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

Stewart D. Hodges
Financial Options Research Centre
University of Warwick
Coventry, United Kingdom
Email: Stewart.Hodges@wbs.ac.uk

Robert G. Tompkins
Vienna University of Technology
Doeltergasse, A-1220 Vienna, Austria
Phone: +43-1-726-0919, Fax: +43-1-729-6753,
Email: rtompkins@ins.at

William T. Ziemba#
Faculty of Commerce
University of British Columbia
University of British Columbia
Vancouver, BC V6T 1Z2 Canada
Email: ziemba@interchange.ubc.ca

November 27, 2002

* Without implicating them we would like to thank Murray Frank, Terrance Odean, the editor, Richard Green and the referee for helpful comments on a previous draft of this paper. Financial support from the Social Sciences and Humanities Research Council of Canada is also gratefully acknowledged. The second author acknowledges partially financial support by the Austrian Science Foundation (FWF) under grant SFB#10 (Adaptive Information Systems and Modelling in Economics and Management Science).

Corresponding Author

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

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 the S&P 500 futures, the FTSE 100 futures and the British Pound/US Dollar futures for seventeen years from March 1985 to September 2002. Calls on the FTSE 100 with three months to expiration display a relationship between probabilities and expected returns that are very similar to the favorite long-shot 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 calls on the S&P 500 futures and increasingly greater losses as the call options are out-of-the-money. For 3 month calls on the FTSE 100 futures, the favorite bias is not found but a significant long-shot bias is for the deepest out of the money options. For call options in both markets for the one month horizon only a long shot bias is found. 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 the expected cost of insurance. The patterns of expected 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.

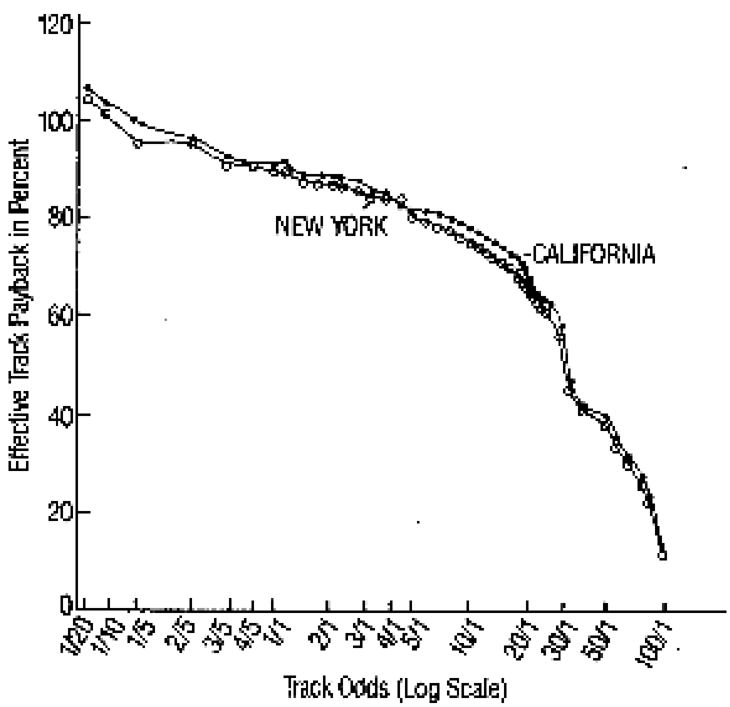

Figure 1. The effective track payback less breakage for various odds levels in California and New York for 300,000 plus races over various years and tracks. Source: Ziemba and Hausch (1986).

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 out-of-the-money call options, which we do not observe. 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 calls 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. We find exactly the opposite and conclude that the long-shot bias is more likely than the Bollen and Whaley (2002) buyer-initiated put hypothesis.

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 proven to be a fruitful area for research. Recently, Buraschi & Jackwerth (2001) examined this effect and showed that in and out-of-the-money options are required to span the state space. They go on to confirm the hypothesis that "These findings suggest that returns on away-from-the-money options are driven by different economic factors that those relevant for at-the-money options." (Page 523).

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 unique. Prices may be determined by supply and demand. Dumas, Fleming and Whaley (1996) 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 volatility) associated with out-of-the-money options exists 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 exchange traded stock options. They suggest 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 when exercising call options early, it is possible they also act irrationally when assessing the value of the option and might display similar irrational behaviour to other speculative endeavours such as gambling.

In this research, we will examine the returns from investing in call and put options on stock index futures markets and assess if investors behave rationally or irrationally (falling prey to a favourite long shot bias). To test the hypothesis that investors display such biases requires actively traded option markets with a wide range of strike prices and a sufficient number of independent trials. Ideally, our research would examine such hypotheses with stock option markets, as these are more likely to be dominated by retail customers engaging in speculative trading. However, 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 and it is unknown what biases this selection process might introduce.

For the sakes of underlying asset consistency and available data, stock index options markets were examined. These markets have a wide range of available strike prices and trade on a monthly expiration cycle yielding more independent trials than for stock options. It is likely that Index Option markets are dominated by institutional investors buying portfolio insurance [according to Bollen & Whaley (2002] and therefore should not be prone to irrational speculation. However, if such evidence is found that such irrational speculation occurs, it is likely to be even more extreme for individual stock option markets (or option markets with more retail involvement). To assess the possibility that irrational speculative trading is more likely by non-professional investors, we examined another stock index option market with more retail trading activity. 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 claims 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 favourite long-shot bias.

