The Favorite / Long-shot Bias in S&P 500 and FTSE 100 Index Futures Options: The Return to Bets and the Cost of Insurance*

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ABSTRACT

This paper examines whether the favorite/long-shot bias that has been found in gambling markets (particularly horse racing) applies to options markets. We investigate this for options on the S&P 500 futures, the FTSE 100 futures and the British Pound/US Dollar futures for the seventeen plus years from March 1985 to September 2002. Calls on the S&P 500 with both three months and one month to expiration display a relationship between probabilities and average returns that are very similar to the favorite bias in horse racing markets pointed out by Ali (1979), Snyder (1978) and Ziemba & Hausch (1986). There are slight profits from deep in-the-money and at-the-money calls on the S&P 500 futures and increasingly greater losses as the call options are out-of-the-money. For 3 month and 1 month calls on the FTSE 100 futures, the favorite bias is not found, but a significant long-shot bias has existed for the deepest out of the money options. For the put options on both markets, and for both 3 month and 1 month horizons, we find evidence consistent with the hypothesis that investors tend to overpay for all put options as an expected cost of insurance. The patterns of average returns is analogous to the favorite / long-shot bias in racing markets. For options on the British Pound/ US Dollar, there does not appear to be any systematic favorite / long-shot bias for either calls or puts.

JEL classifications: C15, G13

Keywords: Long-shot bias, gambling, option prices, implied volatilities.

Ali (1979), Snyder (1978) and others have documented a favorite / long-shot bias in racetrack betting.[1] The data shows that bets on high probability – low payoff gambles have high expected value and low probability – high payoff gambles have low expected value. For example, a 1-10 horse having more than a 90% chance of winning has an expected value of about $1.03 (for every $1 bet), whereas a 100-1 horse has an expected value of about 14 cents per dollar invested. The favorite / long-shot bias exists in other gambling markets such as sports betting; see Hausch, Lo and Ziemba (1994) for a survey of results.

In Ziemba and Hausch (1986), the expected return per dollar bet versus the odd levels are studied for more than 300,000 horse races. They found that the North American public underbets favorites and overbets longshots. This bias has appeared across many years and across all sizes of race track betting pools. The effect of these biases are that for a given fixed amount of money bet, the expected return varies with the odds level; see Figure 1. For bets on extreme favorites, there is an positive expected return. For all other bets, the expected return is negative. The favorite long-shot bias is monotone across odds and the drop in expected value is especially large for the lower probability horses. The effect of differing track take – transactions costs is seen in the California versus New York graphs.

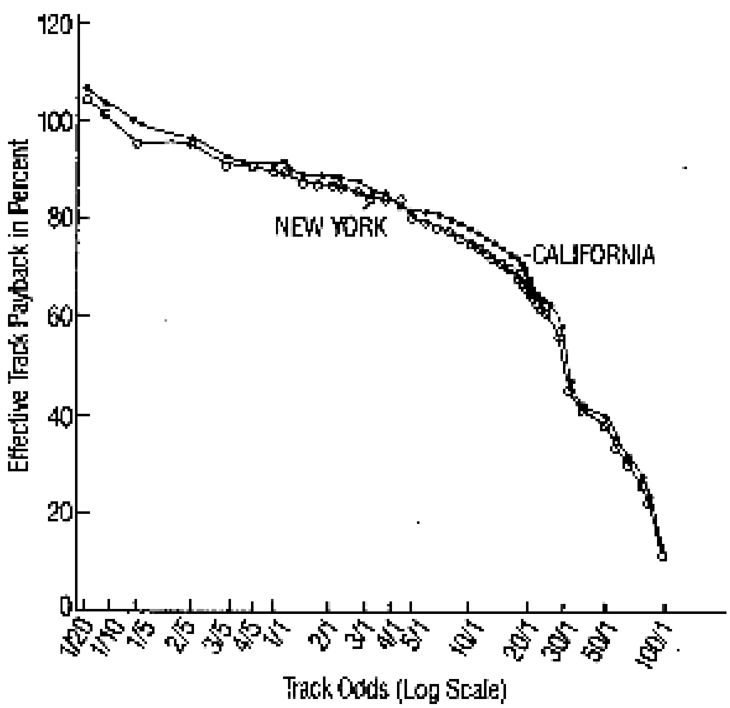

Figure 1. The effective track payback less breakage for various odds levels in California and New York for 300,000 plus races over various years and tracks. Source: Ziemba and Hausch (1986).

Thaler and Ziemba (1988) suggest a number of possible reasons for this bias. These include bettors' overestimation of the chances that long-shot bets will win or as in Kahneman & Tversky (1979) and Tversky & Kahneman (1983) bettors might overweight small probabilities of winning when the potential payout is large (in calculating their utility). Bettors may derive utility simply from the hope associated with holding a ticket on a long-shot, as it is more "fun" to pick a long-shot to win over a favorite and this has more *bragging rights.* Transaction costs also play a role. Finally, they suggest that some bettors may choose horses for irrational reasons such as the name of the horse.

Put and calls on stock index futures represent leveraged short or long positions on the index and their behaviour might have similar features to racetrack bets. Demand for options come from both hedging and speculation. The primary use of put options is for hedging.

For the call options, the most obvious hedging demand is to sell them against existing holdings of equity. This covered call strategy tends to depress the price of (especially out-of-the-money) call options. If this were the sole mechanism for dealing in call options, this should result in an increase in the expected return for purchasers of out-of-the-money call options. The expected loss from the purchase of out-of-the-money call options is possibly due to some speculative activity similar to that for long-shot horse race bets. However, Bollen and Whaley (2002) showed that buyer-initiated trading in index puts dominates the market. Because there are few natural counter-parties to these trades (apart from hedge funds), the implied volatilities of these options rise and the implied volatilities of the corresponding call options rise due to put-call parity. However, they show that the primary choice of buyer-initiated index put trading occurs for the nearest OTM put options. They also stated " Since portfolio insurers generally buy OTM puts rather than ITM puts…" this implies that relatively speaking the demand for ITM puts is less and given that they argue that option mispricing is due to supply and demand imbalances at different strike prices, then ITM puts would be relatively less expensive. By put-call parity, this implies that the costs of the OTM call options would be relatively less expensive and offer a higher return. Nevertheless, our results suggest that the out-of-the-money call options have also tended to be overpriced.

Rubinstein (1994) examined options on the S&P 500 index and as with our research considered the impacts of extreme events on investor's perceptions of option values. He pointed out that the implied volatilities for options on the S&P 500 changed after the 1987 stock market crash. The prices of out-of-the-money put options rose and the prices of out-of-the-money call options fell (relative to the price of the at-the-money option). The explanation for the change in the implied volatility pattern post October 1987 from a smile to a skew is driven by portfolio insurers who had dynamic portfolio insurance failures and substituted the purchase of index puts in their hedging strategy. Rubinstein (1994) states: "One is tempted to hypothesise that the stock market crash of October 1987 changed the way market participants viewed index options. Out-of-the-money puts (and hence in-the-money calls by put-call parity) became valued much more highly". This effect, which is commonly referred to as the implied volatility skew (or smile), has recently been an active area of research. Buraschi & Jackwerth conclude, “returns on away-from-the-money options are driven by different economic factors that those relevant for at-the-money options.” (Page 523) as part of their 2001 study, which examines the skew and shows that in and out-of-the-money options are required to span the state space.

