The Impact of News on Investment Habits

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Group video

Content

Presentation Overview

- Problems Addressed
- Methodology
- Full model equations
- Challenges Encountered
- Key Insights
- Code and results

Problems addressed

- **Impact of News on Market sentiment**: Simulating how discrete news events, such as earnings announcements or geopolitical developments, affect stock prices.
- **Volatility Modeling:** Accounting for sudden spikes in stock volatility driven by unexpected news.
- **Dynamic Market Sentiment:** Incorporating market sentiment changes (bullish, neutral, bearish) through a Markov process, influenced by news events.
- **Stochastic Jump Rates:** Handling time-varying intensity of stock price jumps, modeling the irregular frequency of impactful news.

Methodology

Stock Price Dynamics

- Combines Brownian motion and jumps for gradual and sudden price changes.
- Jump frequency modeled using a Cox-Ingersoll-Ross process.

Heston Variance with Jumps

- Mean-reverting stochastic variance with jumps for news impact on volatility.

Markov Process for Sentiment

- Transition matrix models bullish, neutral, and bearish states.
- News dynamically adjusts transition probabilities.

Jump Size Distribution

- Normal distributions for price and volatility jumps.
- Captures asymmetric effects of positive and negative news.

Full model Equations

- **Stock Price Dynamics with Jump-Diffusion:**

$$dS_t = rS_t\,dt + \sqrt{V_t}S_t\,dB_t + S_t\int_{\mathbb{R}}(z-1)\,\tilde{N}(dt,dz)$$

- **Variance Dynamics with Jumps (Heston Process):**

$$dV_t = \kappa(\theta - V_t)\,dt + \eta\sqrt{V_t}\,dW_t + \int_{\mathbb{R}}\xi(z)\,\tilde{N}(dt,dz)$$

- **Stochastic Intensity Process (CIR Process):**

$$d\lambda_t = \alpha(\beta - \lambda_t)\,dt + \delta\sqrt{\lambda_t}\,dZ_t$$

- **Compensated Poisson Random Measure**

$\tilde{N}(dt,dz)$ is the compensated Poisson random measure with **stochastic intensity** $\lambda_t\,dt\,\nu(dz)$, where $\nu(dz)$ is the distribution of jump sizes z.

Challenges Encountered

- **Data Dependency:** Accurate simulation depends on reliable historical data for calibration of parameters such as jump size distributions, sentiment transitions, and volatility dynamics.
- **Model Complexity:** Combining jump diffusion, Heston variance, and a Markov process increases computational intensity and parameter estimation challenges.
- **Behavioral Assumptions:** Modeling sentiment transitions based on predefined probabilities might oversimplify complex investor behaviors and external influences.
- **Unpredictable Events:** Sudden, unprecedented events (e.g., pandemics) may not be well-captured by historical-based parameterization.

Model Parameters

T = 3 Time horizon in years
N = 252 Number of steps (trading days)
dt = T / N # Time increment

Parameters for stock dynamics:

r = 0.043 Risk-free rate
S0 = 30.12 Initial stock price
kappa = 1.2 Mean reversion speed of volatility
theta = 0.02 Long-term mean of variance
eta = 0.5 Volatility of variance
v0 = 0.16 Initial variance (volatility squared)
alpha = 0.1 Speed of mean reversion for jump intensity
beta = 1.66 Long-term mean jump intensity
delta = 0.1 Volatility of jump intensity

Jump parameters:

jump_mean = 0.02 Mean jump size for stock price
jump_vol = 0.37 Volatility of jump size
vol_jump_mean = 0.06 Mean jump size for volatility
vol_jump_vol = 0.1 Volatility of jump size

ASSUMPTIONS WE MADE

For the model graph for Nvidia we made the following assumptions:

- There is 252 days in trading year
- Risk free rate for 2024 was used: r = 4.3%
- Only 3 sectors were used to simplify the model
- Market initial sentiment is Neutral
- Jump parameters are subject to changes to subtle changes in reality, we used a fixed values instead
- Markov chain for market sentiment changes whenever a news happens and probabilities are fixed
- Impact of the news is measured as a value between 0 and 1
- News were derived from real time events that occurred during the period of time studied

CODE

NVIDIA Stock Price

Key insights

News Events as Catalysts

The model highlights how news acts as a trigger for discrete jumps in both price and volatility, capturing real-world market reactions.

