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Is the Banker a Myth?

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Abstract: The actions of the anonymous banker in the high stake television gambling programme Deal or No Deal is examined. If a model can successfully predict his behaviour it might suggest that an automatic process is employed to reach his decisions. Potential strategies associated with a number of games are investigated and a model developed for the offers the anonymous banker makes to buy out the player. This approach is developed into a selection strategy of the optimum stage at which a player should accept the money offered. This is reduced to a simple table, by knowing their current position players can rapidly arrive at an appropriate decision strategy with associated probabilities. These probabilities give a guide as to the confidence to be placed in the choice adopted.

Key words: Deal or No Deal, Discriminant Analysis, Probability Game Show.

1. Introduction

This paper addresses the operation of a risk-based game show where prizes range from very high to very low in monetary value; no skill but limited judgement is involved. Other authors have recently studied this show, their work is now briefly described.

For instance Post *et al.* (2008) analysed 151 games (51 from the Netherlands, 47 from Germany and 53 from the United States) and employed expected utility theory. They found the players choices could be explained in a large part by previous outcomes experienced during the game. In addition they found that risk aversion decreases after earlier expectations have been shattered by unfavourable outcomes or surpassed by favourable outcomes.

While Deck *et al.* (2008) estimated the degree of risk aversion of players appearing in the Mexican version (52 shows, some of which provided different prizes). They considered both dynamic players, who fully backward induct and myopic players that only look forward one period. They also varied the level of forecasting sophistication by the players.

Also Blavatskyy and Pogrebna (2008) having described the Italian (114 shows) and United Kingdom (256 shows) versions of the game, proceeded to consider a natural experiment in which two groups were studied. They had been told that the chances of their boxes containing a large prize were 20% and 80% respectively. Their approach was to break the players into two such groups. Players in both groups received qualitatively similar price offers for selling the contents of their boxes. If players are less risk averse when facing unlikely gains, the price offer is likely to be more frequently rejected in the first group than in the second group. The authors found that the fraction of rejections was virtually identical between the two groups. Thus, players appear to have identical risk attitudes over (large) gains of low and high probability.

In a preprint de Roos and Sarafidis (2006) analysed the choices of 399 players in the Australian version of the programme. They calculated risk-aversion bounds for each player, revealing considerable heterogeneity. They estimated a structural stochastic choice model that captured the dynamic decision problem faced by players. They also examined generalisations to expected utility theory, finding that the rank dependent utility model provides substantially improved explanatory power.

It should be stressed that the precise format of the games differed between the countries studied, while the basic principle was retained. The primary aim here differs from the prtevious works in that it is desired to develop a simple decision tool to aid contestants in successfully playing the game.

Firstly the television game show as played in the United Kingdom is described. Channel 4 in the U.K. began broadcasting the game show Deal or No Deal from October 31, 2005. It is presented by Noel Edmonds and has a 45 minute time slot, normally broadcasting from 4.15 p.m. to 5.00 p.m. on weekdays and slightly later on Saturdays. The show is repeated on the digital station, More 4, some two hours later and on More 4 + 1 a further one hour later.

The game studied here involves twenty-two known amounts of money, ranging from one penny to 1/4million pounds that are (symbolically) randomly placed in 22 numbered, sealed boxes. Each participant chooses a box and a single contestant (referred to as the Player) is selected at random to play the game, the unknown sum in the sealed box they select is theirs. The game consists of a series of rounds and in the first; the Player chooses 5 of the other 21 boxes to open. Then the "Banker" offers to buy the Player's box for a sum based on its expected value, given the information now at hand, but adjusted sometimes to make the game more interesting. The Player can accept ("Deal") or opt to continue playing ("No Deal"). If the game continues, 3 more boxes are opened in the second round; another offer is made, and accepted or refused. If the Player continues to refuse the Banker's offers, then in subsequent rounds three boxes are opened until only two are left. The Banker makes one last offer; the Player accepts that offer or takes whatever money is in the initially chosen box. As a final twist the Banker may invite the Player to swap their box for the sole remaining box in the game. Two points are worthy of note. The identity of the Banker is a closely guarded secret. The sum the Banker offers for the box reflects any future expected returns.