In the presence of market imperfections (such as transaction costs or other frictions that allow riskless hedges to be constructed in continuous time) or incomplete markets, option prices are no longer uniquely determined by arbitrage, and may be determined (within limits) by supply and demand. Dumas, Fleming and Whaley (1998) suggest that the behaviour of market participants may be the reason for the existence of smiles. They state: “With institutional buying pressures for out-of-the-money puts and no naturally offsetting selling pressure, index put prices rise to a level where market makers are eventually willing to step in and accept the bet that the index level will not fall below the exercise price before the option's expiration (i.e. they sell naked puts) ... option series clienteles may induce patterns in implied volatilities, with these patterns implying little in terms of the distributional properties of the underlying index." (Page 21).

Figlewski (1989) also suggests that the reason for the existence of volatility smiles is due to the demands of option users. He suggests that the higher prices (and resulting higher implied volatilities) associated with out-of-the-money options exist because people simply like the combination of a large potential payoff and limited risk. He likens out-of-the-money options to lottery tickets with prices such that they embody an expected loss. Nevertheless, this does not dissuade some from purchasing them. This would suggest that investors might be acting irrationally. Poteshman and Serbin (2002) show that this is the case for the exercise of exchange-traded stock options. They conclude that the early exercise of American calls on stocks during the period of 1996-1999 was in many instances “clearly irrational without invoking any model or market equilibrium”. If investors act irrationally in this regard, it is also possible they also act irrationally when assessing the value of the option and could display similar irrational behaviour to other speculative endeavours such as gambling.

We examine the returns from investing in call and put options on stock index futures markets and assess whether the average returns are biased against high leverage situations, as they seem to be in other betting markets. To test the hypothesis that options display such biases requires a sufficiently large number of independent observations inactively traded markets with a wide range of strike prices. We have therefore chosen to work with stock index options data, even though these may be dominated by institutional investors buying portfolio insurance [as suggested by Bollen & Whaley (2002)], and the type of bias we hypothesize is perhaps more likely in stock option markets, with a higher concentration of retail customers[2].

The equity index markets have a wide range of available strike prices and trade on a monthly expiration cycle yielding more independent trials than for stock options. If evidence of bias related to leverage is found for stock index options,: it is likely that it would even more extreme for individual stock option markets (or option markets with more retail involvement). To examine this issue, we have examined three separate markets with different levels of retail trading activity. Our first is the S&P 500 futures options market. According to the Marketing Department of the Chicago Mercantile Exchange (and from Large Position reports from the Commodity Futures Trading Commission) virtually all trading activity for options on the S&P 500 futures comes from institutional traders. For options on the Financial Times Stock Index (FTSE) 100 futures traded at the London International Financial Futures Exchange (LIFFE) there is more retail involvement. Press releases from LIFFE report that retail involvement in these options comprise up to 10% of the total volume (similar to that of the individual stock options traded on the LIFFE). This additional market will provide some insights into the impacts of non-professional trading on the favorite long-shot bias. Our final market is on options on the British Pound/US dollar. This clearly differs from the equity index markets in that a put on one currency is a call on the other. These options are primarily traded by professionals and provide a robustness test for our methodology.

Section 1 presents data sources and the methodology for the transformation of option prices into odds, so that the results can be compared to the horse racing literature. Section 2 presents results for the S&P 500, FTSE 100 options markets and British pound/US dollar options (to provide a robustness test). Section 3 concludes.

1. Methodology

To investigate whether a favorite / long-shot bias exists in option markets requires a transformation of option prices into odds. In the Black Scholes (1973) equation, $N(d_2)$ is the forward price of a digital option that pays \$1 if $F > X$. It is the (risk neutral) odds at which investors can bet on this event. For a put option, the digital that pays \$1 if $X < F$ is $N(-d_2)$. As with Ali (1979), Snyder (1978) and Ziemba and Hausch (1986), one needs to collect a large sample of independent events, determine the odds of certain events occuring, invest a fixed amount in each bet (say 1\$) and examine the posterior payoff of that bet. A pool of bets with the same odds must be aggregated and the average of the payoffs calculated. The data used in this study consists of settlement prices for the futures contract and all call and put options on the S&P 500 and FTSE 100 index markets and US Dollar/British pound future and options on those dates when the options had either exactly one month or three months to expiration.[3] The period of analysis for all markets was from March 1985 to September 2002 and yielded 68 independent quarterly observations for the S&P 500, FTSE 100 and the British Pound/US Dollar.[4] For the monthly observations (serial options), we obtained 187 independent observations for the S&P 500 and 124 observations for the FTSE 100 index options markets. The data were obtained from the Chicago Mercantile Exchange for the S&P 500 and British Pound/US Dollar futures and options. Both option contracts are American Style options on Futures. The data for the FTSE 100 futures and options were obtained from the London International Financial Futures Exchange (LIFFE) for the European Style options on futures from 1992 to 2002 and from Gordon Gemmill of City University, London for the American Style options on Futures prior to 1992. The interest rate inputs were obtained from the British Bankers Association (US Dollar or British Pound LIBOR).

We chose monthly and quarterly, instead of daily data to ensure independence of the observations and final outcomes. We identified all expiration dates for all available options over the sample period. On that day, we recorded the settlement levels of the futures contract (the nearest to expiration futures contract and possibly the cash index if that date was a simultaneous expiration of the futures and options contract), and all available option prices on this nearby futures contract that had either one month or three months to expiration.

Given that settlement prices were used, it was not necessary to conduct the standard filtering procedures such as butterfly arbitrages; see Jackwerth and Rubinstein (1996). However, we did remove all options with prices below 0.05 (as for a trade to take place the offer price must be at least 0.05).

With seventeen years of quarterly data, we had 69 quarterly observations in our analysis with an average of 39.1 available strike prices per observation for the options on the S&P 500, 30.8 strikes for options on the FTSE 100 and 17.8 available strike prices per observation for the options on the British Pound / US Dollar. For the monthly expirations, the average number of strike prices available for the S&P 500 options was 39.0 and 28.6 for the FTSE 100.

The first step is to calculate a measure of the odds of options finishing in the money (analogous to book-making odds in horse racing). Since the options are American, the Barone-Adesi and Whaley (1987) approximation has been used to recover the implied volatilities, which have then been substituted into the Black (1976) formula to calculate the pseudo-European option probabilities [$N(d_2)$ and $N(-d_2)$]. For the European style options on the FTSE 100, the Black (1976) implied volatilities were directly used.[5] In all markets, the implied volatilities for each option were used to calculate the odds. To make a more consistent comparison with horse race betting, the premium for the options were expressed in forward value terms. Thus, the forward version of the Black (1976) formula was used

$$C_{fv} = FN(d_1) - XN(d_2) \tag{1a}$$

$$P_{fv} = XN(-d_1) - FN(-d_2)\,. \tag{1b}$$

where, $d_1 = \dfrac{\ln(F/X) + \frac{1}{2}\sigma^2\ (T-t)}{\sigma\sqrt{(T-t)}}$ and $d_2 = d_1 - \sigma\sqrt{(T-t)}$.

