APPENDICES OF THE THESIS OF

Constraint-based Co-evolutionary Genetic Programming for Bargaining Problems

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Appendix A

Notations and Abbreviations

Table A.1: Notations and Explanation

Explanation	Notation
The player who makes the first offer	1
The second player	2
A player	i
The other player	j
Population	P
Individual (Genetic Program)	g
An individual in population for the player i	g_i
Strategy of g_i	$s(g_i)$
Utility	u
g_i's utility from the outcome of bargaining with g_j	$u_{s(g_i)\to s(g_j)}$
Game fitness of g_i	$GF(g_i)$
Fitness of g_i	$F(g_i)$
Discount factor of i	δ_i
Discount rate of i	r_i
Discount factor of the weak player 2	δ_w
Discount factor of the strong player 2	δ_s
Discount factor of the inactive player 2	δ_2'
Player 2 whose discount factor is δ_w	2_w
Player 2 whose discount factor is δ_s	2_s
Player 2 whose discount factor is δ_2'	$2'$
The possibility of 1' initial belief that player 2's discount factor is δ_w	ω_0
Outside option of player i	w_i
The larger one of two possible player 2's outside option	w_l
The smaller one of two possible player 2's outside option	w_s
The inactive player 2's outside option	w_2'
The possibility of 1' initial belief that player 2's outside option is w_s	ω_0'
Random value	r
Player 1' share from an agreement in the theoretic solution	x_1^*
Player 1' average experimental shares from agreements	$\bar{x_1}$
Player 2' share from an agreement in the theoretic solution	x_2^*
Player 2' average experimental shares from agreements	$\bar{x_2}$
The bargaining time for reaching agreements by the theoretic solution	t^*
The average bargaining time for reaching experimental agreements	$\bar{t}$
Deviation	σ
t-test critical value	tc
t-test statistical value	tsv

Table A.2: Abbreviations and Explanation

Explanation	Abbreviations
Evolutionary Algorithms	EA
Genetic Programming	GP
Genetic Algorithms	GA
Constraint-based Co-evolutionary Genetic Programming	CCGP
Rubinstein Complete Information Alternating-offer Bargaining Model	CRub82
Rubinstein Incomplete Information Alternating-offer Bargaining Model	ICRub85
Unilateral Imprecise Information Alternating-offer Bargaining Model	UII
Unilateral Ignorance Information Alternating-offer Bargaining Model	UGI
Bilateral Ignorance Information Alternating-offer Bargaining Model	BGI
Complete Information Outside Option Alternating-offer Bargaining Model	COO
Incomplete Information on Outside Option Alternating-offer Bargaining Model	ICOO
Subgame Perfect Equilibrium	SPE
Perfect Bayesian Equilibrium	PBE

Appendix B

Non-technical Introduction to Game-theoretic Analysis of CRub82 Bargaining Problem

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Appendix C

One-population Co-evolution for CRub82 Bargaining Problem

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Appendix D

GP Terminal set with t for CRub82 bargaining problem

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Appendix E

Experimental results for Chapter 6

This appendix provides raw experimental data for Chapter 6: *CCGP for Bargaining Problems with Incomplete Information.*

Exp	Game Setting				*PBE*				*Exp. Results*	
No.	δ_1	δ_2	δ_2'	ω_0	x_1^*	V_s	x^{ω_0}	y^{ω_0}	$\bar{x_1}$	σ
# 1	0.1	0.1	0.2	0.1	0.8163	0.8163	0.9009	0.0091	0.9162	0.0316
# 2	0.1	0.1	0.2	0.5	0.8163	0.8163	0.9045	0.0455	0.9269	0.0269
# 3	0.1	0.1	0.2	0.9	0.9082	0.8163	0.9082	0.0818	0.9367	0.0242
# 4	0.1	0.1	0.9	0.1	0.1099	0.1099	0.9009	0.0091	0.9273	0.0277
# 5	0.1	0.1	0.9	0.5	0.9045	0.1099	0.9045	0.0455	0.9335	0.0253
# 6	0.1	0.1	0.9	0.9	0.9082	0.1099	0.9082	0.0818	0.9387	0.0250
# 7	0.1	0.5	0.4	0.1	0.5263	0.5263	0.6024	0.0061	0.6273	0.0180
# 8	0.1	0.5	0.4	0.5	0.5263	0.5263	0.6123	0.0308	0.6329	0.0196
# 9	0.1	0.5	0.4	0.9	0.0561	0.5263	0.6224	0.0561	0.6356	0.0199
# 10	0.1	0.5	0.9	0.1	0.1099	0.1099	0.5025	0.0051	0.6318	0.0185
# 11	0.1	0.5	0.9	0.5	0.5129	0.1099	0.5129	0.0258	0.6362	0.0178
# 12	0.1	0.5	0.9	0.9	0.5236	0.1099	0.5236	0.0472	0.6318	0.0196
# 13	0.1	0.9	0.1	0.1	0.1099	0.1099	0.9009	0.0091	0.1486	0.0311
# 14	0.1	0.9	0.1	0.5	0.0455	0.1099	0.9045	0.0455	0.1507	0.0312
# 15	0.1	0.9	0.1	0.9	0.0818	0.1099	0.9082	0.0818	0.1492	0.0314
# 16	0.1	0.9	0.8	0.1	0.1099	0.1099	0.2016	0.0020	0.1488	0.0315
# 17	0.1	0.9	0.8	0.5	0.1099	0.1099	0.2084	0.0105	0.1572	0.0285
# 18	0.1	0.9	0.8	0.9	0.0194	0.1099	0.2155	0.0194	0.1543	0.0271

Table E.1: The experimental results and its corresponding PBE solutions. $\bar{x_1}$ is the mean of player 1's shares from agreements of 100 trials. $\delta_1 = 0.1$.

