# OANDA Group

## FX Volatility Prediction and Insights from Tick Data and Market Events

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# Problem Revisited

# Objectives

- Classify and characterize the volatility regime for a given FX pair.
- Understand the relationship between the current volatility regime and market reaction to known event.

# Snapshot of price data and event data

**Figure 1:** Snapshot of several lines of price data

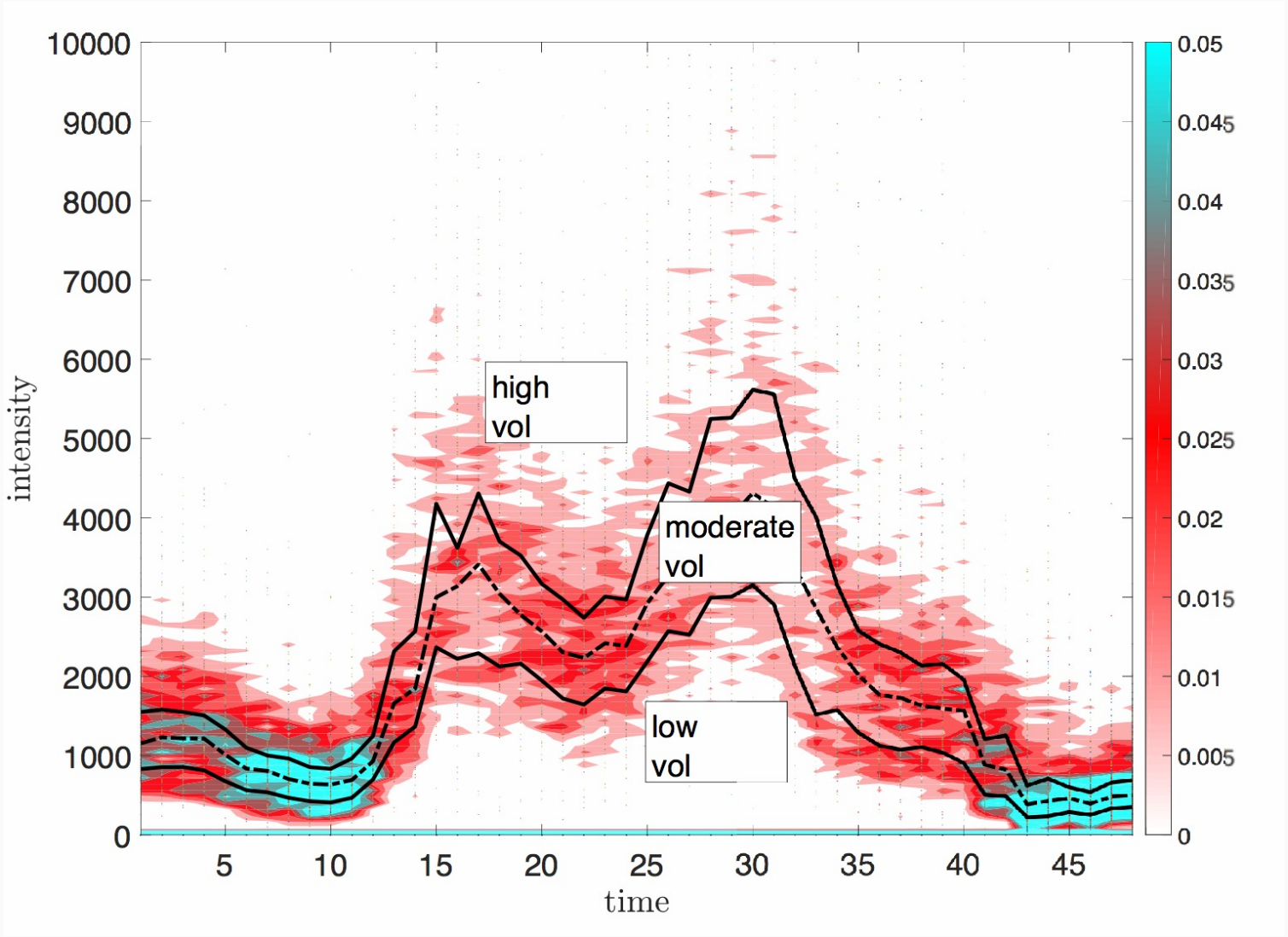
| Currency | Timestamp | Ask Price | Bid Price | Trade or not |
|---|---|---|---|---|
| EUR/USD | 1514844002 | 1.20022 | 1.20082 | T |
| EUR/USD | 1514844092 | 1.20073 | 1.20133 | T |
| EUR/USD | 1514844092 | 1.20077 | 1.20137 | T |
| EUR/USD | 1514844092 | 1.20061 | 1.20121 | T |
| EUR/USD | 1514844092 | 1.20074 | 1.20134 | T |
| EUR/USD | 1514844092 | 1.20053 | 1.20113 | T |
| EUR/USD | 1514844092 | 1.20047 | 1.20107 | T |

