



# Global Equity Strategy

Who's a pretty boy then? Or beauty contests,  
rationality and greater fools

## Keynes' beauty contest

We have played a “Keynes’ beauty contest” with our clients. The results show that most investors are gaming the market, using an average two steps of strategic thinking. The game demonstrates the difficulty of “beating the gun”, and highlights the extreme risk that investors run in momentum orientated markets.

- ▶ Keynes likened professional investment to a newspaper beauty contest in which the aim was to pick the face that the average respondent would deem to be the prettiest. We have played a version of this game with our clients. The game was to pick a number between 0-100, the winner would be the player who picked the number closest to 2/3rds of the average number chosen.
- ▶ In fact, we had over 1000 respondents (my thanks to everyone who participated), making this the fourth largest such game ever played, and the first played purely amongst professional investors on such a scale. The average number picked was 26, giving a 2/3rds average of 17.4.
- ▶ Many clients suffered a curse of knowledge. That is, once the solution is known, it is hard to imagine that others can't see it. Hence 8.5% of the players in our game ended up at the “rational” solution of zero. The largest spike occurred at 22, with nearly 9% of the players picking this number. On average, our market is characterised by those doing between one and two steps of strategic thinking.
- ▶ Hence, in order to escape the market before the mass exodus, you would need to be using three step thinking. In our sample that represents very few players. Perhaps this lends some support to our oft-voiced scepticism over the ability of the majority to “beat the gun”.

### Equity asset allocation

Very Overweight	Overweight	Neutral	Underweight	Very Underweight
UK			US	Cont. Europe
Emerging Mrkts			Japan	
Cash				

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# Beauty contests, rationality and greater fools

## Background

In what must be the second most common quotation from Keynes (the first presumably being “In the long run, we are all dead”) the great man opines:

The actual, private object of the most skilled investment to-day is “to beat the gun”, to outwit the crowd, and to pass the bad, or depreciating, half-crown to the other fellow.

This battle of wits to anticipate the basis of conventional valuation a few months hence, rather than the prospective yield of an investment over a long term of years, does not even require gulls amongst the public to feed the maws of the professional; — it can be played by professionals amongst themselves. Nor is it necessary that anyone should keep his simple faith in the conventional basis of valuation having any genuine long-term validity. For it is, so to speak, a game of Snap, of Old Maid, of Musical Chairs — a pastime in which he is victor who says *Snap* neither too soon nor too late, who passes the Old Maid to his neighbour before the game is over, who secures a chair for himself when the music stops. These games can be played with zest and enjoyment, though all the players know that it is the Old Maid which is circulating, or that when the music stops some of the players will find themselves unseated.

Or, to change the metaphor slightly, professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the problem from the same point of view. It is not a case of choosing those which, to the best of one’s judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees.



If the reader interjects that there must surely be large profits to be gained from the other players in the long run by a skilled individual who, unperturbed by the prevailing pastime, continues to purchase investments on the best genuine long-term expectations he can frame, he must be answered, first of all, that there are, indeed, such serious-minded individuals and that it makes a vast difference to an investment market whether or not they predominate in their influence over the game-players. But we must also add that there are several factors which jeopardise the predominance of such individuals in modern investment markets. Investment based on genuine long-term expectation is so difficult to-day as to be scarcely practicable.

John Maynard Keynes, Chapter 12, General Theory of Employment, Interest, and Money, (1935) p155-6

## The game

I fear that some of you think I have finally flipped. Two weeks ago I sent out an email to the e-readers of our strategy product to ask them to participate in a guessing game. The email is reproduced below:

Dear all,

We would like to ask your help. Please consider the following question and email your reply to me. The overall results will be written up in a forthcoming weekly. However, as ever, none of your individual responses will be disclosed. As an incentive, we are offering a bottle of champagne to the winner.

You are taking part in a competition with the other readers of our strategy products. The aim of the game is to pick a (real) number between 0-100 ( $[0,100]$ ). The winner will be the respondent who chooses the number closest to  $\frac{2}{3}$  of the average number chosen.

Many thanks in advance for your input.

If you weren't on the e-mail list, to get the most out of the rest of the note consider your answer before you go any further. Having just read the quotation from Keynes it is presumably obvious that the game outlined in the email is a version of Keynes' beauty contest<sup>1</sup>. So why are we playing a beauty contest game with you? We will show a little later that it has applications in understanding the dynamics of gaming the market, but for now please bear with us.

<sup>1</sup> This game was first played by Nagel (1995) Unraveling in Guessing Games: An Experimental Study, American Economic Review, 85



## The solution

The game itself should be a simple one under the standard assumptions of economics. i.e. rationality *and* common knowledge. Since *all* players want to choose 2/3rds of the average, there is only one number that satisfies the equation  $x = 2/3 * x$ , zero. So the only equilibrium<sup>2</sup> answer to this question is zero (as many of you pointed out).

