Adopting "bid preference" program (e.g., Krasnokutskaya and Seim 2011, AER).
    4.2 Replace simultaneous auction by sequential auction (e.g., Roberts and Sweeting 2013, AER)?

Thank You!

Summary of Accepted Annuities

GP Years	N Accepted	Average # of 1^{st} Round Offers	# Accepted in 2^{nd} Round	Increase	Average % Requested 2^{nd} Round	Best	Dominated
			Inmediate				
0	21,292	11.3	16,357	1.5	80	59	22
120	26,907	11.1	23,463	1.3	89	51	28
180	24,452	11.6	22,070	1.4	92	49	29
240	14,464	11.8	13,020	1.5	92	51	29
Total	87,115	11.4	74,910	1.4	88	53	27
			Deferred				
0	11,703	10.9	8,919	1.5	79	53	23
120	26,119	11.0	23,390	1.4	91	46	31
180	26,775	11.4	24,324	1.4	92	42	34
240	8,675	11.0	7,864	1.3	92	42	34
Total	73,272	11.1	64,497	1.4	90	45	31

What explains Channel?

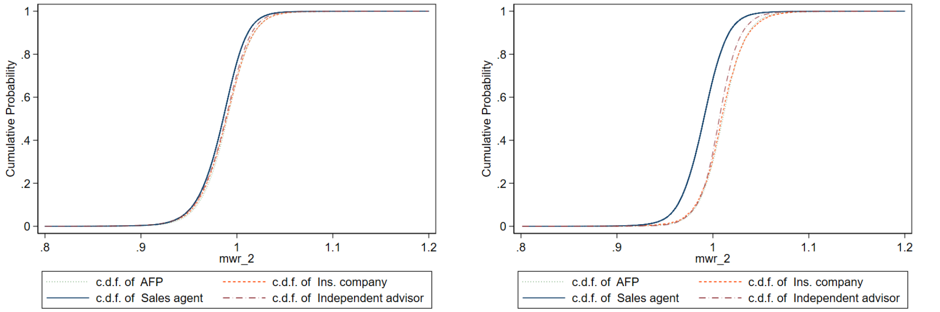
Intermediary Channel - Estimates from Multinomial Logit

	Insurance Company	**Sales-Agent**	**Advisor**
Balance ($million)	0.629***	-0.857***	-0.130***
	(0.128)	(0.0436)	(0.0447)
Age	0.0131	-0.0408***	-0.0816***
	(0.00857)	(0.00189)	(0.00218)
Female	0.437***	-0.0588***	-0.124***
	(0.0546)	(0.0120)	(0.0140)
Married	0.0245	0.0620***	0.0874***
	(0.0491)	(0.0107)	(0.0127)
Constant	-5.029***	2.333***	4.326***
	(0.560)	(0.123)	(0.142)
N	238,548	238,548	238,548

Notes. Estimates of Multinomial Logit regression of channel choices on individual covariates. Standard errors are reported in the parentheses. **Pseudo $\mathbf{R^2} = \mathbf{0.4\%}$.** $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

Some Channels offer lower MWR than others

CDFs of Offered (left) and Accepted (right) MWR, by Channel



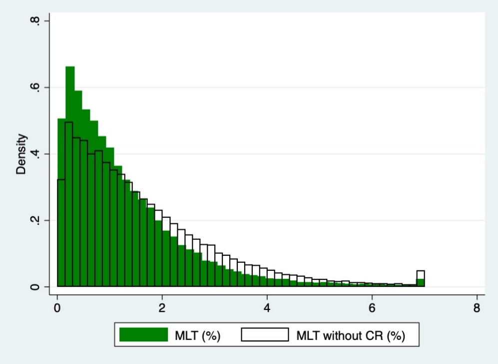
MWR is money's worth ratio, which is a popular measure of determining whether annuities deliver an adequate value-for-money. It is defined as the expected return to the annuity purchased per premium dollar invested.

Does the decision to go to second-round depend on the Channel?

	N	**Requests 2^{nd} Round**	**Chooses PW**	**Chooses in 2^{nd} Round**
AFP	109,786	0.251	0.661	0.235
Company	2,169	0.852	0.066	0.817
Sales-agent	79,120	0.920	0.030	0.907
Advisor	47,473	0.878	0.066	0.846
Total	238,548	0.603	0.328	0.584

Proportion of retirees by their choices, separated by their intermediary channel.

Money Left on the Table (MLT)



Histograms of MLT, defined as the difference between the chosen pension and the maximum pension offered by a company with same or better credit-rating as the chosen company expressed as the percentage of the chosen pension, and if we ignore the credit-rating, we get MLT without CR. The values are top-coded at 7%.

Back

Dominated Choices, by Channel

Channel	**Type**	**Obs.**	**% Dominated**
AFP	Inmediate	23,213	16
	Deferred	14,041	13
Ins. company	Inmediate	1,118	15
	Deferred	907	14
Sales agent	Inmediate	37,203	46
	Deferred	39,567	49
Advisor	Inmediate	25,581	11
	Deferred	18,757	9
Total		160,387	29

Proportion of retirees who choose a dominated pension, separated by the intermediary channel and product type.