As we only observe the current option prices C_{pv} and P_{pv}, we transform these to the results in equations (1a) and (1b) by multiplying the observed prices by $e^{r(T-t)}$ (where r is the LIBOR interpolated between adjacent standard maturities as reported by the British Bankers Assocation on the observation date, t and T is the expiration date).

The terminal payoffs of the options are

$C_T = MAX(F_T - X, 0)$ and $P_T = MAX(X - F_T, 0)$, respectively. (2)

We calculate the wealth relatives of the ratios of these to the initial option forward values: in the absence of risk premia these would be expected to average to one.

An important issue in averaging them is how the wealth relative on each option should be weighted. As we go through our data sample, the number of strikes available increases with time. We would therefore lose efficiency if we weighted all options equally, as this would correspond to investing increasing amounts over time, where, for a given day the returns on options at different strikes are not independent. Our first principle is therefore to weight each monthly or quarterly period equally, by investing a fixed amount of money (e.g. $1) at each date.

To achieve the same investment amount for the alternative option contracts, the number of options purchased equals

$$Q_C = 1\$ / C_{fv} \text{ and } Q_P = 1\$ / P_{fv}, \text{ respectively, for all Calls and Puts.} \tag{3}$$

Equation (3) suggests that for higher priced options (e.g. in-the-money), the quantity purchased will be small and for lower priced options (e.g. out-of-the-money), the number of options purchased will be large. We interprete the in-the-money options as the favorites and the out-of-the-money options as the long-shots.

Unlike horse racing, the (risk neutral) probabilities of payoff in the options markets are not expressed as odds but in a continuous probability range from 0% to 100% (and at random points). In horse racing, while the bets are expressed as odds, such bets actually represent a continous probability range for all bets between discrete categories (and are rounded down). As examples, 9-5 bets cover all ranges from 1.80 to 1.99 to 1 and 5-2 bets covers all bets with ranges from 2.00 to 2.49 to 1.

To determine expected wealth relative at fixed "odds" levels [$N(d_2)$ or $N(-d_2)$], we use interpolation to estimate what strike and option price would apply. Within the range of "odds" which exist on a given day[6], we linearly interpolate the implied volatility between adjacent strikes. With each wealth relative estimated thus, we form a simple average of wealth relatives from non-overlapping periods, and can therefore easily perform significance tests.

Standard significance tests (such as a one-tailed t-test) may be inadequate when the sample distribution is not normal. The holding period return distributions of options tend to be quite positively skewed, and particularly so for out-of-the-money options, and when a risk premium on the underlying increases (for calls) or reduces (for puts) the (objective) probability of exercise. Care is therefore needed in testing the significance of the mean wealth relative to any given null hypothesis. In order to address this, we have conducted Monte Carlo simulations to obtain the distribution of the realized mean wealth relatives for samples of suitable sizes (60 for quarterly and 160 for monthly horizons).[7] These simulations were done under Black-Scholes assumptions, with and without a risk premium, and for one month and three month times to expiry. The confidence intervals obtained in this way were noticably different from the t-test intervals which would have been applicable for a normal (or nearly normal) distribution.[8]

2. Results

The first step is to examine what the payoffs of call and put options would be under the Black Scholes (1973) model. Although the presence of a risk premium on the equity index does not affect the option valuation, it will affect the pattern of realized wealth relatives. When risk premia exist (for example in equity markets), the expected return for the investment in options will differ from the $1 investment. To assess this, we examined call and put options using the Black Scholes (1973) formula with no risk premium and risk premia of 2%, 4% and 6%. This is done by using –2%, -4% and –6%, respectively, as the continuous dividend rate, using the Merton (1973) dividend adjustment, in the Black Scholes formula. The ratio of the option prices are determined and plotted as a function of the moneyness. This can be seen in Figure 2 for call and put options. The calls lie above the $1 investment and the puts lie below the $1 investment.

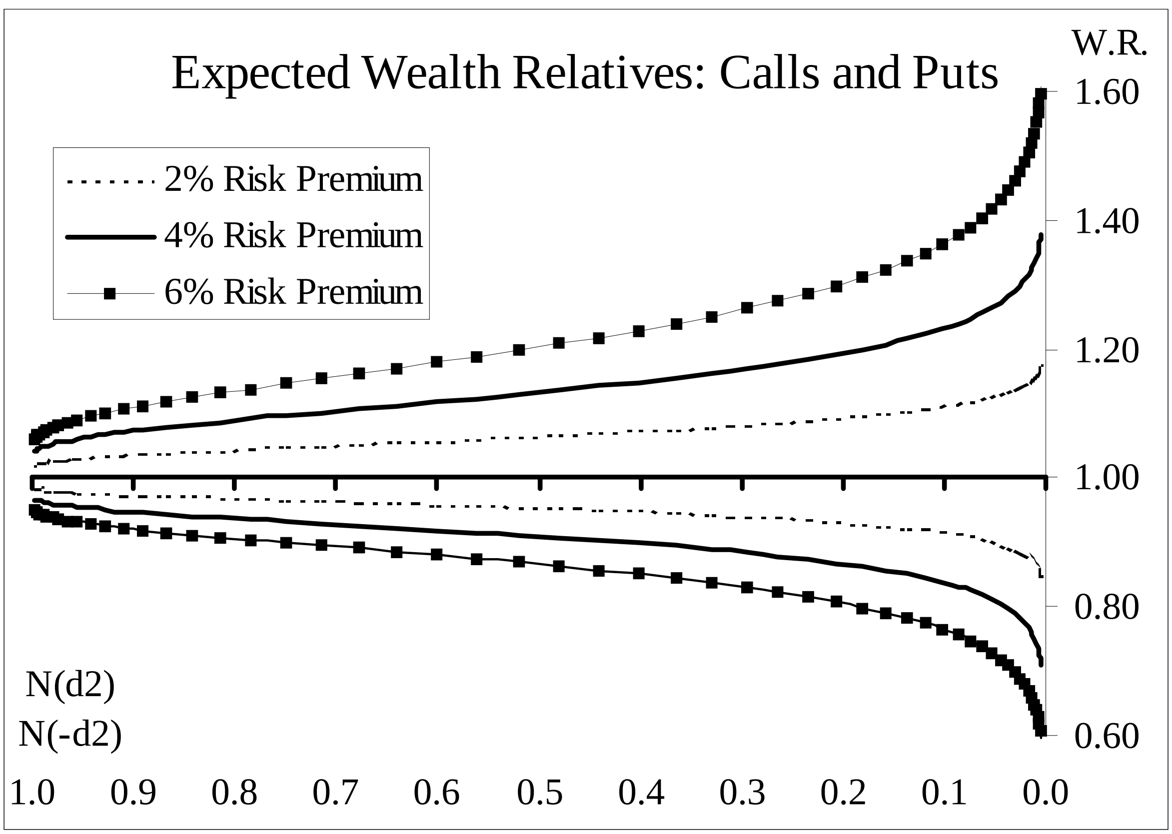

Figure 2: Expected Wealth Relatives for Call and Put Options with alternative risk premium levels

With these figures providing guidance as to how we would expect option returns to behave as a function of the Black Scholes (1973) model with risk premia, we can now assess the returns actually observed for options on the S&P 500 and FTSE 100 futures. The results appear in Tables 1 and 2 for three month options on these index futures. In both tables, the call and puts options appear on the left-hand and right-hand sides, respectively. For both, the first column is the odds of finishing in the money as measured by $N(d_2)$ or $N(-d_2)$. The next column indicates the number of observations we have for that particular 5% band (i.e. days for which $1 could be invested). The average payoff for a $1 investment in that particular option band appears next and is followed by the standard deviation of the option payoffs within the band.

