

## Day 1 Research Note

### Exploring Prices, Returns, and Volatility in SPY (2010–Present)



#### Abstract

This research note documents the construction of a reproducible data pipeline for extracting daily SPY market data and transforming raw prices into return and volatility series. Day 1 focuses on understanding price dynamics, return behavior, and rolling volatility. Results show that daily returns behave like noise, while volatility displays clear clustering patterns.

#### 1. Introduction

This research exercise establishes the foundation of quantitative analysis, including cleaning market data, computing returns, and estimating rolling volatility. The goal is to build intuition for how financial time series behave.

#### 2. Data & Methodology

##### 2.1 Data Source

Ticker: SPY

Period: 2010–present

Frequency: Daily

Provider: Yahoo Finance (via yfinance)

##### 2.2 Transformations

Simple daily returns:

$$r_t = (P_t / P_{(t-1)}) - 1$$

Log daily returns:

$$\log_r_t = \ln(P_t) - \ln(P_{(t-1)})$$

##### 2.3 Rolling Volatility (20-Day Annualized)

Annualized rolling volatility is computed as:

$$\sigma_{20} = \sqrt{252} * \text{std}(\log_r_t \text{ over past 20 days})$$

#### 3. Results

##### 3.1 Price Behavior

SPY prices show long-term drift but no meaningful short-term structure. Prices are non-stationary and unsuitable for direct modeling.

##### 3.2 Simple and Log Returns

Simple and log returns are nearly identical at daily scale. Returns appear centered around zero, with no visible autocorrelation, behaving like noise.

### **3.3 Rolling Volatility & Volatility Clustering**

Volatility evolves smoothly and shows clear clustering behavior. High-volatility days tend to follow other high-volatility days. Low-volatility days cluster similarly.

### **4. Interpretation & Insights**

Returns behave unpredictably Volatility is persistent and predictable Log returns are mathematically convenient and additive Rolling windows naturally produce initial NaN values

### **5. Limitations**

Only daily data was used 20-day window is arbitrary No distribution or autocorrelation analysis yet

### **6. Conclusion**

Day 1 establishes a solid foundation for deeper research. Returns resemble noise, prices are non-stationary, and volatility clusters in regimes—core properties of financial markets.

### **7. Next Steps**

Analyze return distributions Study fat tails and extreme moves Compute autocorrelation of absolute returns Prepare first mini-paper