The game can be solved by a process known as “iterated dominance”. A dominated strategy is one that yields a lower payoff than another, regardless of what other players are doing. For example, choosing a number greater than 67 is a dominated strategy because the highest possible solution to the game is 67 (i.e. if everyone else picks the maximum number 100). However, if no-one violates dominance by choosing a number above 67, then the highest outcome is 2/3rds of 67 and so on. Deleting dominated strategies in this fashion will eventually lead you to zero<sup>3</sup>. This fact was explicitly identified by some 14.5% of our sample (and probably many more who didn’t bother to state the “rational” answer as it wasn’t required).

Of course, this only works under the assumption that everyone you are playing against is rational, and they know that you are rational as well. As one client put it “the whole thing gets much more difficult when you can’t assume that everybody is a perfect logician trying to maximize his or her own best interest”. As soon as we start to see that at least some of the market is not fully rational then the problem becomes more and more complex.

Before looking at the results, I’ll try to link this work back to our work on rational bubbles. In *Global Equity Strategy*, 12 January 2004, we outlined the conditions for various kinds of bubbles. One of these was the near rational bubble driven by myopia (short time horizons) and overconfidence. We concluded that this kind of bubble most closely matched the current market conditions.

A lack of backward induction is also part of this process. Even if all investors foresee a crash, they don’t backward induct all the way to today – otherwise there would be no bubbles and no busts. They guess that other investors will try to sell a couple of steps before the crash. Hence everyone expects and plans to sell just before the mass exodus. This failure of backward induction helps to explain why bubbles can persist even when everyone knows that they must eventually burst.

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<sup>2</sup> Technically, zero is the only fixed point Nash equilibrium

<sup>3</sup> This process is also known as backward induction



**Another failure of backward induction – The paradox of the unexpected hanging**

A man was sentenced on Saturday. “The hanging will take place at noon on one of the seven days of next week” said the judge, he continued “But, you will not know which day it is, until you are informed on the morning of the day of the hanging”.

Can the judge’s sentence be carried out?

It would seem not. If the man has not been hung by next Friday, he will then know that he must be hung the next day. However, this violates the judge’s ruling that he won’t know until the day itself. Thus we can rule out next Saturday as the execution day. Then by the same logic, if the man has not been hung by next Thursday, then he knows he must be hung on Friday (since we have just ruled out Saturday). This, of course, contradicts the judge’s orders that he mustn’t know the day until the morning of the day itself. And so on, we end up ruling out all the days. Hence it appears the judge’s sentence can’t be carried out.

Actually, the man was hung on Monday, and he did not know in advance that Monday would be the day of his death, just as the judge ordered!

## The results

The beauty contest provides a simple way of roughly measuring the number of steps of strategic thinking that players are doing. As one client response noted “I am curious how this little game will end... So, let’s see how inefficient this market is. Isn’t that the dilemma/contradiction we are all in? We know the efficient (right) answer should be 0, however as a rational investor our estimates have to include our guesstimates on how rational our competitors are!”

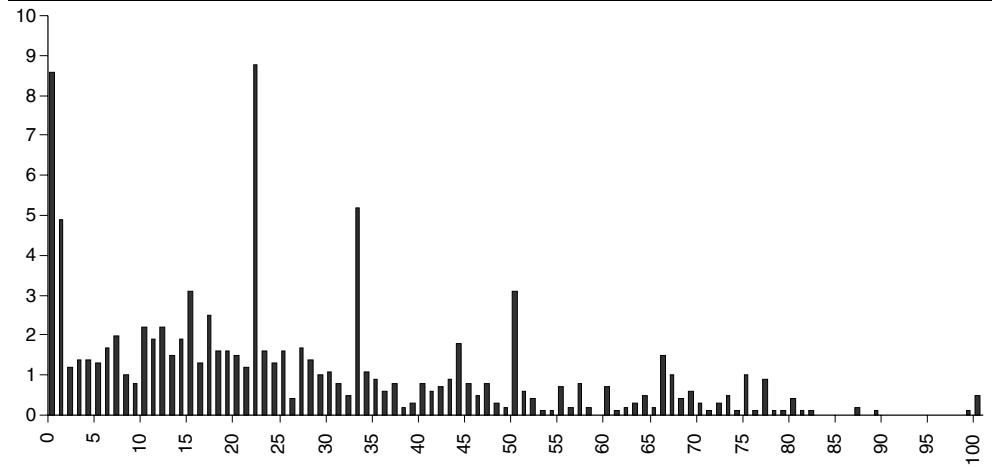
Since our email list consists of professional investors alone, we can take our results as a proxy for the market as a whole. In fact, we had a truly impressive 1002 replies – making this the fourth largest such contest ever played! Thank you to everyone who took part.

The average number selected was 26, giving a 2/3rds average of 17.4. The chart below shows the relative frequency of the choices in our game<sup>4</sup>. This reveals some interesting features about the level of strategic thinking that market participants are using.

<sup>4</sup> For pedagogical, expositional, and graphical ease I’ve transformed the answers into integers. However, rest assured that the average was calculated on the true answers.