It should be noted that to preserve the games format and presumably retain viewers, after a Player has dealt the full game is played out. This enables the presenter to tease the Player with what they might have won. In fact the presenter's role seems to be to drag the show out and interject with naïve probabilistic statements. The presenter, Noel Edmonds, quoted in The Times (Sherwin, 2006) described the pressure placed on players, "We currently have the most demanding work schedule in television, filming over six hours per day for ten days and producing in each session five weeks of shows".

It should be stressed that no attempt is made to model the actual decisions reached by the players. To attempt this would require additional information not all of which is readily available. As well as the state of the game and the Bankers offer plus the age and sex of the Player, which are available or could be estimated, one would need to know their financial position and their desired financial goal. Bearing in mind the variety of additional relevant factors, data on a much greater number of games would be required to adequately attempt to fit such a model.

In the following sections the raw data is initially described and the Bankers offer is modelled. The analysis is extended to the prime decision of interest to the Player, the optimum time of when to deal. For ease of use these findings are summarised. Finally the previously proposed models are briefly discussed and conclusions drawn.

2. The Data

Information was gathered on 81 shows aired between late 2005 and mid 2006. A typical show is presented in Table 1, showing the remaining sealed boxes after each round. In each game data collection ceased when the player dealt.

For example in round 1 the five boxes chosen were 10p, £250, £15,000, £75,000 and £250,000 (not a very auspicious start!) and in round 2 the three boxes chosen were 1p, £50 and £100 (a rather better round for the Player). From the Players standpoint it is desirable to keep the high value boxes in play. Note that in the currency employed here, one pound equates to one hundred pence (£1=100p).

Finally the remaining two sealed boxes contained £5 and £10,000, although the Player was offered the option to swap, they declined, retaining their original

Table 1: The boxes still in play on 30 March 2006

Round **Box Contents**	**1**	**2**	**3**	**4**	**5**	**6**
1p	£0.01					
10p						
50p	£0.50	£0.50				
£1	£1	£1	£1	£1		
£5	£5	£5	£5	£5	£5	£5
£10	£10	£10	£10			
£50	£50					
£100	£100					
£250						
£500	£500	£500	£500	£500	£500	
£750	£750	£750	£750	£750		
£1,000	£1,000	£1,000	£1,000			
£3,000	£3,000	£3,000	£3,000			
£5,000	£5,000	£5,000	£5,000	£5,000	£5,000	
£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000
£15,000						
£20,000	£20,000	£20,000	£20,000	£20,000		
£35,000	£35,000	£35,000	£35,000	£35,000	£35,000	
£50,000	£50,000	£50,000				
£75,000						
£100,000	£100,000	£100,000				
£250,000						
Average	£13,260	£16,090	£6,842	£8,907	£10,101	£5,003
Bankers Offer	£50	£6,050	£1,800	£3,500	£7,500	£2,500
Median	£750	£2,000	£1,000	£2,875	£5,000	£5,003
Players Action	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal

box, leaving them with £5. None of the offers were sufficiently attractive to persuade the Player to abandon their game.

Usually in rounds one to five the Bankers offer lies between the median and average (arithmetic mean) of the remaining boxes. Occasionally, for dramatic effect, such as in round 1 above, an aberrant offer is made. For clarity the remaining boxes, plus relevant measures, are displayed in Table 1.

It has been suggested (Bother, 2008) that the Banker's software throws up a lower and higher cash sum based on the values left in the game. The Banker then puts his own spin on the proceedings by picking a figure between the two boundaries. Factors such as the attitude of the Player and who (the Player or the Banker) is having the better run of luck are all considerations. Producer Glenn Hugill talking of the Banker says, I don't pretend to know how he operates but I believe there is a range which is considered to mathematically cover the financial risk (Bother, 2008). However if the Banker wishes to gamble or indeed play safe he can accordingly pitch his offer anywhere below or above it. Whilst this may be true, the Banker must nevertheless act to keep the programme interesting, and if all games followed the pattern of this game (Table 1) with low monetary offers, then viewing figures would fall as the excitement is gone.

3. Modelling the Bankers Offer

Following Post *et al.* (2006) interest initially centres on predicting the Bankers offer. It is clear that the Bankers offer will be round dependent, the television network have a vested interest in the Player not dealing too early. In view of this the offers for successive rounds will be examined separately, for convenience the observations from the 81 shows have been arranged in numerical order in Figure 1, also a logarithmic transformation has been adopted for clarity. The label above each pain gives the round, while the index $(1, \cdots, 427)$ gives the entry in the database. The breakdown of the actual rounds included is 81 for rounds 1, 2 and 3 then 78 for round 4, 63 for round 5 and finally 43 for round 6. So no Player dealt in rounds 1, 2 or 3 while 3 dealt in round 4 and so on.