Exp	Game Setting				*PBE*				*Exp. Results*	
No.	δ_1	δ_2	δ_2'	ω_0	x_1^*	V_s	x^{ω_0}	y^{ω_0}	$\bar{x_1}$	σ
# 19	0.5	0.1	0.2	0.1	0.8889	0.8889	0.9058	0.0584	0.9304	0.0312
# 20	0.5	0.1	0.2	0.5	0.8889	0.8889	0.9265	0.2647	0.9378	0.0250
# 21	0.5	0.1	0.2	0.9	0.8889	0.8889	0.9435	0.4355	0.9373	0.0244
# 22	0.5	0.1	0.9	0.1	0.1818	0.1818	0.9058	0.0584	0.9391	0.0254
# 23	0.5	0.1	0.9	0.5	0.9265	0.1818	0.9265	0.2647	0.9391	0.0233
# 24	0.5	0.1	0.9	0.9	0.9435	0.1818	0.9435	0.4355	0.9445	0.0246
# 25	0.5	0.5	0.4	0.1	0.6667	0.6667	0.6159	0.0397	0.6309	0.0194
# 26	0.5	0.5	0.4	0.5	0.6667	0.6667	0.6774	0.1935	0.6307	0.0207
# 27	0.5	0.5	0.4	0.9	0.3396	0.6667	0.7358	0.3396	0.6406	0.0182
# 28	0.5	0.5	0.9	0.1	0.1818	0.1818	0.5167	0.0333	0.6354	0.0172
# 29	0.5	0.5	0.9	0.5	0.5833	0.1818	0.5833	0.1667	0.6356	0.0184
# 30	0.5	0.5	0.9	0.9	0.6500	0.1818	0.6500	0.3000	0.6397	0.0183
# 31	0.5	0.9	0.1	0.1	0.1818	0.1818	0.9058	0.0584	0.1072	0.0191
# 32	0.5	0.9	0.1	0.5	0.2647	0.1818	0.9265	0.2647	0.1088	0.0195
# 33	0.5	0.9	0.1	0.9	0.4355	0.1818	0.9435	0.4355	0.1106	0.0256
# 34	0.5	0.9	0.8	0.1	0.1818	0.1818	0.2109	0.0136	0.1111	0.0206
# 35	0.5	0.9	0.8	0.5	0.1818	0.1818	0.2593	0.0741	0.1097	0.0233
# 36	0.5	0.9	0.8	0.9	0.1463	0.1818	0.3171	0.1463	0.1113	0.0196

Table E.2: The experimental results and its corresponding PBE solutions. $\bar{x_1}$ is the mean of player 1's shares from agreements of 100 trials. $\delta_1 = 0.5$.

Exp	Game Setting				*PBE*				*Exp. Results*	
No.	δ_1	δ_2	δ_2'	ω_0	x_1^*	V_s	x^{ω_0}	y^{ω_0}	$\bar{x_1}$	σ
# 37	0.9	0.1	0.2	0.1	0.9756	0.9756	0.9309	0.3092	0.9269	0.0290
# 38	0.9	0.1	0.2	0.5	0.9756	0.9756	0.9736	0.7364	0.9400	0.0243
# 39	0.9	0.1	0.2	0.9	0.9756	0.9756	0.9870	0.8699	0.9415	0.0280
# 40	0.9	0.1	0.9	0.1	0.5263	0.5263	0.9309	0.3092	0.9293	0.0322
# 41	0.9	0.1	0.9	0.5	0.9736	0.5263	0.9736	0.7364	0.9443	0.0233
# 42	0.9	0.1	0.9	0.9	0.9870	0.5263	0.9870	0.8699	0.9446	0.0238
# 43	0.9	0.5	0.4	0.1	0.9091	0.9091	0.6919	0.2298	0.7151	0.0413
# 44	0.9	0.5	0.4	0.5	0.9091	0.9091	0.8602	0.6506	0.7287	0.0407
# 45	0.9	0.5	0.4	0.9	0.9091	0.9091	0.9267	0.8168	0.7225	0.0416
# 46	0.9	0.5	0.9	0.1	0.5263	0.5263	0.5996	0.1991	0.7338	0.0382
# 47	0.9	0.5	0.9	0.5	0.8041	0.5263	0.8041	0.6081	0.7272	0.0358
# 48	0.9	0.5	0.9	0.9	0.8940	0.5263	0.8940	0.7879	0.7304	0.0397
# 49	0.9	0.9	0.1	0.1	0.5263	0.5263	0.9309	0.3092	0.4708	0.0273
# 50	0.9	0.9	0.1	0.5	0.7364	0.5263	0.9736	0.7364	0.4779	0.0309
# 51	0.9	0.9	0.1	0.9	0.8699	0.5263	0.9870	0.8699	0.4817	0.0295
# 52	0.9	0.9	0.8	0.1	0.5263	0.5263	0.2724	0.0905	0.4817	0.0301
# 53	0.9	0.9	0.8	0.5	0.5263	0.5263	0.5064	0.3830	0.4864	0.0313
# 54	0.9	0.9	0.8	0.9	0.5978	0.5263	0.6782	0.5978	0.4780	0.0278

