J.P. MORGAN CENTER FOR COMMODITIES
UNIVERSITY OF COLORADO DENVER BUSINESS SCHOOL

GLOBAL COMMODITIES
APPLIED RESEARCH DIGEST

WINTER 2021

EDITORIAL ADVISORY BOARD ANALYSIS

"THE SMILE OF THE VOLATILITY RISK PREMIA"

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Supported by funding from

INTEGRATED PORTFOLIO INTELLIGENCE LLC

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The Smile of the Volatility Risk Premia

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The paper presents selected results from the comprehensive study of the volatility risk premium (VRP) in the oil market. We introduce the smile of VRP that represents variation in profitability and risk of this systematic strategy across option moneyness and maturities. We identify the structural break in VRP evolution over time driven by behavioral changes among producer hedgers and the securitization of the strategy by financial institutions.

Introduction

Commodity options resemble insurance contracts. Option buyers pay the premium to protect themselves against the adverse price movement. Producers buy puts to ensure minimum acceptable return on investments in capital intensive projects; consumers buy calls to protect against price appreciation of raw materials essential to their manufacturing process or to the services they provide. Sellers of commodity options are dealers, institutional investors, and professional volatility traders acting as insurers in anticipation of reward for providing the service of risk absorptions.

Like any other insurance product, writing commodity options carries asymmetric risks. Small frequent gains in the form of premium collected create a buffer to offset the impact of rare but potentially large losses. To keep providers motivated to stay in business with such asymmetric payoffs, prices must be set at a premium to the contract actuarial value, or its average historical payout. Despite similarities to the traditional insurance industry, commodity options have one important advantage. In the derivatives market, the asymmetric option risk can be partially offset by dynamically trading the futures contract, the instrument on which the option is written. This technique, which became known as delta-hedging, replaced actuarial pricing of options with the cost of their dynamic replication. Delta-hedging cannot eliminate the asymmetry of the payoff, but it transforms the strategy risk profile. The investment return on such a dynamically hedged short option strategy is known as the volatility risk premium, or VRP.

Volatility Risk Premia by Moneyness and Maturity

In this short paper, we summarize some important observations resulting from the comprehensive study of VRP strategies for West Texas Intermediate (WTI) options. We have constructed the broad set of systematic volatility strategies for options across different moneyness and maturities using daily data since 2000. The moneyness of the option can be thought of as a deductible on the insurance contract, and it should not be surprising that the profitability of option selling varies significantly with the choice of moneyness. We define moneyness simply as the ratio of the strike price to the futures price and analyze strategies for the range of moneyness from 0.9 to 1.1. Our results provide some new insights on the variation of the risk premium across parameters that characterize various options. We find that VRP exhibits the pronounced smile with much higher returns generated by selling out-of-the-money (OTM) options, especially for contracts with shorter maturities.

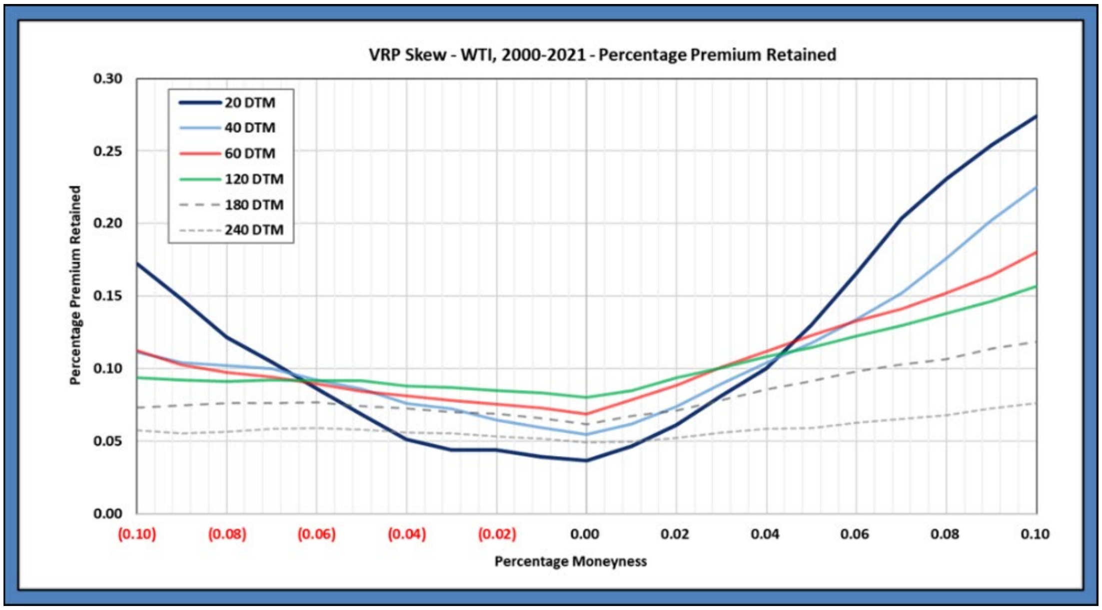
When it comes to option trading, the concept of investment return is ambiguous and needs to be clarified. For linear instruments, such as futures, the return is typically presented as net profit expressed as the percentage of the notional value of futures at the time of investment. In practice, the actual required cash investment to trade futures is significantly smaller and is limited to the initial margin posted with the clearing broker, but such metric would have been difficult to track as it fluctuates with the market volatility. For similar reasons, and to keep the results simple and transparent, we define a normalized profitability metric for VRP strategies as the percentage of the premium collected. Similarly, the concept of investment risk needs to be clarified in the case of options, which we discuss separately below.