**Relative frequency of choices in our game (%)**

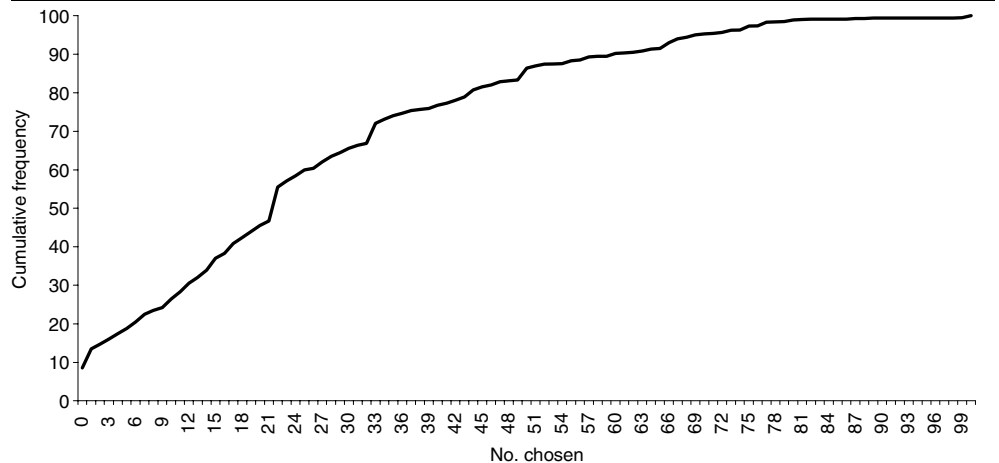


Source: DrKW Macro research

Only 5% of the sample chose numbers above 67, implying that they didn't understand the question or that they are clearly irrational. As one player wrote "100... I'm not a rational investor, my favourite stocks are Amazon and EBAY". (US\$46.38, US\$68.60).

However, such responses don't really have market power because of the size of our sample. Technically we can define market power as the number of additional votes of "100" that would be necessary to change the result by "1", given that sample size. This comes down to  $100^2 / (99 - 26) = 13.7$ . So we would require a considerable number of "100" picks in order to affect our market.

**Cumulative frequency of choices in our game (%)**



Source: DrKW Macro research

Even if we exclude all those who chose numbers greater than 67, we still end up with an average number of 23, and hence a 2/3rds average of 15.2 – still massively above the Nash equilibrium.

Rather than using the iterated dominance strategies outlined earlier, most players assume (perfectly rationally) that the starting point should be 50, i.e. the mean from a random draw. Hence level zero players chose 50 (3% of our total sample). Level one players chose the best reaction to the level zero players i.e. they picked 2/3rds of 50,



providing a spike at 33 (5% of our sample). Level two players “best react” to a 33, yielding the massive spike at 22 (nearly 9% of our sample – the highest single selection). Level three players end up with 15 as their pick (3% of the sample). Once past level two or three reasoning, players frequently slide down the slippery slope towards the infinite iterations that produce zero (8.5% of our sample).

It is easy to measure the number of steps of strategic thinking that are being carried out by the following formula (for choices less than 50)  $\ln(x/50)/\ln(2/3)$ . So with an average of 26, the average level of thinking comes out at 1.6. The most common level of thinking (the mode) was 2 steps of thinking (corresponding to 22).

This pattern of behaviour fits well with other studies of such contests. For instance, Nagel et al<sup>5</sup> (1999) actually called their paper “One, Two, (Three), Infinity” because the pattern of thinking seems to follow exactly the same behaviour as that outlined above.

As noted earlier some 14% of our players identified zero as the “rational” equilibrium. A majority identifying the “rational” answer ended up with that as their final answer. The following answers help identify this sentiment:

“If we were 100% logical, then everyone should enter 0. Since people seldom are, I should therefore, (also logically!), choose another, higher, number, reflecting human nature. However, I cannot bring myself to believe people are so irrational. I therefore stick with 0.”

“My guess is 0. But if I am right, nobody should win: It does not pay to be rational!”

This group was effectively suffering from the curse of knowledge. One particular form of the curse of knowledge is once we know something, we can’t ever imagine thinking otherwise. This makes it hard for us to realise that what we know may be less than obvious to others who are less informed. Better informed players are unable to ignore private information even when it would be in their interest to do so, more information isn’t better information!<sup>6</sup>

Some 41% of those identifying the zero equilibrium chose a number other than zero as their estimate of the likely outcome. Effectively they are taking a rational view on the degree of irrationality or the amount of bounded rationality that governs the market. This kind of thinking was typified by responses such as:

“If I remember correctly, that’s a question about rational expectations and game theory and a rational answer should tend towards zero, but let’s go for 10 to account for frictions and rigidities in real life.”

“Theoretically, the answer should be 0, if all participants were rational. Since I do not assume all participants to be rational, my pick is 6.”

<sup>5</sup> Nagel, Bosch-Domènech, Satorra and Garcia-Montalvo (1999) “One, Two, (Three) Infinity: Newspaper and Lab Beauty-Contest Experiments”, available from [www.ssrn.com](http://www.ssrn.com)

<sup>6</sup> See Camerer, Loewenstein and Weber (1989) The curse of knowledge in economic settings: An experimental analysis, *Journal of Political Economy*, 97, for evidence that such biases can affect market prices and behaviour



“If all contestants are rational, the answer should be zero. However as I suspect that your recipients spend their time in the market for stocks, rationality is an irrational assumption, and I will therefore select the number 12 (!!!)”