Table E.3: The experimental results and its corresponding PBE solutions. $\bar{x_1}$ is the mean of player 1's shares from agreements of 100 trials. $\delta_1 = 0.9$.

Exp	Game Setting				*PBE*	*Experimental*
No.	δ_1	δ_2	δ_2'	ω_0	t^*	$\bar{t}$
# 1	0.1	0.1	0.2	0.1	0	0.00
# 2	0.1	0.1	0.2	0.5	0	0.00
# 3	0.1	0.1	0.2	0.9	0	0.00
# 4	0.1	0.1	0.9	0.1	0	0.00
# 5	0.1	0.1	0.9	0.5	0	0.00
# 6	0.1	0.1	0.9	0.9	0	0.00
# 7	0.1	0.5	0.4	0.1	0	0.04
# 8	0.1	0.5	0.4	0.5	0	0.05
# 9	0.1	0.5	0.4	0.9	1	0.05
# 10	0.1	0.5	0.9	0.1	0	0.05
# 11	0.1	0.5	0.9	0.5	0	0.05
# 12	0.1	0.5	0.9	0.9	0	0.05
# 13	0.1	0.9	0.1	0.1	0	0.34
# 14	0.1	0.9	0.1	0.5	1	0.40
# 15	0.1	0.9	0.1	0.9	1	0.48
# 16	0.1	0.9	0.8	0.1	0	0.41
# 17	0.1	0.9	0.8	0.5	0	0.37
# 18	0.1	0.9	0.8	0.9	1	0.41

Table E.4: PBE bargaining time t^* and experimental bargaining time $\bar{t}$. $\bar{t}$ is the mean of the bargaining time for reaching agreements of 100 trials.

Exp	Game Setting				*PBE*	*Experimental*
No.	δ_1	δ_2	δ_2'	ω_0	t^*	$\bar{t}$
# 19	0.5	0.1	0.2	0.1	0	0.00
# 20	0.5	0.1	0.2	0.5	0	0.00
# 21	0.5	0.1	0.2	0.9	0	0.00
# 22	0.5	0.1	0.9	0.1	0	0.00
# 23	0.5	0.1	0.9	0.5	0	0.00
# 24	0.5	0.1	0.9	0.9	0	0.00
# 25	0.5	0.5	0.4	0.1	0	0.05
# 26	0.5	0.5	0.4	0.5	0	0.05
# 27	0.5	0.5	0.4	0.9	1	0.05
# 28	0.5	0.5	0.9	0.1	0	0.05
# 29	0.5	0.5	0.9	0.5	0	0.05
# 30	0.5	0.5	0.9	0.9	0	0.05
# 31	0.5	0.9	0.1	0.1	0	0.20
# 32	0.5	0.9	0.1	0.5	1	0.23
# 33	0.5	0.9	0.1	0.9	1	0.23
# 34	0.5	0.9	0.8	0.1	0	0.22
# 35	0.5	0.9	0.8	0.5	0	0.29
# 36	0.5	0.9	0.8	0.9	1	0.23

Table E.5: PBE bargaining time t^* and experimental bargaining time $\bar{t}$. $\bar{t}$ is the mean of the bargaining time for reaching agreements of 100 trials.

Exp	Game Setting				*PBE*	*Experimental*
No.	δ_1	δ_2	δ_2'	ω_0	t^*	$\bar{t}$
# 37	0.9	0.1	0.2	0.1	0	0.00
# 38	0.9	0.1	0.2	0.5	0	0.00
# 39	0.9	0.1	0.2	0.9	0	0.00
# 40	0.9	0.1	0.9	0.1	0	0.00
# 41	0.9	0.1	0.9	0.5	0	0.00
# 42	0.9	0.1	0.9	0.9	0	0.00
# 43	0.9	0.5	0.4	0.1	0	0.32
# 44	0.9	0.5	0.4	0.5	0	0.26
# 45	0.9	0.5	0.4	0.9	0	0.32
# 46	0.9	0.5	0.9	0.1	0	0.28
# 47	0.9	0.5	0.9	0.5	0	0.34
# 48	0.9	0.5	0.9	0.9	0	0.33
# 49	0.9	0.9	0.1	0.1	0	3.99
# 50	0.9	0.9	0.1	0.5	1	3.64
# 51	0.9	0.9	0.1	0.9	1	3.98
# 52	0.9	0.9	0.8	0.1	0	3.76
# 53	0.9	0.9	0.8	0.5	0	3.73
# 54	0.9	0.9	0.8	0.9	1	3.83

Table E.6: PBE bargaining time t^* and experimental bargaining time $\bar{t}$. $\bar{t}$ is the mean of the bargaining time for reaching agreements of 100 trials.

