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How effective are protective puts?

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- Protective puts look like a straight forward insurance against major drawdowns.
- However, the effectiveness of this derivative overlay strategy is highly path dependent and suffers from the volatility risk premium.
- While many studies focus solely on the S&P 500 we also analyze the performance of the strategy on seven other equity markets and find that the alleged insurance can even increase drawdowns relative to a 100% long portfolio.
- While using longer dated options improved the effectiveness of the strategy during the Great Financial Crisis it resulted in poor results during the Covid crash.

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As markets are reaching new records in a highly uncertain environment and at sky high valuation levels, investing can feel a bit like rope dancing without a safety net. For multi asset investors the problem gets exacerbated by extremely low or negative bond yields raising questions about the ability of traditional safe haven assets to provide sufficient protection. In front of this background, alternative strategies involving derivatives may look like a promising solution. However, insuring against downside risk is less trivial than it seems at first sight.

1 About protective puts

The most popular and seemingly straight forward approach to reducing downside risk while maintaining upside exposure is to buy put option. As a put option gives the buyer the right to sell the asset at a guaranteed price they are, by definition, highly effective at putting a floor under the asset over a certain period of time (protective put). However, this desirable insurance comes at the cost of having to pay the option premium. Trading off some return for significantly reduced risk may look like a favorable deal, especially given that the distribution of equity returns tends to be fat tailed. However empirical evidence shows that in practice this kind of insurance behaves very differently from textbook illustrations. Most importantly there are two elements that adversely impact the risk/return parameters of systematic protective put strategies, namely:

- the expensiveness of traded put options relative to their theoretical fair value (volatility risk premium),
- as well as the impact of the options lifetime and position rolling on the effectiveness of the hedge over time (path dependency).

It is important to note that we are focusing on protective put strategies that systematically hedge the underlying portfolio and not on market timing. It is unlikely that an investor who can effectively forecast returns would turn to expensive options rather than outright short-selling. Furthermore, we are approaching the topic from an asset allocator's point of view and study index options rather than single stocks.

Figure 1: *Theoretical payoff profile of a protective put*

We assume that investors will primarily judge the effectiveness of a protective put strategy based on two measures.

- The Sharpe ratio, measuring the strategy's return relative to its volatility, which is the most commonly used measure of risk in finance.
- While volatility is the most widely accepted measure of risk, protective put holders may in practice be more concerned about drawdowns. We therefore use the Calmar ratio, which measures return relative to maximum drawdown, as the second indicator of effectiveness.

To analyse effectiveness, we study the returns of a range of protective put indices and contrast them to the respective underlying markets. Furthermore, we simulate the theoretical performance of a monthly protective put strategy on the S&P 500 using the Black-Scholes model and compare it to the CBOE S&P 500 5% Put Protection Index (PPUT Index). This provides us with an estimate of the historical overpricing of index options and also illustrates the fallacies of simple, option pricing model based backtests. For further information on the index and its methodology please refer to the methodology description provded by the CBOE[1].

2 Looking beyond the US box

Most literature focuses on the PPUT Index which tracks a protective put strategy on the S&P 500. This may be motivated by the popularity of the underlying index but among all indices we could find on Bloomberg it is also the index with the longest history, reaching back to 1985. However there is no compelling reason why research should be restricted to this index. On the contrary, we consider a broadening of the scope highly important as it allows us to study and compare the performance of the strategy under various conditions. Bloomberg currently lists 6 active protective put indices, covering the S&P 500 (SPX), the MSCI Emerging Market (MXEF), the DAX, the Euro Stoxx 50 (SX5E) and the IBEX 35.

Furthermore, we have found discontinued protective put indices on the CAC 40 (CAC) and the AEX. It is important to also include these strategies in order to avoid survivorship bias. Obviously none of these indices is investable. However, between 2007 and 2019 Lyxor managed an ETF on the DAXplus Protective Put index which tracked it perfectly. We therefore make the assumption that the indices adequately represent the realizable performance of the underlying strategy.

