Beyond Tit for Tat: A Deep Dive into Strategy and Social Preferences

Liam Andrew Beattie[a], Abdul Qaadir Cassiem[a]

[a] *Microeconomics 871, Stellenbosch University, South Africa*

1. Introduction

The phrase horses for courses alludes to the fact that a racehorse performs best on a racecourse to which it is specifically suited. More generally this idiom is used to express that certain tools and strategies are better suited over others depending on the task or situations at hand. In the context of the repeated prisoners' dilemma, the strategy of Tit for Tat (TfT), where one mimics their opponent's previous move, reigns supreme and is best suited over others for most situations at hand.

This paper investigates strategic behaviour in the repeated Prisoner's Dilemma by conducting a tournament inspired by Axelrod (1980) but expands the original framework by including distinct strategies. These strategies, categorised into cooperative, defecting, random, and adaptive types, play against each other in 200 rounds of the Prisoner's Dilemma, allowing for a comprehensive evaluation of their performance. By considering both standard scenarios and environments with varying levels of social preferences, this study explores how different strategies fare in diverse settings, particularly focusing on the adaptability and effectiveness of TfT variants, which have historically been prominent in such tournaments.

2. Literature Review

The exploration of strategy choices within the framework of the prisoner's dilemma has garnered extensive attention in recent literature. Axelrod (1980)'s foundational work emphasised effective strategies in iterated scenarios, sparking a wealth of research on strategic behaviour in repeated interactions. His tournament studies laid the groundwork for understanding how cooperation can emerge in repeated prisoner's dilemmas through strategies like TfT and other forms of reciprocity. This exploration of cooperative behaviour in an inherently competitive framework has been expanded

Email addresses: 22562435@sun.ac.za (Liam Andrew Beattie), 20863667@sun.ac.za (Abdul Qaadir Cassiem)

by various scholars, each contributing unique insights into how individuals and institutions behave when faced with the tension between cooperation and defection.

Recent studies, such as Bó & Fréchette (2019), have focused on the strategic complexity observed in infinitely repeated games. They provide empirical evidence that players in these settings are highly adaptive, often switching strategies depending on the payoffs and the perceived actions of their opponents. In contrast, Breitmoser (2015) questions the reciprocity-based models that dominate much of the literature, suggesting that while cooperation is often observed, it may not always stem from reciprocal motivations. Breitmoser (2015) finds that in many cases, cooperation might emerge from individual incentives structured by the game's dynamics, rather than a direct desire to reciprocate.

A significant portion of the literature has also addressed the challenges of finite versus infinite iterations of the dilemma. Kreps, Milgrom, Roberts & Wilson (1982) introduced the idea that even in finitely repeated games, players may behave as though they are in an infinite game, cooperating for fear of future retaliation, despite the known endpoint. This idea challenges the strict predictions of defection in the final stages of finitely repeated games and has been explored further by Embrey, Fréchette & Yuksel (2018), who conducted laboratory experiments to observe how players adapt their strategies in finite games. Their findings support the hypothesis that cooperation can persist under certain conditions, even in games with a clear end.

Romero & Rosokha (2018) investigated the cognitive processes behind strategy construction in indefinite games, emphasising how players use heuristics and simplified mental models to navigate the uncertainty of the game's length. This aligns with Farrell & Ware (1989) earlier work on evolutionary stability, where they explored how long-term strategies evolve to withstand deviations from equilibrium behaviours.

From a computational perspective, García & Veelen (2018) utilised simulations to demonstrate that no single strategy could consistently dominate in the repeated prisoner's dilemma, suggesting that adaptability and context-dependent strategy selection are key to success in such settings. Similarly, Gaudesi, Piccolo, Squillero & Tonda (2016) leveraged evolutionary modelling techniques to demonstrate how strategies evolve, competing in a dynamic landscape shaped by both cooperation and competition.

The link between theoretical models and real-world applications has also been a point of focus. Lange & Baylor (2007) developed computerized tournaments to teach the mechanics of the repeated prisoner's dilemma, blending theory with practice and providing insights into how strategic choices might play out in educational settings. Such studies highlight the importance of teaching and learning mechanisms in understanding strategic behaviour in social dilemmas. Taken together, the contemporary literature on strategy selection in the prisoner's dilemma underscores the complexity of human decision-making in repeated interactions.