In addition to studying the strategy across moneyness, we also construct VRP term-structure. We analyze the volatility strategy for the range of maturities from one month to one year. We first study each position in isolation before considering the portfolio effect of overlapping positions. For example, for the 60 days to maturity tenor, a portfolio of positions would carry three overlapping positions at a point in time. In order to separate the resulting increasing portfolio effect with maturity, we report performance and risk metrics as a function of premium collected on a per-position basis, and then comment on portfolio benefits using more traditional risk-adjusted performance metrics.

To draw an analogy with the way option traders look at implied volatility versus moneyness and maturity, we display VRP performance returns in a similar format. Figure 1 on the next page shows the resulting skew, or the smile, of the VRP. The presence of the smile indicates that the relative profitability of selling out-of-the-money options is higher than selling at-the-money options. The result makes intuitive sense as selling out-of-the-money options carries higher risk and is often compared to picking up pennies in front of a steamroller, whereas selling at-the-the money is merely picking up dimes in front of a steamroller. As a result of higher risk on the wings, sellers are rewarded with retention of a higher proportion of collected premium.

Figure 1 represents terminal profit as a proportion of premium collected. It does not reflect the path-dependent “pain” felt by the investors during the life of the positions comprising the portfolio. Analogous to the manner in which we represent profit as a proportion of premium collected, we represent risk as the average of the maximum loss experienced during the life of each position divided by the premium collected for each position. Figure 2, which is also on the next page, confirms that in return for the potential to retain a higher proportion of premium collected, the investor can expect to feel a greater degree of pain during the life of the trade as a proportion of premium collected. In other words, there is no free lunch.