Exp	Game Setting		*CRub82*	*Experimental Results*		
No.	δ_1	δ_2	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.9091	0.9438	0.0254	0.00
# 2	0.1	0.4	0.6250	0.8476	0.0293	0.03
# 3	0.1	0.9	0.1099	0.1474	0.0371	0.22
# 4	0.4	0.1	0.9375	0.9456	0.0238	0.00
# 5	0.4	0.6	0.5263	0.4981	0.0063	0.02
# 6	0.4	0.9	0.1563	0.0999	0.0051	0.01
# 7	0.5	0.5	0.6667	0.6765	0.0083	0.01
# 8	0.9	0.1	0.9890	0.9836	0.0130	0.00
# 9	0.9	0.4	0.9375	0.8944	0.0128	0.00
# 10	0.9	0.6	0.8696	0.7144	0.0571	0.37
# 11	0.9	0.8	0.7143	0.6178	0.0581	1.91
# 12	0.9	0.9	0.5263	0.4965	0.0503	3.82

Table E.7: Experimental Results for UII: shares of player 1 $\bar{x_1}$s, bargaining time t^*s and stationarity σs.

Exp	Game Setting		*CRub82*	*Experimental Results*		
No.	δ_1	δ_2	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.9091	0.9536	0.0229	0.00
# 2	0.1	0.4	0.6250	0.8529	0.0276	0.02
# 3	0.1	0.9	0.1099	0.1414	0.0408	0.20
# 4	0.4	0.1	0.9375	0.9546	0.0211	0.00
# 5	0.4	0.6	0.5263	0.4982	0.0066	0.01
# 6	0.4	0.9	0.1563	0.1016	0.0026	0.01
# 7	0.5	0.5	0.6667	0.6763	0.0091	0.01
# 8	0.9	0.1	0.9890	0.9859	0.0119	0.00
# 9	0.9	0.4	0.9375	0.8974	0.0118	0.01
# 10	0.9	0.6	0.8696	0.7275	0.0505	0.46
# 11	0.9	0.8	0.7143	0.6245	0.0641	1.76
# 12	0.9	0.9	0.5263	0.4901	0.0432	3.66

Table E.8: Experimental Results for UGI: shares of player 1 $\bar{x_1}$s, bargaining time t^*s and stationarity σs.

Exp	Game Setting		*CRub82*	*Experimental Results*		
No.	δ_1	δ_2	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.9091	0.9536	0.0229	0.00
# 2	0.1	0.4	0.6250	0.8531	0.0261	0.03
# 3	0.1	0.9	0.1099	0.1306	0.0393	0.23
# 4	0.4	0.1	0.9375	0.9546	0.0211	0.00
# 5	0.4	0.6	0.5263	0.4951	0.0269	0.02
# 6	0.4	0.9	0.1563	0.1033	0.0141	0.03
# 7	0.5	0.5	0.6667	0.6761	0.0088	0.01
# 8	0.9	0.1	0.9890	0.9859	0.0119	0.00
# 9	0.9	0.4	0.9375	0.8971	0.0119	0.01
# 10	0.9	0.6	0.8696	0.7195	0.0514	0.35
# 11	0.9	0.8	0.7143	0.6484	0.0643	1.48
# 12	0.9	0.9	0.5263	0.4930	0.0550	2.96

Table E.9: Experimental Results for BGI: shares of player 1 $\bar{x_1}$s, bargaining time t^*s and stationarity σs.

Appendix F

Experimental results for Chapter 7

This appendix provides raw experimental data for Chapter 7: *CCGP for Bargaining Problem with Outside Options*.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.5	0	0.2	0.5263	0.6179	0.0275	0.02
# 2	0.1	0.9	0	0.7	0.1099	0.1104	0.0184	0.12
# 3	0.1	0.9	0	0.2	0.1099	0.1350	0.0321	0.20
# 4	0.5	0.9	0	0.7	0.1818	0.0869	0.0159	0.10
# 5	0.5	0.9	0	0.2	0.1818	0.0979	0.0190	0.18
# 6	0.9	0.9	0	0.2	0.5263	0.4326	0.0338	2.06
# 7	0.5	0.1	0.1	0	0.9474	0.9311	0.0250	0.00
# 8	0.5	0.5	0.1	0	0.6667	0.6292	0.0204	0.04
# 9	0.9	0.1	0.1	0	0.9890	0.9336	0.0234	0.00
# 10	0.9	0.1	0.5	0	0.9890	0.9376	0.0235	0.00
# 11	0.9	0.5	0.1	0	0.9091	0.7227	0.0419	0.25
# 12	0.9	0.5	0.5	0	0.9091	0.7129	0.0430	0.26
# 13	0.9	0.9	0.1	0	0.5263	0.4731	0.0281	3.73
# 14	0.1	0.9	0.01	0.02	0.1099	0.1496	0.0372	0.24
# 15	0.5	0.5	0.03	0.03	0.6667	0.6294	0.0218	0.03
# 16	0.9	0.9	0.4	0.4	0.5263	0.4350	0.0098	0.07