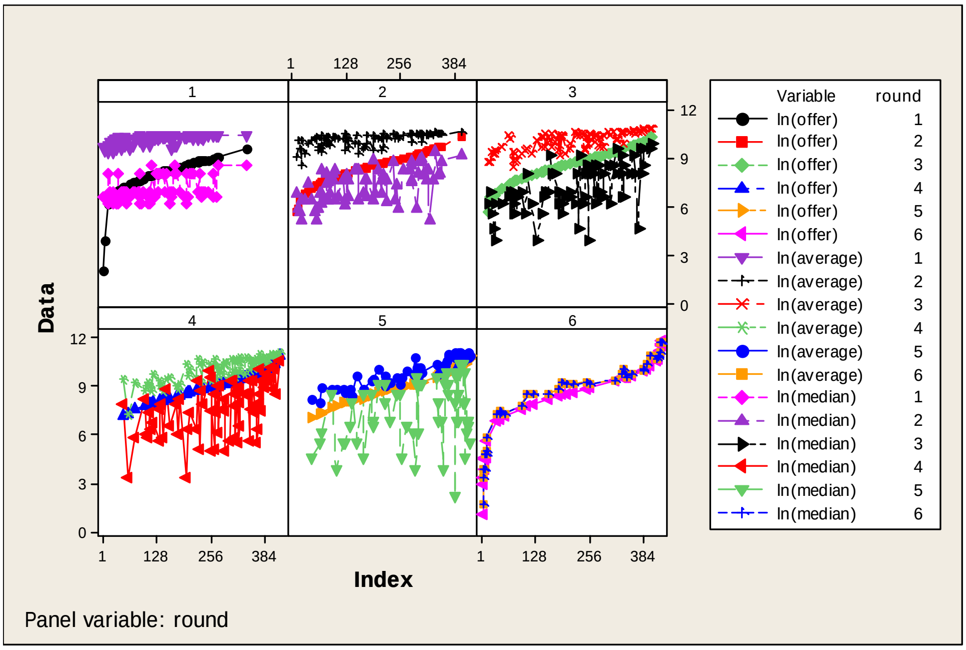

Figure 1: The Bankers offer, also the average and median by round

It looks as if there may be a relationship between the Bankers offer and the average of the boxes still in play. However the median simply appears to provide a bound. There are one or two unusual offers, particularly in the first round. These have little effect, since it is a virtual certainty that the Player will progress to the second round. Similarly round 6 is of little interest, there are only two boxes and hence the average and the median are identical and now provide an upper bound on the Bankers offer.

In modelling the Bankers offer the first step is to plot the data (ln(offer) versus ln(average)) for each round, as shown in Figure 2.