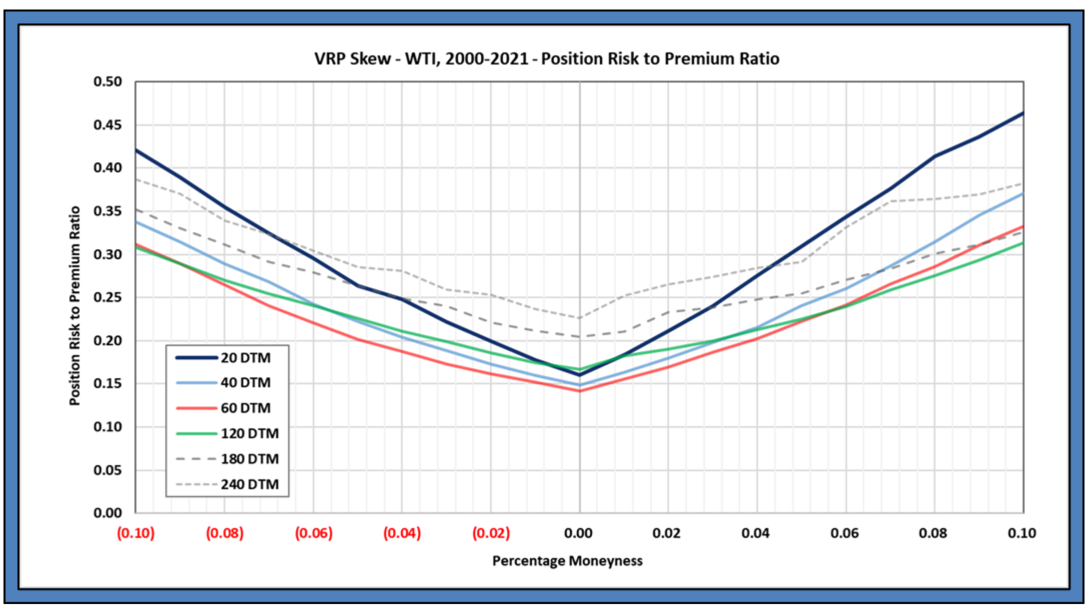
Figure 1



Notes: Percentage of the premium retained in VRP portfolios aggregated by moneyness and maturity.
DTM is an acronym for days-to-maturity.

Sources: Authors' calculation and graphic, CME data.

Figure 2



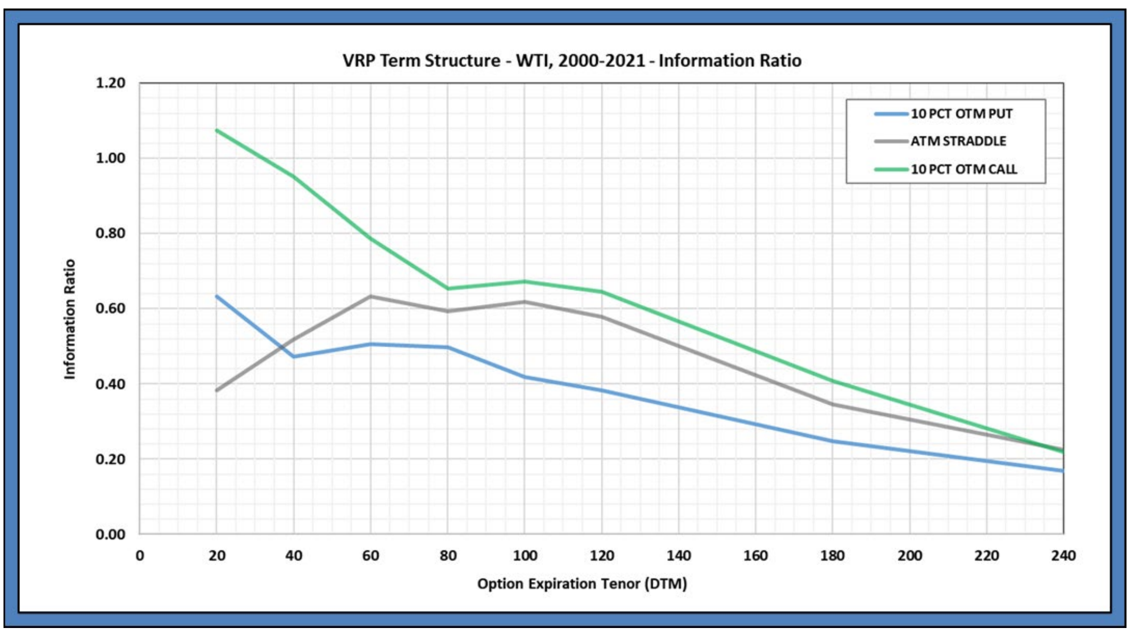
Note: Position risk measured as the average position path maximum loss as a proportion of premium collected by moneyness and maturity.

Sources: Authors' calculation and graphic, CME data.

The intent of the present analysis is to highlight the relative value of VRP across the surface (i.e., across tenor and moneyness) without regard to transaction cost considerations. Efficient implementation of the VRP strategy is a multi-factor topic comprising execution strategies for options entry and futures hedge execution, and use of tactical algorithmic execution for slippage minimization. In fact, the current authors have demonstrated the efficacy of applying machine-learning based algorithmic automated multi-timescale delta hedging to optimize the return on risk characteristics of the VRP capture strategy. Such algorithmic hedging removes human bias and can be tuned to realize risk management objectives while monetizing VRP. The current analysis provides a starting point for identifying candidate portions of the VRP surface that, when combined with tactical execution, provide positive investment returns and decorrelated sources of yield enhancement in certain regimes.