Call Options on the S&P 500 Futures					**Put Options on the S&P 500 Futures**				
Odds (%)	# Obs	Average Payoff	Std. Dev of Payoff	t-test vs. 1$	Odds (%)	# Obs	Average Payoff	Std. Dev of Payoff	t-test vs. 1$
.95 -1.00	47	1.0010	0.3204	0.02	.95 -1.00	37	0.8998	0.4493	**-1.35** *
.90 - .95	60	1.0561	0.4605	0.95	.90 - .95	44	0.8662	0.5872	**-1.50** *
.85 - .90	66	1.1231	0.5704	**1.76** **	.85 - .90	50	0.8426	0.7265	**-1.53** *
.80 - .85	67	1.1407	0.6990	**1.66** **	.80 - .85	54	0.7937	0.8120	**-1.86** **
.75 - .80	63	1.0938	0.5953	1.25	.75 - .80	53	0.8137	0.8950	**-1.51** *
.70 - .75	64	1.1366	0.7732	**1.41** *	.70 - .75	51	0.7879	0.9979	**-1.51** *
.65 - .70	62	1.1461	0.8648	**1.33** *	.65 - .70	53	0.7702	0.9648	**-1.73** **
.60 - .65	59	1.1311	0.9972	1.01	.60 - .65	54	0.6215	1.0258	**-2.70** ****
.55 - .60	58	1.1727	1.1154	1.18	.55 - .60	50	0.8225	1.2458	-1.01
.50 - .55	54	0.9890	1.0410	-0.08	.50 - .55	56	0.5807	1.1377	**-2.76** ****
.45 - .50	56	1.1365	1.3925	0.73	.45 - .50	51	0.7344	1.4487	**-1.31** *
.40 - .45	58	1.2063	1.6012	0.98	.40 - .45	56	0.6785	1.5367	**-1.57** *
.35 - .40	51	0.9770	1.7015	-0.10	.35 - .40	56	0.4744	1.2383	**-3.19** ****
.30 - .35	54	0.9559	1.6041	-0.20	.30 - .35	62	0.6257	1.6791	**-1.76** **
.25 - .30	59	1.2923	2.7539	0.81	.25 - .30	64	0.6316	1.8231	**-1.62** *
.20 - .25	53	1.1261	2.5378	0.36	.20 - .25	65	0.6426	1.9854	**-1.45** *
.15 - .20	55	0.8651	2.0742	-0.48	.15 - .20	64	0.6696	2.2441	-1.18
.10 - .15	56	1.2262	3.6982	0.46	.10 - .15	66	0.6602	2.6359	-1.05
.05 - .10	53	1.5085	5.3370	0.69	.05 - .10	66	0.6432	3.4256	-0.85
.00 - .05	39	0.0123	0.1345	**-44.89** ****	.00 - .05	57	0.7525	5.6025	-0.33
All Options	69	1.1935	2.4124	0.67	All Options	69	0.6212	2.5247	-1.25

Table 1. Average Return per $1 bet vs. odds levels: 3m Options on S&P 500 Futures 1985-2002

Call Options on the FTSE Futures					Put Options on the FTSE Futures				
Odds (%)	# Obs	Average Payoff	Std Dev of Payoff	t-test vs. 1$	Odds (%)	# Obs	Average Payoff	Std Dev of Payoff	t-test vs. 1$
.95 -1.00	32	1.0294	0.3215	0.52	.95 - 1.00	29	1.0019	0.5058	0.02
.90 - .95	38	1.0485	0.4830	0.62	.90 - .95	38	0.8995	0.6101	-1.02
.85 - .90	41	1.1025	0.5901	1.11	.85 - .90	36	0.8564	0.7274	-1.19
.80 - .85	43	1.1033	0.7033	0.97	.80 - .85	37	0.9628	0.8862	-0.25
.75 - .80	44	0.9531	0.6601	-0.47	.75 - .80	40	0.9709	0.9221	-0.20
.70 - .75	49	0.9473	0.7491	-0.49	.70 - .75	37	0.9201	1.0829	-0.45
.65 - .70	47	1.1151	1.0764	0.73	.65 - .70	40	1.0430	1.1861	0.23
.60 - .65	49	0.8999	0.7903	-0.89	.60 - .65	43	0.8264	1.1006	-1.03
.55 - .60	44	1.1142	1.1296	0.67	.55 - .60	38	0.9276	1.3428	-0.33
.50 - .55	45	0.9505	1.2324	-0.27	.50 - .55	39	0.8525	1.3050	-0.71
.45 - .50	44	1.0148	1.1783	0.08	.45 - .50	48	0.8615	1.5273	-0.63
.40 - .45	41	0.8594	1.1062	-0.81	.40 - .45	43	0.8764	1.7370	-0.47
.35 - .40	43	1.1381	1.8821	0.48	.35 - .40	48	0.7311	1.4967	-1.25
.30 - .35	43	0.6177	1.1931	**-2.10*****	.30 - .35	44	1.0169	2.2145	0.05
.25 - .30	47	1.0396	2.1356	0.13	.25 - .30	53	0.7216	2.2611	-0.90
.20 - .25	38	0.8813	1.9081	-0.38	.20 - .25	49	0.6252	1.9079	**-1.37***
.15 - .20	40	0.4773	1.3779	**-2.40*****	.15 - .20	48	1.0081	3.3628	0.02
.10 - .15	42	0.9025	2.6841	-0.24	.10 - .15	46	0.4131	1.9507	**-2.04*****
.05 - .10	37	0.1421	0.7891	**-6.60******	.05 - .10	44	0.3600	2.2526	**-1.88****
.00 - .05	35	0.1877	1.1102	**-4.32******	.00 - .05	38	0.0893	1.0420	**-5.39******
All Options	70	0.9983	1.4668	-0.01	All Options	70	0.6016	1.6203	**-2.05*****

Table 2. Average Return per $1 bet vs. odds levels: 3m Options on FTSE Futures 1985-2002

The final column is a modified one tailed t-test of the hypothesis that the average return is equal to the initial investment of $1 using

$$t = (\overline{X}_i - 1\$\lambda)/(s_i/\sqrt{n}). \quad (4)$$

Where $\overline{X}_i = \sum_{j=1}^{n} X_{i,j} \Big/ n$, $X_{i,j}$ is the wealth relative of the j^{th} option in the i^{th} continuous "odds" range and λ is the equity risk premium. Critical levels for the t-test were determined using a Monte Carlo simulation. When the hypothesis is rejected at a 90% level or above, the t–statistic appears in bolded print. The addition of a "*", "**","***" or "****" to the right of the t-statistic indicates whether the level of significance is greater than the 90%, 95%, 97.5% or 99% levels, respectively.[9]

Figures 3 and 4 provide a graphical view of the average returns, related to moneyness, in these markets. These are not plots of the data in Tables 1 and 2, but were calculated by our continuous interpolation method. This was done solely to allow continuous, smooth curves to be drawn (and does not alter our interpretation of the results for ranges in Tables 1 and 2).

