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Deep Hedging with Options Using the Implied Volatility Surface

We propose a deep hedging framework for index option portfolios, grounded in a realistic market simulator that captures the joint dynamics of S&P 500 returns and the full implied volatility surface. Our approach integrates surface-informed decisions with multiple hedging instruments and explicitly accounts for transaction costs. The hedging strategy also considers the variance risk premium embedded in the hedging instruments, enabling more informed and adaptive risk management. Tested on a historical out-of-sample set of straddles from 2020 to 2023, our method consistently outperforms traditional delta-gamma hedging strategies across a range of market conditions.