A more familiar approach to characterizing risk for trading portfolios with multiple overlapping positions is to use the so-called information ratio, which we define as the ratio of annualized profits expressed in dollar per barrel to the annualized standard deviation of daily profit and loss. Such definition allows us to avoid the ambiguity of percentage returns for leveraged instruments. Figure 3 shows that for out-of-the-money options the best results are achieved from selling short-term one-month maturity options. In contrast, for at-the-money (ATM) straddles the risk-adjusted performance can be significantly improved if we construct a portfolio of overlapping positions with 60 to 100 days to expiration. Such portfolio benefits are primarily driven by additional strike diversification. Since options that are ATM at initiation are also more likely to be ATM at expiration than options which were initially out-of-the-money, the strike diversification becomes more powerful for ATM straddles as it smooths the portfolio's overall gamma profile.

Figure 3



Notes: The term-structure of Information Ratio vs. Days-to-Maturity (DTM) for a portfolio with multiple overlapping entries. Information ratio is defined as annualized profit divided by the annualized standard deviation of daily price changes.

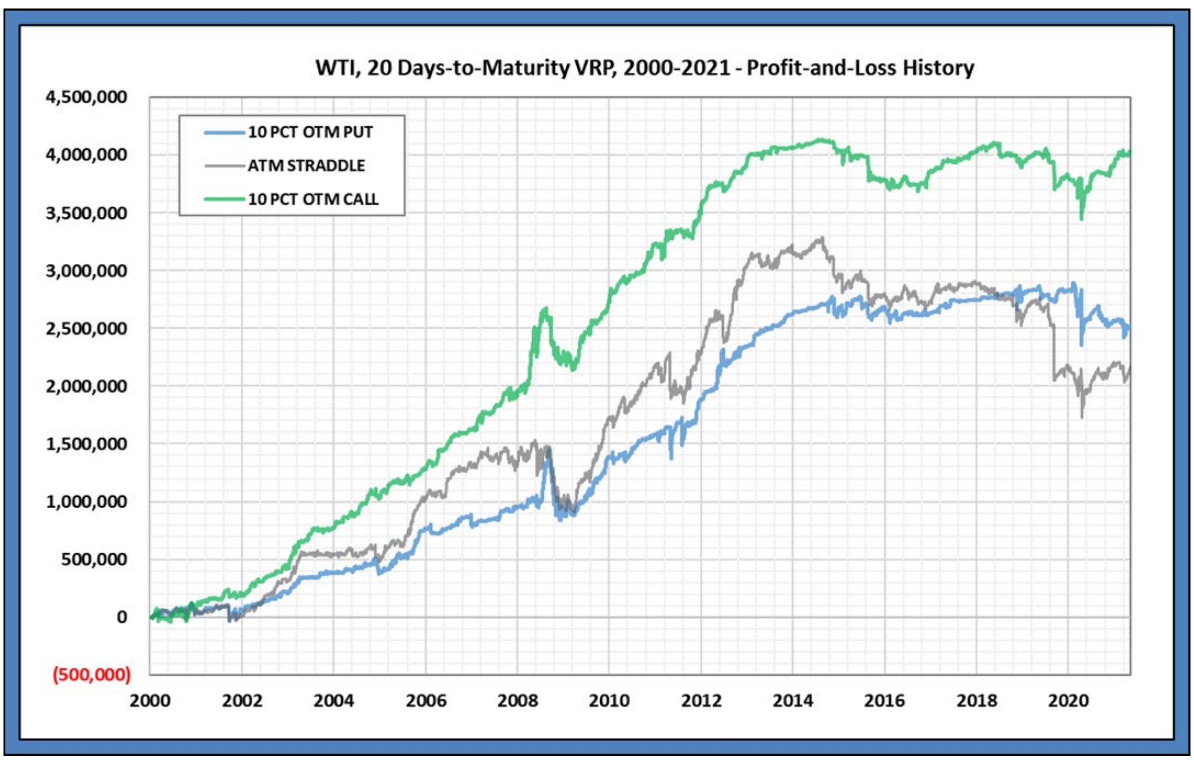
Sources: Authors' calculation and graphic, CME data.

The term-structure of information ratios presented in Figure 3 is provided only to highlight a salient diversification feature of the generic VRP portfolio, and it is not meant to suggest a particular portfolio design. The portfolio construction is a separate topic which we do not address here, but significantly higher information ratios could be achieved with a proper portfolio construction. Importantly, one also needs to be aware of VRP evolution over time which we discuss next.