3. The Standard Prisoners Dilemma

This paper conducts a tournament modelled after Axelrod (1980) but incorporates a wider array of strategies. A total of 25 strategies are used in this repeated Prisoner's Dilemma tournament. These strategies are categorized in Table 3.1 according to their types. Some strategies always cooperate or always defect, while others, called random strategies, cooperate with a set probability. For example, Random 90% cooperates 90% of the time and defects 10% of the time. Strategies not explained are standard in the literature.

Always Strategies	**Tit for Tat Variants**	**Win-Stay/ Lose-Switch**	**Punishment-Based**	**Adaptive/ Adjusting**	**Gradient/ Probability-Based**	**Random Strategies**
Always Cooperate	Tit for Tat	Pavlov[1]	Grim Trigger	Adaptive Defector	Progressive Cooperator	Random 10%
Always Defect	Tit for Two Tats		Bully	Adaptive Peacekeeper	Diminishing Cooperator	Random 25%
	Tit for Tat with Randomisation		Retaliatory Defector	Probing Adjuster	Bounded Gradient	Random 50%
	Tit for Tat with Forgiveness			Forgiving Tester	Recent Gradient	Random 75%
				Prober		Random 90%
				Cautious Rebuilder		

Table 3.1: Categorisation of Strategy Types Used in the Prisoner's Dilemma Tournament

Progressive Cooperator starts with a 0% cooperation rate and gradually increases it to 100% by the end of the game, while Diminishing Cooperator does the opposite, starting with a high cooperation rate and steadily decreasing it to 0%. Bounded Gradient adjusts its probability of cooperating by considering all previous actions of the opponent. Recent Gradient, on the other hand, adjusts its cooperation probability based only on the opponent's last 5 actions, making it more responsive to recent behaviour.

One such strategy is Retaliatory Defector. It begins by cooperating but defects for two rounds if its opponent defects. After two rounds, if the opponent resumes cooperation, Retaliatory Defector will also return to cooperating. Another strategy, Adaptive Defector, also starts by cooperating, but thereafter assesses the opponent's behaviour over the last five rounds. If the opponent has defected more than 40% of the time, Adaptive Defector will defect; otherwise, it continues to cooperate. Adaptive Peacekeeper focuses on maintaining cooperation while testing the opponent's behaviour periodically. It starts by cooperating but defects every sixth round to probe the opponent's reaction. If the opponent defects more than twice consecutively after these probes, Adaptive Peacekeeper responds with defection. However, if both players defected in the previous round, the strategy returns to cooperation, signalling a willingness to restore collaboration.

[1] As found in Wedekind and Milinski (1996)

Probing Adjuster is another adaptive strategy. It begins by cooperating but alters its behaviour based on the opponent's past actions. If the opponent defects three times in a row, Probing Adjuster responds by defecting as well. However, if both players defected in the previous round, it tries to re-establish cooperation by cooperating again. If the opponent cooperates after the player defects, the player will continue defecting, exploiting the opponent's leniency. Additionally, if the player cooperates while the opponent cooperates, the player switches to defection to test the opponent's reaction to a shift in strategy.

Prober tests the opponent's resilience to defection by defecting for three consecutive rounds if the opponent defects. It always begins with cooperation, but when an opponent defects, Prober immediately retaliates with three rounds of defection before returning to cooperation. This approach aims to probe the opponent's willingness to adjust their behaviour in response to repeated defection while maintaining a cooperative default when unprovoked.

Forgiving Tester emphasizes cooperation but incorporates occasional defections to gauge the opponent's response. It begins by cooperating, but every fourth round it defects. If the opponent defects three times in a row, Forgiving Tester will retaliate by continuing to defect until the opponent cooperates again. However, if the opponent cooperates after a test defection, or if both players defect in the same round, Forgiving Tester quickly forgives and returns to cooperation. This strategy encourages long-term collaboration while punishing consistent defections.