Table F.1: Category 1-a Ineffective Threats: The experimental results $\bar{x_1}$ and its corresponding SPE solutions x_1^*. $\bar{x_1}$ is the mean of 100 trials for a game setting.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0	0.7	0.3000	0.2663	0.0111	0.00
# 2	0.1	0.1	0	0.2	0.8000	0.7017	0.0328	0.00
# 3	0.1	0.5	0	0.7	0.3000	0.2681	0.0126	0.00
# 4	0.5	0.1	0	0.7	0.3000	0.2676	0.0127	0.00
# 5	0.5	0.1	0	0.2	0.8000	0.7148	0.0243	0.00
# 6	0.5	0.5	0	0.7	0.3000	0.2643	0.0123	0.00
# 7	0.5	0.5	0	0.2	0.6667	0.6194	0.0222	0.02
# 8	0.9	0.1	0	0.7	0.3000	0.2663	0.0126	0.00
# 9	0.9	0.1	0	0.2	0.8000	0.7098	0.0329	0.00
# 10	0.9	0.5	0	0.7	0.3000	0.2687	0.0109	0.00
# 11	0.9	0.5	0	0.2	0.8000	0.6894	0.0340	0.07
# 12	0.9	0.9	0	0.7	0.3000	0.2530	0.0203	0.10
# 13	0.9	0.1	0.2	0.7	0.3000	0.2807	0.0077	0.00
# 14	0.9	0.1	0.7	0.2	0.8000	0.7438	0.0206	0.00
# 15	0.9	0.5	0.2	0.7	0.3000	0.2834	0.0060	0.00
# 16	0.9	0.5	0.7	0.2	0.8000	0.7457	0.0231	0.03
# 17	0.9	0.9	0.2	0.7	0.3000	0.2695	0.0111	0.06
# 18	0.5	0.1	0.1	0.5	0.5000	0.4569	0.0177	0.00
# 19	0.5	0.5	0.1	0.5	0.5000	0.4596	0.0160	0.00
# 20	0.9	0.1	0.1	0.5	0.5000	0.4571	0.0142	0.00
# 21	0.9	0.1	0.5	0.1	0.9000	0.8357	0.0235	0.00
# 22	0.9	0.5	0.1	0.5	0.5000	0.4635	0.0146	0.00
# 23	0.9	0.5	0.5	0.1	0.9000	0.7059	0.0411	0.15
# 24	0.9	0.9	0.1	0.5	0.5000	0.3426	0.0295	0.48
# 25	0.1	0.1	0.01	0.02	0.9091	0.8736	0.0375	0.00
# 26	0.5	0.1	0.4	0.05	0.9474	0.8603	0.0289	0.00
# 27	0.5	0.1	0.4	0.05	0.9474	0.8615	0.0323	0.00
# 28	0.9	0.1	0.4	0.01	0.9890	0.9123	0.0302	0.00

Table F.2: Category 2-b Effective Threats: The experimental results $\bar{x_1}$ and its corresponding SPE solutions x_1^*. $\bar{x_1}$ is the mean of 100 trials for a game setting.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.1	0	0.9100	0.9199	0.0294	0.00
# 2	0.1	0.1	0.5	0	0.9500	0.9349	0.0281	0.00
# 3	0.1	0.5	0.1	0	0.5500	0.6248	0.0243	0.04
# 4	0.1	0.5	0.5	0	0.7500	0.6873	0.0254	0.04
# 5	0.1	0.9	0.1	0	0.1900	0.1782	0.0364	0.20
# 6	0.1	0.9	0.5	0	0.5500	0.5101	0.0165	0.09
# 7	0.5	0.1	0.5	0	0.9500	0.9357	0.0289	0.00
# 8	0.5	0.5	0.5	0	0.7500	0.6886	0.0255	0.05
# 9	0.5	0.9	0.1	0	0.1900	0.1726	0.0070	0.09
# 10	0.5	0.9	0.5	0	0.5500	0.5156	0.0151	0.09
# 11	0.9	0.9	0.5	0	0.5500	0.5196	0.0181	0.18
# 12	0.1	0.9	0.2	0.7	0.2800	0.2563	0.0076	0.04
# 13	0.1	0.9	0.7	0.2	0.7300	0.6703	0.0161	0.00
# 14	0.5	0.9	0.2	0.7	0.2800	0.2574	0.0089	0.04
# 15	0.5	0.9	0.7	0.2	0.7300	0.6763	0.0164	0.01
# 16	0.9	0.9	0.7	0.2	0.7300	0.6880	0.0176	0.09
# 17	0.1	0.5	0.5	0.1	0.7500	0.6867	0.0218	0.03
# 18	0.1	0.9	0.1	0.5	0.1900	0.1704	0.0062	0.08
# 19	0.1	0.9	0.5	0.1	0.5500	0.5139	0.0157	0.08
# 20	0.5	0.5	0.5	0.1	0.7500	0.6832	0.0245	0.03
# 21	0.5	0.9	0.1	0.5	0.1900	0.1716	0.0094	0.08
# 22	0.5	0.9	0.5	0.1	0.5500	0.5171	0.0145	0.08
# 23	0.9	0.9	0.5	0.1	0.5500	0.5200	0.0199	0.18