We also assess if racing and equity markets are fundamentally different than other futures markets. Options on the British Pound/US dollar are assessed to see if the favorite long-shot bias exists in currency markets. A priori, currency markets seem less likely to have such biases because of the symmetric nature of buying/selling each of the two currencies (long one of the currencies is by definition short the other). However, currencies are known to trend over long periods, which could create a bias.

Section I 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 II presents results for the S&P 500, FTSE 100 options markets and British pound/US dollar options (to provide a useful robustness test). Section III concludes.

I. Methodology

To investigate such biases for puts and calls in option markets requires a transformation of option prices into odds. In the Black Scholes (1973) equation, N(d2) 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(-d2). 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 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. 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. 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.

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 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 price must be at least 0.05). The interest rate inputs were obtained from the British Bankers Association (US Dollar or British Pound LIBOR).

With seventeen years of quarterly data, we had 68 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 was to determine the risk neutral probabilities of finishing in the money. 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. 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).

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

$$Q_C = 1\$ / C_{fv} \text{ and } Q_P = 1\$ / P_{fv}, \text{ respectively, for all Calls and Puts.} \quad (2)$$

Equation (2) 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.

With the constant amount invested in each option, the terminal payoff of the options are

$$C_T = MAX(F_T - X, 0) \text{ and } P_T = MAX(X - F_T, 0), \text{ respectively.} \quad (3)$$

Unlike horse racing, probabilities of payoff in the options markets are not expressed as odds but in a continuous probability range from 0% to 100%. 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 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. Thus, to obtain comparable results, we also aggregrated the initial odds [N(d2) and N(-d2)] into equal probability bands of 5%. We pooled all the options in these twenty ranges and averaged the outcomes for the same 1$ initial investment. As subsequent analysis will show that this choice of probability band pooling will display instability (and is arbitrary in terms of band width size), we will also produce continuous probability payoff diagrammes to better compare the results to Figure 1.

II. Results

The first step is to examine what the payoffs of call and put options would be under the Black Scholes (1973) model. Given the model is derived under the risk neutral assumption, all options should pay the risk free rate and we assume that they have no risk premium[2]. Since we have expressed the quantity of options purchased in future value terms, this is equal to an expected return of $1 for every $1 invested in that option.[3]

When risk premium 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.

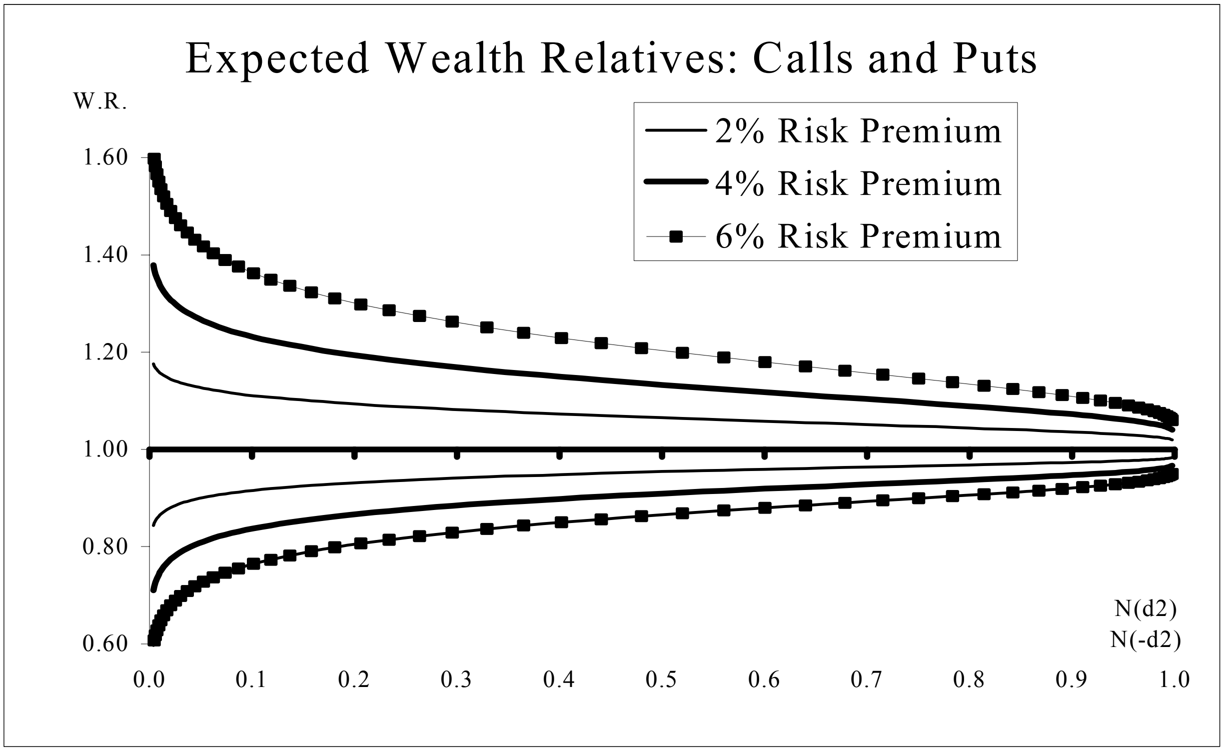

Figure 2: Expected Wealth Relatives for Call and Put Options with alternative risk premium levels

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 I and II for three month 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 options that fall into that particular 5% band. 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 that band. The final column is a one tailed t-test of the hypothesis that the average return is equal to the initial investment of 1\$ using

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

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[4].