“I would like to choose 5.852. I know this is theoretically too high, but I'm relying on a lot of people picking randomly.”

“If everyone is rational and everyone knows that everyone else is rational and everyone knows that everyone knows that everyone is rational, then everyone will guess zero. So everyone gets half a thimble of champagne. So I'm guessing 1 in the hope that some people guess a random number.”

This group also suffered from a curse of knowledge. In effect, they were suffering a false consensus effect. That is the tendency to think that others are just like us. Ask a group of mixed smokers and non-smokers how common smoking is in the population and the chances are you will find that the smokers think more people smoke, and the non-smokers will think that smoking is a minority pastime.

Players who identified zero as the “rational” solution seemed to anchor on that figure. That is to say, although they picked a number higher than zero, they generally stayed too close to zero, i.e. underestimating the degree of irrationality within the market.

The classic experiment in this field was conducted by Tversky and Kahneman (1974)<sup>7</sup> (weren't they all!). In this experiment, people were asked a general knowledge question such as “What percentage of the UN is made up of African nations?” A wheel of fortune with numbers 1 to 100 was spun in front of the participants before they answered. Being psychologists Tversky and Kahneman had rigged the wheel so it gave either 10 or 65 as the result of a spin. The subjects were then asked if their answer was higher or lower than the number on the wheel, and also asked their actual answer. The median response from the group that saw the wheel present 10 was 25, whilst the median response from the group that saw 65 was 45! Effectively people were grabbing at irrelevant anchors when forming their expectations.

Of course, zero isn't irrelevant in our contest, but it may be that players were fixating on zero as too much of an anchor in forming their expectations of the overall game. However this shouldn't be taken as proof that all non-zero choices are a “rational” comment on the degree of irrationality within the market.

In an intriguing paper Grosskopf and Nagel (2001)<sup>8</sup> use two player beauty contest games to assess whether players are boundedly rational or whether they are making a “rational” comment on the irrationality of others. The two-player game is a special case of the beauty contest because zero is always a first best choice regardless of the number picked by your opponent (assuming a 2/3rds like game). For instance, say one-player picks 15, and the other picks 0, then two thirds of the average will be 5, and the zero player wins. This holds true for all numbers.

<sup>7</sup> Tversky and Kahneman (1974) Judgement under uncertainty: Heuristics and biases, Science, 185

<sup>8</sup> Grosskopf and Nagel (2001) Rational reasoning or adaptive behaviour? Evidence from two-person beauty contest games, available from [www.ssrn.com](http://www.ssrn.com)



Thus, if players were truly rational one would expect them to pick zero in two player games. Grosskopf and Nagel used participants who were in general pretty familiar with the beauty contest game (many of whom used the game in teaching). Yet despite this experience, in the first round a mere 12% of participants chose 0! Grosskopf and Nagel go on to show how information feedback can improve performance. However, their conclusion is that very few players are independently rational; instead players seem to grope almost blindly, using imitation and adaptation, towards equilibrium.

So our market can be characterised by the following facts:

- ▶ Most players use one, two, (three) or infinity levels of thinking.
- ▶ A significant number who reach zero choose a number greater than zero because they believe others are boundedly rational. However, virtually all such players still ended up choosing too low a number.
- ▶ A significant proportion of players do choose either zero or one – doomed by their own rationality, or the curse of knowledge.

## A simple model of our contest

Camerer, Ho and Chong (2003)<sup>9</sup> argue a simple model can characterise many strategic games including the kind we have played. The model assumes bounded rationality and overconfidence on the part of the players.

The model is based on the fact that players do not realise that other players are using more than a certain level of steps, that is to say players have limited cognitive abilities (bounded rationality). The model also assumes that people are overconfident, in as much as they don't realise that others are using as many steps of thinking as they are.

Based on their model, Camerer et al have found that most games are characterised by one or two steps of thinking. They recommend using a 1.6 average level of reasoning for a one shot game. This would generate a mean number of 33, and a 2/3rds average of 22.

However, in games with those trained in logic (as one would generally hope market participants are!) a higher level of reasoning should probably be expected. Hence I ran their model based on an average 2 steps of reasoning before the results of our game were known. Using this model resulted in a prediction of a mean number of 29.8, with a 2/3rds average of 20. Not bad, compared to the actual outcome, and certainly a massive improvement on the standard game theory prediction of Nash equilibrium – zero.

In fact one client came very close to using a very similar methodology without even knowing about the cognitive hierarchy model:

"I believe that most people are going to go for 50 as the mean response and 2/3 of that is clearly 33.3. However I am anticipating that most of the people on your distribution

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<sup>9</sup> Camerer, Ho and Chong (2003) A Cognitive Hierarchy Theory of One-Shot Games and Experimental Analysis, forthcoming in the Quarterly Journal of Economics, available from <http://www.hss.caltech.edu/~camerer/camerer.html>



list are going to anticipate that the average answer is 33.3 and will therefore go for 2/3 of that which is 22.2. The quandary now is to determine how many iterations the average person in your survey will assume that the other participants go through. On the assumption that 25% of the respondents are naive and say 33, and that 50% are more sophisticated and say 20, with the remaining 25% going to the logical extreme and saying zero, then I'm left with a weighted average of 19.4."