Cautious Rebuilder starts by cooperating and follows three rules in its decision-making. First, if the opponent defects three times in a row, Cautious Rebuilder will defect until the opponent cooperates again. Second, if the opponent's last move was a defection but the opponent has not defected three times consecutively, Cautious Rebuilder will cooperate, trying to repair relations. Third, after every five rounds, it will defect once to test the opponent's tolerance for defection. In line with Axelrod (1980), each strategy plays against itself and every other strategy once in the tournament. Each game consists of 200 rounds of the repeated Prisoner's Dilemma, and the payoffs and outcomes are recorded for every round. The strategy that accumulates the most points after 200 rounds wins the individual game. The overall winner of the tournament is the strategy that achieves the highest total points across all games. The standard Prisoners Dilemma from Axelrod (1980) will be played and is given in the table below:

Player 1 / Player 2	**C (Cooperate)**	**D (Defect)**
C (Cooperate)	$(3, 3)$	$(0, 5)$
D (Defect)	$(5, 0)$	$(1, 1)$

Table 3.2: Prisoner's Dilemma Payoff Matrix

3.1. Introducing Social Preferences

This game is played the same as above except now Social Preferences are taken into account. From-game adjustments are a bit different and it considers the utility a player gets from the payoffs of its opponent. The standard Prisoners Dilemma payoff Matrix with from-game adjustments is given below:

Player 1 / Player 2	**C (Cooperate)**	**D (Defect)**
C (Cooperate)	$(3(1-p)+3p, 3(1-p)+3p)$	$(0(1-p)+5p, 5(1-p)+0p)$
D (Defect)	$(5(1-p)+0p, 0(1-p)+5p)$	$((1-p)+p, (1-p)+p)$

Table 3.3: Prisoner's Dilemma Payoff Matrix

The level p here is adapted from Charness & Rabin (2002) who created a utility function that captures various social preferences. In essence, p is how much you care about your opponent's pay-offs as well as your own. This paper will conduct the tournament as above for a range of p values starting from p = -1 where individuals are status seeking to p = 0.5 where individuals care half as much about themselves as they do about others

4. Game Results

After the conclusion of the tournament, most interestingly unlike Axelrod (1980), this paper does not find Tft as the winner in the standard Repeated Prisoners Dilemma. Table 4.1 gives the standard tournament without social preferences. The winner of the tournament was Probing Adjuster with 13575 points followed by Tft with Randomization which had 12887 points and Bully coming in third with 12869 points. In this game, Tft came fourth which leads us to believe similarly to Axelrod (1980) that Tft may have won due to the other strategies in the tournament. The winner of the Prisoners Dilemma is highly dependent on the strategies in the tournament. Always Cooperate and Random 90% came in second last and last respectively. This is as expected as the tournament included strategies that took advantage of other strategies which always cooperated. Most interestingly, if the adaptive strategies were removed then the Grim/Trigger strategy would have won the game. Also, even though Probing Adjuster won the tournament, the group of adaptive strategies as a whole performed worse than the group of Tit for Tat variant strategies. This result shows the robustness of Tit for Tat variants to perform well against both cooperators and defectors, maintaining high scores overall.