Call Options on the S&P 500 Futures					Put Options on the S&P 500 Futures				
Odds (%)	# Options	Average Payoff	Std. Dev of Payoff	T-test vs. 1$	Odds (%)	# Options	Average Payoff	Std. Dev of Payoff	T-test vs. 1$
.95 -1.00	68	0.9867	0.2813	-0.39	.95 -1.00	68	1.0637	0.5161	1.02
.90 - .95	68	1.0453	0.3905	0.96	.90 - .95	68	0.9962	0.6828	-0.05
.85 - .90	68	1.1178	0.4717	**2.06****	.85 - .90	68	0.8780	0.7818	**-1.29***
.80 - .85	68	1.0942	0.5942	**1.31***	.80 - .85	68	0.8825	0.8676	-1.12
.75 - .80	68	1.0765	0.5907	1.07	.75 - .80	68	0.9106	0.9492	-0.78
.70 - .75	68	1.1036	0.7326	1.17	.70 - .75	68	0.8628	1.0131	-1.12
.65 - .70	68	1.0657	0.7986	0.68	.65 - .70	68	0.9005	1.0556	-0.78
.60 - .65	68	1.0494	0.9249	0.44	.60 - .65	68	0.8102	1.1543	**-1.36***
.55 - .60	68	1.0612	1.0319	0.49	.55 - .60	68	0.9404	1.2585	-0.39
.50 - .55	68	0.9784	1.0579	-0.17	.50 - .55	68	0.6134	1.1198	**-2.85*****
.45 - .50	68	1.0141	1.3035	-0.05	.45 - .50	68	0.7883	1.4101	-1.24
.40 - .45	68	0.9919	1.4553	-0.14	.40 - .45	68	0.7557	1.5499	**-1.30***
.35 - .40	68	0.9746	1.5862	-0.87	.35 - .40	68	0.5484	1.3076	**-2.85*****
.30 - .35	68	0.8318	1.4621	0.71	.30 - .35	68	0.7400	1.7283	-1.24
.25 - .30	68	1.1251	2.4099	0.19	.25 - .30	68	0.6959	1.8143	**-1.38***
.20 - .25	68	1.0552	2.2557	-0.52	.20 - .25	68	0.5034	1.6138	**-2.54*****
.15 - .20	68	0.8565	1.9881	0.53	.15 - .20	68	0.6264	2.0985	**-1.47***
.10 - .15	68	1.1285	3.1499	-0.27	.10 - .15	68	0.5512	2.2888	**-1.62***
.05 - .10	68	0.8972	3.8374	**-2.14****	.05 - .10	68	0.3928	2.4827	**-2.02****
.00 - .05	68	0.0063	0.0957	**-4.77*****	.00 - .05	68	0.3074	3.4904	**-1.65****
All Options	1360	0.9446	1.4646	**-1.39***	All Options	1360	0.6508	2.0690	**-6.22*****

Table I. Expected 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 (%)	# Options	Average Payoff	Std Dev of Payoff	T-test vs. 1$	Odds (%)	# Options	Average Payoff	Std Dev of Payoff	T-test vs. 1$
.95 -1.00	68	0.9244	0.3341	**-1.87****	.95 -1.00	68	1.0504	0.5264	0.79
.90 - .95	68	0.9277	0.3926	**-1.52***	.90 - .95	68	1.0080	0.6094	0.11
.85 - .90	68	0.9738	0.5119	-0.42	.85 - .90	68	0.9377	0.7734	-0.66
.80 - .85	68	0.9960	0.6084	-0.05	.80 - .85	68	0.9779	0.8043	-0.23
.75 - .80	68	0.9038	0.6217	**-1.28***	.75 - .80	68	0.9813	0.9320	-0.17
.70 - .75	68	0.9153	0.7104	-0.98	.70 - .75	68	0.8822	1.0148	-0.96
.65 - .70	68	1.0799	0.9893	0.67	.65 - .70	68	1.0435	1.1988	0.30
.60 - .65	68	0.8977	0.7767	-1.09	.60 - .65	68	0.7864	1.0511	**-1.68****
.55 - .60	68	1.0554	1.0666	0.43	.55 - .60	68	0.9496	1.3188	-0.32
.50 - .55	68	0.9520	1.1699	-0.34	.50 - .55	68	0.8819	1.3631	-0.71
.45 - .50	68	1.0104	1.1434	0.07	.45 - .50	68	0.8048	1.4355	-1.12
.40 - .45	68	0.7857	1.0232	**-1.73****	.40 - .45	68	0.8319	1.6137	-0.86
.35 - .40	68	1.0634	1.7171	0.30	.35 - .40	68	0.7776	1.5949	-1.15
.30 - .35	68	0.6827	1.2240	**-2.14****	.30 - .35	68	0.8527	1.9740	-0.62
.25 - .30	68	0.8793	1.9310	-0.52	.25 - .30	68	0.7642	2.1537	-0.90
.20 - .25	68	0.7335	1.7650	-1.25	.20 - .25	68	0.7672	2.1987	-0.87
.15 - .20	68	0.4346	1.3724	**-3.40*****	.15 - .20	68	0.8422	2.8365	-0.46
.10 - .15	68	0.6310	2.2039	**-1.38***	.10 - .15	68	0.5608	2.3641	**-1.53***
.05 - .10	68	0.1195	0.7198	**-10.09*****	.05 - .10	68	0.5356	2.7241	**-1.41***
.00 - .05	68	0.0373	0.4951	**-16.03*****	.00 - .05	68	0.1729	1.4276	**-4.78*****
All Options	1360	0.7763	1.0378	**-7.95*****	All Options	1360	0.6765	1.7456	**-6.84*****