Time-Varying Intensity

Stochastic jump intensity adapts to periods of high or low news impact, simulating volatile market phases and calm intervals.

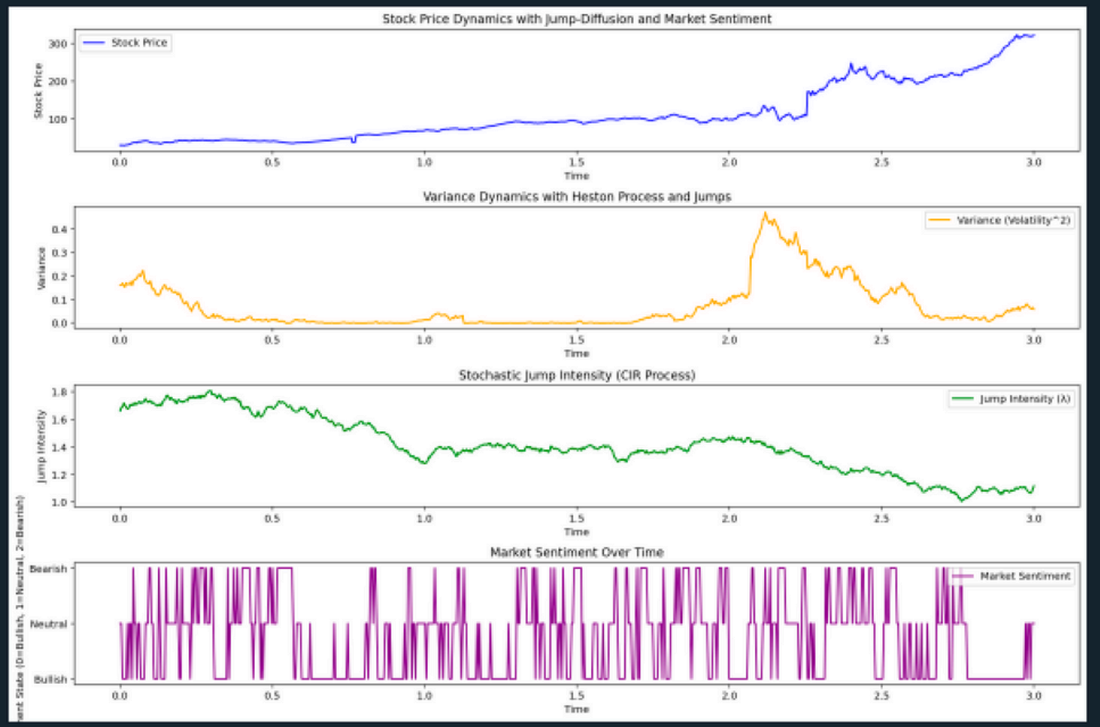
Dynamic Sentiment Integration

Market sentiment transitions, influenced by news, provide a behavioral layer to the model, reflecting investor psychology.

Holistic Market Dynamics

The combination of jump diffusion, volatility modeling, and sentiment analysis creates a comprehensive framework for understanding market behavior.

