PERFORMANCE OF PORTFOLIO INSURANCE STRATEGIES: EVIDENCE FROM TURKEY

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─Abstract ─

In this study, we compare the performances of the two standard portfolio insurance methods: the Option Based Portfolio Insurance (OBPI) and the Constant Proportion Portfolio Insurance (CPPI). In prior works, data on many established markets were utilised to investigate this issue. There have also been many empirical studies of portfolio insurance (PI) utilising emerging market data. However, we are not aware of an application PI on Turkish data. This is where our study contributes to PI literature. We use a data set that covers the Istanbul Stock Exchange 30 (ISE-30) stocks, from 1.3.1997 to 29.8.2008. Our main finding is that the implementation of PI (especially CPPI) enhances portfolio performance.

Key Words: *Option Based Portfolio Insurance (OBPI), Constant Proportion Portfolio Insurance (CPPI), Emerging Markets*

JEL Classification: G11, G13

1. INTRODUCTION

The seminal work of Black and Scholes (1973) on the valuation of options opened the door for the invention of numerous financial products. Soon after the Black and Scholes (BS) model was introduced, many organized exchanges around the world started offering option products. These products have become invaluable tools for risk management. As a risk management tool, portfolio insurance (PI), is one of the innovations that followed the introduction of exchange traded options. The aim of PI is to protect the value of a given portfolio against market downturns for a specified period of time. While controlling a portfolio's downside risk, PI does not limit its upside potential. This unique feature of PI appealed many academics and institutional investors. As a result, many alternative PI techniques and products have been developed.

Leland and Rubinstein (1976) were first to formalize the theoretical framework for PI. Leland states that the PI idea was born on September 11, 1976. On September 11, 1976, Leland's brother mentioned him that after the decline of 1973-74 many pension funds had withdrawn from the stock

market. These funds missed the subsequent bullish market in 1975. Leland's brother had said: "If only insurance were available, those funds could be attracted back to the market". This motivated Leland to consider providing the PI as a product. Leland knew a little bit about the local arbitrage argument used by Black-Scholes (1973) to value options. He came to realize that this argument can be extended to create options synthetically. However, he was aware that this would require a thorough understanding of options theory. As he was lacking this technical information, he sought assistance from an academic who was an expert in this area: Mark Rubinstein. Later, they together formed Leland-Rubinstein Associates to develop the technique and appropriate software to provide portfolio insurance. With John O'Brien's inclusion this company has become Leland-O'Brien-Rubienstein (LOR) Associates, Inc. in 1981. Within a month company gained its first PI account and business grew rapidly afterwards. The successful commercialization of PI by LOR attracted many other competitors to the market and PI has been rapidly institutionalized.

LOR approach to PI essentially creates a European put option synthetically to provide downside protection. This procedure is based on the BS model and involves the frequent shifting of risky asset to Treasury bills, and vice versa as the market value of the risky asset fluctuates. This synthetic put approach to portfolio insurance, also known as Option Based Portfolio Insurance (OBPI), enables portfolio managers to avoid downside risks and preserve upside potential even when options markets do not exist. However, as the procedure is based on the BS model, it suffers from its limitations. The volatility and interest rates are exogenous to BS model and they are assumed to be constant. Moreover, transaction costs, jumps in price movements and mispriced securities are assumed away by the model. These unrealistic assumptions may result in important replication errors and may render OBPI useless especially during periods of market turmoil. In fact, OBPI strategies failed to provide the required protection during the 1987 crash. This failure greatly undermined their credibility.

As a consequence, many researchers attempted to remedy the limitations of OBPI by modifying the procedure to factor in real-world conditions. Models incorporating stochastic volatility, stochastic interest rates, transaction costs, etc. have emerged. However, Constant Proportion Portfolio Insurance (CPPI), a method that uses a simplified strategy to allocate assets dynamically over time has become the most viable alternative to OBPI and its derivatives.