Based on the launch and in some cases suspension date of the indices we form three samples. The longest reaches from 1991 to today and includes only the protective put strategies on the S&P 500 and the DAX. The broadest sample spans from 2000 to 2017 and includes protective put strategies on the S&P 500, DAX, Euro Stoxx 50, S&P Europe, IBEX 25, AEX and CAC 40. Finally, the third sample stretches from 2007 to today. It also includes the MSCI Emerging Markets but excludes the protective put strategies on AEX and CAC 40 which where discontinued in 2017. We compute excess returns using the yield of 2 year US government bonds as risk free reference rate for the S&P 500 and the MSCI Emerging Markets and 2 year German government bonds as reference rate for the European strategies.

2.1 The performance of protective put indices

Figure 2 and Figure 3 depict the Sharpe and Calmar ratios for the S&P500 and the DAX against the respective underlying index for the complete sample period from 1991 to today. As can be seen, the findings are somewhat mixed. The protective put improved the risk/adjusted performance of the DAX especially when defined through the Calmar ratio but it decreased the risk adjusted performance of the S&P 500. The latter confirms the finding of earlier research such as Israelov 2019 [2] who studied the S&P 500 protective put strategy on a sample reaching from 1986 to 2016 finding that "systematically buying put options offers a very modest improvement over the simple alternative of reducing the underlying equity position, if the options are priced with no volatility risk premium" and significantly worsens the outcome if options are priced to include volatility (as they are in reality). The paper also includes a comprehensive conceptual discussion of the topic and elaborates, in greater detail than we we do, on the mechanics of the strategy's path dependency.

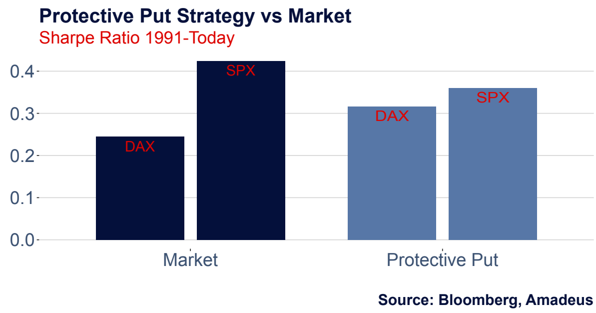

Figure 2: *Sharpe ratio 1991-today*

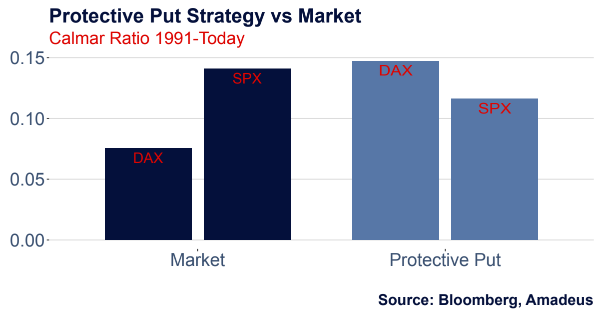

Figure 3: *Calmar ratio 1991-today*

Unfortunately our second, broader sample is not poised to comfort risk averse investors looking for downside protection either. Looking at Figure 4 and Figure 5 we find that for the sample period from 2000 to 2017 only the put strategy on DAX and S&P Europe outperformed the underlying markets on a risk adjusted basis. At the same time, the strategy resulted in outright disastrous results if applied to CAC 40, IBEX and Euro Stoxx 50. For all these indices, the protective put strategy resulted in negative excess returns. The protective put index on the IBEX which was discontinued