2.1. Results for Quarterly Options on Stock Index Futures

For the call options on the S&P 500 futures, we find a similar favorite / long-shot bias as in horse racing. The deep in-the-money call options in the probability ranges of 65% to 90% return signficantly more than the initial investment of 1$ on average. For the remaining ranges from 10% to 80%, we cannot reject the hypothesis that the return is significantly different from the $1 investment. This suggests that at-the-money calls (ranges from 0.45 - 0.55) and slightly in-the-money calls yield a return is about equal to the $1 investment. However, for the deepest out-of-the-money calls, the average returns are remarkably low. We reject the hypothesis of an expected return of $1 for the lowest 5% at a 99% level or above. This result supports the hypothesis of Figlewski (1989) that out-of-the-money call options are seen by investors like lottery tickets and investors overpay for deep out-of-the-money call options on the S&P 500 futures. Thus, the literature on "excessive optimism" in the assessment of risky situations may apply here; see Kahneman & Tversky (1979) and Tversky & Kahneman (1983).

For the call options on the FTSE 100 futures, there is no favorite bias. However, there is a significant longshot bias. For most of the range from 35% to 100%, we cannot reject the hypothesis that the return is significantly different from the $1 investment. However, for most of the out-of-the-money calls with probabilities less than 35%, we reject the hypothesis of an expected return of $1. Given that our contention that the FTSE 100 options market has a higher proportion of retail participants, who may be purely speculating on stock index futures prices, it is suggestive that the more the involvement of retail trading in options markets, the greater the long-shot bias.

For the put options on the both the FTSE 100 and S&P 500 futures, (essentally) all have negative average returns. Moreover, the average payoff is decreasing as the probabilities decrease, which is analogous also to the horse racing favorite long-shot bias. This is also consistent with the contentions of Rubinstein and Jackwerth (1996), Dumas, Fleming and Whaley (1998) and Bollen and Whaley (2002) that investors view put options as insurance policies and are willing to accept an expected loss to protect their holdings of equity. To allow a clearer comparison between our results and those of Ziemba and Hausch (1986), the figures use similar axes: probabilities equal the reciprocal of the odds plus one. This can be seen for sets of stock index options in Figures 3 and 4.

This type of presentation allows direct comparison to Figure 2, that presents the theoretical relationship between option's expected returns and risk premia. If risk premium was causing call options returns to return more than the $1 investment, we would expect Figure 3 to resemble the upper portion of Figure 2. When the returns are expressed as wealth relatives, out-of-the-money options offer a lower rate of return – exactly the opposite to what we expect. Therefore we conclude that the mechanism at work is not the risk premium but a favorite / long-shot bias.

In Figure 3, in-the-money call options yield more than the $1 invested in each option. This is not surprising, given the existence of a risk premium for the equity market. However, the overall pattern is surprising: we would expect all calls to offer a higher rate of return, and for this to increase as the odds lengthen, as in Figure 2. For put options on the stock index futures in Figure 4, the average return tends to decrease, as the option is further out of the money. This is more consistent with Figure 2, but still suggests some anomalous behaviour. Interestingly, for the put option returns, for the S&P 500 options, it is the in-the-money ones which are significant, for the FTSE 100 options, only the out-of-the-money ones that are significant. In all cases, the returns on the "long-shot" options are much more variable than on the "favourites". Thus a much larger deviation of the sample mean from one is required, for a given number of observations, in order to reject the hypothesis.

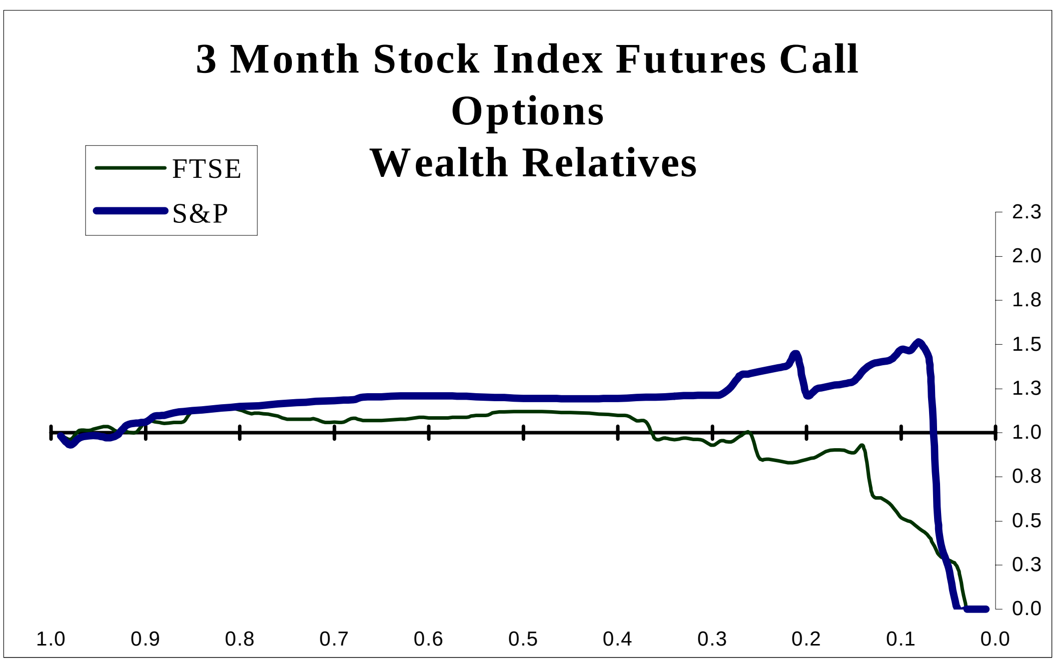

Figure 3: Average Return per dollar bet vs. odds levels: 3 month Stock Index Calls 1985-2002

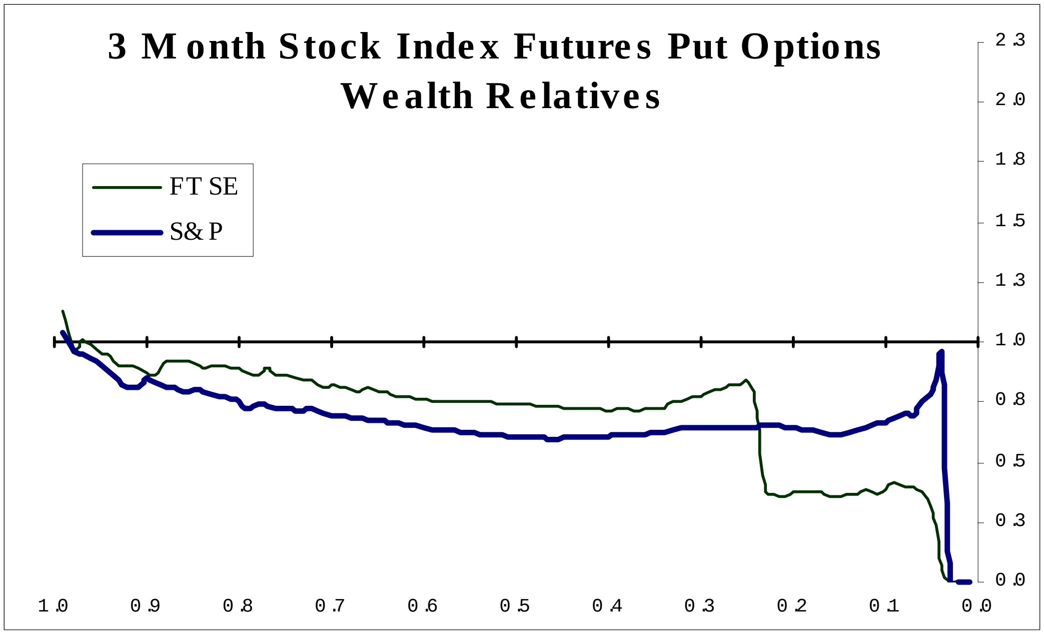

Figure 4: Average Return per dollar bet vs. odds levels: 3 month Stock Index Puts 1985-2002