Table 4.1: Tournament Payoff Matrix for p= 0

	Payoff Against Other Strategies																									Total	Rank
	AC	AD	TfT	Tf2T	TfTF	TfTR	P	G/T	B	RD	ADe	APe	PA	FT	P	CR	PC	DC	BG	RG	R0.1	R0.25	R0.5	R0.75	R0.9		
Always Cooperate	600	0	600	600	600	600	600	600	147	600	600	501	3	453	600	483	291	261	600	600	69	156	300	420	519	**10803**	**24**
Always Defect	1000	200	204	208	276	204	204	204	396	992	204	212	208	212	1000	212	664	600	204	1000	276	392	648	792	896	**11408**	**20**
Tit for Tat	600	199	600	600	600	600	600	600	346	600	600	567	399	551	600	561	441	426	600	600	250	344	432	531	580	**12827**	**4**
Tit for Two Tats	600	198	600	600	600	600	600	600	296	600	600	501	298	453	600	483	372	370	600	600	244	288	394	480	548	**12125**	**15**
Tit for Tat with Forgiveness	600	183	600	600	600	600	600	600	322	600	600	561	370	539	600	553	408	411	600	600	249	321	403	527	571	**12618**	**8**
Tit for Tat with Randomisation	600	199	600	600	600	600	600	600	346	600	600	567	399	551	600	561	422	436	600	600	252	357	478	542	577	**12887**	**2**
Pavlov	600	199	600	600	600	600	600	600	346	600	600	567	399	551	600	561	453	434	600	600	243	325	442	519	582	**12821**	**5**
Grim/Trigger	600	199	600	600	600	600	600	600	395	600	600	223	205	219	600	221	607	575	600	600	263	399	551	823	933	**12813**	**6**
Bully	902	151	351	551	399	351	351	155	298	894	155	683	355	751	902	631	533	554	348	902	230	319	556	700	847	**12869**	**3**
Retaliatory Defector	600	2	600	600	600	600	600	600	149	600	600	505	9	457	600	487	263	283	600	600	74	122	319	463	541	**10874**	**23**
Adaptive Defector	600	199	600	600	600	600	600	600	395	600	600	501	205	453	600	483	448	420	600	600	276	387	457	487	548	**12459**	**10**
Adaptive Peacekeep	666	197	567	666	576	567	567	213	263	660	666	534	256	503	666	543	418	400	572	666	223	285	393	483	600	**12150**	**14**
Probing Adjuster	998	198	404	553	436	404	404	205	345	989	205	591	400	557	998	643	587	544	325	998	264	369	549	719	890	**13575**	**1**
Forgiving Tester	698	197	551	698	563	551	551	209	246	692	698	583	297	502	698	572	452	431	565	698	239	275	393	543	631	**12533**	**9**
Prober	600	0	600	600	600	600	600	600	147	600	600	501	3	453	600	483	324	303	600	600	63	156	318	492	540	**10983**	**21**
Cautious Rebuilder	678	197	561	678	576	561	561	211	276	672	678	573	238	522	678	522	413	385	554	678	229	270	402	541	641	**12295**	**11**
Progressive Cooperator	798	102	439	557	484	417	414	105	271	794	444	546	203	503	790	504	417	467	289	798	159	247	506	658	742	**11654**	**18**
Deminishing Cooperator	784	109	438	536	454	432	447	141	263	799	410	543	235	487	818	522	499	431	619	798	176	262	435	653	715	**12006**	**16**
Bounded Gradient	600	199	600	600	600	600	600	600	342	600	600	564	245	520	600	545	513	325	600	600	273	374	442	540	566	**12648**	**7**
Recent Gradient	600	0	600	600	600	600	600	600	147	600	600	501	3	453	600	483	285	312	600	600	84	150	291	462	549	**10920**	**22**
Random 10%	960	184	255	340	354	251	267	182	381	966	184	325	266	375	938	351	589	560	242	976	238	381	542	812	882	**11801**	**17**
Random 25%	886	149	367	452	415	353	354	156	329	900	233	533	314	406	900	508	553	498	353	904	216	364	564	695	809	**12211**	**13**
Random 50%	794	100	428	654	497	460	469	105	260	803	480	634	259	576	806	565	427	467	448	806	188	257	445	625	710	**12263**	**12**
Random 75%	714	59	538	656	538	525	536	77	217	692	643	609	151	536	726	574	377	358	530	704	107	224	325	532	660	**11608**	**19**
Random 90%	630	21	570	634	581	572	577	64	169	628	631	541	94	471	620	517	319	324	555	634	76	147	329	460	591	**10755**	**25**

4.1. The Prisoners Dilemma Tournament with Social Preferences

Table 4.2 gives the standings of the tournament across different social preferences. The rankings of strategies change across these different values of p, illustrating how varying degrees of altruism or hostility affect the success of each strategy. Notably Always Cooperate improves its ranking as p increases, moving from 25th at p = -0.1 to 1st when p = 0.45, showing that cooperative strategies perform better in environments where mutual benefit is prioritized. Always Defect, conversely, declines in rank as p increases, indicating that purely selfish strategies are less effective when players care about the well-being of others. Tit for Tat maintains a relatively stable performance across various p values, reflecting its robustness as a strategy that adapts well to different social preferences. This holds for the TfT variations in general. Probing Adjuster, which ranked first when p = -0.1, drops significantly as p increases, indicating that more complex strategies designed for selfish environments are less effective in altruistic settings.