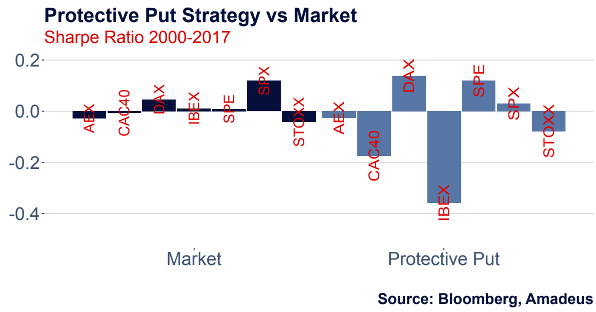

Figure 4: *Sharpe ratio 2000-2017*

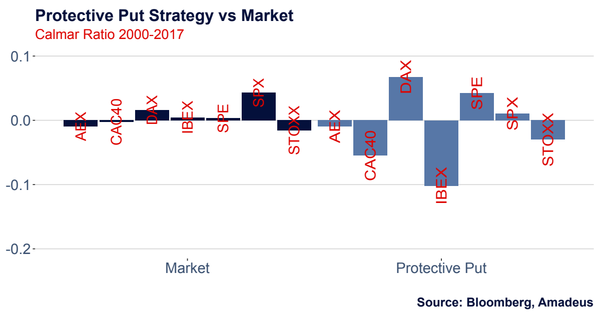

Figure 5: *Calmar ratio 2000-2017*

in 2017 accumulated an absolute loss of 33% over its lifetime which compares to a roughly 30% return in the market. While the Spanish stock market clearly didn't shine throughout this sample it still implies that the absolute performance loss induced by the option overlay alone was roughly 60%. Most importantly the low Sharpe and Calmar ratios are not just attributable to lower returns. Figure 18 and Figure 19 in the appendix also clearly show that in the case of the CAC 40 and the IBEX, the option overlay, while somewhat reducing volatility, was totally ineffective in protecting against drawdowns. This brings us to our last sample which is particularly interesting as it includes the Great Financial Crisis (one of the worst market crashes in history), the more recent Covid crisis (the fastest crash in history) as well as one of the strongest bull markets ever observed in global equities (the time between the end of the 2008 crisis and today), We find that during

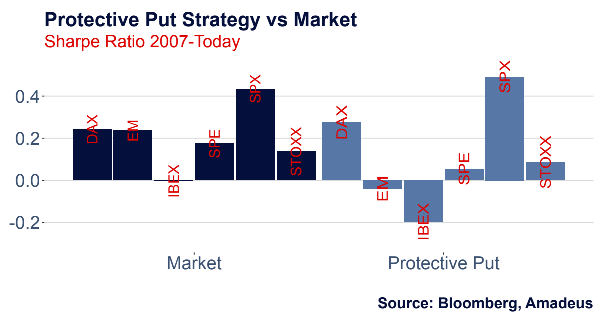

Figure 6: *Sharpe ratio 2000-2017*

this particular period of time the protective put strategy has delivered slightly higher risk adjusted returns for the DAX and the S&P 500 but again resulted in a very poor performance if applied to any of the other indices, especially the IBEX 35 and the MSCI Emerging

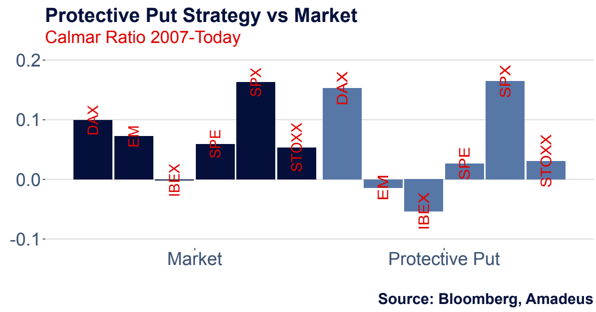

Figure 7: *Calmar ratio 2000-2017*

Markets. We provide the risk/return scatter plots in the appendix. Again, we find that the protective put strategy effectively results in a lower standard deviation of returns, which is expected as being long the put implies being short volatility. However, it fails to protect investors against drawdowns in the case of the MSCI Emerging Markets and the IBEX. Looking into the actual return time series we find that this is mostly induced by the mounting cost of buying options resulting in permanent loss of capital once the performance of the underlying index is not strong enough to offset it. Figure 8 illustrates this for the MSCI Emerging Market that went through an extended period of rather subdued performance during the sample period. Of