RESULTS



Help | Variable Explorer | Debugger | Plots | Files

Console 1/A

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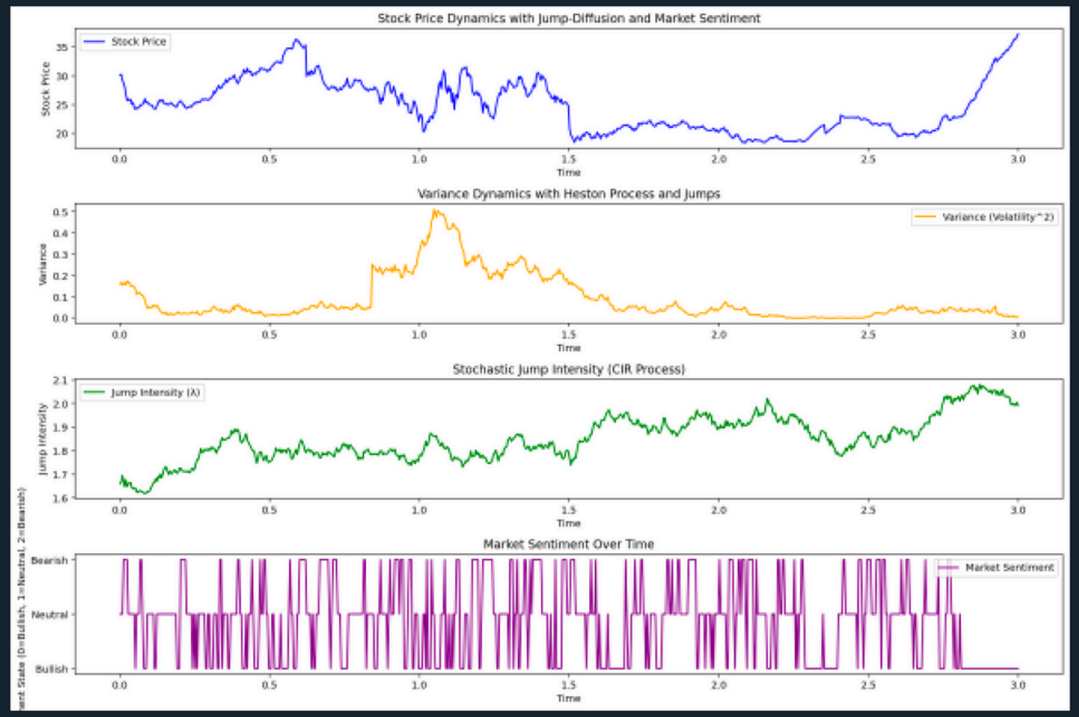
**********RELEVANT NEWS REPORTED HEREE**********
Time: 0.40, News: Cryptocurrency Mining Bust , sector: Technology, nature: Negative, Impact Strength: 0.84
Time: 0.60, News: Product Releases and Market Optimism, sector: Technology, nature: Positive, Impact Strength: 0.91
Time: 0.69, News: AI Surge , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 0.99, News: Strategic Partnerships, sector: Technology, nature: Positive, Impact Strength: 0.00
Time: 1.19, News: Positive Sentiment from AI Boom , sector: Technology, nature: Positive, Impact Strength: 0.81
Time: 1.98, News: Competition Concerns , sector: Technology, nature: Negative, Impact Strength: 0.00
Time: 2.58, News: Data Center Growth , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 2.78, News: Stock Split , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 2.88, News: Collaboration with AWS, sector: Technology, nature: Positive, Impact Strength: 0.72
Time: 2.98, News: Resilience Amid Market Challenges, sector: Technology, nature: Negative, Impact Strength: 0.67