**Figure 2:** The event data

| Timestamp | Name | Volatility | Country | Actual | Consensus |
|---|---|---|---|---|---|
| 1488333600 | Trump's speech to Congress | 3 | United States | | |
| 1488380400 | ISM Manufacturing PMI | 3 | United States | 57.7 | 56 |
| 1488564000 | Fed's Yellen Speech | 3 | United States | | |
| 1489152600 | Nonfarm Payrolls | 3 | United States | 235 | 190 |
| 1489152600 | Unemployment Rate | 3 | United States | 4.7 | 4.7 |
| 1489581000 | Retail Sales (MoM) | 3 | United States | 0.1 | 0.1 |
| 1494568800 | Gross Domestic Product (YoY) | 3 | Germany | 1.7 | 1.7 |

# The analysis of uncategorized events' impact

# Diurnal pattern of intensity (1 min window)



# Formula of transition matrix

- Transition matrix from intensity $\lambda_t^k$ to volatility regimes $\Lambda_t^k \in \{1, 2, 3\}$, where $k$ is day index and $t$ is bin index.
- Unconditioned transition matrix:

$$A_{ij} = \frac{a_{ij}}{\sum_j a_{ij}}$$

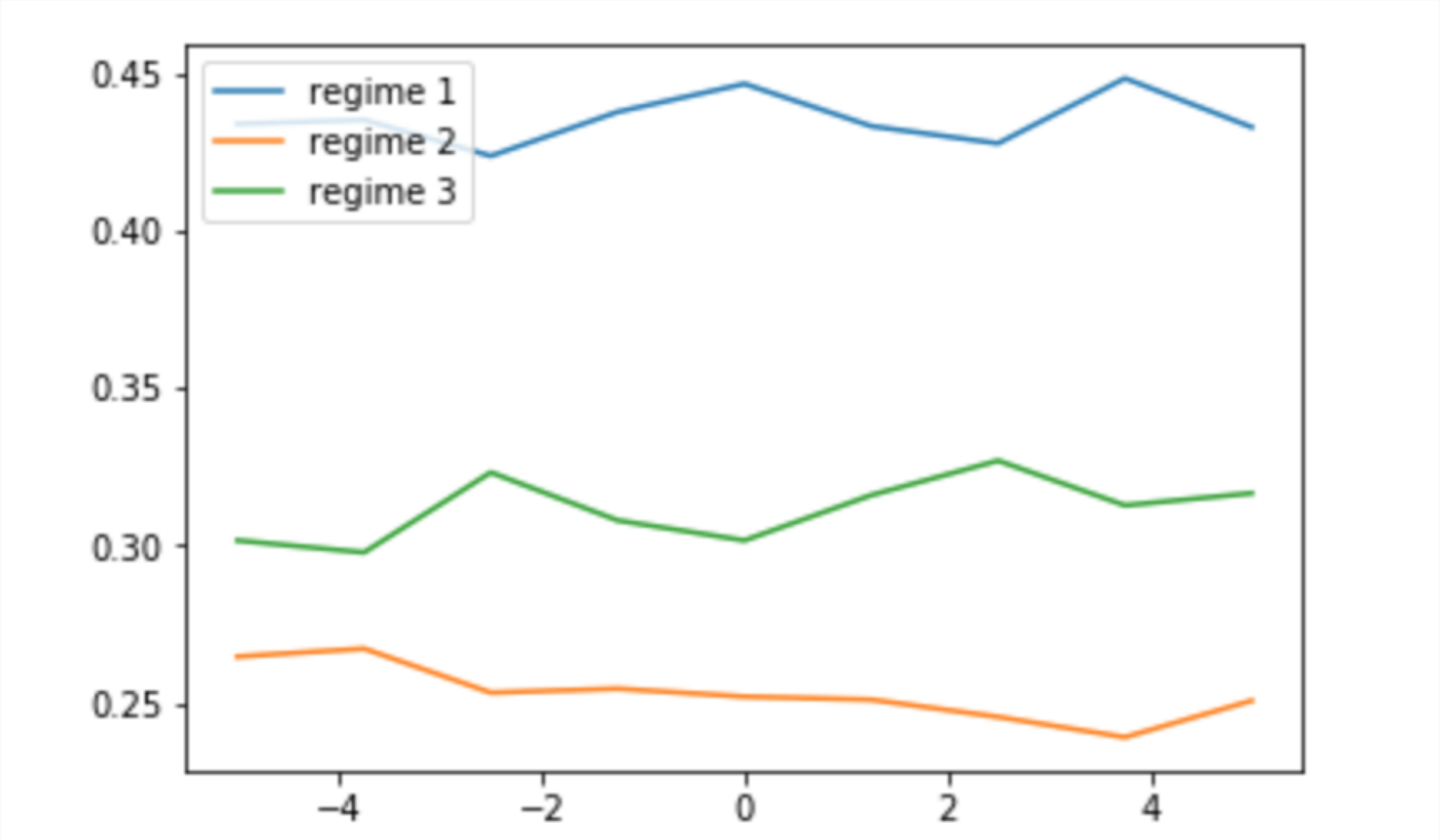
$$a_{ij} = \sum_{t,k} 1_{\{\Lambda_t^k = i, \Lambda_{t+1}^k = j\}}$$

- Conditional transition matrix with event impact:

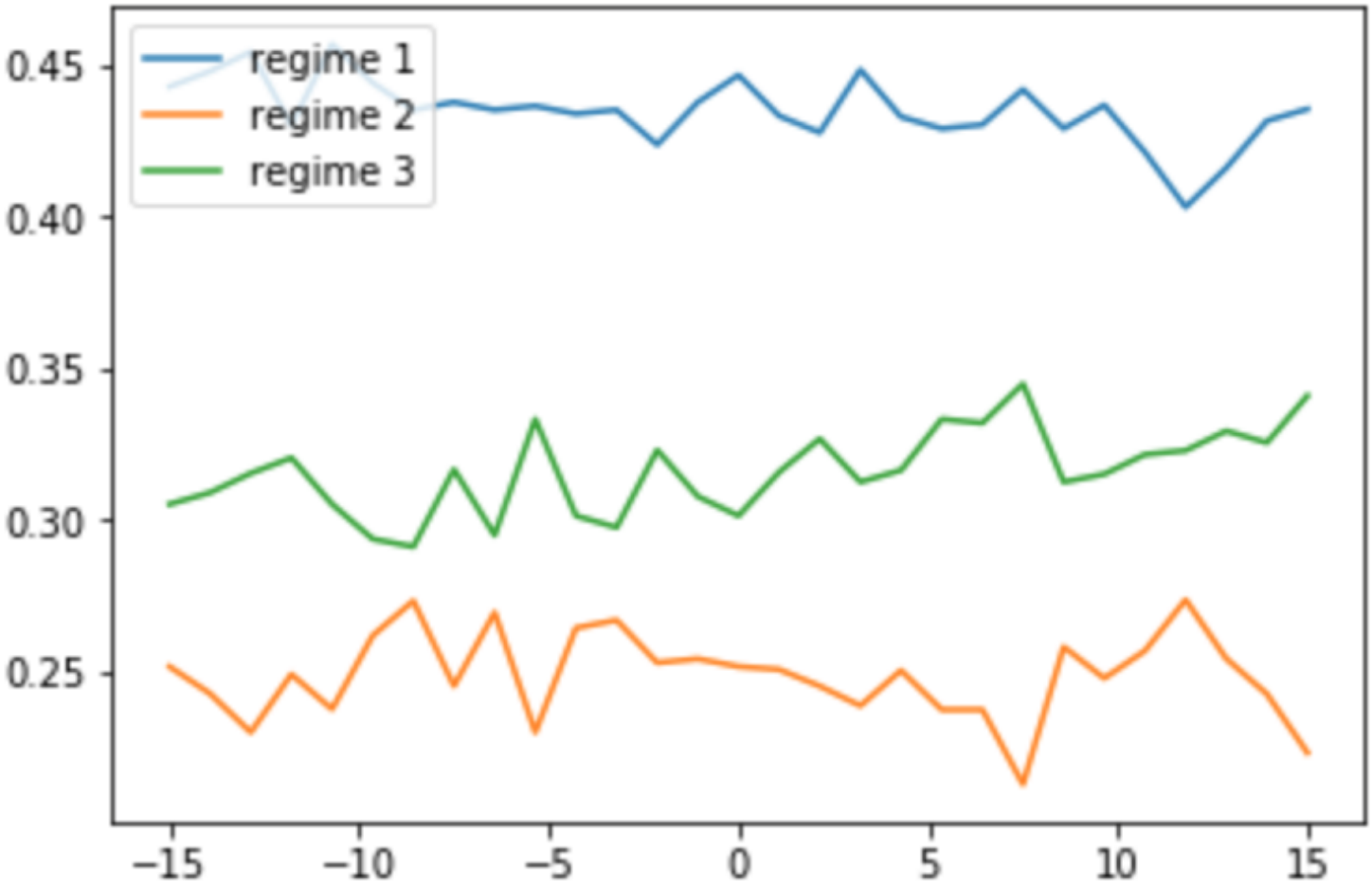
$$B_{ij} = \frac{b_{ij}}{\sum_j b_{ij}}$$

$$b_{ij} = \sum_n 1_{\{\Lambda_{t_n}^{k_n} = i, \Lambda_{t_{n+1}}^{k_n} = j\}}$$

# Average distribution of regime ratio 5 mins before/after event



# Average distribution of regime ratio 15 mins before/after event



# Transition Matrix

```
Unconditioned matrix t->t+1
[[ 0.79  0.17  0.04]
 [ 0.19  0.53  0.28]
 [ 0.03  0.26  0.71]]
Transition matrix during event and 1 minute after
[[ 0.66  0.27  0.07]
 [ 0.15  0.52  0.33]
 [ 0.04  0.25  0.71]]
Unconditioned matrix t->t+2
[[ 0.57  0.26  0.17]
 [ 0.29  0.34  0.37]
 [ 0.15  0.34  0.51]]
Transition matrix 1 minute before event and 1 minute after
[[ 0.62  0.23  0.14]
 [ 0.17  0.52  0.31]
 [ 0.04  0.25  0.71]]
Unconditioned matrix t->t+3
[[ 0.52  0.28  0.2 ]
 [ 0.31  0.33  0.36]
 [ 0.19  0.34  0.48]]
Transition matrix 1 minute before event and 2 minute after
[[ 0.61  0.23  0.16]
 [ 0.2   0.49  0.31]
 [ 0.05  0.29  0.65]]
```