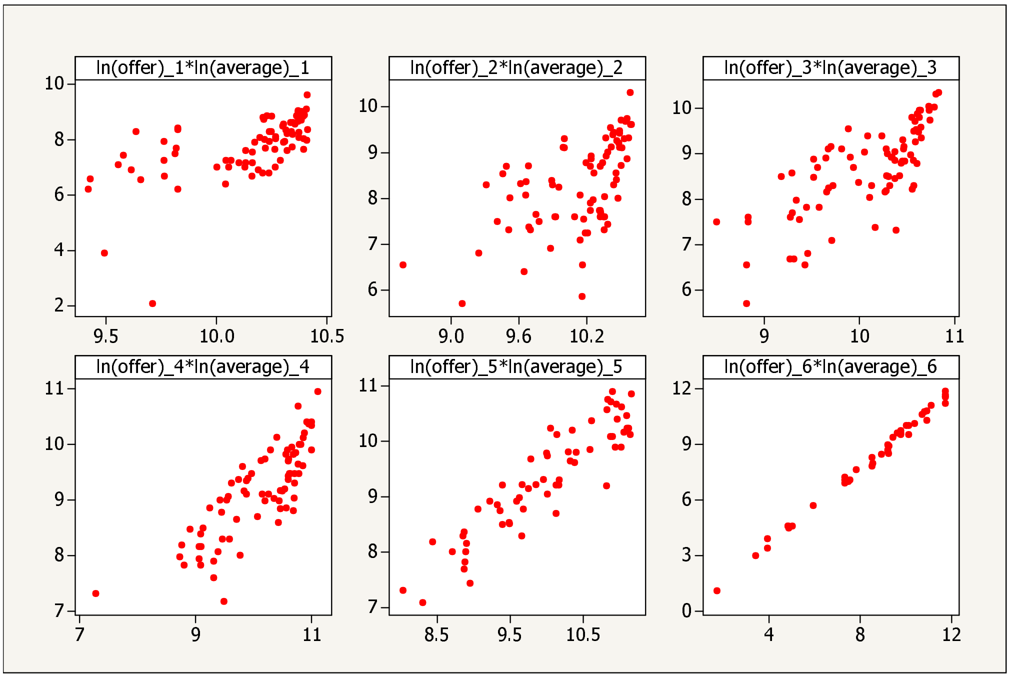

Figure 2: The Bankers offer versus the average by round

There is probably a linear relationship, which clearly improves as the rounds progress. It is also reasonable to seek the simplest model, of the form $\ln(\text{offer}_i) = \alpha_i \ln(\text{average}_i) : i = 1, \cdots, 6$, relating the Bankers offer_i to the Players average_i at round i.

The simplest model has been adopted for ease of use later. At which stage its performance is assessed. An equation, which included a linear term, was considered, however in a number of cases this additional coefficient did not differ significantly from zero. Having no constant term the standard calculation of R^2, the coefficient of determination, which assumes a constant term was employed in the regression, cannot be used. In fact it could be negative Greene (1997).

The results are summarised in Table 2.

The relatively small standard errors linked to negligible p values ($p < 0.0005$)

Table 2: The relationship between the Bankers offer and the Players average

Round(i)	**Coefficient(α_i)**	**Standard Error of the Coefficient**	t	p
1	0.7679	0.0108	70.89	<0.0005
2	0.8189	0.0090	90.64	<0.0005
3	0.8597	0.0075	114.08	<0.0005
4	0.9076	0.0052	174.86	<0.0005
5	0.9348	0.0050	186.48	<0.0005
6	0.9719	0.0044	219.20	<0.0005

give us some confidence in the usefulness of the estimates. It is interesting to investigate how the coefficients vary with the round. A scatter plot and simple linear regression suggest that the coefficient for round i is modelled by $\alpha_i = 0.7353 + 0.0404i$ ($R^2 = 99.2\%$). This encourages the fitting of a more general model, $\ln(\text{offer}_i) = 0.7332 \ln(\text{average}_i) + 0.0413i \ln(\text{average}_i)$ this model corresponds to $\text{offer}_i = \text{average}_i^{0.7332\ +0.0413i}$ which can be compared with the raw data. The Pearson correlation between the Bankers offer and the values fitted by the model is 0.92 ($p < 0.0005$). This is comparable in performance to the values fitted to the model of Post *et al.* (2006) (see below). A schematic for the decisions taken over a game is shown in Figure 3.