```

RESULTS



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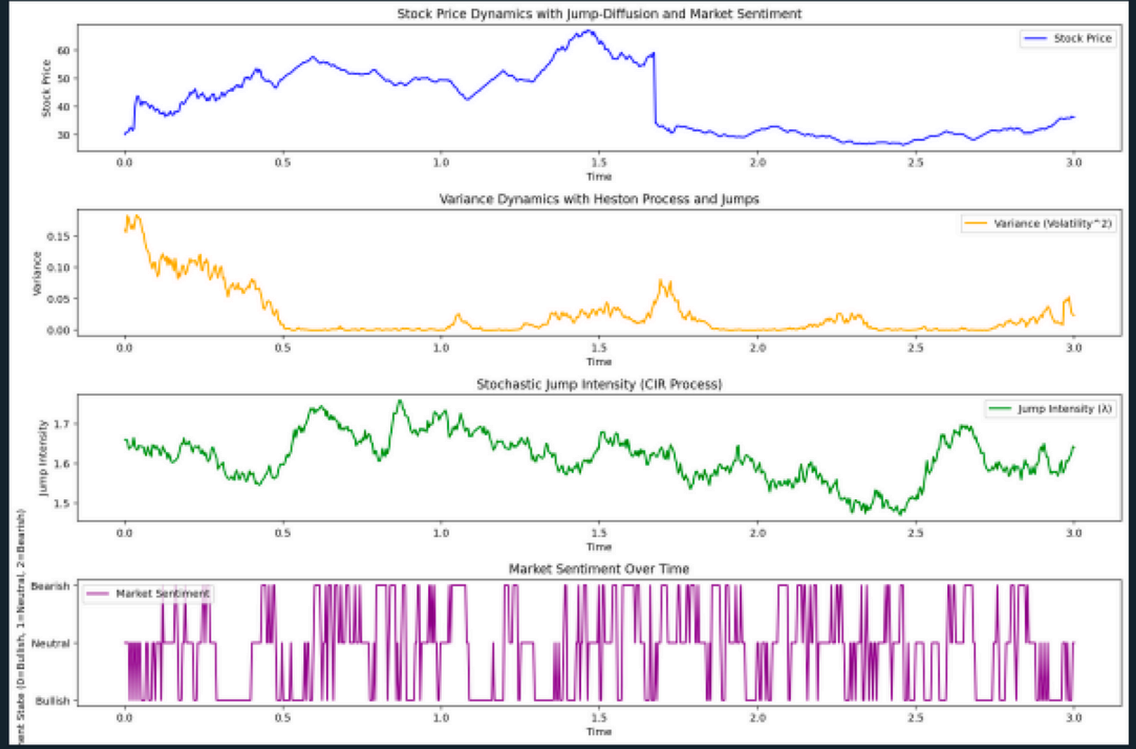
IPython Console | History

Inline | Conda: spyder-runtime (Python 3.11.10) | LSP: Python | Line 1, Col

RESULTS



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Console 1/A

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**********RELEVANT NEWS REPORTED HEREE**********
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Time: 0.30, News: AI Surge , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 0.50, News: Positive Sentiment from AI Boom , sector: Technology, nature: Positive, Impact Strength: 0.81
Time: 0.79, News: Cryptocurrency Mining Bust , sector: Technology, nature: Negative, Impact Strength: 0.84
Time: 1.09, News: Product Releases and Market Optimism, sector: Technology, nature: Positive, Impact Strength: 0.91
Time: 1.29, News: Stock Split , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 1.39, News: Competition Concerns , sector: Technology, nature: Negative, Impact Strength: 0.00
Time: 2.28, News: Resilience Amid Market Challenges, sector: Technology, nature: Negative, Impact Strength: 0.67