To assess if these results are general for all options or specifically apply to stock index options, we selected as a robustness test an asset which should not possess a risk premium, options on British Pound/US Dollar Futures. We do not find evidence for the existence of the favorite / long-shot bias. Many of the in-the-money puts seem to return more than the intial investment of $1; however this effect is solely due to the single expiration period from September to December 1992. when the British Pound fell from 1.9620 (when the options were purchased) to 1.5624 at expiration. There is no systematic pattern of average returns above or below the initial investment of $1. Because, the results depend upon the choice of the numeraire currency, we removed this possible bias by aggregating all call and put options into the relative probability ranges. This allows us to assess if there is an overall in-the-money versus out-of-the-money favorite / long-shot bias. The results for the British Pound/US Dollar options appear in Table 3.

All Options on the BP/$ Futures				
Odds (%)	# Obs	Average Payoff	Std. Dev of Payoff	t-test vs. $1
.95 -1.00	65	0.8164	0.5358	**-2.78******
.90 - .95	68	0.8899	0.6150	**-1.47***
.85 - .90	68	0.8452	0.6952	**-1.84****
.80 - .85	66	0.9324	0.8585	-0.64
.75 - .80	60	0.9514	0.9604	-0.39
.70 - .75	54	0.6265	0.8856	**-3.09******
.65 - .70	55	1.0438	1.1301	0.29
.60 - .65	47	0.6618	0.9376	**-2.47*****
.55 - .60	53	0.8348	1.2485	-0.97
.50 - .55	50	0.7813	1.4403	-1.07
.45 - .50	70	1.3643	9.5498	0.32
.40 - .45	34	0.7825	1.3463	-0.94
.35 - .40	46	0.9227	1.8934	-0.28
.30 - .35	46	0.7265	1.7224	-1.08
.25 - .30	50	0.8041	2.0124	-0.69
.20 - .25	56	0.8199	2.3275	-0.58
.15 - .20	56	0.7716	2.6543	-0.64
.10 - .15	62	0.8861	3.0897	-0.29
.05 - .10	70	1.0873	4.2582	0.17
.00 - .05	69	1.3113	7.4403	0.35
All Options	68	2.8945	24.0543	0.65

Table 3. Average Return per $1 bet vs. odds levels:
3m Options on British Pound/US Dollar Futures 1985-2002

Table 3 shows that there is no significant favorite / long-shot bias.

2.2. Results for Monthly Options on Stock Index Futures

An enlargment of the data for the index options occurs when one considers options on futures with monthly expirations. This also allows a comparison with the three month terms to expiration discussed above. The results appear in Tables 4 and 5 for the 1 month calls and puts for the S&P 500 futures and FTSE 100 futures, respectively.

For both the S&P 500 and FTSE 100 option markets, the the deep in the money one month calls have an average wealth relative close to one. The further the options are out of the money, the lower the average payoff, as shown in Figures 5 and 6 using our interpolation method to give returns for odds spaced at every 1%. The pattern is quite striking for both markets: the payoff decays monotonically and is similar to the racetrack long shot bias found in Figure 1. However, the only cases of average returns significantly below one are for the FTSE 100 options, for which there is more retail activity. We seem to have the usual problem of the large measurement error in expected returns measured with limited observations over short horizons.

For all the put options, the pattern of average returns for the 1 month puts is extremely close to those found for the 3 month put options.The deepest in the money puts pay on average the initial bet. Losses increase as the puts are further out of the money displaying a similar long shot bias to Figure 1.

Figures 5 and 6 show the average return for one month options on the S&P 500 and FTSE 100 futures across continuous probability bandwidths. In Figure 5, most call options tend to return the 1$ invested in each option on average. For the S&P 500, the wealth relatives are significantly positive at the 10% level for options in the "odds" ranges from 0.85 to 1.00.[10] This can be interpreted as a favorite bias similar to that observed for horse racing bets. For the FTSE 100, there is no evidence of a favorite bias as the expected wealth relative is either equal to the initial investment or is statistically significantly below the initial investment. However, the options on the FTSE 100 do display a long-shot bias; as many of the out of the money calls return significantly less than the initial investment. However, the degree of the loss is smaller than for the 3 month FTSE 100 options seen in Table 2. This is not surprising as the expected losses occur at an almost steady rate over time, and we have only a third of the previous time to expiry. There does not appears to be a long-shot bias for call options on the S&P 500 with one month horizons.

Call Options on the S&P 500 Futures					Put Options on the S&P 500 Futures				
Odds (%)	# Obs	Average Payoff	Std. Dev of Payoff	t-test vs. $1	Odds (%)	# Obs	Average Payoff	Std. Dev of Payoff	t-test vs. $1
.95 -1.00	178	1.0318	0.2664	**1.59***	.95 -1.00	160	0.9307	0.4625	**-1.87****
.90 - .95	182	1.0433	0.3973	**1.49***	.90 - .95	169	0.9074	0.6032	**-2.01*****
.85 - .90	186	1.0455	0.4944	**1.26***	.85 - .90	161	0.9317	0.7342	-1.18
.80 - .85	176	1.0505	0.5952	1.12	.80 - .85	123	0.8779	0.8117	**-1.67***
.75 - .80	150	1.0576	0.6857	1.03	.75 - .80	132	0.9503	0.9468	-0.61
.70 - .75	152	0.9979	0.7738	-0.03	.70 - .75	122	0.8663	0.9658	**-1.54***
.65 - .70	124	1.0089	0.8813	0.11	.65 - .70	113	0.9262	1.0616	-0.74
.60 - .65	137	0.9814	0.9556	-0.23	.60 - .65	120	0.8931	1.2022	-0.97
.55 - .60	115	0.9707	1.1130	-0.28	.55 - .60	113	0.8340	1.1956	**-1.48***
.50 - .55	125	0.9780	1.1217	-0.22	.50 - .55	108	0.9053	1.3641	-0.72
.45 - .50	114	0.9379	1.3044	-0.51	.45 - .50	124	0.8010	1.4392	**-1.54***
.40 - .45	111	0.9528	1.4064	-0.35	.40 - .45	113	0.8266	1.5698	-1.17
.35 - .40	132	0.9868	1.5432	-0.10	.35 - .40	129	0.6642	1.5108	**-2.53*****
.30 - .35	105	0.9290	1.7178	-0.42	.30 - .35	134	0.7377	1.8517	**-1.64***
.25 - .30	123	0.9963	1.8432	-0.02	.25 - .30	129	0.6189	1.8135	**-2.38*****
.20 - .25	127	0.7960	1.8680	-1.23	.20 - .25	157	0.5863	2.0329	**-2.55*****
.15 - .20	138	1.0477	2.8312	0.20	.15 - .20	166	0.4815	2.0373	**-3.28******
.10 - .15	156	0.7547	2.8924	-1.06	.10 - .15	181	0.4681	2.2946	**-3.11******
.05 - .10	172	0.7537	3.6790	-0.88	.05 - .10	186	0.3877	2.3694	**-3.52******
.00 - .05	164	0.6608	4.4505	-0.97	.00 - .05	182	0.0434	0.8903	**-14.49******
All Options	188	0.9668	2.1085	-0.22	All Options	188	0.5033	1.3827	**-4.92******