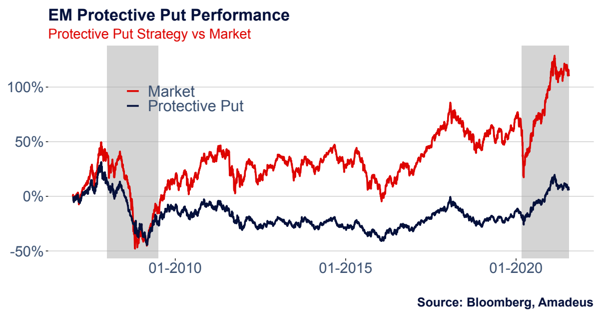

Figure 8: *MSCI EM vs MSCI EM Protective Put*

course it is not surprising that in the absence of positive underlying returns, insurance premium will eat into a portfolio's value but it seems likely that investors tend to underestimate the magnitude of this effect especially over longer periods of time given compounding. Also, as Figure 9 illustrates, we find that even during market crashes drawdowns can be much larger than we would intuitively expect. The CBOE MSCI Emerging Markets 5% rolls monthly put options that at initiation are 5% out of the money. This effectively guarantees a price only for a short period of time. Once the put expires, the investor needs to enter into a new contract with a lower strike. Eventually in the case of the MSCI Emerging Markets the protective put reduced the drawdown during the Great Financial Crisis only by 7.2% (-57% instead of -65%).

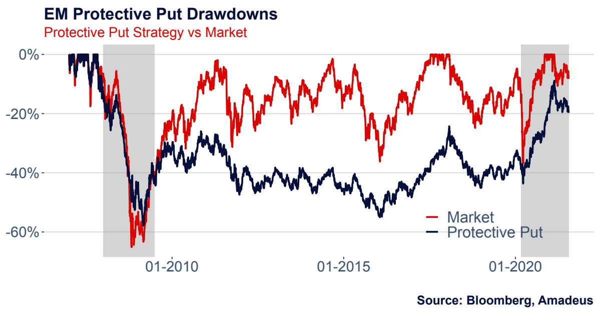

Figure 9: *MSCI EM vs MSCI EM Protective Put*

3 How the volatility risk premium drags on performance

As mentioned earlier, Israelov [2] found that despite the problem of poor downside protection during longer drawdowns, a protective put strategy generated slightly better risk adjusted performance than a long-only portfolio under the assumption of options pricing zero volatility risk premium. It is no secret that on average, implied volatility exceeds realized volatility. To develop a better understanding of the magnitude of the volatility risk premium's impact on the performance of the strategy we simulate the historical performance of the protective put strategy on the S&P 500 using the Black-Scholes model. We run three simulations:

- The first simulation uses historically observed put implied volatility,
- The second simulation uses realized 28 day volatility. On average, over the sample period, this was the best proxy for with historical put implied volatility, yielding a daily R^2 of 0.7599 (Figure 10.
- Finally, the third simulation uses implied volatility reduced by the average premium of implied volatility over the realized volatility.

We use 1 month Libor as a proxy for the risk free rate. Furthermore we obtain consensus expected dividend yield for the S&P 500 from Bloomberg. For the time before January 2001, for which this time series is not available, we assume a dividend yield of 2%.

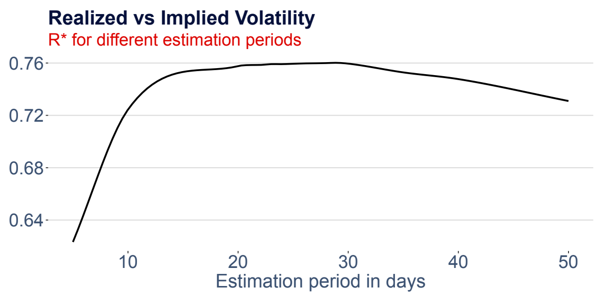

Figure 10: *Realized vs Implied Volatility*

3.1 Realized vs implied volatility

Figure 11 shows the results of the first simulation which uses historical implied volatility from Bloomberg. The simulation starts in 1991 which is the earliest data for which the implied volatility time series is available. We construct a portfolio that rolls short-term put options on a monthly basis and estimate the price of these options using the Black-Scholes formula. Options are assumed to be rolled on the third Friday of each month. Beyond this we deduct a fixed basis point value of the underlying reference index at each rollover date. This factor captures model inaccuracies that lead to systematically elevated returns relative to the reference index and is set to the value that maximizes the fit between the protective put index (PPUT Index) and our simulation. With these settings we manage to approximate the daily returns of the PPUT Index with a R^2 of 0.9173 or a correlation coefficient of 95.78%. We then run