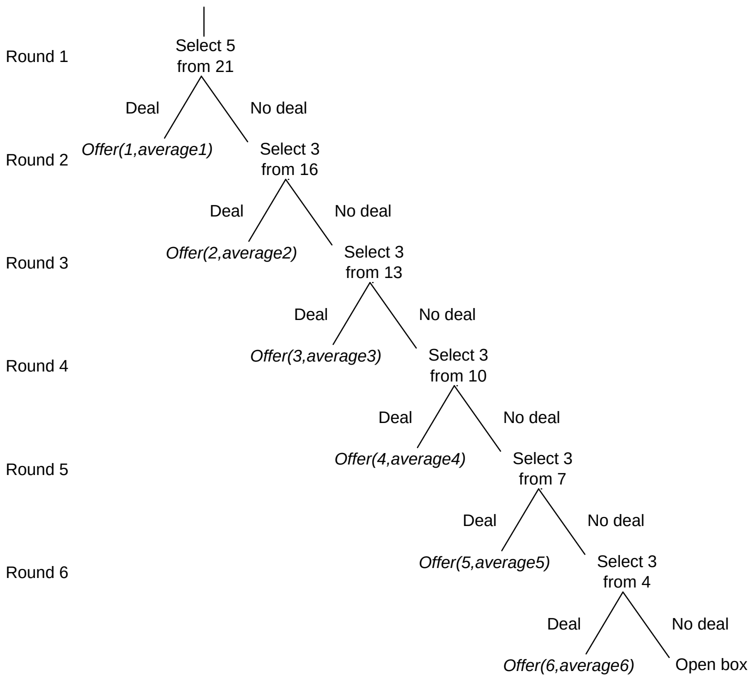

Figure 3: The decisions made during a game

To test the reliability of the model data from an additional fourteen games (some 62 useful rounds) was employed. The correlation between the observed and fitted values for $\ln(\text{offer}_i)$ were compared, the correlation was 0.934, a comparatively high value. This rose to 0.956 on omitting the values for round 1. This indicates the flexibility (arbitrariness) employed by the Banker in the initial round.

The standard deviation of the difference between the Bankers offer and the fitted values are (2418, 4655, 5235, 6888, 7732, 9333) for the six rounds. These values may be summarised by $\text{StDev}_i = 1497 + 1299i$ with $R^2 = 98\%$. This may be coupled with the previously fitted values to mimic the Bankers offer by employing standard normal random numbers, that is the predicted offer is randomly chosen from $\phi(average_i^{0.7332+0.0413i}, (1497 + 1299i)^2)$ for round i and the current average of the available boxes. Such a function could be built in to a simulation of the U.K. game comparable to that for the U.S. game (NBC, 2009).

While previous interest (Post *et al.*, 2006) seems to have concentrated on the Bankers offer it is also interesting to model the optimal Players decision. In other words, the optimal stage of the game for the Player to elect to deal.

There have been some reservations voiced about the box allocation being truly random and hence affecting the Players behaviour, it is believed that this is not a problem here since the model will attempt to predict a strategy given the current state of the game (Bankers offer, Players average and boxes actually available), no information being retained on which boxes contained which sums.

4. When to Deal?

Each game is reviewed and the Bankers offer examined and reported as three dealing strategies, "Too Early", "Deal" and "Too Late". As an example the game from Table 1 is split into these categories in Table 3.

Table 3: The dealing strategy on 30 March 2006

Round	**1**	**2**	**3**	**4**	**5**	**6**
Bankers Offer	£50	£6,050	£1,800	£3,500	£7,500	£2,500
Players Action	Too Early	Too Early	Too Early	Too Early	Deal	Too Late

Interest centres on the deterministic stages of the game. Following a "No Deal" decision in round 6 the Banker may offer the Player the option to switch boxes, however this offer is not guaranteed. In view of this uncertainty, and the essential difference of this later stage, this step has not been modelled. Hence in the approach presented here the Player cannot obtain the optimal value (£250,000), in fact the maximum return is bounded by £175,000, the average of the highest boxes), still a reasonable sum and more than the majority of players receive.

Interest is restricted to the “Too Early” and “Deal” actions; there is no point in modelling “Too Late”, so these events are excluded from consideration. The aim is to model the Players optimal decision based on the Bankers offer. As an initial analysis the boxes are assigned a binary variable (1 – opened, 0 – available) while all offers are scaled by the maximum value (£250,000) to make all coefficients in any resulting models of a similar magnitude.

A discriminant analysis was performed to ascertain if the model could correctly identify the optimal decision. For the first model the predictors were all the binary variables, while for the second the Bankers offer is also included. The results are summarized in Table 4.

Table 4: Full discriminant analysis

Model 1			**Model 2**		
	True Group			**True Group**	
Put into Group	**Deal**	**Too Early**	**Put into Group**	**Deal**	**Too Early**
Deal	67	55	**Deal**	68	38
Too Early	14	220	**Too Early**	13	237
Total	81	275	**Total**	81	275
Correct	67	220	**Correct**	68	237
Proportion	0.827	0.800	**Proportion**	0.840	0.862

In summary from the 356 (excluding the 71 “Too Late” 427-71=356) entries for Model 1 a proportion of 0.806 were correct, while for Model 2 the proportion was 0.857. The method appears to work quite well. As might be expected introducing the Bankers offer does produce a slightly superior model. However the fact that both models work reasonably suggest that the Bankers offers are consistent and predictable. The negative aspect is that a model is being dealt with either 22 (the state of each box from 1p to £250,000 individually) or 23 parameters (the previous 22 plus the bankers offer). For completeness the fitted coefficients are presented in Table 5.