# Probability Transformation of Intensity Data

- $\hat{F}_t$: the ecdf of intensity in bin t
- Unconditional:

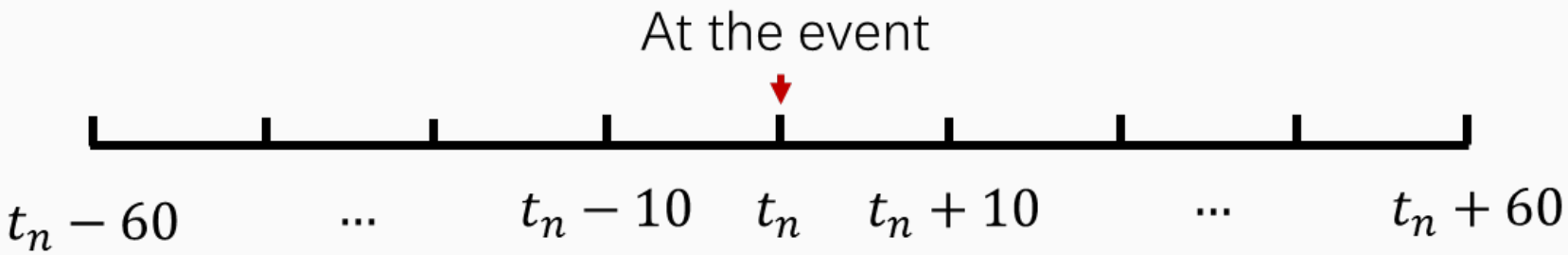
$$\lambda_t^k \xrightarrow{\hat{F}_t} \rho_t^k \in [0,1]$$

- Conditional:

$$\lambda_{t_n}^{k_n} \xrightarrow{\hat{F}_t} \rho_{t_n}^{k_n} \in [0,1] \text{(at the event)}$$

- The unconditional distribution should be uniform (in theory).

We will see the conditional distributions before and after the event.



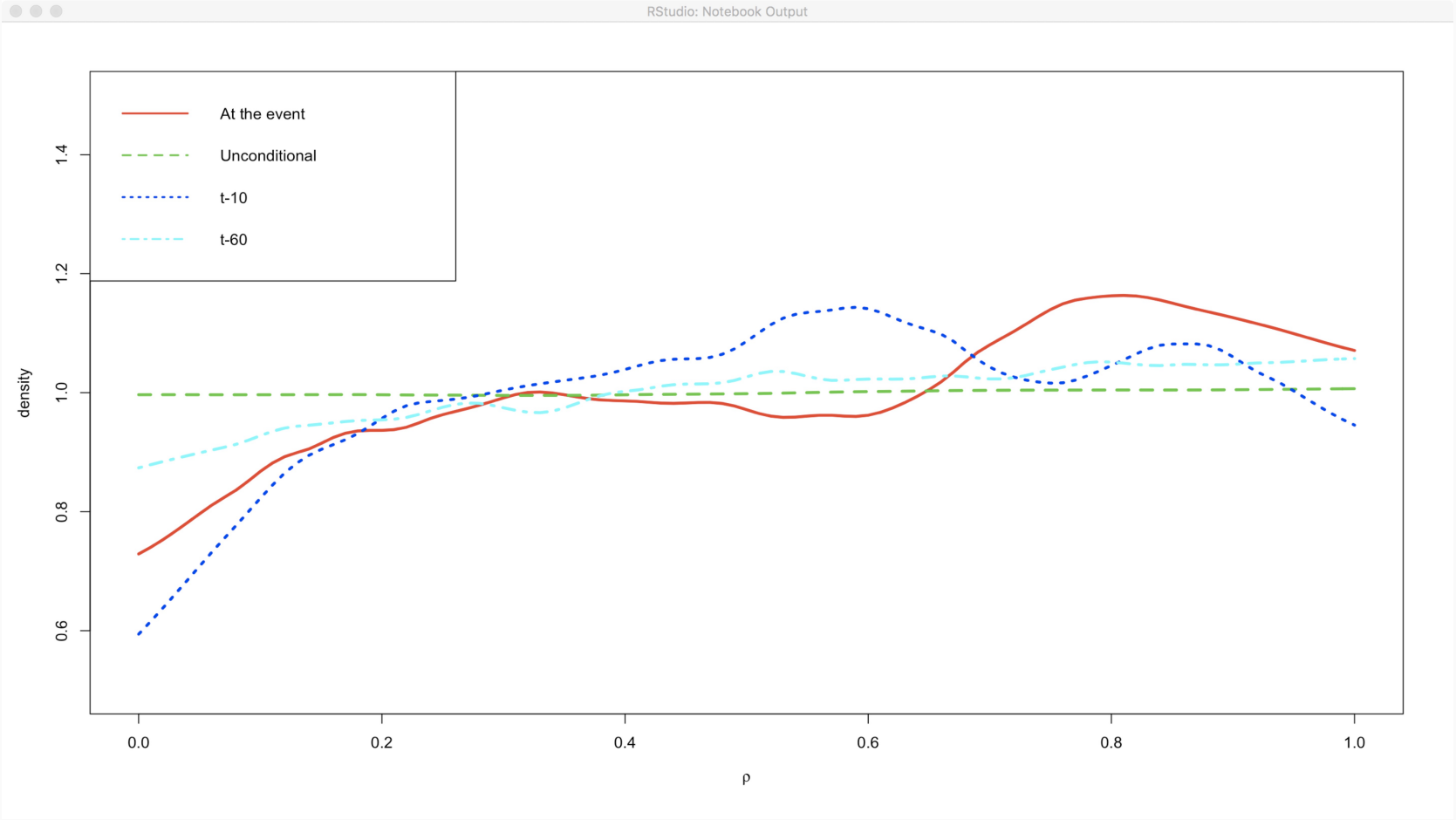



**Figure 3:** Conditional distributions at and before the event

(x axis: $\rho$, y axis: density)