Table II. Expected return per 1$ bet vs. odds levels: 3m Options on FTSE Futures (1985-2002)

IIa. Results for Quarterly Options on Stock Index Futures

For the call options on the S&P 500 futures, we find a similar favourite – longshot bias as in horse racing. The deep in-the-money call options in the probability ranges of 80% 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 .45 - .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 expected returns are steadily decreasing (from 10% and below). We reject the hypothesis of an expected return of $1 at a 95% level or above. This result confirms 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 favourite bias. However, there is a significant longshot bias. As opposed to the S&P 500, deep in-the-money call options in the probability ranges of 90% to 100% return signficantly less than the initial investment of 1$ on average. For most of the range from 20% to 85%, we cannot reject the hypothesis that the return is significantly different from the 1$ investment. However, for the out-of-the-money calls with probabilities less than 20%, 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) and Dumas, Fleming and Whaley (1996) 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), 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.

To assess this effect, option payoffs as a continuous range of probabilities was estimated. This was done by straightline interpolation between the implied volatilities at each observation point and using these estimated implied volatilities to determine N(d2) or N(-d2) for a continous range of strike prices. This provides detail about the exact relationship between the observed options and their payoffs (which may be lost by the selection of the 5% bandwidths) and allows exact confidence intervals to be estimated. 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 – longshot bias.

Figures 3 and 4 show the average return for options on the S&P 500 and FTSE 100 futures across continuous probability bandwidths (using the results from Tables I and II). In Figure 3, in the money call options yield more than the 1$ invested in each option. One reason for this could be the existence of a risk premium for the equity market. Given a risk premium, call options would yield more than the $1 invested, as the risk neutrality assumes a riskfree growth rate, while the actual growth rate was higher; see Constantinides (2002). If the additional yield were due to a risk premium, we would expect all calls to offer a higher rate of return.

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 consistent with Figure 2, where the addition of a risk premium could cause this type of pattern. In Figure 4, the interpolated series provides more information about the sampling properties of the deepest out of the money put options compared to the 5% bandwidth approach.

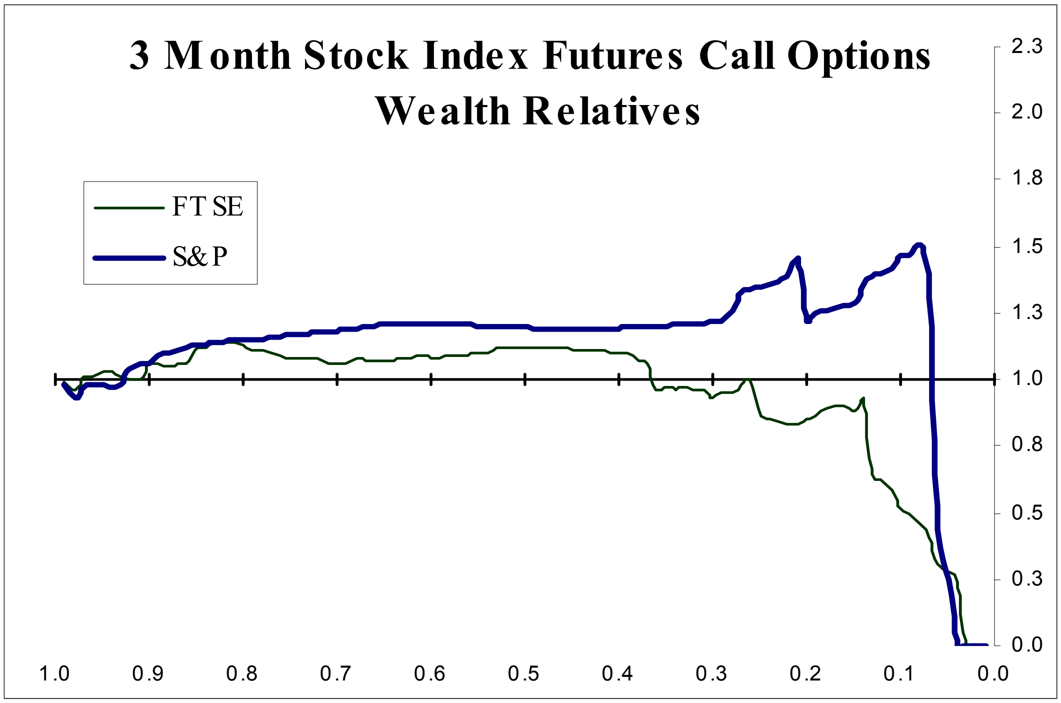

Figure 3: Expected return per dollar bet vs. odds levels: 3 month Stock Index Calls (1985-2002)