Hedgers Behavior and Regime Change

Further important insights can be gained by looking at the performance of volatility risk premia strategies over time. Many risk premia strategies in energy markets are known to be sensitive to regimes, as described by Bouchouev and Zuo (2020). Energy markets constantly evolve, adjusting for new fundamental drivers like the growth of shale and structural factors from the market financialization. These factors lead to changing behavior among hedgers and speculators that impact the supply and demand for risk management services, and the resulting volatility risk premium. The VRP strategy is no exception. Figure 4 presents the equity history of the non-overlapping position VRP strategy comprising out-of-the money puts, out-of-the-money calls, and at-the-money straddles, which highlights the presence of a structural break that separates two distinct regimes – three if we consider pre and post financial crisis as two regimes.

Figure 4



Note: Cumulative performance of a non-overlapping position VRP strategy. The strategy sells 100 contracts of 10% out-of-the-money puts, calls and at-the money straddles with one month to expiry and delta hedges daily.

Sources: Authors' calculation and graphic, CME data.

During the decade leading up to the financial crisis, the strategy generated impressive returns with a Sharpe Ratio well above 1.0. For those brave enough to sell into the aftermath, superior returns continued as liquidity providers raised "insurance premiums" and stopped providing liquidity altogether as a result of the carnage felt by the short vol trade. Then by the beginning of 2014 the salad days of the VRP strategy in oil markets were gone. Where did it go and why?

The strategy became a victim of its own success. As the business of passive commodity investments lost its allure pressured by the prevalence of contango and punitive rolling costs, the capital shifted towards more dynamic strategies designed to capture various systematic risk premia. To make it easier for investors, the VRP concept has also been packaged into investable indices, and the cumbersome task of daily delta-hedging was effectively outsourced to index providers. Such indices allowed large pools of capital held by pension funds and other institutional investors to access what used to be an obscure opportunity that previously could only be captured by oil specialists equipped with the right technology and risk management capabilities.

Another important factor behind the structural break in VRP is the evolution of hedging strategies by U.S. shale producers. Unlike traditional oil projects, shale is closer to mining operations where constant drilling is required to keep the production flowing. The shale business has been developed mostly by independent and highly leveraged producers whose access to capital provided by lending banks is often conditional on hedging the price risks. While hedging for producers became nearly mandatory, their ability to pay the premium for the insurance was limited. Instead, their hedging strategies shifted to more leveraged structures, such as costless collars which are net volatility neutral, and three-way collars where producers sell two options, an out-of-the-money put and an out-of-the-money call, to finance the purchase of at-the-money put.

Finally, the impact of one large-scale annual sovereign put buying program consistently executed by the Finance Ministry of Mexico since 2002 gradually became more muted. This program, which is described in more detail by Bouchouev and Fattouh (2020), was designed to protect the country's export revenues, which are heavily dependent on oil, and the program quickly turned into the largest derivatives deal of each year. The hedge effectively treated put options as an insurance product with over one billion dollars spent annually on the option premium. More recently, the hedging volumes were reduced as the country's overall oil production and exports decreased. In addition, to reduce costs in certain years, the strategy of buying outright puts was replaced with buying cheaper put spreads whose overall impact on the volatility is much smaller.

The impressive historical performance of the oil VRP strategy attracted more providers of oil insurance, who were willing to accept lower returns and take on larger risks. In addition, the natural buyers of the insurance, producers and consumers, demonstrated their own creativity by restructuring their approaches to hedging. Instead of buying relatively expensive outright insurance, the hedgers now routinely buy an option and finance it by selling another option, often monetizing the real optionality embedded in their assets.

The business of extracting VRP via the traditional approach of selling at-the-money straddles is no longer attractive for financial investors. However, the aggregate premium has not entirely disappeared, rather it became somewhat spread out across various strikes and maturities, but not in a uniform manner. The opportunities to provide insurance-like products in commodity options became more dynamic with some options becoming more expensive than others. To spot these opportunities, one needs more granular quantitative metrics for the performance of such tailored strategies. Like the concept of implied volatility skew became the standard tool for the volatility traders, we believe that the concept of the volatility risk premium skew could become as valuable for systematic risk premia investors seeking new sources of alpha.

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APPLIED RESEARCH DIGEST

The *Global Commodities Applied Research Digest (GCARD)* is produced by the J.P. Morgan Center for Commodities (JPMCC) at the University of Colorado Denver Business School.

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