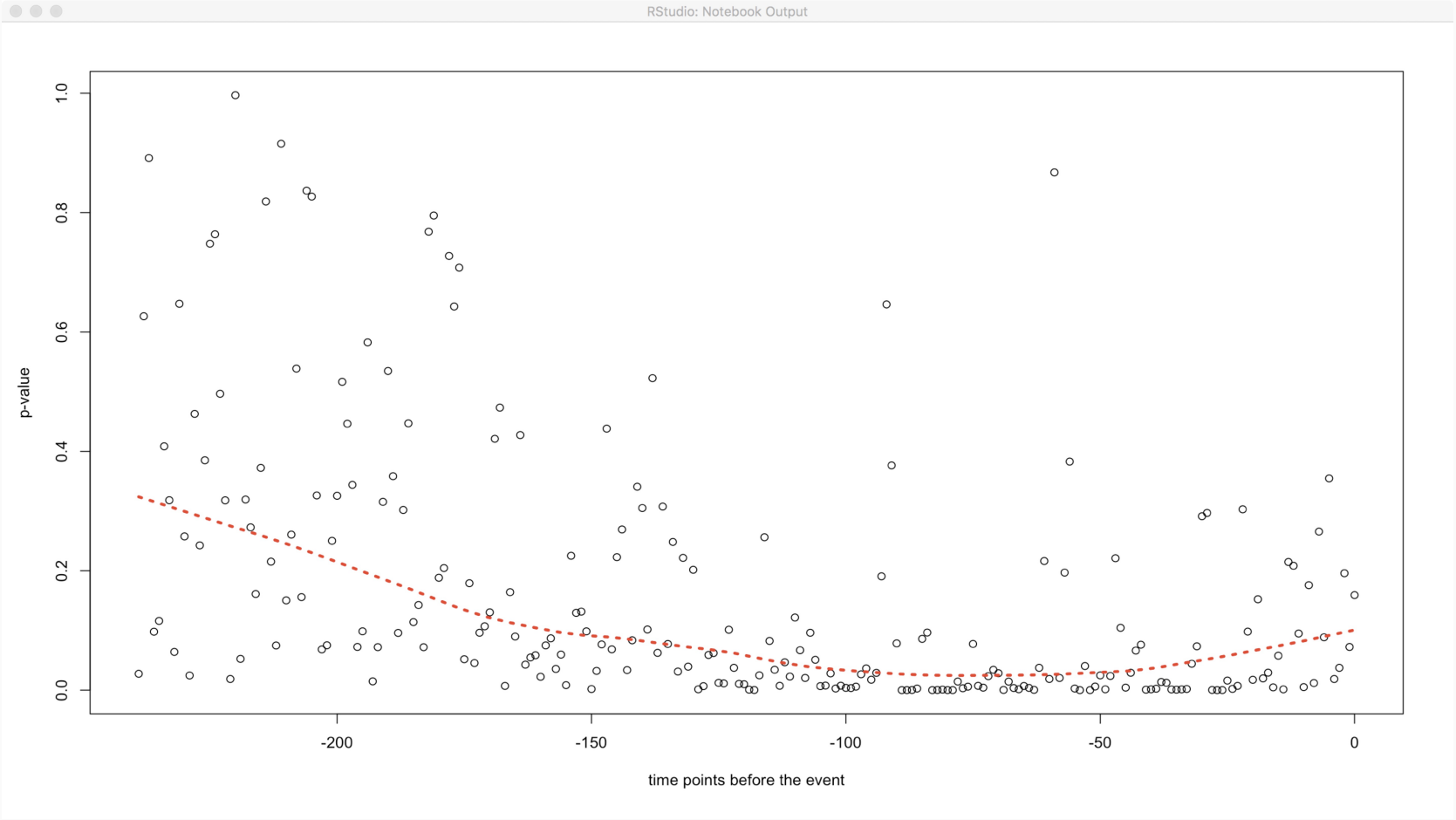



**Figure 4:** Conditional vs unconditional distributions (ks.test) before the event

(x axis: time points before the event, y axis: p-value)