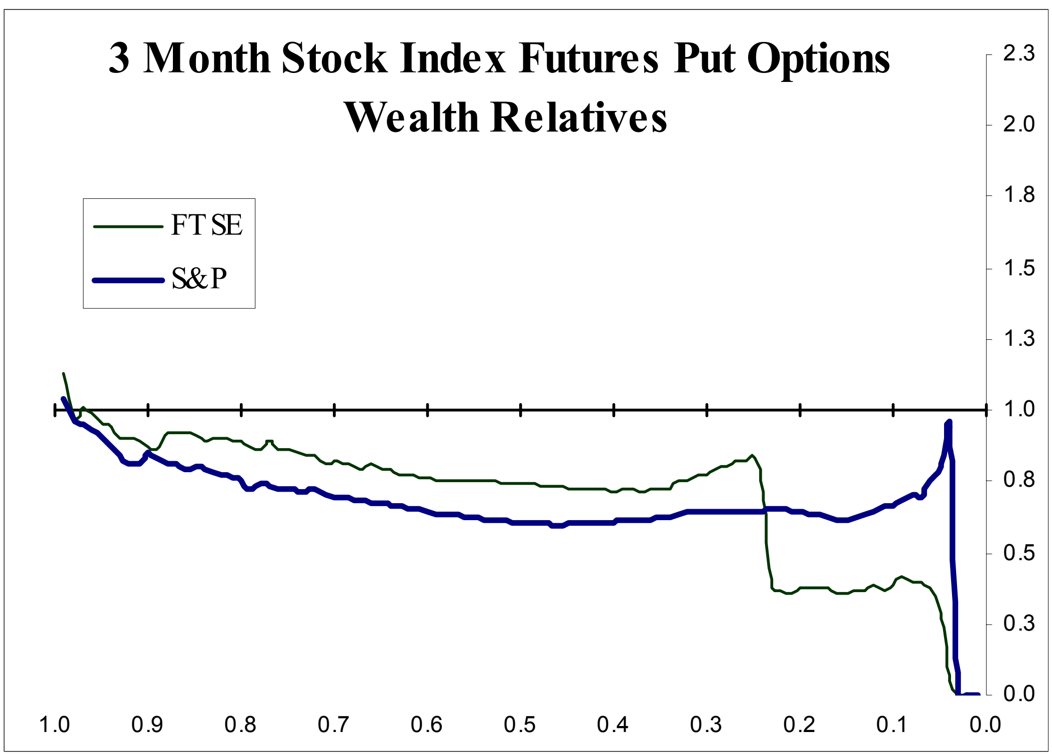

Figure 4: Expected return per dollar bet vs. odds levels: 3 month Stock Index Puts (1985-2002)

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 favourite – longshot bias. In our analysis it did appear that in-the-money calls seem to return more than the intial investment of 1$, however this effect is barely significant at the 90% level. This result was solely due to a single expiration period from September to December 1992. when the British Pound fell from 1.9620 (when the options were purchased) to 1.5624 at expiration. There is no systematic pattern of expected returns above or below the initial investment of 1$. Because, results will depend upon the choiec 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 III.

Table III. All Options on the BP/$ Futures

Odds (%)	# Options	Average Payoff	Std. Dev of Payoff	T-test vs. 1$
.95 -1.00	60	0.9830	0.3936	-0.3344
.90 - .95	60	0.9860	0.5043	-0.2153
.85 - .90	60	0.9562	0.6334	-0.5357
.80 - .85	60	1.0589	0.8602	0.5301
.75 - .80	60	1.1058	0.8966	0.9141
.70 - .75	60	0.8491	0.9623	-1.2147
.65 - .70	60	1.0976	1.1632	0.6498
.60 - .65	60	0.8490	0.9987	-1.1711
.55 - .60	60	0.9762	1.3112	-0.1404
.50 - .55	60	1.1023	1.6582	0.4779
.45 - .50	60	0.7743	1.3003	**-1.3445***
.40 - .45	60	0.9520	1.9016	-0.1957
.35 - .40	60	1.1205	2.0420	0.4569
.30 - .35	60	0.9914	2.2436	-0.0297
.25 - .30	60	0.9569	2.4930	-0.1340
.20 - .25	60	1.0084	2.9101	0.0222
.15 - .20	60	1.0094	3.3437	0.0217
.10 - .15	60	1.0971	4.2474	0.1771
.05 - .10	60	0.9887	6.4626	-0.0136
.00 - .05	60	4.2855	29.4684	0.8636
All Options	1200	1.4061	10.7340	**1.3105***

Table III. Expected return per 1$ bet vs. odds levels:
3m Options on British Pound/US Dollar Futures (1985-2002)

Table III shows that there is no significant favourite long-shot bias.

IIb. 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 IV and V 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 payoff equal to the intial bet. Thus, the favorite bias does not exist. The further the options are out of the money, the lower the average payoff. This is especially the case for the one-month FTSE 100 options. As more retail trading occurs in this market, it suggests that such traders are prone to the long-shot bias. In Table V, almost all probablity buckets that are in-the-money (above 50%) provide an expected payoff less than the initial investment. In contrast to the S&P 500 in Table VI, where only two probability buckets are significantly less than the initial investment. In both markets, the payoff decays monotonically and is simlar to the racetrack long shot bias found in Figure 1. Relative to the 3 month call options, the long shot and favorite biases are reduced. Thus, it appears that if an investor wishes to buy call options: they should buy longer maturity in the money call options (thus gaining from the favorite bias) and sell shorter maturity out of the money call options (as there is less of a long shot bias for 1 month options compared to 3 month options).

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 and losses increase as the puts are further out of the money displaying a similar long shot bias as is in Figure 1.Investors should be indifferent between purchasing put options on stock indices at either 3 month or 1 month expirations, as the expected return as a function of the moneyness is similar.

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 (using the results from Tables IV and V). In Figure 5, most call options tend to return the 1$ invested in each option on average. For the S&P 500, this is slightly above (however, not statistically significant) and for the FTSE 100, this is slightly below (and statistically significant). For both sets of options, the deepest 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 options seen in Tables I and II. This is not surprising as the expected losses occur continuously in time.