In actual fact, it transpires that our market is best characterised by an average of 2.8 steps in the thinking process (if we model up to level six players). Level zero players essentially pick a random number (i.e. 50). Level 1 players assume that everyone else is a level zero player, and hence pick 2/3rds of 50. Level 2 players assume that they are the only level 2 player (overconfidence) and so normalise the true distribution to give the relevant weights i.e. they assume that there are 30% level 0 players, and 70% level 1 players (8/28 level 0, and 20/28 level 1). Hence they "best react" to the combined mixture of level 0 and level 1, an average of 38.7, and pick a 2/3rds figure of 25.1. This process continues at each level of thinking. The cognitive hierarchy model suggests that our game consists of a population as shown below.

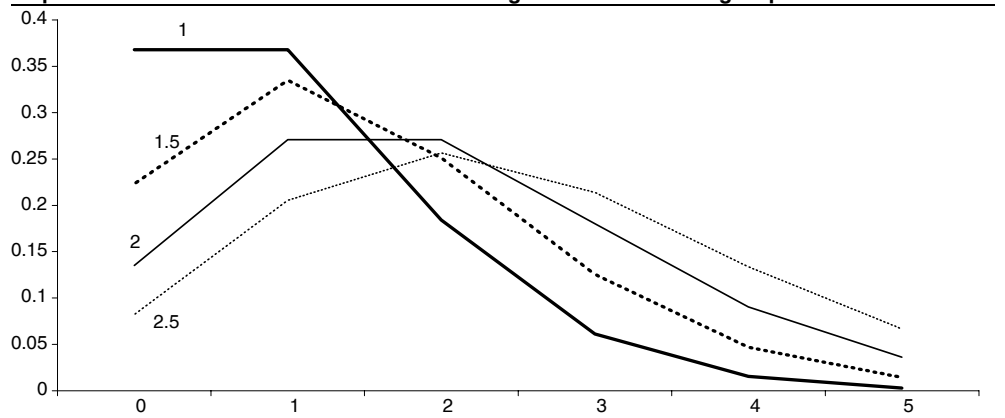
**Cognitive hierarchy model of our game**

No of steps	% of population	Number selected
0	7.9	50.0
1	20.0	33.3
2	25.4	25.1
3	21.5	25.1
4	13.7	25.1
5	6.9	25.1

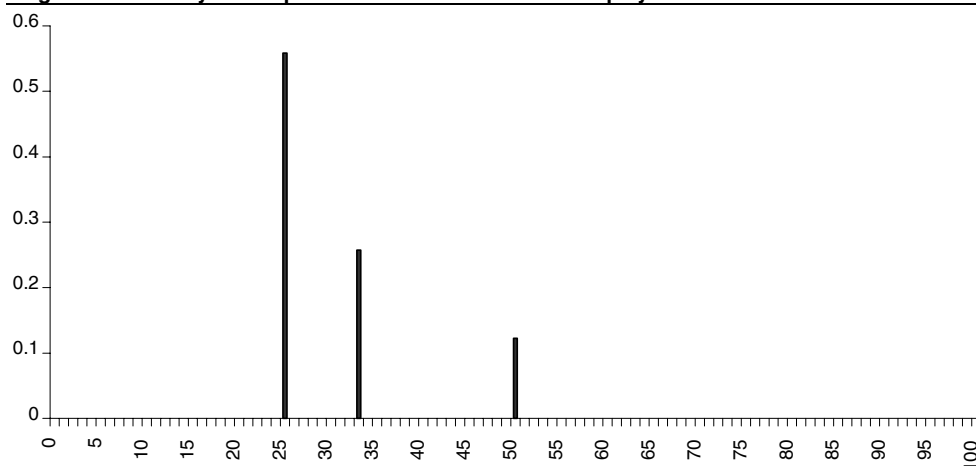
Source: DrKW Macro research

Note that something interesting happens in this model. All players using 2 or more steps of strategic thinking end up selecting the same number. Effectively no one in this contest would need to think beyond two steps of reasoning, so even if players can, they are better off not doing so (i.e. avoiding the curse of knowledge). This occurs because the size of the distribution is so large at groups 1, 2 and 3.

**Population of the universe as a function of average number of thinking steps**



Source: DrKW Macro research

**Cognitive hierarchy model prediction of the distribution of players in our contest**


Source: DrKW Macro research

## Comparison with other experiments

So how do our results stack up against other beauty contests? The table below shows a summary of beauty contests that have been played with a wide variety of participants. We have also estimated the average level of thinking from the cognitive hierarchy model outlined earlier. In general, the results we have obtained are very similar to those found by other researchers.