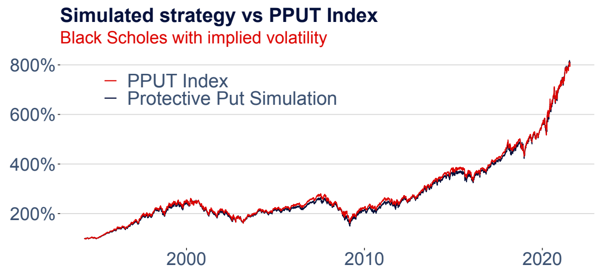

Figure 11: *Black-Scholes simulation vs PPUT Index*

the simulation again with the same settings but this time using realized 28 day volatility to price the protective put. The resulting return series is displayed in Figure 12. For the protective put strategy, we measure a 0.4% improvement in annual returns compared to the first simulation. Over the observed period of time, the S&P 500 long-only portfolio returned 10.7% per year, while the PPUT Index achieved annual returns of 7.94%. The simulation using realized volatility results in annual returns of 8.34%. At the same time, the series is slightly more volatile (14.38% instead of 13.56%) which is likely a function of implied volatility reacting faster to negative news resulting in more effective protection in the short-term. The fit could probably be improved by using a more sophisticated model to estimate realized volatility such as a GARCH based approach. However, the problem is also mitigated by the last simulation (Figure 13) which uses implied volatility but adjusts for the average volatility risk premium priced into options. Not surprisingly, the simulation results in a similar standard deviation of returns as observed for the PPUT Index (13.9%) and an annualized strategy return of 8.9%. It therefore indicates that the volatility risk premium observable in actual options markets costs the strategy approximately 1% per year. We find that the protective put strategy fares a bit better over the sample period covered by us than during the time analyzed by Israelov 2019[2]. This

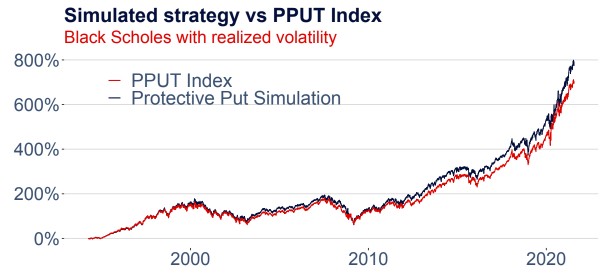

Figure 12: *Black-Scholes simulation vs PPUT Index*

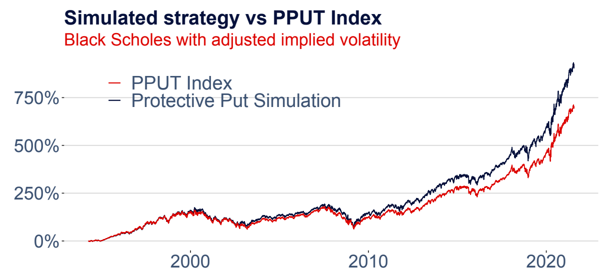

Figure 13: *Black-Scholes simulation vs PPUT Index*

seems to be a function of the strong bull market during the past few years and the extremely v-shaped Covid 19 crash. Obviously, prolonged periods of low volatility interrupted by sharp but very short drawdowns are the optimal environment for a strategy that uses short dated protective puts like the PPUT Index.

4 What about longer dated options?

The disappointing risk adjusted performance of protective put strategies using monthly options raises the question, whether investors are better off protecting themselves using longer dated options. We therefore run our simulation again assuming quarterly and yearly rolling of put options. Unfortunately, Bloomberg does