Determinants of MLT

Regressorss/Regressand	(1) Pr(**MLT** > 0)	(2) **MLT**	(3) Pr(**MLT** > 0)	(4) **MLT**
Balance($million)	-0.169***	-1.461***	-0.142***	-1.385***
	(0.0122)	(0.0686)	(0.0122)	(0.0685)
Age	0.00424***	0.00709***	0.00421***	0.00713***
	(0.000392)	(0.00215)	(0.000390)	(0.00214)
Female	-0.00737***	-0.0762***	-0.00572**	-0.0741***
	(0.00248)	(0.0129)	(0.00247)	(0.0129)
Married	-0.0113***	-0.0813***	-0.0105***	-0.0810***
	(0.00225)	(0.0117)	(0.00224)	(0.0117)
Second round			-0.0974***	-0.234***
			(0.00345)	(0.0180)
Ins.company	-0.00121	0.109*	0.00857	0.139**
	(0.00741)	(0.0633)	(0.00734)	(0.0634)
Sales agent	0.278***	0.279***	0.293***	0.358***
	(0.00257)	(0.0157)	(0.00256)	(0.0169)
Advisor	-0.0275***	-0.206***	-0.0122***	-0.114***
	(0.00249)	(0.0188)	(0.00250)	(0.0204)
Company F.E.	✓	✓	✓	✓
Observations	160,387	43,717	160,387	43,717
R-squared		0.0850		0.0887

Marginal effects on Pr($MLT > 0$) (columns 1 and 3) and level of MLT from OLS

Average Predicted $\Pr(MLT > 0|\texttt{second-round})$

	$\Pr(MLT > 0\|\texttt{2nd R.})$	$\Pr(MLT > 0\|\texttt{2nd R.} = 1)$	$E(MLT\|\texttt{2nd R.})$	$E(MLT\|\texttt{2nd R.} = 1)$
$D_2 = 0$	25.80	17.75	1.32	1.09
$D_2 = 1$	27.53	27.53	1.23	1.23
		Channel		
AFP	12.51	10.75	1.00	0.91
Ins. company	13.58	12.72	1.19	1.12
Sales agent	46.01	45.21	1.33	1.32
Independent advisor	8.10	7.73	0.68	0.67
Total	27.34	26.44	1.24	1.22

$\Pr(MLT > 0|\texttt{2nd Round})$ is the predicted probability of $\{MLT > 0\}$ using the actual second round dummy $D_2 \in \{0, 1\}$. $\Pr(MLT > 0|\texttt{2nd Round} = 1)$ is the (counterfactual) predicted probability of $\{MLT > 0\}$ when everyone negotiates, i.e., $\texttt{2nd Round} = 1$.

$\mathbb{E}(MLT|\texttt{2nd round}) = 1.3\%$ is same as delaying retirement 9.4/8.4. months for M/F. Back

Number of Participating Companies, by Savings

Savings-Deciles	Min	P5	P25	Median	P75	P95	Max
1	1	1	5	7	8	10	14
2	1	6	8	9	10	12	15
3	1	8	10	11	12	13	15
4	1	9	10	11	12	13	15
5	1	9	11	12	12	13	15
6	1	9	11	12	13	14	15
7	1	10	12	13	14	15	15
8	1	10	11	13	14	15	15
9	1	9	11	12	13	15	15
10	1	9	11	12	13	14	15
Overall	1	5	9	11	12	14	15

Number of participating companies grouped by the decile of retirees' savings.

Credit-Ratings

Rating	Frequency	%	Cumulative %
AA+	155	24.64	24.64
AA	245	38.95	63.59
AA-	171	27.19	90.78
A+	2	0.32	91.1
A	15	2.38	93.48
BBB+	1	0.16	93.64
BBB	6	0.95	94.59
BBB-	15	2.38	96.98
BB+	19	3.02	100
Total	629	100	

Observable Factors that can affect Entry

	(1) OLS	(2) Poisson
Savings (million U.S. $)	11.51***	10.00***
	(0.151)	(0.178)
Age	0.0743***	0.0699***
	(0.00243)	(0.00249)
Female	0.618***	0.619***
	(0.0149)	(0.0152)
Married	0.0685***	0.0767***
	(0.0134)	(0.0137)
Insurance Company	-0.0614	-0.0598
	(0.0542)	(0.0543)
Sales-agent	-0.186***	-0.192***
	(0.0157)	(0.0161)
Advisor	-0.202***	-0.198***
	(0.0181)	(0.0185)
1 Deferred Year	0.0575***	0.0611***
	(0.0143)	(0.0148)
2 Deferred Years	0.237***	0.258***
	(0.0158)	(0.0160)
3 Deferred Years	-0.195***	-0.159***
	(0.0225)	(0.0224)
120 Guaranteed Months	0.251***	0.233***
	(0.0189)	(0.0197)
180 Guaranteed Months	0.667***	0.672***
	(0.0181)	(0.0184)
240 Guaranteed Months	0.400***	0.415***
	(0.0208)	(0.0212)
Constant	3.083***	
	(0.187)	
N	160,387	160,387
R-squared	0.245	

Order statistics

- Suppose r is returns.
- Suppose 3 firms 1, 2 and 3 with returns 1.1, 1.2 and 1.3, respectively.
- (i) All $\tilde{\beta}Z = 0$: 3 wins by offering 1.2. So $r_{k_i^*}$ is the **second highest return**.
- (ii) Only 2 has advantage $\tilde{\beta}Z_2 = 0.15$, and the rest zero.
- 2 wins with 1.15, 3 is runner-up, so $r_{k_i^*} = 1.3 = 1.15 - (0 - 0.15) =$ the **highest return**.
- (iii) $\tilde{\beta}Z_3 = 0.15$, and the rest zero.
- 3 wins with 1.25, 1 is runner-up, and $r_{k_i^*} = 1.25 - (0 - 0.15) =$ the **third highest return**.
- Heuristically, order statistic of a sum is not equal to the sum of order statistics.
- But, we have identified the second-order statistic of total value $\tilde{\beta}Z + r$.

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