Table 4. Average Return per $1 bet vs. odds levels: 1m Options on S&P 500 Futures 1985-2002

Call Options on the FTSE Futures					Put Options on the FTSE Futures				
Odds (%)	# Obs	Average Payoff	Std Dev of Payoff	T-test vs. $1	Odds (%)	# Obs	Average Payoff	Std Dev of Payoff	T-test vs. $1
.95 -1.00	104	0.9595	0.3027	-0.27	.95 -1.00	104	0.9920	0.4823	-0.17
.90 - .95	117	0.9719	0.4279	-0.24	.90 - .95	106	0.9860	0.6156	-0.23
.85 - .90	109	0.9596	0.5178	-0.98	.85 - .90	104	1.0328	0.7130	0.47
.80 - .85	98	0.9474	0.6396	-0.47	.80 - .85	86	0.9610	0.7892	-0.46
.75 - .80	93	0.9761	0.6596	-0.87	.75 - .80	75	0.9875	0.9198	-0.12
.70 - .75	92	0.8576	0.7701	**-1.82****	.70 - .75	81	1.0340	1.0451	0.29
.65 - .70	80	0.9296	0.8661	-0.75	.65 - .70	72	0.9501	1.0716	-0.40
.60 - .65	81	0.8632	0.8292	**-1.66***	.60 - .65	74	0.9226	1.1748	-0.56
.55 - .60	77	0.8866	1.0519	-1.25	.55 - .60	65	0.9320	1.1919	-0.46
.50 - .55	71	0.8295	0.9131	**-2.09*****	.50 - .55	71	0.8572	1.2604	-0.95
.45 - .50	77	0.9129	1.2252	-0.52	.45 - .50	77	0.8267	1.4153	-1.08
.40 - .45	72	0.7647	1.2249	**-1.93****	.40 - .45	72	0.9539	1.5619	-0.25
.35 - .40	66	0.7588	1.0992	**-2.03****	.35 - .40	78	0.9276	1.7521	-0.37
.30 - .35	76	0.8685	1.6315	-0.75	.30 - .35	84	0.7536	1.8513	-1.22
.25 - .30	81	0.4707	1.1176	**-4.22******	.25 - .30	85	0.8578	2.1183	-0.62
.20 - .25	82	0.7006	2.0764	-1.36	.20 - .25	92	0.7329	2.3074	-1.11
.15 - .20	83	0.4952	1.4613	**-3.22******	.15 - .20	99	0.5148	2.3530	**-2.06***
.10 - .15	101	0.4779	2.7186	-1.55	.10 - .15	112	0.6099	2.8315	-1.46
.05 - .10	107	0.4920	4.8145	-0.39	.05 - .10	117	0.4175	3.2062	**-1.97***
.00 - .05	107	0.3427	6.8040	-0.49	.00 - .05	110	0.2794	3.3510	-2.25
All Options	124	0.7926	2.4858	-0.65	All Options	124	0.6419	2.2501	-1.77

Table 5. Average Return per $1 bet vs. odds levels: 1m Options on FTSE Futures 1985-2002

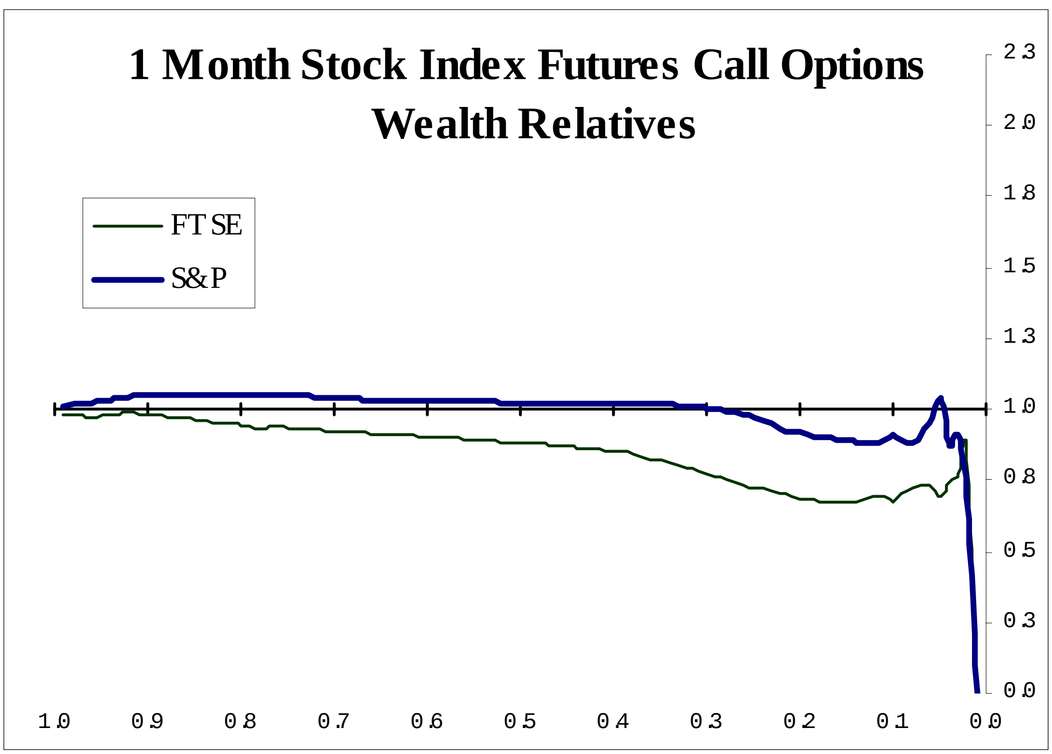

Figure 5: Average Return per dollar bet vs. odds levels: 1 month Stock Index Calls 1985-2002

The one month put options appear in Figure 6. As with Figure 4 for the 3 month put options, the average return tends to decrease, as the option is further out of the money. For these options, the shape of the average return function is smoother than the three-month pattern. One possible explanation for this comes from Bollen and Whaley (2002). They indicate that the greatest concentration of trading in Stock index put options is for put options with one month or less to expiration. Therefore, with more actively traded put options across the entire maturity spectrum, there is less need to interpolate.