Call Options on the S&P 500 Futures					Put Options on the S&P 500 Futures				
Odds (%)	# Options	Average Payoff	Std. Dev of Payoff	T-test vs. 1$	Odds (%)	# Options	Average Payoff	Std. Dev of Payoff	T-test vs. 1$
.95 -1.00	187	1.0092	0.2506	0.50	.95 -1.00	187	0.9792	0.4949	-0.57
.90 - .95	187	0.9938	0.3923	-0.22	.90 - .95	187	0.9883	0.6677	-0.24
.85 - .90	187	1.0029	0.4877	0.08	.85 - .90	187	0.9989	0.7746	-0.02
.80 - .85	187	0.9796	0.5925	-0.47	.80 - .85	187	0.9544	0.8778	-0.71
.75 - .80	187	1.0064	0.6762	0.13	.75 - .80	187	0.9880	0.9814	-0.17
.70 - .75	187	0.9346	0.7612	-1.18	.70 - .75	187	0.9437	0.9879	-0.78
.65 - .70	187	0.9693	0.8699	-0.48	.65 - .70	187	0.9520	1.0734	-0.61
.60 - .65	187	0.9656	0.9497	-0.50	.60 - .65	187	0.9193	1.2257	-0.90
.55 - .60	187	0.9196	1.0671	-1.03	.55 - .60	187	0.8867	1.2654	-1.22
.50 - .55	187	0.9586	1.1004	-0.51	.50 - .55	187	0.9217	1.4020	-0.76
.45 - .50	187	0.8954	1.2820	-1.12	.45 - .50	187	0.8146	1.4427	**-1.76****
.40 - .45	187	0.9204	1.3652	-0.80	.40 - .45	187	0.9064	1.6557	-0.77
.35 - .40	187	0.9671	1.5108	-0.30	.35 - .40	187	0.7672	1.6412	**-1.94****
.30 - .35	187	0.8673	1.6712	-1.09	.30 - .35	187	0.7987	1.9158	**-1.44***
.25 - .30	187	0.9927	1.8245	-0.05	.25 - .30	187	0.7454	2.0390	**-1.71****
.20 - .25	187	0.7939	1.8764	**-1.50***	.20 - .25	187	0.6910	2.1639	**-1.95****
.15 - .20	187	0.9257	2.5402	-0.40	.15 - .20	187	0.6101	2.3346	**-2.28****
.10 - .15	187	0.7585	2.8601	-1.15	.10 - .15	187	0.5303	2.4037	**-2.67*****
.05 - .10	187	0.6940	3.5704	-1.17	.05 - .10	187	0.4039	2.3630	**-3.45*****
.00 - .05	187	0.50958	3.9119	**-1.71****	.00 - .05	187	0.0508	0.9785	**-13.27*****
All Options	3740	0.8940	1.8954	**-3.42*****	All Options	3740	0.5907	0.5907	**-42.37*****

Table IV. Expected 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 (%)	# Options	Average Payoff	Std Dev of Payoff	T-test vs. 1$	Odds (%)	# Options	Average Payoff	Std Dev of Payoff	T-test vs. 1$
.95 -1.00	123	0.9595	0.2694	**-1.67***	.95 -1.00	123	1.0105	0.4717	0.25
.90 - .95	123	0.9719	0.4011	-0.78	.90 - .95	123	0.9847	0.6005	-0.28
.85 - .90	123	0.9596	0.5020	-0.89	.85 - .90	123	1.0229	0.6874	0.37
.80 - .85	123	0.9474	0.6020	-0.97	.80 - .85	123	0.9235	0.7736	-1.10
.75 - .80	123	0.9761	0.6480	-0.41	.75 - .80	123	0.9760	0.9099	-0.29
.70 - .75	123	0.8576	0.7525	**-2.10****	.70 - .75	123	1.0093	1.0292	0.10
.65 - .70	123	0.9296	0.8458	-0.92	.65 - .70	123	0.9501	1.0715	-0.52
.60 - .65	123	0.8632	0.8191	**-1.85****	.60 - .65	123	0.8984	1.1686	-0.96
.55 - .60	123	0.8866	1.0456	-1.20	.55 - .60	123	0.9579	1.1831	-0.39
.50 - .55	123	0.8295	0.9372	**-2.02****	.50 - .55	123	0.8033	1.2349	**-1.77****
.45 - .50	123	0.9129	1.2141	-0.80	.45 - .50	123	0.8161	1.4092	**-1.45***
.40 - .45	123	0.7647	1.2268	**-2.13****	.40 - .45	123	0.9409	1.5550	-0.42
.35 - .40	123	0.7588	1.1234	**-2.38****	.35 - .40	123	0.8699	1.6963	-0.85
.30 - .35	123	0.8685	1.6097	-0.91	.30 - .35	123	0.7072	1.7646	**-1.84****
.25 - .30	123	0.4707	1.1119	**-5.28*****	.25 - .30	123	0.8041	2.0297	-1.07
.20 - .25	123	0.7006	2.0045	**-1.66****	.20 - .25	123	0.5855	2.0360	**-2.26****
.15 - .20	123	0.4952	1.4297	**-3.92*****	.15 - .20	123	0.5423	2.4428	**-2.08****
.10 - .15	123	0.4779	2.4364	**-2.38*****	.10 - .15	123	0.5878	2.8156	**-1.62***
.05 - .10	123	0.4920	3.6893	**-1.53***	.05 - .10	123	0.4872	3.3026	**-1.72****
.00 - .05	123	0.3427	4.8288	**-1.51***	.00 - .05	123	0.2968	3.4337	**-2.27****
All Options	2460	0.7926	2.0670	**-4.98*****	All Options	2460	0.6535	2.4630	**-6.98*****