**Summary of beauty contests**

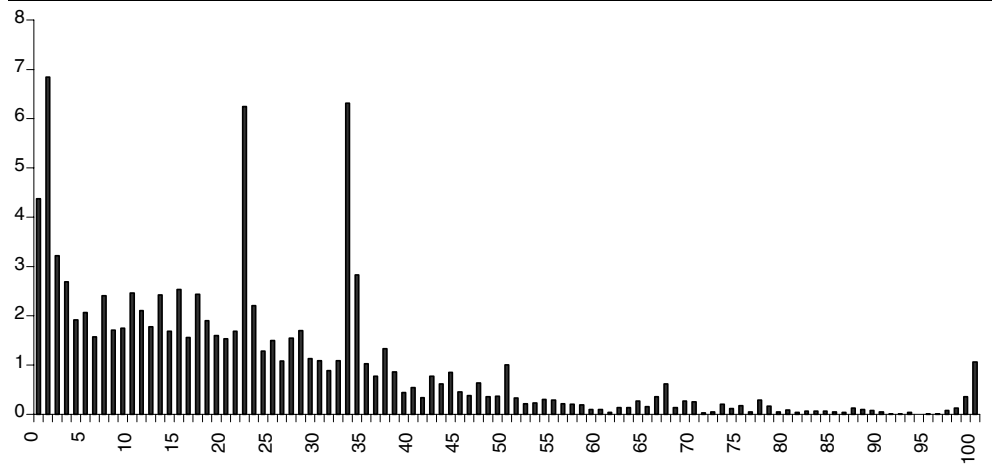
	Average	2/3rds	No of players	Experimenter	Average level of thinking
Caltech Board	42.6	28.4	73	Camerer	0.5
CEOs	37.9	25.3	20	Camerer	1.0
German students	37.2	24.8	14-16	Nagel	1.1
70 year olds	37.0	24.7	33	Kovalchik	1.1
US high school	32.5	21.7	20-32	Camerer	1.6
Econ Phds	27.4	18.3	16	Camerer	2.6
Portfolio Managers	24.3	16.2	26	Camerer	3.2
CalTech Students	23.0	15.3	17-25	Camerer	3.5
FT	18.9	12.6	1476	Thaler	4.3
Expansion	25.5	17.0	3696	Nagel	3.0
Spektrum	22.1	14.7	2728	Nagel	3.7
Game theorists	19.1	12.7	136	Nagel	4.3
CalTech students	30.2	20.1	10-12	Weber	2.1
Portfolio managers (single firm)	29.3	19.6	22	Montier	2.3
Harvard Econ students	18.3	12.2	124	Laibson	4.4
DrKW Strategists/Economists	12.3	8.2	6	Montier	5.7
BF Group	24.2	16.1	22	Montier	3.3
German institutions (Sentix)	40.5	27.0	61	Hüber	0.8
German private clients (Sentix)	44.3	29.6	185	Hüber	0.4
Global Investors	26.0	17.3	1002	Montier	2.8

Source: DrKW Macro research, Camerer et al (2003)

The closest games in terms of size have been those played in newspapers. The results of aggregation of all three papers (FT, Expansion and Spektrum) are shown in the chart below.



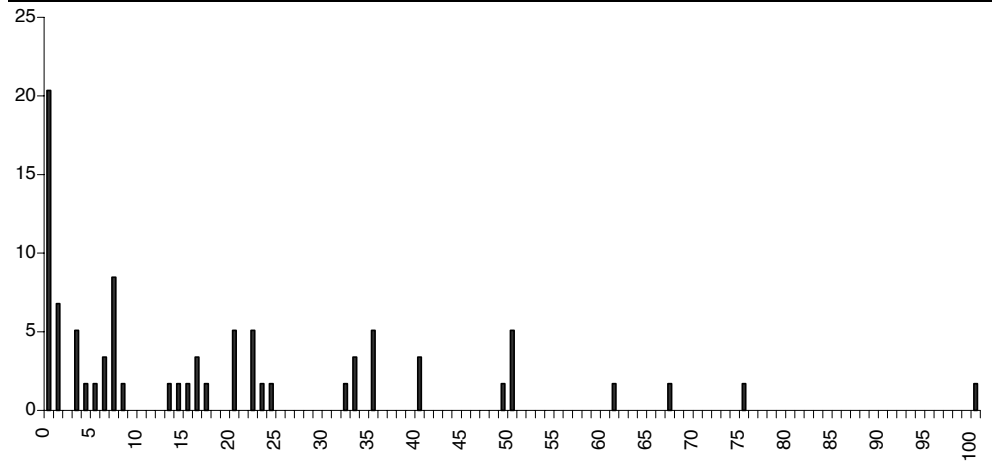
**Newspaper beauty contests**



Source: DrKW Macro research

I've also included four other new games. The first was played over Christmas 2001 by some of my colleagues in the macro team at DrKW. As you might expect from the game theorists examined by Nagel, the average number chosen was markedly lower, when economists were playing amongst themselves.