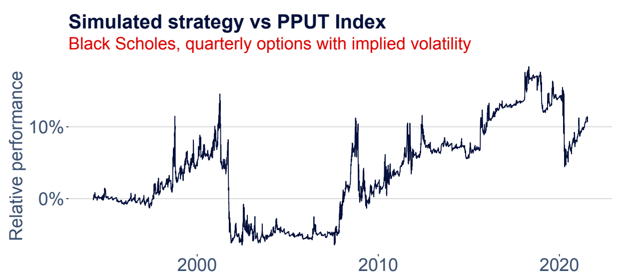

Figure 14: *Black-Scholes simulation, quarterly options vs PPUT Index*

not provide 12 months implied volatility for the whole sample period. To derive implied volatility for the longer dated options, we therefore calculate the average term premium for the time period for which we can retrieve the data which reaches from September 2011 to July 2021. We then interpolate implied volatility linearly based on the remaining time to expiry of the options. Simulation results are displayed in Figure 14 and Figure 15. These plots show the relative performance of the simulated strategies compared to the PPUT Index. The aggregate return of the quarterly protective put strategy is slightly higher than that of the PPUT Index driven by outperformance during the Great Financial Crisis. At the same time, the strategy underperformed during the Dotcom crash and the Covid crisis. The yearly protective put strategy delivered better protection during the Dotcom crash and stronger outperformance during the Great Financial Crisis but gave back a lot of this during the Covid crash. Both results are not surprising and confirm the findings of Israelov 2019[2].

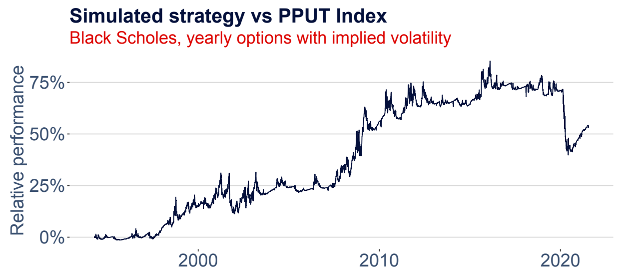

Figure 15: *Black-Scholes simulation, yearly options vs PPUT Index*

The effectiveness of protective puts is highly path dependent as investors benefit from the put options only if the length of a drawdown commensurates with the time to expiry of the options held. The Great Financial Crisis in particular was characterized by an extended and rather slow decline of prices making monthly options an ineffective hedging instrument. On the contrary, the Covid crash stands out due to the speed of the price slump and the subsequent recovery. Unfortunately this also means that their is no optimal strategy. The protective put only provides an effective hedge if the investor manages to time the option expiry correctly. This however brings us back to the earlier mentioned point that an investor who can effectively forecast returns is unlikely to turn to protective puts.

5 Conclusion - illusory risk reduction at a high price

At first sight, protective puts look like a straight forward strategy. However, the typical payoff diagram as illustrated in Figure 1 vastly understates its actual complexity. Puts provide effective downside protection only in a one period model covering the time until expiry. Once the investment horizon differs from the option's life cycle, the effectiveness of this insurance product is severely impaired.

This holds regardless of whether the investment horizon is shorter or longer than the remaining lifetime but for the vast majority of investors the latter is more relevant. Once options need to be rolled, they provide little downside protection but, over time, option premiums heavily eat into returns. The latter becomes especially painful once the underlying reference market enters into a prolonged phase of rather low returns. In this case, protective puts don't reduce but increase maximum drawdowns even when compared to a long-only equity portfolio.

Existing literature which focuses mostly on the S&P 500 has noted the meagre benefits of protective put strategies even when applied to this historically strong index. However as our study of the IBEX or the MSCI Emerging Market index shows, this still understates the risk investors actually tale when they systematically hedge their portfolio with put options. Implicitly, an investor pursuing such a strategy always takes two bets:

- A bet on the medium to long-term performance of the underlying market as in the absence of strong returns, the expensive insurance eventually results in higher, not lower drawdowns.
- A bet on the peak-to-trough ratio of future drawdowns as protection is only effective if the time to expiry of the put options matches the duration of the market decline.

Investors who get these bets right can possibly achieve a better risk adjusted performance than the underlying market using protective puts but under the assumption of such market timing ability there is hardly an incentive to choose the strategy. For risk reduction, selecting a more defensive asset allocation in the first place looks like the better decision.

References

[1] CBOE. *Information Circular IC12-017*. URL: https://cdn.cboe.com/api/global/us_indices/governance/PPUT_Methodology.pdf. (accessed: 26.07.2021).