Table V. Expected return per 1$ bet vs. odds levels: 1m Options on FTSE Futures (1985-2002)

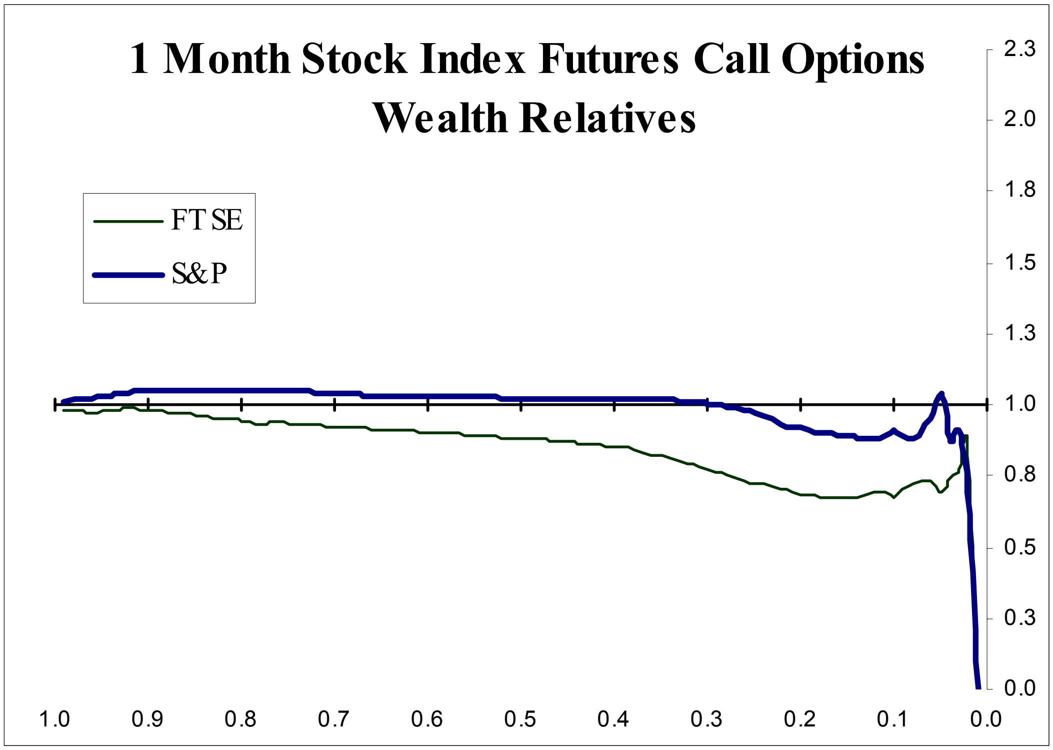

Figure 5: Expected return per dollar bet vs. odds levels: 1 month Stock Index Calls (1985-2002)

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 expected value 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 across the bandwidths.

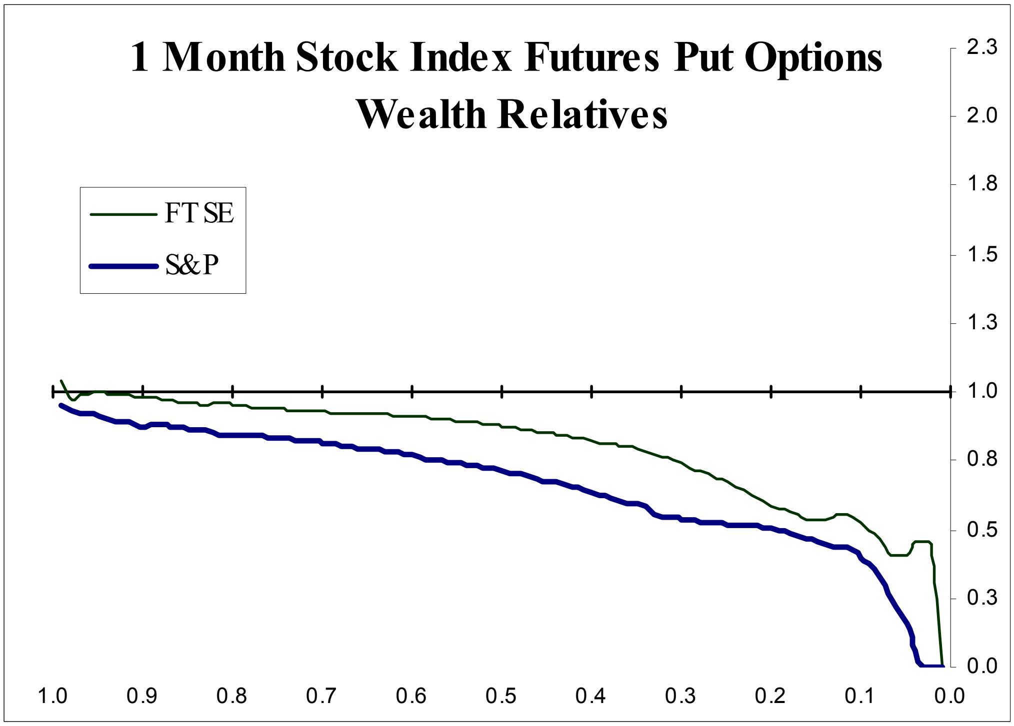

Figure 6: Expected return per dollar bet vs. odds levels: Puts on Stock Index Futures (1985-2002)

III. 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 (1996) 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 expected return. During 1985-2002, the expected payback from the purchase of 3 month call options in the probability range of 0% to 5% was less than 0.7 and 3.7 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 on both the S&P 500 and FTSE 100 provide an expected 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 (1996) 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, we do not find evidence of a favorite bias. The in-the-money calls on both the S&P 500 and FTSE 100 tend to pay an average return equal 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. For the deepest out-of-the-money options the payoff was 50.9 and 34.3 cents for every 1$ bet for the S&P 500 and FTSE 100, respectively.