**Game theorists and Experimenters contest**

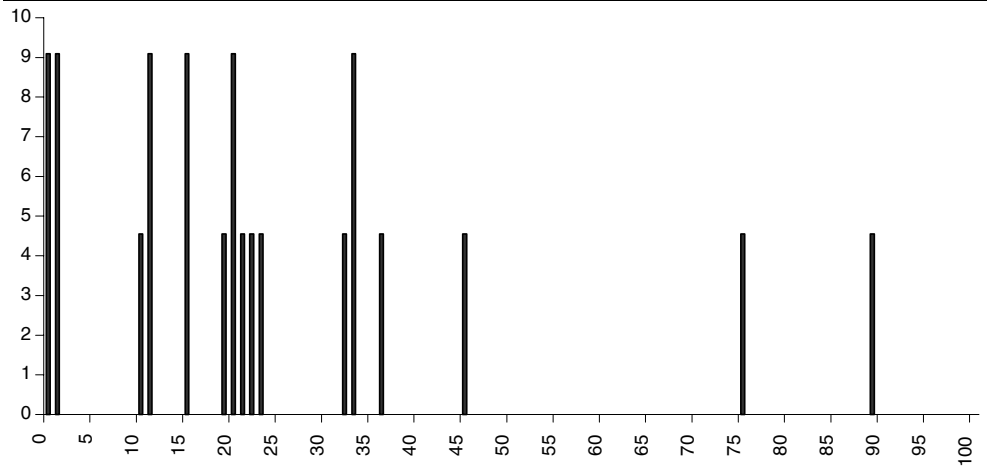


Source: Nagel

The other three games were played simultaneously with the contest amongst our clients. I played the game with the Yahoo Behavioural Finance group. They showed a very similar performance to the newspaper readers in the table above.



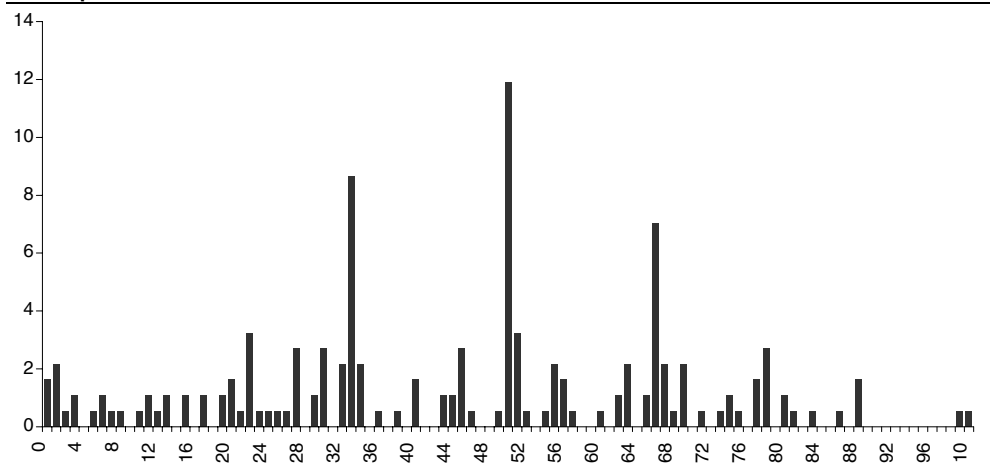
**Yahoo Behavioural Finance group**



Source: DrKW Macro research

The final two games were played by a survey organisation based in Germany ([www.sentix.de](http://www.sentix.de)). Manfred Hüber, founder of the site, offered to run the beauty contest as part of their weekly poll of sentiment. Always greedy for information I eagerly accepted Manfred's kind offer. Sentix separated the responses into private investors and institutional investors.