[2] Roni Israelov. "Pathetic Protection: The Elusive Benefits of Protective Puts". In: *The Journal of Alternative Investments* 21 (21 2019).

Figure 16: *Volatility/Return Scatter 1991-Today*

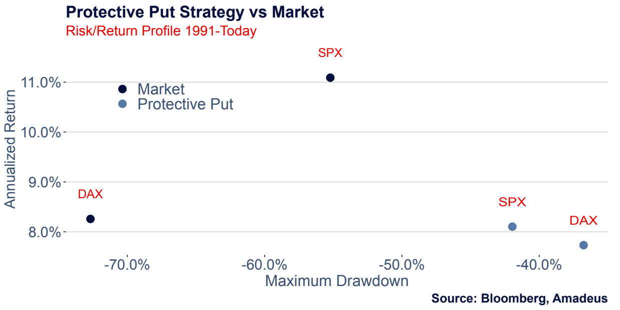

Figure 17: *Maximum Drawdown/Return Scatter 1991-Today*

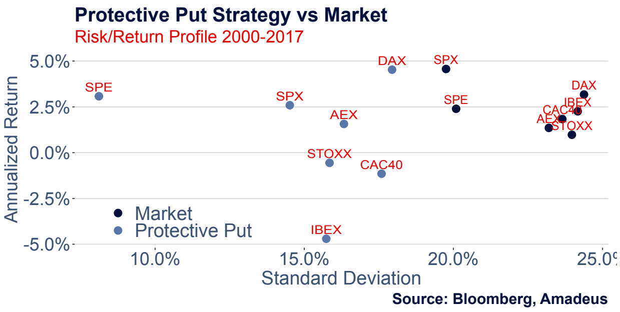

Figure 18: *Volatility/Return Scatter 2000-2017*

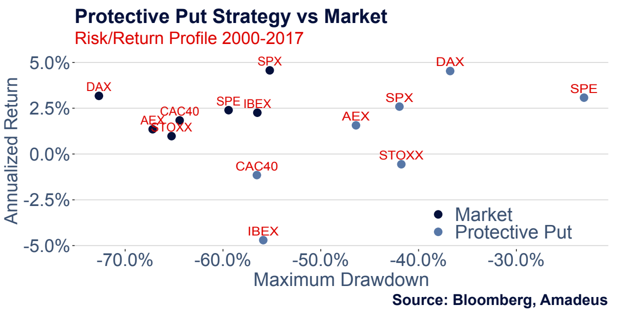

Figure 19: *Maximum Drawdown/Return Scatter 2000-2017*

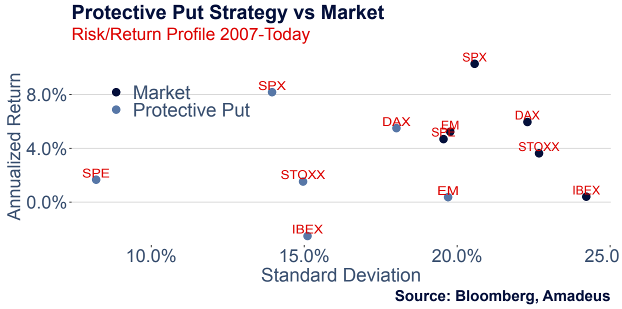

Figure 20: *Volatility/Return Scatter 2007-Today*

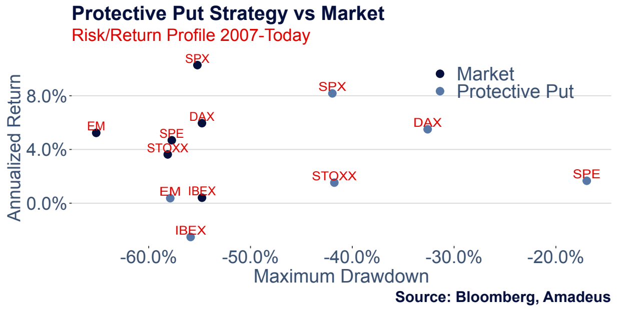

Figure 21: *Maximum Drawdown/Return Scatter 2007-Today*