Time: 2.68, News: Collaboration with AWS, sector: Technology, nature: Positive, Impact Strength: 0.72
Time: 2.88, News: Data Center Growth , sector: Technology, nature: Positive, Impact Strength: 1.00
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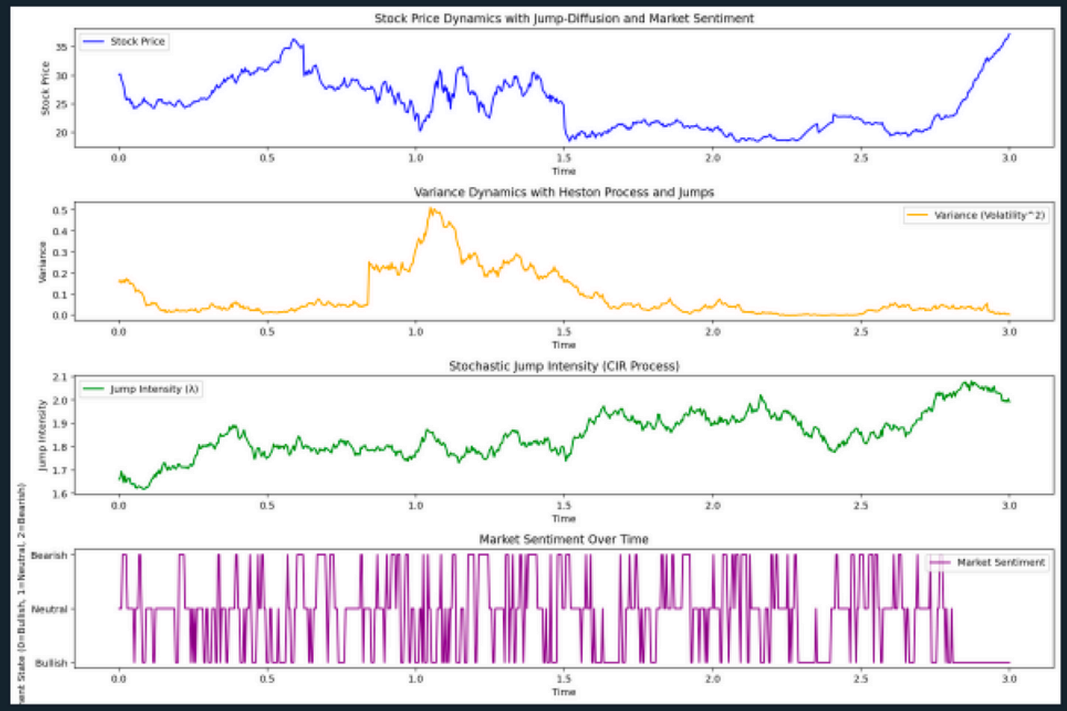
IPython Console | History

RESULTS



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Console 1/A

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**********RELEVANT NEWS REPORTED HEREE**********
Time: 0.50, News: Stock Split , sector: Technology, nature: Positive, Impact Strength: 1.00
Time: 0.89, News: Resilience Amid Market Challenges, sector: Technology, nature: Negative, Impact Strength: 0.67
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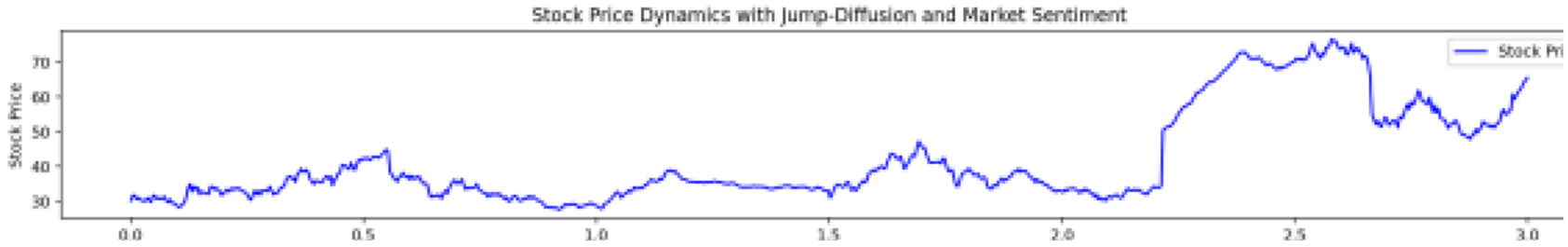
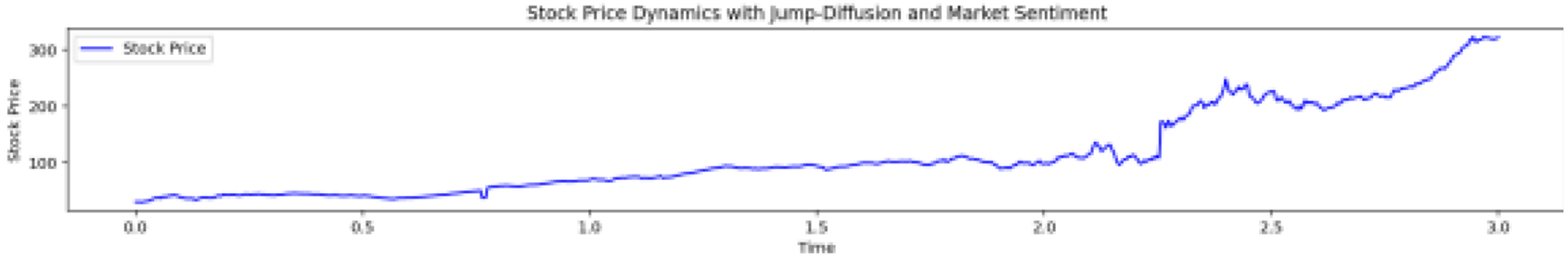
Comparisons with Nvidia stock price

Here we are making a side by side comparison with two of the outputs we obtained randomly

- Model 1 has more variation in price
- Model 2 is exponentially growing





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Thank you!