On examining the coefficients in Table 5, in particular those, which are largest and hence have the greatest impact, no obvious pattern emerges. For instance the £0.01 is not consistently the smallest, neither is £250k the largest. In fact it could be argued that £0.10 and £35k are most important while £0.01, £0.50 and £250 are the least important.

A number of simpler models were considered and are summarised in Table 6.

By, for example, 1p-£750 a discrete variable is employed that counts the number of boxes in the range [1p, £750] that are currently available. The final three columns indicate the effectiveness of the model giving the proportion of

Table 5: Coefficients for the full discriminant analysis

	Model 1		**Model 2**	
Coefficient	**Deal**	**No Deal**	**Deal**	**No Deal**
Constant	-2.2636	-6.4519	-6.7830	-9.0160
£0.01	-0.2128	0.3387	0.8060	1.1060
£0.10	0.8490	1.6583	1.8350	2.4010
£0.50	0.1133	0.5842	0.3330	0.7500
£1	0.8106	1.3593	1.2370	1.6810
£5	0.1297	0.4522	1.0480	1.1440
£10	0.3096	0.9181	1.2530	1.6290
£50	0.0530	0.7135	0.9330	1.3760
£100	0.3688	1.6237	0.7510	1.9120
£250	0.1222	0.5179	0.5550	0.8440
£500	0.4384	1.4333	1.9300	2.5570
£750	0.0742	0.8449	0.1460	0.8990
£1k	0.2722	1.0306	1.0140	1.5900
£3k	0.5738	1.2979	1.1820	1.7560
£5k	0.1666	0.6707	0.9330	1.2480
£10k	1.2994	1.1350	1.9230	1.6050
£15k	0.5653	1.3590	1.1710	1.8150
£20k	-0.0259	0.7736	0.9040	1.4740
£35k	1.6268	1.6018	1.9690	1.8600
£50k	1.0617	0.7259	1.6290	1.1530
£75k	0.5301	0.1748	0.1410	-0.1180
£100k	0.4608	0.9667	-0.8130	0.0070
£250k	2.2025	1.8385	-0.5110	-0.2050
Offer			67.8930	51.1390

Table 6: Limited discriminant analysis

	Proportion Correct		
Predictors	**Deal**	**No Deal**	**Total**
1p-£750, £1,000-£20,000	0.840	0.760	0.778
1p-£750, £1,000-£20,000, Offer	0.790	0.836	0.826
1p-£750, £1,000-£20,000, £35,000-£250,000	0.840	0.767	0.784
1p-£750, £1,000-£20,000, £35,000-£250,000, Offer	0.778	0.840	0.826
1p-£750, £1,000-£20,000, £35,000-£100,000, £250,000	0.840	0.760	0.778
1p-£750, £1,000-£20,000, £35,000-£100,000, £250,000, Offer	0.778	0.836	0.823

"Deal" decisions correctly identified, similarly for "No Deal" (or "Too Early"), also the overall proportion correct is given. There is little to choose between the models, so in the interests of parsimony the simplest model is adopted. Obviously at any stage of the game knowing the number of boxes in the range [1p,

£750] and [£1,000, £20,000] enables the evaluation of the number of boxes in the range [£35,000, £250,000]. It is interesting to note that including box £250,000 specifically has little effect. Similarly inclusion of the Bankers offer is not essential, probably because this value can be obtained from knowing which boxes are available using the result derived above. The fitting coefficients obtained are presented in Table 7.

Table 7: Linear discriminant function for groups

Variable	**Deal**	**No Deal**
Constant	-1.3130 (a_0)	-5.4458(b_0)
1p-£750(n_1)	0.4911(a_1)	1.0808(b_1)
£1,000-£20,000(n_2)	0.6464(a_2)	1.1825(b_2)

Using n_1 and n_2, to denote the number of boxes currently available in the ranges [1p,£750] and [£1,000,£20,000] respectively. The "Deal" coefficients are labelled a_0, a_1 and a_2, and the "No Deal" coefficients are b_0, b_1 and b_2, and then the probability associated with a "Deal" decision is

$$\text{Prob(Deal)} = \frac{1}{1 + e^{-a_0 - a_1 n_1 - a_2 n_2 + b_0 + b_1 n_1 + b_2 n_2}}$$