Table F.3: Category 2-c Effective Threats: The experimental results $\bar{x_1}$ and its corresponding SPE solutions x_1^*. $\bar{x_1}$ is the mean of 100 trials for a game setting.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x_1^*	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.2	0.7	0.3000	0.2789	0.0073	0.00
# 2	0.1	0.5	0.2	0.7	0.3000	0.2816	0.0072	0.00
# 3	0.1	0.5	0.7	0.2	0.8000	0.7420	0.0191	0.02
# 4	0.5	0.1	0.2	0.7	0.3000	0.2823	0.0067	0.00
# 5	0.5	0.1	0.7	0.2	0.8000	0.7382	0.0199	0.00
# 6	0.5	0.5	0.2	0.7	0.3000	0.2822	0.0068	0.00
# 7	0.5	0.5	0.7	0.2	0.8000	0.7391	0.0220	0.03
# 8	0.1	0.1	0.1	0.5	0.5000	0.4535	0.0176	0.00
# 9	0.1	0.1	0.5	0.1	0.9000	0.8219	0.0290	0.00
# 10	0.1	0.5	0.1	0.5	0.5000	0.4607	0.0166	0.00
# 11	0.5	0.1	0.5	0.1	0.9000	0.8207	0.0283	0.00
# 12	0.1	0.1	0.7	0.2	0.8000	0.7355	0.0212	0.00

Table F.4: Category 2-d Effective Threats: The experimental results $\bar{x_1}$ and its corresponding SPE solutions x_1^*. $\bar{x_1}$ is the mean of 100 trials for a game setting.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x^*	$\bar{x}$	σ	$\bar{t}$
# 1	0.1	0.1	1	0	1	0.9313	0.0260	0.00
					0	0.0687	0.0260	
# 2	0.1	0.1	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 3	0.1	0.5	1	0	1	0.8892	0.0451	0.08
					0	0.1108	0.0451	
# 4	0.1	0.5	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 5	0.1	0.9	1	0	1	0.9046	0.0359	0.08
					0	0.0954	0.0359	
# 6	0.1	0.9	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 7	0.5	0.1	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 8	0.5	0.1	1	0	1	0.9310	0.0256	0.00
					0	0.0690	0.0256	
# 9	0.5	0.5	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 10	0.5	0.5	1	0	1	0.8570	0.0759	0.20
					0	0.1430	0.0759	
# 11	0.5	0.9	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 12	0.5	0.9	1	0	1	0.9348	0.0293	0.09
					0	0.0652	0.0293	
# 13	0.9	0.1	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 14	0.9	0.1	1	0	1	0.9326	0.0266	0.00
					0	0.0674	0.0266	
# 15	0.9	0.5	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 16	0.9	0.5	1	0	1	0.9385	0.0283	0.26
					0	0.0615	0.0283	
# 17	0.9	0.9	0	1	0	0.0000	0.0000	0.00
					1	1.0000	0.0000	
# 18	0.9	0.9	1	0	1	0.9399	0.0272	0.11
					0	0.0601	0.0272	

Table F.5: Category 3-e Over strong threats: The experimental results $\bar{x}$ and its corresponding SPE solutions x^*. $\bar{x}$ is the mean of 100 trials for a game setting. In the cells under SPE x^* and $\bar{x}$, the above values are x_1^* and $\bar{x_1}$ respectively. The below values are x_2^* and $\bar{x_2}$ respectively. In theory, players take their outside options immediately so $x_1 + x_2 \neq 1$.

Exp	Game Setting				*SPE*	*Experimental Results*		
No.	δ_1	δ_2	$w1$	$w2$	x^*	$\bar{x}$	σ	$\bar{t}$
# 19	0.1	0.1	0.7	0.5	0.7	0.6559	0.0194	0.01
					0.5	0.52	0.0125	
# 20	0.1	0.1	0.5	0.7	0.5	0.4715	0.0122	0.01
					0.7	0.7069	0.0094	
# 21	0.1	0.5	0.7	0.5	0.7	0.6665	0.0154	0.05
					0.5	0.5196	0.0100	
# 22	0.1	0.5	0.5	0.7	0.5	0.4781	0.0097	0.02
					0.7	0.7085	0.0059	
# 23	0.1	0.9	0.7	0.5	0.7	0.6698	0.0139	0.05
					0.5	0.5184	0.0090	
# 24	0.1	0.9	0.5	0.7	0.5	0.4806	0.0088	0.05
					0.7	0.7094	0.0047	
# 25	0.5	0.1	0.7	0.5	0.7	0.6621	0.0155	0.01
					0.5	0.5171	0.0109	
# 26	0.5	0.1	0.5	0.7	0.5	0.4760	0.0112	0
					0.7	0.708	0.0064	
# 27	0.5	0.5	0.7	0.5	0.7	0.6669	0.0145	0.07
					0.5	0.5183	0.0090	
# 28	0.5	0.5	0.5	0.7	0.5	0.4818	0.0104	0.04
					0.7	0.7054	0.0065	
# 29	0.5	0.9	0.7	0.5	0.7	0.6704	0.0156	0.04
					0.5	0.5166	0.0099	
# 30	0.5	0.9	0.5	0.7	0.5	0.4837	0.0104	0.04
					0.7	0.7078	0.0056	
# 31	0.9	0.1	0.7	0.5	0.7	0.6605	0.0162	0.01
					0.5	0.5168	0.0113	
# 32	0.9	0.1	0.5	0.7	0.5	0.4775	0.0092	0.01
					0.7	0.7061	0.0081	
# 33	0.9	0.5	0.7	0.5	0.7	0.6748	0.0132	0.06
					0.5	0.5138	0.0083	
# 34	0.9	0.5	0.5	0.7	0.5	0.4864	0.0083	0.04
					0.7	0.704	0.0053	
# 35	0.9	0.9	0.7	0.5	0.7	0.6778	0.0114	0.05
					0.5	0.5129	0.0074	
# 36	0.9	0.9	0.5	0.7	0.5	0.4869	0.0082	0.06
					0.7	0.7064	0.0046	