The CPPI was first introduced by Perold (1986), Perold and Sharpe (1988) for fixed income instruments. Black and Jones (1986), Black and Perold (1992), Bookstaber and Langsam (2000) have extended the procedure for equity instruments. The CPPI strategy is much easier to implement. Moreover, according Black and Perold (1992) it is weakly path independent (hence less prone to tracking errors) when there are no borrowing constraints .Yet, despite these attractive properties, CPPI has a feature which is less than desirable: it lacks a theoretical foundation.

These competing PI procedures and their derivations have been extensively investigated in the literature and the PI literature is still growing. Although, an extensive review of the PI literature is beyond the scope of this article, we refer readers to Jacobs (1983), Garcia and Gould (1987) and Merrick (1988) for earlier studies and to Bertrand and Prigent (2005), Annaert et al. (2009) for more recent ones. The findings of the previous studies on the performance of PI are mixed. However, two conclusions can be drawn from the PI literature. First of all, most of the studies focused on the data from USA and from the developed European countries. This results in a data

snooping bias (see Leemar, 1983 and Lo & Mackinlay, 1990 for the details of data snooping phenomenon). Therefore, more work on non-USA and non-European data, especially on emerging market data, is needed. Moreover, another common finding is that the protection provided by PI is not perfect due to market frictions. When market imperfections are considered, emerging markets are of particular interest. There is a growing amount of evidence that emerging markets are less liquid, less informationally efficient and more volatile than mature markets. Therefore, it will be interesting to see the empirical performance of PI startegies on emerging markets. As a rapidly developing emerging market, Turkey is well suited for this task.

The rest of the paper is organized as follows. Section 2 presents the details on OBPI and CPPI strategies. Section 3 summarizes the data and the methodology. Section 4 presents and analyzes the results. Section 5 concludes and provides suggestions for future work.

2. PORTFOLIO INSURANCE STRATEGIES

The methodology of this paper draws upon the empirical work of Do (2002) on Australian data. Do (2002) provides a framework for OBPI which is consistent with Merton's (1973) continuous dividend option pricing model. This methodology also enables the comparison of performance of OBPI and CPPI strategies relative to each other.

2.1. Option Based Portfolio Insurance

Merton's (1973) modification of BS model gives the value of a European put on a security that pays a continuous dividend as:

$$P_t = Ke^{-r(T-t)}N(-d_2) - S_t e^{-q(T-t)}N(-d_1)$$

$$d_1 = \frac{\ln\left(\frac{S_t}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \qquad (1)$$

$$d_2 = d_1 - \sigma\sqrt{T-t}$$

Where

P_t	value of the put at time t
K	the strike price of the option
S_t	the price of the underlying security at time t
r	risk-free interest rate
q	the dividend yield on the stock, continuously compounded
σ	the volatility of stock return
T-t	the time to maturity of the option contract as a fraction of a year
N(.)	the cumulative normal distribution function

Adding S_t to both sides of the first equation of (1) and manipulating results in the following:

$$P_t + S_t = Ke^{-r(T-t)}N(-d_2) + \left(1 - e^{-q(T-t)}N(-d_1)\right)S_t \qquad (2)$$

(2) shows that an insured position on S_t can be replicated by investing an amount of $Ke^{-r(T-t)}N(-d_2)$ to treasury bills and an amount of $\left(1 - e^{-q(T-t)}N(-d_1)\right)S_t$ to risky security. Initially, the total amount to be invested should be $P_0 + S_0$. This sum can also be considered as the initial wealth constraint, W_0.

When the underlying risky asset is the Istanbul Stock Exchange National 30 Index (ISE30), the number of ISE index units, H, to be held initially is given by the following:

$$H = S_0/(I_0 * 0.1) \tag{3}$$

Here I_0 is the initial level of the index. Let S_0 be the initial market value of portfolio that perfectly replicates ISE30 index. If we are attempting to provide a protection level of K to this portfolio, OBPI strategy can be implemented by means of the following algorithm:

$$w_t^0 = Ke^{-r(T-t)}N(-d_2) \tag{4}$$

$$w_t^1 = 0.1\left(1 - e^{-q(T-t)}N(-d_1)\right)I_tH \tag{5}$$

Where w_t^0 and w_t^1 are amounts to be invested on Treasury bills and risky assets at any time, t, until the maturity of the insurance term, T.