As rounds increase (n_1 and n_2 decrease) so the probability of dealing (Prob) increases. Necessarily as $n_1 \geq 0$ and $n_2 \geq 0$ and since

$$\frac{\partial \text{Prob}}{\partial n_1} = \frac{(a_1 - b_1)\, e^{-a_0 - a_1 n_1 - a_2 n_2 + b_0 + b_1 n_1 + b_2 n_2}}{\left(1 + e^{-a_0 - a_1 n_1 - a_2 n_2 + b_0 + b_1 n_1 + b_2 n_2}\right)^2} \propto (a_1 - b_1) < 0,$$

and

$$\frac{\partial \text{Prob}}{\partial n_2} = \frac{(a_2 - b_2)\, e^{-a_0 - a_1 n_1 - a_2 n_2 + b_0 + b_1 n_1 + b_2 n_2}}{\left(1 + e^{-a_0 - a_1 n_1 - a_2 n_2 + b_0 + b_1 n_1 + b_2 n_2}\right)^2} \propto (a_2 - b_2) < 0,$$

employing the estimates from Table 7.

Reverting to the game first examined in Table 1 the associated probabilities and selected decisions are displayed in Table 8.

Table 8: Linear discriminant function for 30 March 2006

Round	**Bankers offer**	**Number of boxes [1p, £750]**	**Number of boxes [£1,000, £20,000]**	**Probability of deciding to deal**	**Decision**
1	£50	9	5	0.021	No Deal
2	£6,050	6	5	0.110	No Deal
3	£1,800	5	5	0.183	No Deal
4	£3,500	4	3	0.541	Deal
5	£7,500	2	2	0.868	Deal

Recall that after round 1 of the game n_1 is 9, so 9 prizes in the range [1p,£750] are still available. While n_2 is 5, so 5 prizes in the range [£1,000,£20,000] are still available. Since $22-5=17$ boxes remain unopened there must be $22-5-9-5=3$ in the range [£35,000, £250,000], which are still available. These figures can be checked against Table 1.

In this case the decision (albeit with a marginal probability at 0.541) is made one round too early.

With such a simple model summary tables may be constructed on recalling that $0 \leq n_1 \leq 11$ and $0 \leq n_2 \leq 6$, these are now presented.

5. Summary

The Players decision may be reduced to simply counting the number of remaining boxes in [1p, £750] denoted by n_1 and the number in [£1,000, £20,000] denoted by n_2. The associated probabilities are displayed in Table 9. The surface associated with these probabilities is presented in Figure 4. The related decisions are summarised in Table 10.

Table 9: Probabilities for the linear discriminant function

		Number of boxes in range [£1,000, £20,000] - n_2						
		0	**1**	**2**	**3**	**4**	**5**	**6**
	0	0.984	0.973	0.955	0.926	0.880	0.810	0.714
	1	0.972	0.953	0.922	0.874	0.802	0.703	0.581
	2	0.950	0.918	0.868	0.793	0.692	0.568	0.435
	3	0.914	0.861	0.784	0.680	0.555	0.421	0.299
	4	0.855	0.775	0.669	0.541	0.408	0.288	0.191
Number of boxes in range [1p,£750] - n_1	**5**	0.766	0.657	0.528	0.396	0.277	0.183	0.116
	6	0.644	0.515	0.383	0.266	0.175	0.110	0.068
	7	0.501	0.370	0.256	0.168	0.105	0.064	0.039
	8	0.358	0.246	0.160	0.100	0.061	0.037	0.022
	9	0.236	0.153	0.096	0.058	0.035	0.021	0.012
	10	0.146	0.091	0.055	0.033	0.020	0.012	0.007
	11	0.087	0.053	0.031	0.019	0.011	0.006	0.004

The Players decision can be reduced to simply looking up a value in Table 10 supported by the value in Table 9. However, any model is only an approximation and may result in an erroneous decision. For instance $n_1 = 7$ and $n_2 = 0$ results in a probability of 0.501; clearly any decision must be marginal.

These tables can be compared to the additional fourteen games considered above. A summary of the results is presented in Table 11.