Table 4.2: Strategy Rankings Across Different p Values

	p Values												
Strategy	-0.1	-0.05	0	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Always Cooperate	25	24	25	22	19	19	14	10	4	4	4	1	3
Always Defect	15	18	20	25	25	25	25	25	25	25	25	25	25
Tit for Tat	5	4	3	3	3	1	2	4	5	8	8	11	9
Tit for Two Tats	18	16	15	13	11	7	6	5	9	6	6	6	6
Tit for Tat with Forgiveness	10	8	7	5	4	4	4	3	6	7	7	7	8
Tit for Tat with Randomisation	4	6	5	4	1	2	1	2	7	9	10	8	11
Pavlov	6	5	2	2	2	3	3	1	8	10	9	9	10
Grim/Trigger	3	3	4	7	9	9	15	18	18	18	19	19	20
Bully	2	2	8	8	10	15	20	21	22	21	21	21	21
Retaliatory Defector	23	21	22	20	17	16	10	9	1	3	2	3	4
Adaptive Defector	12	10	11	9	7	8	7	11	13	13	13	13	14
Adaptive Peacekeep	17	14	13	14	13	10	12	13	15	14	14	14	13
Probing Adjuster	1	1	1	1	5	12	19	20	21	22	22	22	22
Forgiving Tester	9	9	9	10	8	6	8	12	14	15	15	16	16
Prober	21	22	24	24	21	17	13	8	3	1	1	2	1
Cautious Rebuilder	14	12	12	12	12	11	9	16	16	16	16	15	15
Progressive Cooperator	19	20	17	18	23	22	22	22	20	20	20	20	19
Deminishing Cooperator	16	17	16	15	16	20	21	19	19	19	18	18	18
Bounded Gradient	8	7	6	6	6	5	5	6	10	11	12	12	12
Recent Gradient	22	25	23	21	18	18	11	7	2	2	3	4	2
Random 10%	11	15	18	19	24	24	24	24	24	24	24	24	24
Random 25%	7	13	14	16	19	23	23	23	23	23	23	23	23
Random 50%	13	11	10	11	14	13	18	17	17	17	17	17	17
Random 75%	20	19	19	17	15	14	16	15	12	12	11	10	7
Random 90%	24	23	21	23	22	21	17	14	11	5	5	5	5

Figure 4.1 presents a graphical representation of how the total points of different strategies change as p varies. The x-axis represents different p values, while the y-axis shows the total points for each strategy. From the figure we observe that Always Cooperate shows a steady increase in total points as p increases, reinforcing the observation that this strategy benefits from environments where players value mutual cooperation. Always Defect exhibits declining points as p increases, suggesting that

as social preferences rise, defectors are penalized for their selfishness. TfT maintains consistently high points across all p values, further proving its adaptability and effectiveness in both selfish and cooperative environments. Strategies like Probing Adjuster and Bully, which perform well in self-interested settings, see their points drop as p increases, emphasizing their reduced effectiveness in more cooperative contexts.