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

References:

Ali. Mukhtar M. (1979) Some Evidence on the Efficiency of a Speculative Market, *Econometrica*, Volume 47, pp. 387-392.

Barone-Adesi, Giovanni and Robert E. Whaley (1987) Efficient Analytical Approximation of American Option Values, *The Journal of Finance*, Volume 42, Number 2, pp. 301-320.

Black, Fischer (1976) The Pricing of Commodity Contracts, *Journal of Financial Economics*, Volume 3, Number 1/2 (January-March), pp. 167-179.

Black, Fischer and Myron Scholes (1973) The Pricing of Options and Corporate Liabilities, *Journal of Political Economy*, Volume 81, Number 2 (May/June), pp 637-654.

Bollen, Nicolas P.B. and Robert E. Whaley (2002) "Does Net Buying Pressure Affect the Shape of Implied Volatility Functions?", Working Paper, Duke University.

Buraschi, Andrea and Jens Jackwerth (2001), "The Price of a Smile: Hedging and Spanning in Options Markets," *The Review of Financial Studies,* Volume 14, No. 2, pp. 495-527.

Busche, Kelly and Christopher D. Hall (1984) An Exception to the Risk Preference Anomaly, *Journal of Business*, Volume 61, pp 337-346.

Busche, Kelly (1984) Efficient Market Results in an Asian Setting, in Donald B. Hausch, et.al. (Eds.), *Efficiency of Racetrack Betting Markets,* San Diego, California: Academic Press, pp 615- 616.

Constantinides, George M. (2002) Rational Asset Prices, *Journal of Finance,* Volume 57, 1567-1591.

Dumas, Bernard, Jeff Fleming and Robert E. Whaley (1996) Implied Volatility Functions: Empirical Tests, Working Paper, Fuqua School of Business, Duke University, February 1, 1996. [Subsequently published in *Journal of Finance,* Volume 53, 2059-2106].

Figlewski, Stephen (1989), What Does an Option Pricing Model Tell Us About Option Prices, *Financial Analysts Journal*, Volume 45, Number 5, pp. 12-15.

Hausch, Donald B, Victor Lo and William T. Ziemba, Eds. (1994) *Efficiency of Racetrack Betting Markets,* Academic Press, San Diego.

Jackwerth, Jens Carsten and Mark Rubinstein (1996) Recovering Probability Distributions from Option Prices, *The Journal of Finance*, Volume 51, Number 5 (December 1996), pp 1611-1631.

Kahneman, Daniel and Amos Tversky (1979), Choices, Values and Frames, *Econometrica,* Volume 47, pp. 263-291.

Merton, Robert (1973), The Theory of Rational Option Pricing, *Bell Journal of Economics*, Volume 4, pp 141-183.

Poteshman, Allen M. and Vitaly Serbin (2002), Clearly Irrational Financial Market Behavior: Evidence from the Early Exercise of Exchange Traded Stock Options, Forthcoming in *Journal of Finance.*

Rubinstein, Mark (1994), "Implied Binomial Trees," *Journal of Finance*, 49, pp. 771-818

Snyder, Wayne W. (1978) Horse racing : Testing the efficient markets model, *Journal of Finance,* Volume 33 (September 1978), pp. 1109-1118.

Thaler, Richard H. and William T. Ziemba (1988), "Anomalies – Parimutuel Betting Markets: Racetracks and Lotteries," *Journal of Economic Perspectives,* Volume 2, pp. 161-174.

Tversky, Amos and Daniel Kahneman (1983), Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment, *Psychological Review,* 90, pp. 293-315.

Ziemba, William T. and Donald B. Hausch (1986), *Betting at the Racetrack.* Norris M. Strass, New York.

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] Since we are evaluating the forward price of the option, the risk premium on the option does not matter. Furthermore, Bollen and Whaley (2002) show that profits from trading OTM S&P 500 options cannot be explained by specification error (such a volatility risk premium) or discreteness in hedging. They claim that the mispricing in S&P 500 options is not due to a (volatility) risk premium but is due to "option prices that reflect the possibility of extreme events that simply did not occur in our sample" (page 31).

[3] In equation (15) of Black and Scholes (1973), they show that the expected return of an option (expressed in terms of Beta) can be expressed (in our notation) as: $\beta_{C_{FV},P_{FV}} = \frac{F \cdot N(d_1)}{C_{FV}, P_{FV}} \beta_F$. Given that we are purchasing $Q_C = 1\$ / C_{FV}$ and $Q_P = 1\$ / P_{FV}$, respectively, for all Calls and Puts, the investment is now set at $1 for all options. The expected return is therefore $1 expressed in future value terms.

[4] The number of observations in each strike price bucket was higher than the total number of periods in the sample. However, these will often represent options for the same expiration period. Therefore, the observations will not be independent and will bias the t-tests. To reduce this error, we restricted the number of observations to equal the number of non-overlapping options expiration periods examined.