In Table 11 the first column displays the probability used to make the decision in the discriminat function. This is the value compared to the relevant entry in

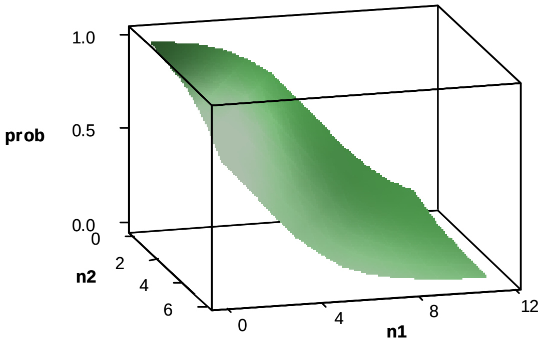

Figure 4: Probabilities for the linear discriminant function

Table 10: Decisions for the linear discriminant function

		Number of boxes in range [£1,000, £20,000] - n_2						
		0	**1**	**2**	**3**	**4**	**5**	**6**
	0	Deal	Deal	Deal	Deal	Deal	Deal	Deal
	1	Deal	Deal	Deal	Deal	Deal	Deal	Deal
	2	Deal	Deal	Deal	Deal	Deal	Deal	No Deal
	3	Deal	Deal	Deal	Deal	Deal	No Deal	No Deal
	4	Deal	Deal	Deal	Deal	No Deal	No Deal	No Deal
Number of boxes in range [1p,£750] - n_1	**5**	Deal	Deal	Deal	No Deal	No Deal	No Deal	No Deal
	6	Deal	Deal	No Deal	No Deal	No Deal	No Deal	No Deal
	7	Deal	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal
	8	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal
	9	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal
	10	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal
	11	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal	No Deal

Table 11: Analysis of an additional 14 games

Decision Probability	**Difference on additional games**	**Average difference on additional games**	**Difference on relevant games**	**Average difference on relevant games**
0.50	-61523	-4395	-13418	-1491
0.55	-61093	-4364	-14488	-1610
0.60	-44603	-3186	-7198	-800
0.65	-44603	-3186	-7198	-800
0.70	-42315	-3023	5790	643
0.75	-42315	-3023	5790	643

Table 9. The next two columns present a summary of the results for all 14 games considered. Thus in the first game the Player postponed dealing till the final

round and was left with £5, adopting a probability of 0.5 the discriminat function would have resulted in a net gain of £14,000-£5. For all 14 games the values are, (-£53,000, -£19,500*, -£9,200, -£8,400*, -£7,000*, -£3,900, -£530*, £0*, £0*, £1,300*, £4,000, £9,712*, £11,000*, £13,995) where a negative value indicates that the Player has achieved a better result than would have been achieved on employing the model. The final two columns restrict attention to the domain in which the model is applicable, ignoring Players who postponed action till the final round. These 9 games are tagged (*) in the above list. While the overall result is negative, choosing a more conservative decision probability, as indicated by successive rows of the table, will over come this. It should be noted that very few games are being dealt with and that they have very large returns. A single negative game can have a large effect.

6. Conclusion

In the work of Post *et al.* (2008), they identified a linear relationship between the ratio of the Bankers offer and the remaining box contents in successive rounds. This relationship was not identified here with R^2 ranging from 3% to 25%. No comparison was attempted with the work of Blavatskyy and Pogrebna (2008) since they considered socio-demographic characteristics of the Players such as gender, age, marital status and region, which were not available in this case. The model proposed by Deck *et al.* (2008) was investigated; the fit resulted in an R^2 value of 77%, far lower than the value for their data. In fact simply fitting ln(offer) in terms of ln(average) and the round, a much simpler model, resulted in an R^2 value of 76%. Implicit in the extended analysis is the segregation of players into two types, sophisticated/naïve, a strategy that has not been pursued, being uncomfortable with this binary divide. While de Roos and Sarafidis (2006) do fit a simple model of the Bankers offer for each round, their main thread concentrates on assessing the players risk aversion. This theme is not currently being pursued.

The Deal or No Deal game in the UK is not played in the same way as elsewhere. Some of the differences may influence the player's behaviour. The game is more personalised than many other gambling games in that contestants play together for several games, for each of which one is chosen to play; the remaining people know they will be the player themselves at some point in a game in the future, which could be the very next game. It is known from Channel 4 that games are recorded at the rate of three per day, so the chances of one contestant being chosen to play on the same day or the next couple of days will be high.

The tentative conclusion is that a deterministic model drives the Banker.

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