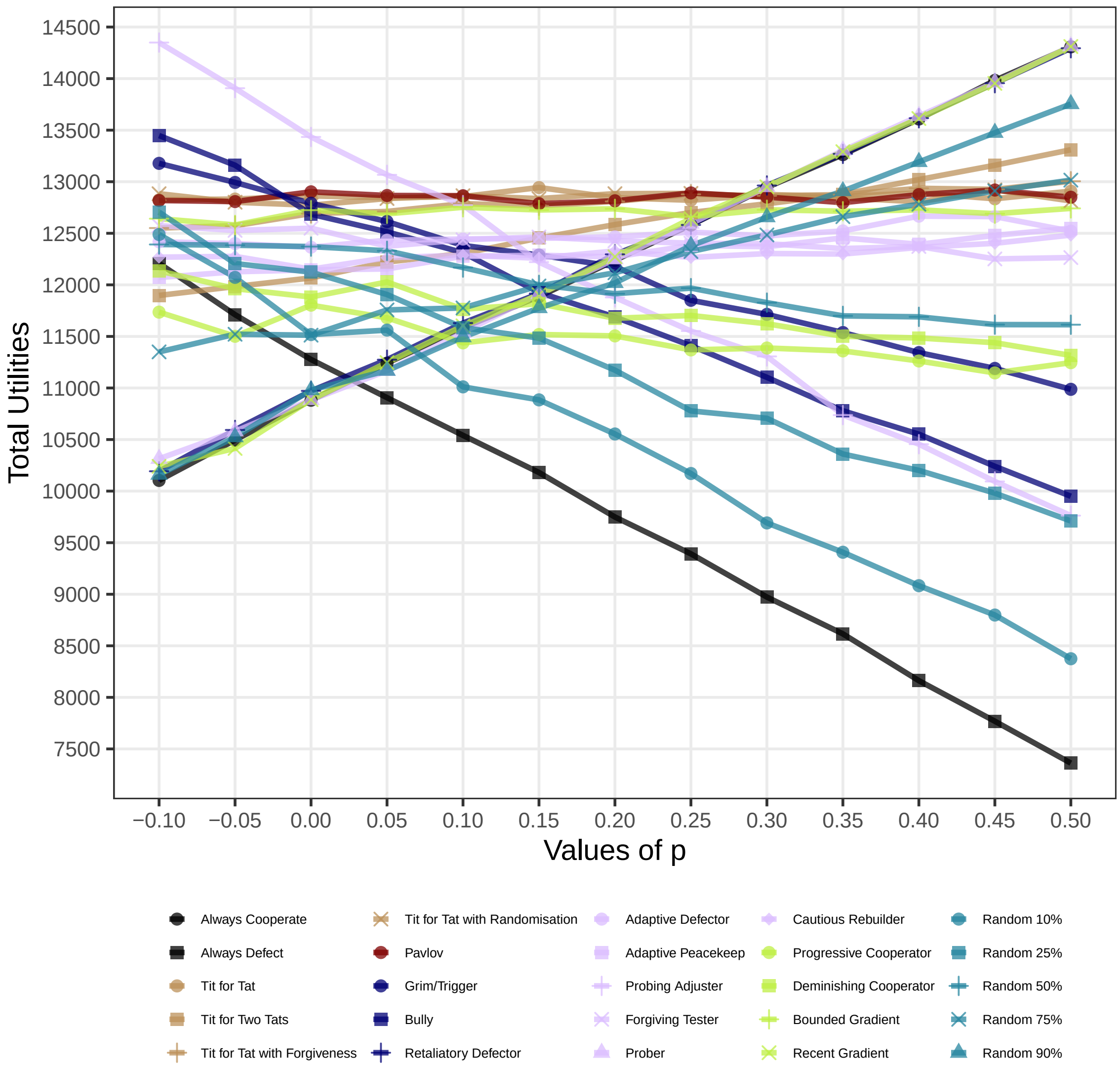

Figure 4.1: Strategies' Total Utilities for Different Strategies Accross p

Figure 4.1 presents a graphical representation of how the total points of different strategies change as p varies. The x-axis represents different p values, while the y-axis shows the total points for each strategy. From the figure we observe that Always Cooperate shows a steady increase in total points as p increases, reinforcing the observation that this strategy benefits from environments where players value mutual cooperation. Always Defect exhibits declining points as p increases, suggesting that as social preferences rise, defectors are penalized for their selfishness. TfT maintains consistently high points across all p values, further proving its adaptability and effectiveness in both selfish and cooperative environments. Strategies like Probing Adjuster and Bully, which perform well in self-interested settings, see their points drop as p increases, emphasizing their reduced effectiveness in more cooperative contexts.

Table 4.3: Strategy Rankings Across All p-Values

Ranking	Strategy	Average
1	Tit for Tat	12861.115
2	Pavlov	12849.538
3	Tit for Tat with Randomisation	12846.385
4	Tit for Tat with Forgiveness	12797.942
5	Bounded Gradient	12701.000
6	Tit for Two Tats	12566.788
7	Adaptive Defector	12487.250
8	Forgiving Tester	12415.192
9	Adaptive Peacekeep	12304.769
10	Cautious Rebuilder	12303.923
11	Retaliatory Defector	12273.365
12	Prober	12261.308
13	Recent Gradient	12256.058
14	Always Cooperate	12239.635
15	Random 75%	12169.135
16	Grim/Trigger	12080.481
17	Random 90%	12037.250
18	Random 50%	11997.865
19	Probing Adjuster	11964.308
20	Deminishing Cooperator	11717.808
21	Bully	11674.346
22	Progressive Cooperator	11457.731
23	Random 25%	11147.538
24	Random 10%	10431.865
25	Always Defect	9757.308

The analysis of the tournament shows how different strategies perform in the Prisoner's Dilemma under varying levels of social preference. The findings yield that in selfish scenarios, probing and aggressive strategies tend to win but as altruism increases, these strategies struggle. TfT variant strategies have shown to be robust under varying social preferences as can be seen in Table 4.3. Tft has the highest average points across the differing p-values showing its robustness in the face of differing social preferences. These findings once again provide insight into the strength of the TfT strategy. In Prisoner's Dilemma games where preferences may be hidden, TfT would according to these findings perform the best.