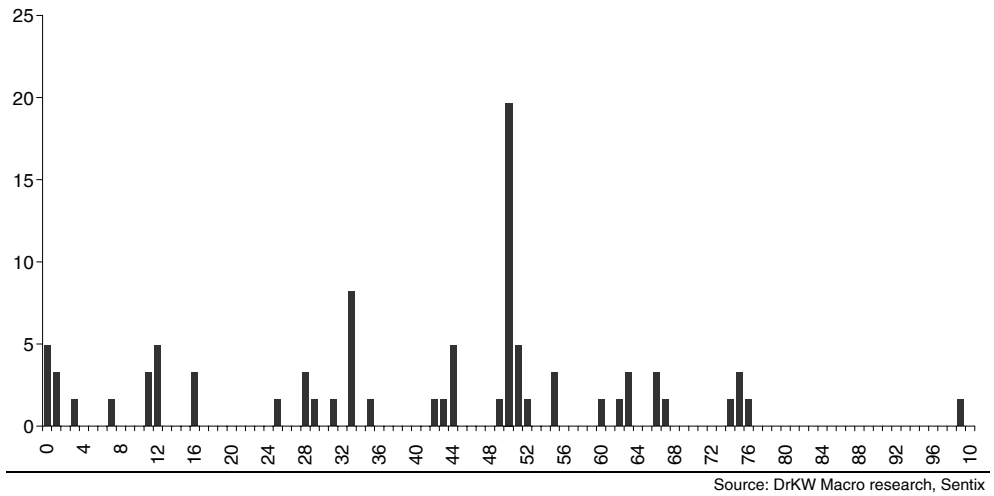
**Sentix private investors contest**



Source: DrKW Macro research, Sentix

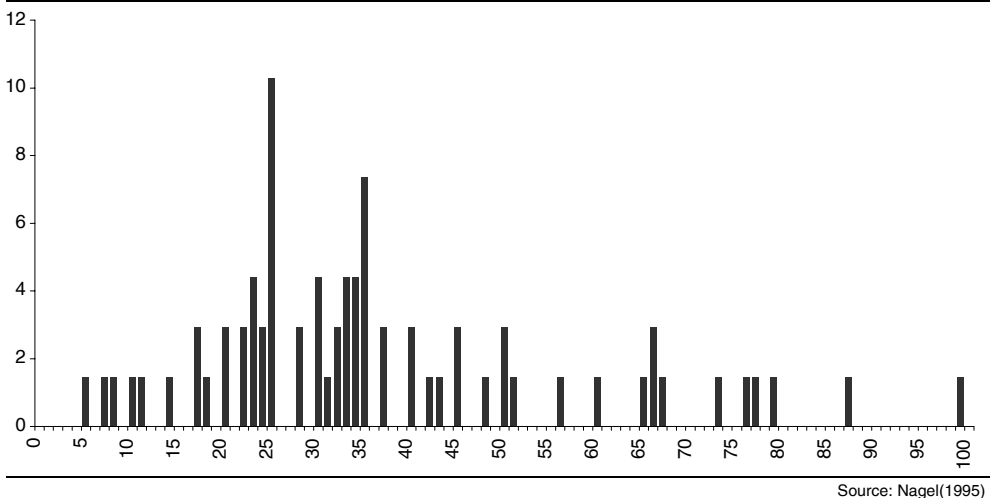


**Sentix institutional investors contest**



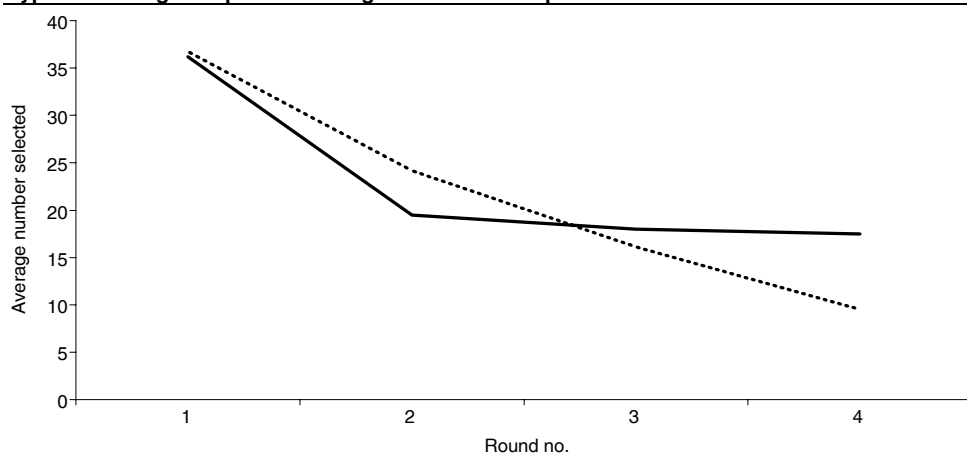
Perhaps because the question was written in English, the average answers were noticeable higher in both the Sentix polls, and hence characterised by much lower average levels of strategic thinking than our other experiments. For comparison I've also shown the average results from student games played by Nagel (1995).

**Student contest**



**Learning**

Just in case you are assuming everything I've discussed here is a function of this being a one shot game, cast your eyes over the chart below which shows two typical multi-round game averages. In each case, the contest was played by several groups over many rounds. The average mean number across groups in each round is shown below. Learning seems to occur only very slowly over time, a finding which sits very comfortably with the vast swathes of psychological research which suggest learning is generally far more difficult than most of us tend to blithely assume!

**Typical learning time paths – average choice in each period**


Source: Camerer (2003)

## Conclusions

We have recently argued that the equity markets are currently experiencing a near rational bubble. This is being driven by increasingly short time horizons and investors' overconfidence. This combination gives birth to the momentum culture that we have all witnessed in recent years.

The pressure to perform on a month-by-month basis is driving professional investors to prolong their exposure to a risky situation. As Keynes noted "It makes a vast difference to an investment market whether or not they predominate in their influence." Because of this pressure to perform on all time horizons, they are being forced to rely on their ability to time this market to perfection. However, not everyone can get out at the top. Inevitably, some will be crushed under foot in the rush for the exit. It was to assess this risk that we have used the classic "Keynes' beauty contest".

If our beauty contest is a proxy for market behaviour, then most investors seem to practice two steps of strategic thinking. In Keynes' parlance most investors seem to be concerned with "The third degree where we devote our intelligences to anticipating what average opinion expects average opinion to be".

Our market seems to be best characterised by investors using between one and two degrees of strategic thinking. Hence if you are to beat the exodus, then you need to be thinking in terms of three steps, but no more. In terms of our sample that represents just 4% of the players! Perhaps this lends some support to our oft-voiced scepticism over the ability of the majority of investors to "beat the gun".



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(Except as otherwise noted, expected performance over next 12 months)

Buy	10% or greater increase in share price	Reduce	5-10% decrease in share price
Add	5-10% increase in share price	Sell	10% or more decrease in share price
Hold	+5%/-5% variation in share price		

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	All covered companies		Companies where a DrKW company has provided investment banking services (in the last 12 months)	
	Count	Percentage	Count	Percentage
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Hold	201	32%	34	34%
Sell/Reduce	122	19%	10	10%
Total	638		99	

Source: DrKW