Table F.6: Category 3-e Over Strong Threats: The experimental results $\bar{x}$ and its corresponding SPE solutions x^*. $\bar{x}$ is the mean of 100 trials for a game setting. In the cells under SPE x^* and $\bar{x}$, the above values are x_1^* and $\bar{x_1}$ respectively. The below values are x_2^* and $\bar{x_2}$ respectively. In theory, players take their outside options immediately so $x_1 + x_2 \neq 1$.

Appendix G

Experimental results for Chapter 8

This appendix provides raw experimental data for Chapter 8: *CCGP for Bargaining Problem with Incomplete Information on Outside Options*.

Exp	Game Setting						*Experimental Results*		
No.	δ_1	δ_2	$w1$	ω_0'	w_2	w_2'	$\bar{x_1}$	σ	$\bar{t}$
# 1	0.1	0.1	0.2	0.5	0.7	0.5	0.2800	0.0071	0.00
# 2	0.1	0.1	0.7	0.5	0.2	0.5	0.7291	0.0203	0.00
# 3	0.1	0.1	0.2	0.5	0.7	0.0	0.2763	0.0078	0.00
# 4	0.1	0.1	0.7	0.5	0.2	1.0	0.6874	0.0532	0.00
# 5	0.1	0.5	0.2	0.5	0.7	0.5	0.2814	0.0069	0.00
# 6	0.1	0.5	0.7	0.5	0.2	0.5	0.7303	0.0295	0.03
# 7	0.1	0.5	0.2	0.5	0.7	0.0	0.2391	0.0365	0.00
# 8	0.1	0.5	0.7	0.5	0.2	1.0	0.7033	0.0562	0.02
# 9	0.1	0.9	0.2	0.5	0.7	0.5	0.2526	0.0078	0.05
# 10	0.1	0.9	0.7	0.5	0.2	0.5	0.6684	0.0147	0.01
# 11	0.1	0.9	0.2	0.5	0.7	0.0	0.2556	0.0069	0.06
# 12	0.1	0.9	0.7	0.5	0.2	1.0	0.6535	0.0306	0.01
# 13	0.5	0.1	0.2	0.5	0.7	0.5	0.2798	0.0081	0.00
# 14	0.5	0.1	0.7	0.5	0.2	0.5	0.7360	0.0249	0.00
# 15	0.5	0.1	0.2	0.5	0.7	0.0	0.2783	0.0081	0.00
# 16	0.5	0.1	0.7	0.5	0.2	1.0	0.7012	0.0485	0.00

Table G.1: The w_2 is the actual value of player 2's outside option and w_2' is another possible value of player 2's outside option in player 1's initial belief. ω_0' is the possibility of player 1's initial belief of $w_2 = MIX(w_2, w_2')$. The experimental results $\bar{x_1}$s and their deviations σs of 100 runs.

Exp	Game Setting						*Experimental Results*		
No.	δ_1	δ_2	$w1$	ω_0'	w_2	w_2'	$\bar{x_1}$	σ	$\bar{t}$
# 17	0.5	0.5	0.2	0.5	0.7	0.5	0.2811	0.0072	0.00
# 18	0.5	0.5	0.7	0.5	0.2	0.5	0.7238	0.0258	0.03
# 19	0.5	0.5	0.2	0.5	0.7	0.0	0.2465	0.0335	0.00
# 20	0.5	0.5	0.7	0.5	0.2	1.0	0.7060	0.0441	0.02
# 21	0.5	0.9	0.2	0.5	0.7	0.5	0.2588	0.0081	0.04
# 22	0.5	0.9	0.7	0.5	0.2	0.5	0.6699	0.0168	0.01
# 23	0.5	0.9	0.2	0.5	0.7	0.0	0.2594	0.0083	0.04
# 24	0.5	0.9	0.7	0.5	0.2	1.0	0.6602	0.0241	0.01
# 25	0.9	0.1	0.2	0.5	0.7	0.5	0.2826	0.0064	0.00
# 26	0.9	0.1	0.7	0.5	0.2	0.5	0.7372	0.0227	0.00
# 27	0.9	0.1	0.2	0.5	0.7	0.0	0.2789	0.0072	0.00
# 28	0.9	0.1	0.7	0.5	0.2	1.0	0.7110	0.0499	0.00
# 29	0.9	0.5	0.2	0.5	0.7	0.5	0.2832	0.0064	0.00
# 30	0.9	0.5	0.7	0.5	0.2	0.5	0.7312	0.0221	0.03
# 31	0.9	0.5	0.2	0.5	0.7	0.0	0.2385	0.0344	0.00
# 32	0.9	0.5	0.7	0.5	0.2	1.0	0.7070	0.0538	0.03
# 33	0.9	0.9	0.2	0.5	0.7	0.5	0.2551	0.0262	0.08
# 34	0.9	0.9	0.7	0.5	0.2	0.5	0.6823	0.0197	0.08
# 35	0.9	0.9	0.2	0.5	0.7	0.0	0.2378	0.0305	0.07
# 36	0.9	0.9	0.7	0.5	0.2	1.0	0.6650	0.0329	0.08