2.1. Constant Proportion Portfolio Insurance

Like OBPI, CPPI is a procedure for deciding on the amount to be allocated on Treasury bills and risky assets during the term of the insurance. The amount allocated to risky asset is called the exposure. Exposure is given by the following:

$$E_t = mC_t \tag{6}$$

Where E_t is the exposure, m is the constant multiple, and C_t is the cushion at time t. Cushion is excess wealth, W_t, over some floor (or desired protection) level K_t:

$$C_t = (W_t - K_t) \tag{7}$$

Notice that the floor is allowed vary during the term of insurance. In this study we equate K_t to the present value of desired floor, K, at time T. When borrowing constraints are imposed on the strategy, procedure becomes path dependent. In that case the exposure becomes:

$$E_t = min(mC_t, bW_t) \tag{8}$$

where b is the maximum leverage ratio.

To be able to compare two competing strategies m is chosen so that the initial index/bill allocation of the CPPI strategy resembles that of the OBPI. Based on these assumptions, time t index/bill allocation of CPPI is given by:

$$w_t^I = \max\{\min[m(W_t - K_t), W_t], 0\} \quad (9)$$

$$w_t^B = W_t - w_t^I \quad (10)$$

3. DATA AND METHODOLOGY

The dataset consists of daily closing values ISE-30 index. This is a weighted average index and includes 30 highest capitalization stocks that are traded on ISE. The sample period is from March 1997 to September 2008. This sample is divided into 69 non-overlapping, consecutive two-month insurance periods. The first insurance period is from March 3, 1997 to April 30, 1997.

For the calculation of the dividend yields, the dividend data provided by ISE is used.

Treasury-bill rates are used as the risk-free rate. To be consistent with BS Model's constant interest rate assumption, the T-bill rate prevailing at the beginning of each insurance period is used as the risk-free rate for that entire insurance period.

Transaction costs are assumed to be 0.8% (which applies to an individual investor and is a conservative estimate for Turkish market). For the sake of the simplicity, transaction costs are assumed to be covered by borrowing and the cost of borrowing is assumed to be the T-bill rate prevailing at the beginning of each insurance period.

The portfolio value is set to 1,000,000 TL and the floor value is set to 987,500 TL at the beginning of each insurance period. The daily rebalancing rule is used for both OBPI and CPPI.

Ex-post realized volatility inputs are used for OBPI. A twenty-day moving average volatility is calculated for each day using daily log returns.

For OBPI, replication is implemented on the index side (i.e. tracking error is allocated to the bill side). The allocation of the tracking error is not an issue for the CPPI strategy.

4. RESULTS

The results of the simulations are summarized on Table 1. The average sub-period return (continuously compounded) of CPPI strategy is 9.41% and the standard deviation is 5.1%. The corresponding figures for OBPI strategy is 6.76% and 17.36% respectively. As these numbers indicate and as can be seen from Figure 1, CPPI strategy provides a slightly better protection than its rival. However, the protection provided by CPPI strategy is much more stable than that of the OBPI strategy.

The average sub-period return on the index is 5.49% and the standard deviation is 19.86%. Both strategies out-performed buy-and-hold strategy in terms of both average sub-period return and standard deviation. A buy-and-hold portfolio with an initial value of 1,000,000 TL on March 3, 1997 would worth 30,423,922.17 TL on August 29, 2008. The market value of a portfolio

protected with OBPI during the whole sample period would worth 106,059,472.70 TL and the final value of a CPPI protected portfolio would be 658,523,363.22 TL.