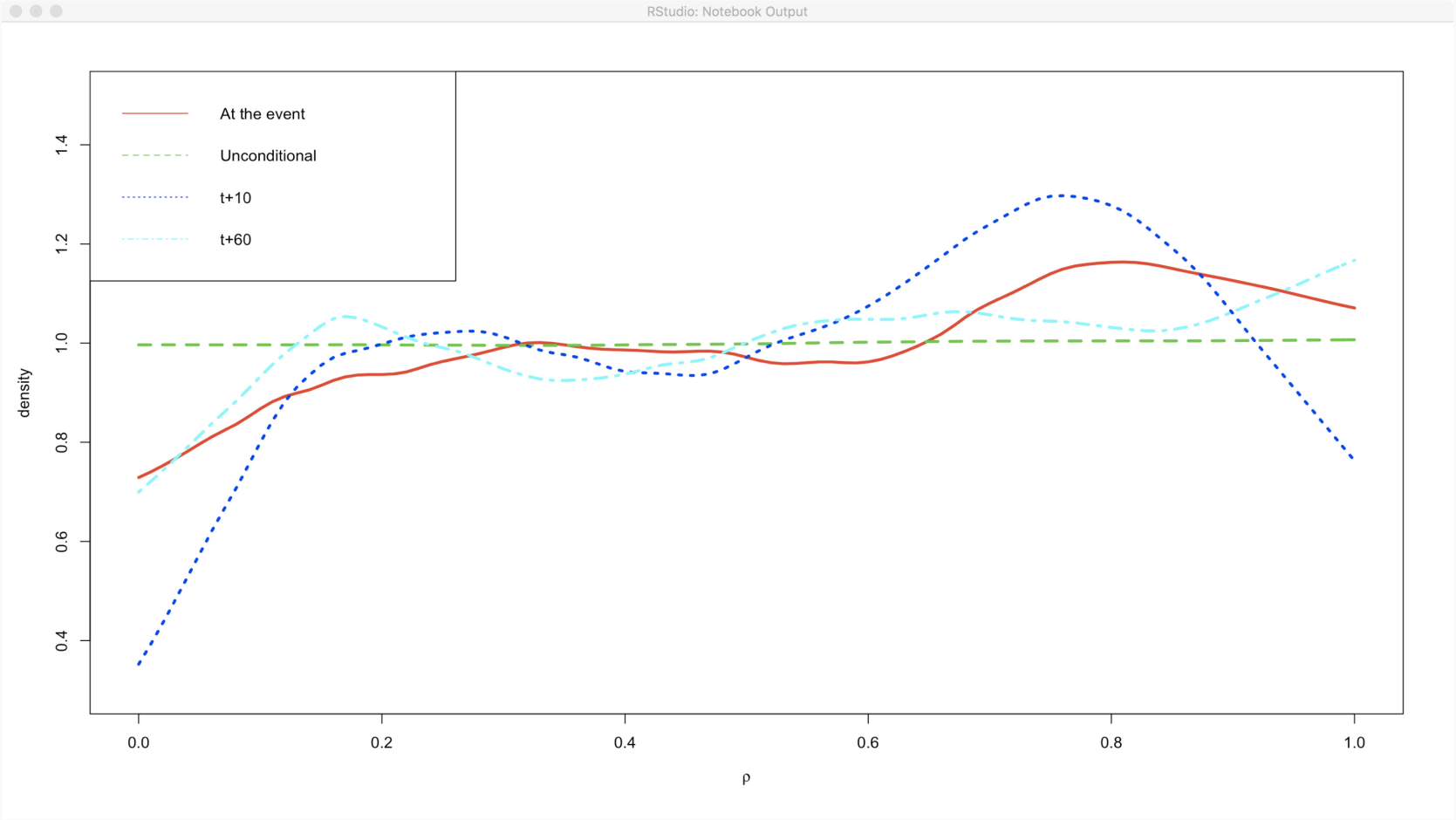



**Figure 5:** Conditional distributions at and after the event

(x axis: $\rho$, y axis: density)