Table G.2: The w_2 is the actual value of player 2's outside option and w_2' is another possible value of player 2's outside option in player 1's initial belief. ω_0' is the possibility of player 1's initial belief of $w_2 = MIX(w_2, w_2')$. The experimental results $\bar{x_1}$s and their deviations σs of 100 runs.

Exp	Game Setting						*ICOO*	COO
No.	δ_1	δ_2	$w1$	ω_0'	w_2	w_2'	$\bar{x_1}$	$\bar{x_1}$
# 1	0.1	0.1	0.2	0.5	0.7	0.5	0.2800	0.2789
# 2	0.1	0.1	0.7	0.5	0.2	0.5	0.7291	0.7355
# 3	0.1	0.1	0.2	0.5	0.7	0.0	0.2763	0.2789
# 4	0.1	0.1	0.7	0.5	0.2	1.0	0.6874	0.7355
# 5	0.1	0.5	0.2	0.5	0.7	0.5	0.2814	0.2816
# 6	0.1	0.5	0.7	0.5	0.2	0.5	0.7303	0.7420
# 7	0.1	0.5	0.2	0.5	0.7	0.0	0.2391	0.2816
# 8	0.1	0.5	0.7	0.5	0.2	1.0	0.7033	0.7420
# 9	0.1	0.9	0.2	0.5	0.7	0.5	0.2526	0.2563
# 10	0.1	0.9	0.7	0.5	0.2	0.5	0.6684	0.6703
# 11	0.1	0.9	0.2	0.5	0.7	0.0	0.2556	0.2563
# 12	0.1	0.9	0.7	0.5	0.2	1.0	0.6535	0.6703
# 13	0.5	0.1	0.2	0.5	0.7	0.5	0.2798	0.2823
# 14	0.5	0.1	0.7	0.5	0.2	0.5	0.7360	0.7382
# 15	0.5	0.1	0.2	0.5	0.7	0.0	0.2783	0.2823
# 16	0.5	0.1	0.7	0.5	0.2	1.0	0.7012	0.7382
# 17	0.5	0.5	0.2	0.5	0.7	0.5	0.2811	0.2822
# 18	0.5	0.5	0.7	0.5	0.2	0.5	0.7238	0.7391
# 19	0.5	0.5	0.2	0.5	0.7	0.0	0.2465	0.2822
# 20	0.5	0.5	0.7	0.5	0.2	1.0	0.7060	0.7391
# 21	0.5	0.9	0.2	0.5	0.7	0.5	0.2588	0.2574
# 22	0.5	0.9	0.7	0.5	0.2	0.5	0.6699	0.6763
# 23	0.5	0.9	0.2	0.5	0.7	0.0	0.2594	0.2574
# 24	0.5	0.9	0.7	0.5	0.2	1.0	0.6602	0.6763
# 25	0.9	0.1	0.2	0.5	0.7	0.5	0.2826	0.2807
# 26	0.9	0.1	0.7	0.5	0.2	0.5	0.7372	0.7438
# 27	0.9	0.1	0.2	0.5	0.7	0.0	0.2789	0.2807
# 28	0.9	0.1	0.7	0.5	0.2	1.0	0.7110	0.7438
# 29	0.9	0.5	0.2	0.5	0.7	0.5	0.2832	0.2834
# 30	0.9	0.5	0.7	0.5	0.2	0.5	0.7312	0.7457
# 31	0.9	0.5	0.2	0.5	0.7	0.0	0.2385	0.2834
# 32	0.9	0.5	0.7	0.5	0.2	1.0	0.7070	0.7457
# 33	0.9	0.9	0.2	0.5	0.7	0.5	0.2551	0.2695
# 34	0.9	0.9	0.7	0.5	0.2	0.5	0.6823	0.6880
# 35	0.9	0.9	0.2	0.5	0.7	0.0	0.2378	0.2695
# 36	0.9	0.9	0.7	0.5	0.2	1.0	0.6650	0.6880

Table G.3: The experimental results $\bar{x_1}$s of ICCO and experimental results $\bar{x_1}$s of CCO under the same $(\delta_1, \delta_2, w1, w2)$

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