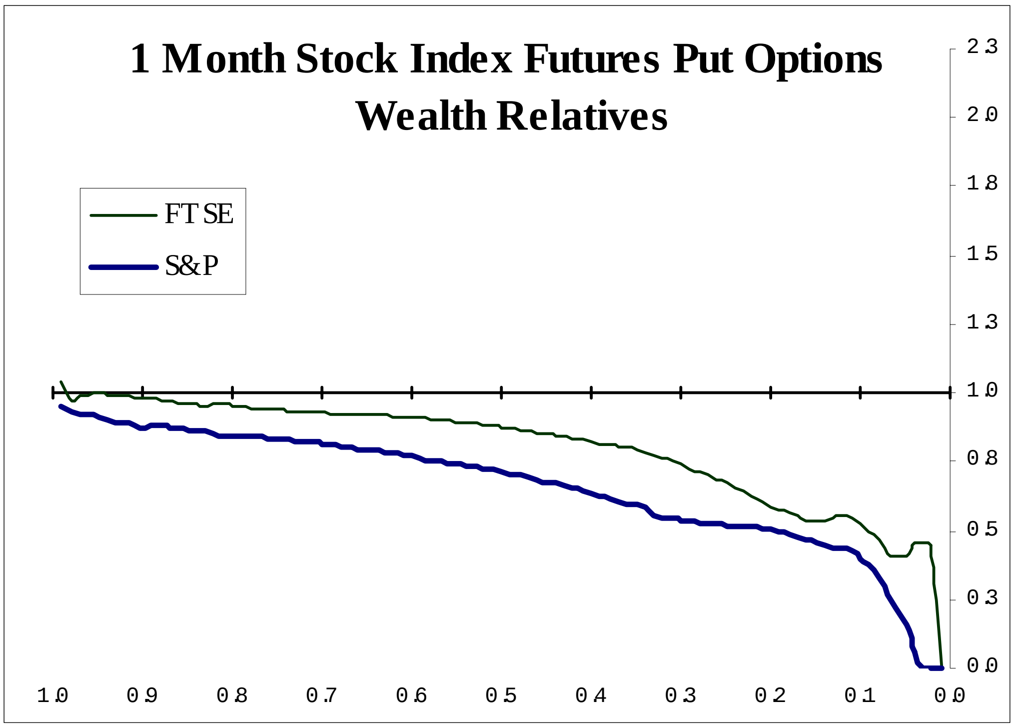

Figure 6: Average Return per dollar bet vs. odds levels: Puts on Stock Index Futures 1985-2002

3. Conclusions

The motivation for this research was to assess if the favorite / long-shot bias that has been found in horse racing and other gambling markets applies to options markets. The choice of stock index options was made due to previous speculation by Figlewski (1989) that OTM stock index call options are seen by investors as the equivalent of low cost/high payoff gambles and Dumas, Fleming and Whaley (1998) that stock index put options are purchased at higher prices due to the need to insurance.We investigated the favorite / long-shot bias for options on the S&P 500 Index Futures, FTSE 100 Index Futures and British Pound/US Dollar Futures.

We find that OTM index call options on the S&P 500 futures and FTSE 100 futures provide a negative average return. During 1985-2002, the average payback from the purchase of 3 month call options in the probability range of 0% to 5% was less than 1.23 and 18.77 cents for every $1 invested in the options (for the S&P 500 and FTSE 100, respectively). In addition, we find that the deep in the money 3 month calls and 1 month calls on the S&P 500 provide an average return higher than the initial investment on average. These results for the calls are very similar to the favorite / long-shot bias in race track markets pointed out by Ali (1979), Snyder (1978) and Ziemba & Hausch (1986).

For the put options on the S&P 500 and FTSE 100, we find evidence consistent with the hypothesis of Dumas, Fleming and Whaley (1998) that investors pay more for puts than they are subsequently worth. However, the degree of overpaying for these options increases monotonically as the probability of finishing in the money decreases. This is similar to the pattern observed for the favorite / long-shot bias. However, this is reduced by what is most probably the expected cost of insurance.

For one month call options on the S&P 500 and the FTSE 100, show essentially the similar patterns, but with magnitudes which are closer to one. Only for the in-the-money calls on the S&P 500 is a favorite bias found. The deep in the money calls on the FTSE 100 tend to pay an average return very close to the intial bet. For the out of the money options, there is a reduction in the expected return (like a long-shot bias). However, this is not as extreme as for the three month options, and only statistically significant for the FTSE 100 options.

As a robustness check, options on British Pound/US Dollars were examined and no systematic long-shot or favorite bias appears to exist.

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FOOTNOTES

[1] While the horse racing favorite long-shot bias is quite stable and pervasive there exist exceptions in Asian race track markets [Busche & Hall (1988) and Busche (1994)].

[2] Data for individual stock options either has too few strike prices to span a sufficiently wide range of bets or (as they are only traded on a quarterly basis) provides too few independent observations to draw meaningful conclusions. Furthermore, trading activity for stock options may vary over time as certain stocks or industry sectors come into (or go out of) fashion. This would require switching between the most actively traded options over time, which could introduce further biases of an unknown kind.

[3] The pit committee of the CME determines the settlement prices rather than by market transactions and this could impact our results (especially for OTM options). However, the actual price at the end of the trading day could be a bid, mid or offer price. Given that our analysis considers the payoffs from purchasing options, if the actual price that could be dealt at was the bid or mid price (rather than the offer price we implicitly assume), the payoffs of the options would be reduced accordingly. Therefore, our estimates of the wealth relatives for buying OTM options are more likely to be over-optimistic.

[4] To examine the impact of the 1987 crash, we also analysed the post-crash period of our data set. The results were not materially different (apart from small reductions in the average wealth relatives of OTM put purchases).

[5] It could be argued that to be strictly comparable with horse racing odds, we should calculate the cost of a digital option under the distribution implied from option prices. However, it is not clear which of the variety of parametric and non-parametric approaches for the determination of implied distributions would be most appropriate. In any case, this would introduce another possible source of error.

[6] Note that we only interpolate: we do not extrapolate beyond the range of traded strikes.

[7] The Monte Carlo simulation entailed simulating 10,000 times the average wealth relative for 60 (quarterly) and 160 (monthly) payoffs for call and put options with $N(d_2)$ from 0.05 to 0.95 in 0.05 increments. The standard error of the wealth relative was determined and the appropriate confidence levels were determined. For the inclusion of the risk premium, the negative continuous dividend adjustment to the Merton (1973) model proposed in the following section was used to determine the ratio of the expected wealth relative compared to the Black Scholes 1973) option price.

[8] Nevertheless, because the confidence intervals most affected are for the right hand tails of out-of-the-money options (which tended not to be observed empirically) the use of the simulated intervals makes rather little difference to our results.

[9] The confidence intervals used were based on a risk premium of 1.75% per quarter, which was the average realised risk premium for the two stock index markets over the period of our analysis. Thus, λ in equation (4) is 1.0175 for quarterly options and 1.00583 for monthly options.

[10] Compared to a standard t-test (assuming a Gaussian distribution), these results would not be statistically significant. However, from the Monte Carlo simulation, the distribution of option returns was skewed and with an equity risk premium of 0.583% per month, the critical significance levels allowed rejection of the null hypothesis of an average wealth relative of 1$ at the 90% level.