Figure-1: The Sub-period Returns on the PI Strategies

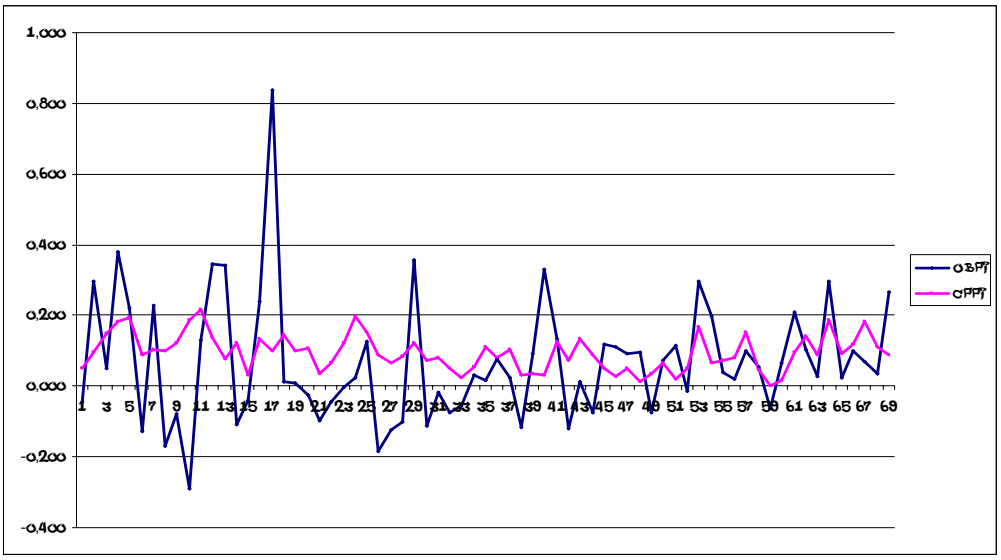

Table 1: The Comparison of Portfolio Insurance Strategies

	Start Date	Index	Finish Date	Index	Index Return	OBPI	CPPI
1	03.03.1997	1619	30.04.1997	1528	-0.045	-0.045	0.052
2	01.05.1997	1576	30.06.1997	2118	0.308	0.296	0.094
3	01.07.1997	2100	29.08.1997	2206	0.062	0.049	0.15
4	01.09.1997	2205	31.10.1997	3223	0.392	0.38	0.181
5	03.11.1997	3241	31.12.1997	4060	0.238	0.222	0.194
6	05.01.1998	4388,91	27.02.1998	3825,25	-0.125	-0.128	0.086
7	02.03.1998	3909,57	30.04.1998	4912,04	0.241	0.229	0.103
8	01.05.1998	4964,86	30.06.1998	4723,92	-0.037	-0.17	0.1
9	01.07.1998	4759,79	31.08.1998	3033,45	-0.438	-0.08	0.123
10	01.09.1998	2929,21	28.10.1998	2607,34	-0.104	-0.291	0.185
11	02.11.1998	2729,29	31.12.1998	3118,65	0.146	0.129	0.218
12	04.01.1999	3323,33	26.02.1999	4849,91	0.391	0.345	0.139
13	01.03.1999	4816,67	30.04.1999	6783,8	0.355	0.342	0.076
14	03.05.1999	6853,9	30.06.1999	6357,34	-0.063	-0.109	0.122
15	01.07.1999	6643,05	31.08.1999	6444,63	-0.018	-0.04	0.033
16	01.09.1999	6590,63	28.10.1999	8384,12	0.253	0.241	0.133
17	01.11.1999	8372,88	28.12.1999	19367,95	0.851	0.839	0.098
18	04.01.2000	22406	29.02.2000	19999,17	-0.101	0.013	0.145
19	01.03.2000	21689,73	28.04.2000	23829,2	0.107	0.008	0.101
20	01.05.2000	23580,11	30.06.2000	18093,22	-0.252	-0.024	0.108
21	03.07.2000	17928,89	31.08.2000	16120,73	-0.084	-0.096	0.035
22	01.09.2000	16014,54	31.10.2000	16830,16	0.062	-0.044	0.064
23	01.11.2000	17493,4	22.12.2000	11909,72	-0.372	-0.001	0.122
24	02.01.2001	11921,16	28.02.2001	11355,65	-0.036	0.023	0.198
25	01.03.2001	12141,48	30.04.2001	15848,51	0.279	0.126	0.154
26	01.05.2001	15421,55	29.06.2001	14225	-0.068	-0.185	0.088
27	02.07.2001	14601,96	31.08.2001	12484,58	-0.144	-0.123	0.066
28	03.09.2001	12154,02	31.10.2001	12551,69	0.015	-0.101	0.083
29	01.11.2001	12266,77	28.12.2001	17516,43	0.369	0.357	0.124
30	02.01.2002	17906,26	28.02.2002	14030,07	-0.231	-0.111	0.071
31	01.03.2002	14562,16	30.04.2002	14569,4	0.013	-0.02	0.082
32	01.05.2002	14629,29	28.06.2002	11891,03	-0.195	-0.075	0.051
33	01.07.2002	12160,78	29.08.2002	11805,97	-0.017	-0.055	0.022
34	02.09.2002	11586,89	31.10.2002	12734,36	0.107	0.032	0.055
35	01.11.2002	12708,66	31.12.2002	12886,2	0.026	0.016	0.112
36	02.01.2003	13166,28	28.02.2003	14439,06	0.105	0.076	0.081
37	03.03.2003	12604,37	30.04.2003	14123,13	0.126	0.022	0.102
38	01.05.2003	14057,67	30.06.2003	13518,33	-0.027	-0.116	0.033
39	01.07.2003	13358,48	29.08.2003	14686,86	0.107	0.092	0.037
40	01.09.2003	14746,18	31.10.2003	20431,73	0.339	0.329	0.032