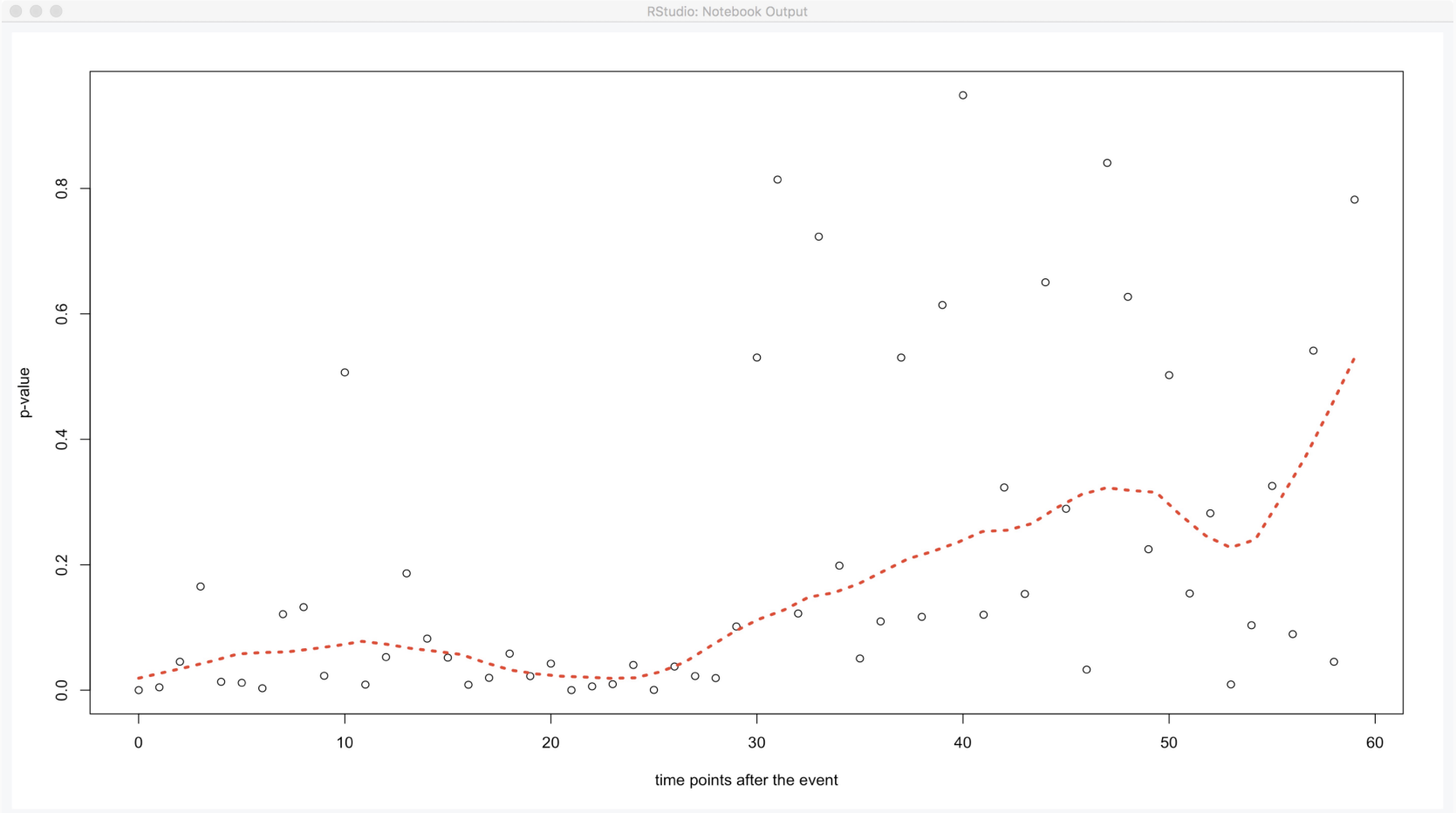



**Figure 6:** Conditional vs unconditional distributions (ks.test) after the event

(x axis: time points after the event, y axis: p-value)