Table 4.4: Strategy Values Across Different p Values

	p Values												
Strategy	-0.1	-0.05	0	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Always Cooperate	10103.5	10495.5	10881	11240.75	11585	11886	12238	12579.75	12945	13262.5	13608	13982.25	14308
Always Defect	12209	11710.75	11276	10906.25	10540.5	10180.5	9749	9391.75	8972.5	8615.75	8162	7768.5	7362.5
Tit for Tat	12824	12832	12863	12844.5	12856	12943.5	12845	12820.5	12875.5	12856.25	12891	12834.75	12908.5
Tit for Two Tats	11897.5	11983.5	12067	12221.25	12304	12453.5	12584	12701.5	12786.5	12878.25	13021	13159.75	13310.5
Tit for Tat with Forgiveness	12551	12573.75	12692	12711.5	12787.5	12766	12809	12878	12863.5	12874.5	12936	12926	13004.5
Tit for Tat with Randomisation	12883.5	12801.25	12772	12837.25	12864.5	12836.5	12884	12886.75	12854	12843.25	12806	12920.5	12813.5
Pavlov	12818	12807.5	12902	12866.5	12864	12787.25	12815	12891.5	12851	12797.25	12875	12919.5	12849.5
Grim/Trigger	13178	12993	12791	12613.75	12382	12289.25	12178	11850.25	11713.5	11537.75	11343	11189.75	10987
Bully	13447.5	13160	12685	12513.75	12312	11926.25	11688	11410	11103	10778.75	10552	10240.25	9950
Retaliatory Defector	10192.5	10593	10972	11274.25	11629.5	11915.75	12296	12581	12963.5	13270.25	13616	13955.5	14294.5
Adaptive Defector	12417.5	12400.25	12365	12433	12444.5	12452	12465	12511.5	12474.5	12522.75	12666	12661.75	12520.5
Adaptive Peacekeep	12071.5	12127	12145	12154.5	12277	12286.75	12271	12382	12370	12455.5	12393	12479.75	12549
Probing Adjuster	14349.5	13907	13434	13067	12773.5	12220.5	11878	11552.25	11306	10737.25	10455	10093.5	9762.5
Forgiving Tester	12574	12528	12549	12374.5	12437	12464.5	12427	12404	12399.5	12352.25	12372	12251.25	12264.5
Prober	10313.5	10580	10884	11166.5	11537.5	11910.75	12248	12593.75	12948	13302.5	13637	13962	14313.5
Cautious Rebuilder	12268.5	12276.25	12152	12263.5	12287	12258.25	12329	12265.5	12303.5	12299	12363	12403	12482.5
Progressive Cooperator	11735.5	11501.25	11803	11680.25	11437.5	11518.25	11505	11369	11387.5	11359.5	11262	11146.25	11245.5
Deminishing Cooperator	12135	11963.25	11882	12028	11763.5	11817	11676	11703	11622.5	11501.75	11485	11439	11315.5
Bounded Gradient	12641.5	12580.75	12724	12688.75	12752.5	12726.5	12737	12661.25	12728.5	12713.75	12727	12690	12741.5
Recent Gradient	10240	10414.25	10887	11246.25	11602.5	11904	12272	12642.75	12951	13291.25	13613	13953.75	14311
Random 10%	12488	12072.5	11518	11561	11011	10884.75	10554	10170.75	9691.5	9407	9083	8798.25	8374.5
Random 25%	12705.5	12206.75	12123	11906	11585	11484	11173	10777.75	10706	10359.75	10201	9980.25	9710
Random 50%	12391.5	12384.25	12371	12330.25	12168	12000	11914	11968.5	11827.5	11699.25	11690	11614.5	11613.5
Random 75%	11350	11521	11512	11756.75	11776	11989.25	12117	12323	12484	12661.25	12782	12911	13015.5
Random 90%	10159.5	10523.5	10980	11167.75	11493	11775.25	12019	12379.75	12656.5	12909.5	13192	13475	13753.5

5. Conclusion

The tournament results reveal that strategic success in the Prisoner's Dilemma is highly dependent on the composition of competing strategies and the level of social preferences. Probing Adjuster outperformed other strategies in the standard setting, but TfT and its variants demonstrated remarkable robustness across different social preference levels. As altruism increases, cooperative strategies gain prominence, while aggressive strategies struggle. The findings highlight the continued relevance of TfT, particularly in contexts where social preferences or hidden intentions influence decision-making, offering valuable insights into strategic adaptability in competitive environments.

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