Table 1: Contiued

	Start Date	Index	Finish Date	Index	Index Return	OBPI	CPPI
41	03.11.2003	21282,15	31.12.2003	24310,03	0.146	0.134	0.127
42	02.01.2004	25036,43	27.02.2004	24472,5	-0.01	-0.12	0.072
43	01.03.2004	24327,18	30.04.2004	22584,09	-0.062	0.014	0.134
44	03.05.2004	22257,38	30.06.2004	23011,65	0.046	-0.076	0.089
45	01.07.2004	23464,72	31.08.2004	25923,44	0.112	0.118	0.049
46	01.09.2004	26325,43	28.10.2004	29321,16	0.12	0.111	0.028
47	01.11.2004	29184,02	29.12.2004	32152,87	0.109	0.091	0.051
48	03.01.2005	32782,15	28.02.2005	36256,86	0.113	0.095	0.013
49	01.03.2005	35376,51	29.04.2005	30319,42	-0.142	-0.073	0.034
50	02.05.2005	31195,63	30.06.2005	34473,76	0.112	0.074	0.067
51	01.07.2005	35341,2	31.08.2005	39738,74	0.13	0.116	0.021
52	01.09.2005	41191,35	31.10.2005	40789,03	0.003	-0.016	0.05
53	01.11.2005	41914,3	30.12.2005	50467,53	0.198	0.298	0.169
54	02.01.2006	50551,02	28.02.2006	59676,14	0.179	0.197	0.066
55	01.03.2006	60245,33	28.04.2006	55190,84	-0.075	0.039	0.073
56	01.05.2006	55505,33	30.06.2006	44734,31	-0.203	0.02	0.081
57	03.07.2006	44835,94	31.08.2006	47160,51	0.063	0.098	0.153
58	01.09.2006	47314,09	31.10.2006	51403,2	0.085	0.054	0.045
59	01.11.2006	51380,98	29.12.2006	48551,38	-0.044	-0.062	0
60	04.01.2007	48413,73	28.02.2007	52061,64	0.085	0.067	0.017
61	01.03.2007	49525,88	30.04.2007	56811,95	0.15	0.208	0.084
62	03.05.2007	56354,07	29.06.2007	58413,71	0.048	0.105	0.139
63	02.07.2007	59277,46	31.08.2007	63211,41	0.077	0.029	0.088
64	03.09.2007	62806,3	31.10.2007	73361,93	0.168	0.298	0.188
65	01.11.2007	73161,28	27.12.2007	70253,75	-0.028	0.025	0.092
66	02.01.2008	69208,99	29.02.2008	55489,04	-0.208	0.1	0.119
67	04.03.2008	53039,57	30.04.2008	54351,16	0.037	0.069	0.181
68	01.05.2008	53107,28	30.06.2008	42223,6	-0.217	0.035	0.11
69	01.07.2008	39722,08	29.08.2008	49256,33	0.228	0.264	0.087