# The analysis of categorized events' impact

# Quadratic variation

$$QV = \sum_{t=0}^{5min} (S_t - S_{t-1})^2$$

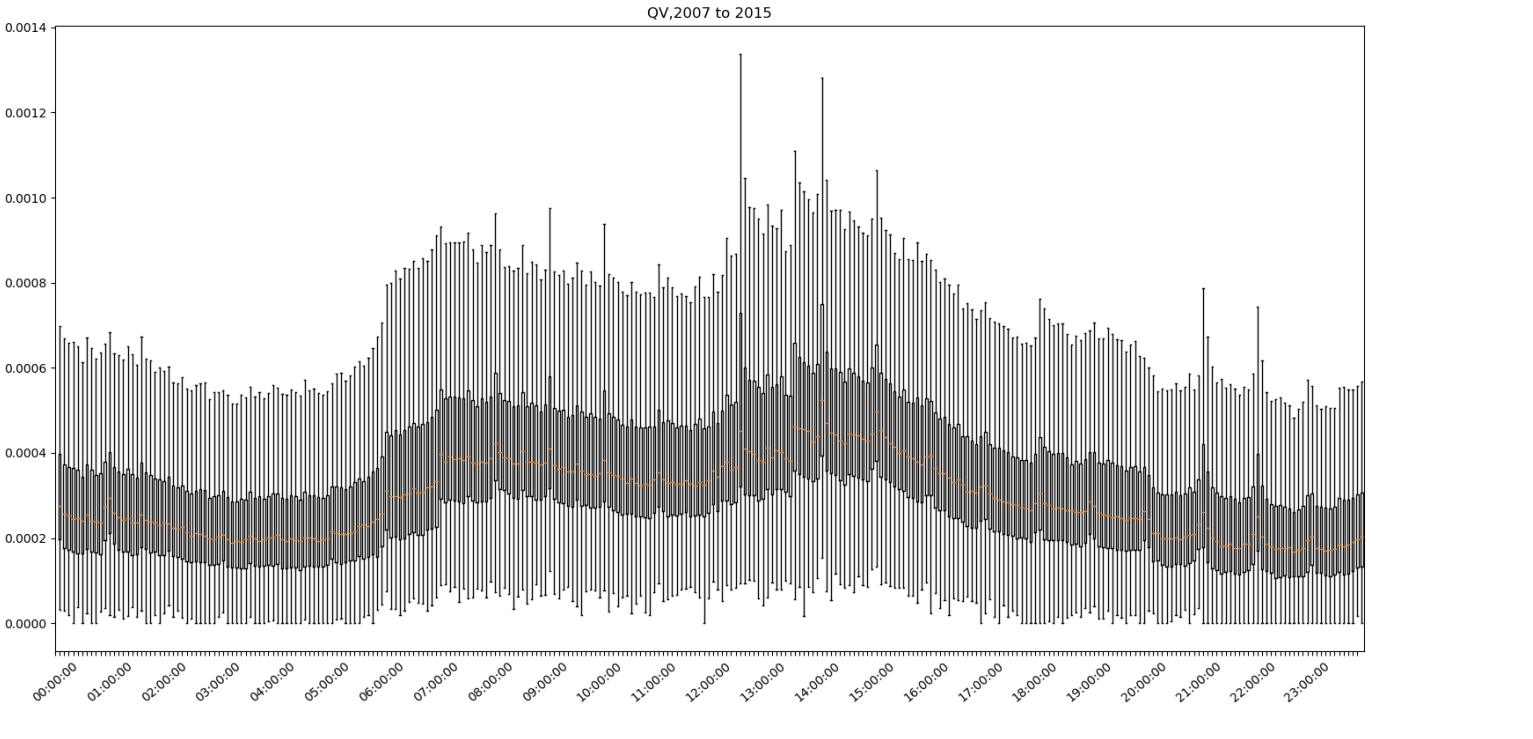



**Figure 7:** Background ratios of increase of volatility over the day

# Measure of Ratio

$$Ratio = \frac{\frac{\text{QV(after 5 mins of event)}}{\text{QV(before 5 mins of event)}}}{\frac{\text{QV(after 5 mins of typical )}}{\text{QV(before 5 mins of typical)}}} - 1$$

# Impact of Events

| Event Name | QV (5mins) | QV (30mins) |
|---|---|---|
| FOMC Minutes United States | 212.80% | 150.75% |
| Fed Interest Rate Decision United State | 201.99% | 233.86% |
| ECB Monetary policy statement and pr | 156.38% | 139.40% |
| Unemployment Rate United States | 141.35% | 125.42% |
| Nonfarm Payrolls United States | 140.88% | 125.05% |
| Retail Sales (MoM) United States | 128.33% | 62.61% |
| Retail Sales ex Autos (MoM) United Sta | 113.58% | 52.14% |
| Consumer Price Index (YoY) United Stat | 112.54% | 62.52% |
| Consumer Price Index Ex Food & Energy | 111.26% | 62.78% |

# Does Mismatch matter?

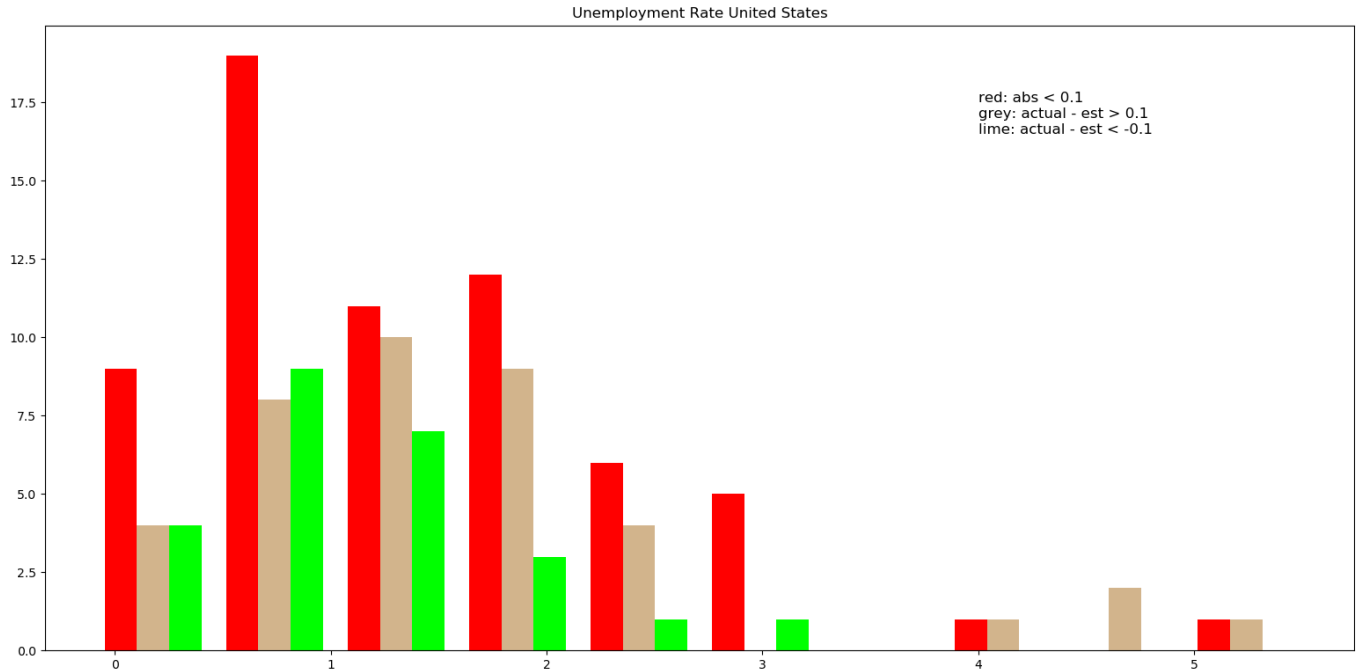



**Figure 8:** The Unemployment Rate

# Latent Variable Modeling

# Thanks!

## Any Questions and Suggestions?