3. CONCLUSION

To our best knowledge, this is the first empirical study on Turkish market data to compare the performance of the OBPI and the CPPI. The objective of this study is to see whether these PI strategies provide better portfolio performance in terms of risk-return trade-off and if they do which one dominates the other. Based on the evidence provided by the simulation results we can conclude that implementing PI strategies enhances portfolio performance. Both strategies investigated provided superior performance results than buy-and-hold strategy. However, the performance of the CPPI clearly stands out.

In prior works, generally data mature markets were utilised to investigate PI issue. Studies employing emerging market data are quite rare. This study contributes to the PI literature by providing the results from an important emerging market.

Many previous studies reported performance enhancements when futures are used in the implementation of PI strategies. Turkish derivatives market commenced trading in 2005 and futures data is accumulating. In future work the performance of futures based PI strategies will also be investigated.

The methodology employed in this study assumes that interest rates and volatility are constants. As mentioned earlier, this is an important limitation of standard PI procedures. In future work these issues will also be addressed and methodologies incorporating stochastic interest rates and volatility will be employed for analysis.

BIBLIOGRAPHY

Annaert, J., Osselaer, S. V., & Verstraete, B. (2009). "Performance evaluation of portfolio insurance strategies using stochastic dominance criteria". *Journal of Banking and Finance*, Vol.33(2), pp.272−280

Bertrand, P., & Prigent, J. L. (2005), "Portfolio insurance strategies: OBPI versus CPPI", *Finance*, Vol. 26(1), pp.5−32.

Black. F and Jones,R, (1987), "Simplifying portfolio insurance", *Journal of Portfolio Management* Vol.14, No.1 , pp. 48–51.

Black, F. and Rouhani, R. (1989). "Constant proportion portfolio insurance and the synthetic put option: a comparison", in Institutional Investor Focus on Investment Management, edited by Frank J. Fabozzi. Cambridge, Mass: Ballinger, pp.695–708.

Black, F. and Perold, A.F. (1992), "Theory of constant proportion portfolio insurance", *Journal of Economic Dynamics and Control* Vol.16, pp. 403–426.

Black, F. and Scholes, M. S. (1973). "The pricing of options and corporate liabilities." *Journal of Political Economy*, Vol.81, pp.637 –654.

Bookstaber, R. and Langsam, J. A. (2000). "Portfolio insurance trading rules",*The Journal of Futures Markets*, Vol.8, pp.15–31.

Do, B.H. (2002), "Relative performance of dynamic portfolio insurance strategies: Australian evidence", *Accounting & Finance,* Vol. 42, No. 3, pp. 279-296.

Garcia, C.B. and Gould, F.J. (1987), "An empirical study of portfolio insurance", *Financial Analysts Journal* Vol. 43, pp. 44–54.

Leamer, E. E. (1983), "Let's take the con out of econometrics", *AmericanEconomic Review*, Vol. 73, pp. 31-43.

Leland, H.E and Rubinstein, M. (1976), "The evolution of portfolio insurance". In: D.L. Luskin, Editor, *Portfolio insurance: A guide to dynamic hedging*, Wiley

Lo, A. and MacKinlay, G. (1990), "Data snooping biases in tests of financial asset pricing models", *Review of Financial Studies*, Vol.3, pp. 431-467.

Merrick, J. (1988), "Portfolio Insurance with Stock Index Futures", *Journal of Futures Markets"* Vol.8, No. 4, pp. 441–455.

Perold, A. (1986). "Constant portfolio insurance", Harvard Business School. Unpublished manuscript.

Perold, A. and Sharpe, W. (1988). "Dynamic strategies for asset allocation" *Financial Analyst Journal,* Vol. 44, pp.16–27.

Jacobs, B., (1983), "The portfolio insurance puzzle", *Pension & Investment Age*, August 22.

İstanbul Exchange (2009), *İstanbul Menkul kıymet borsası,* www. imkb.gov.tr