Bitcoin: Modeling Intraday Price Dynamics

CS 574, Fall 2014
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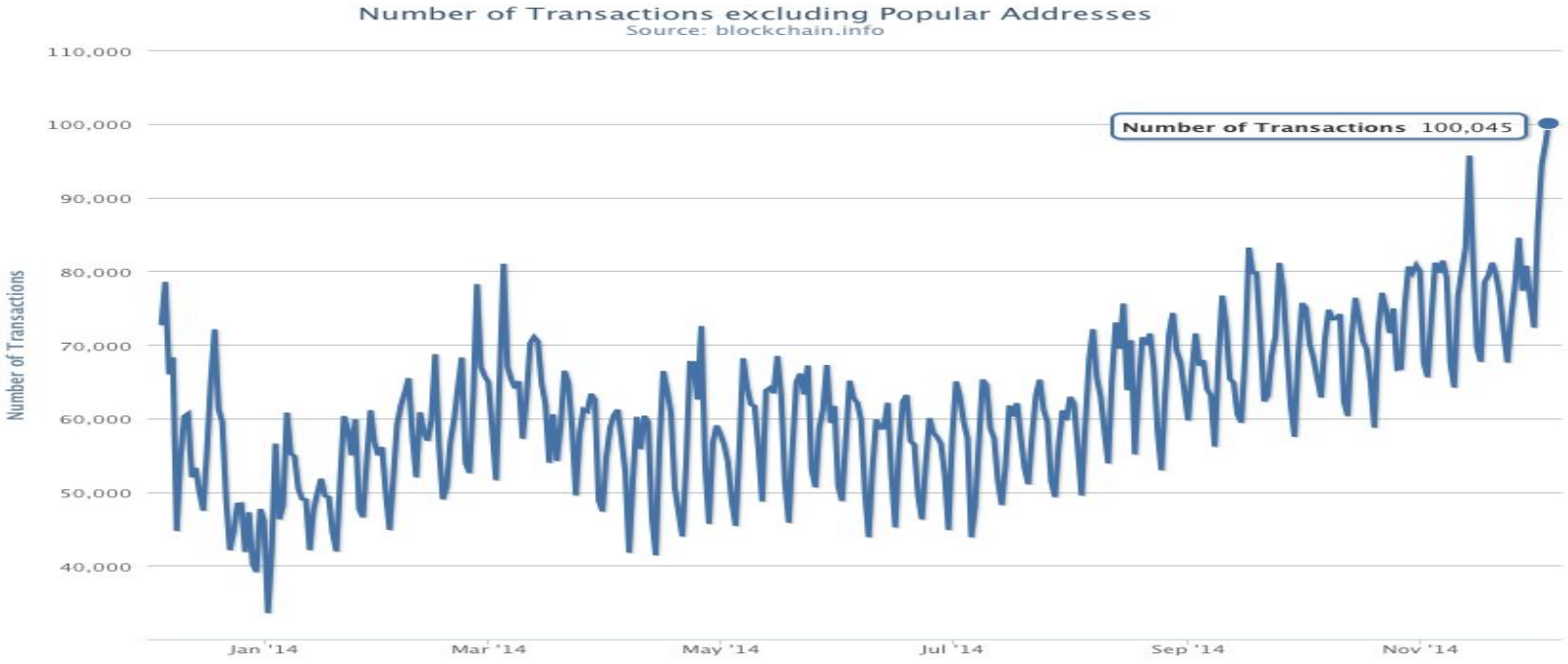
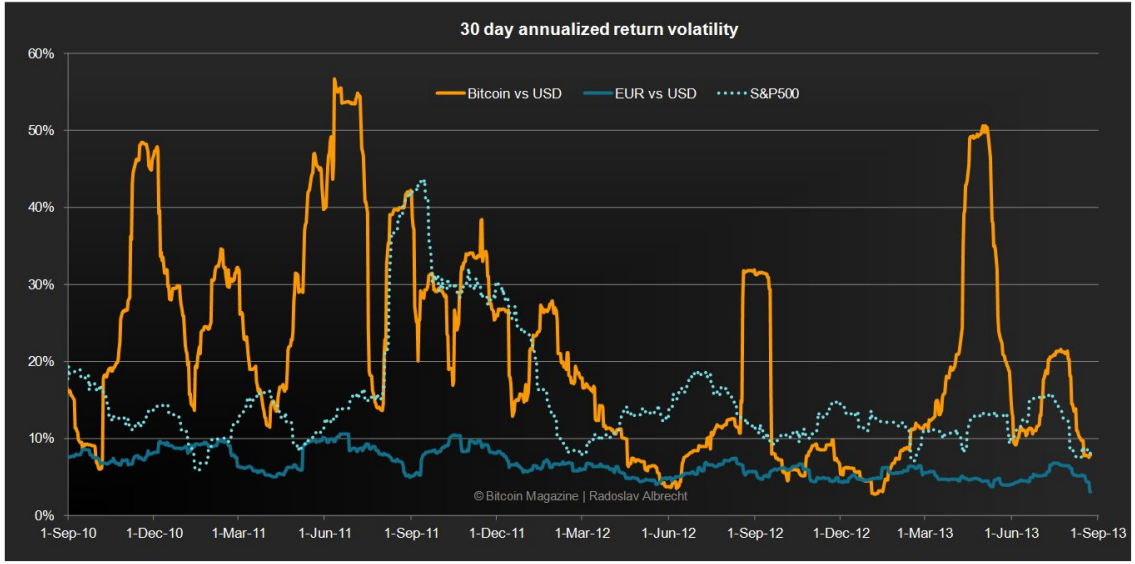
What it is and why you should care

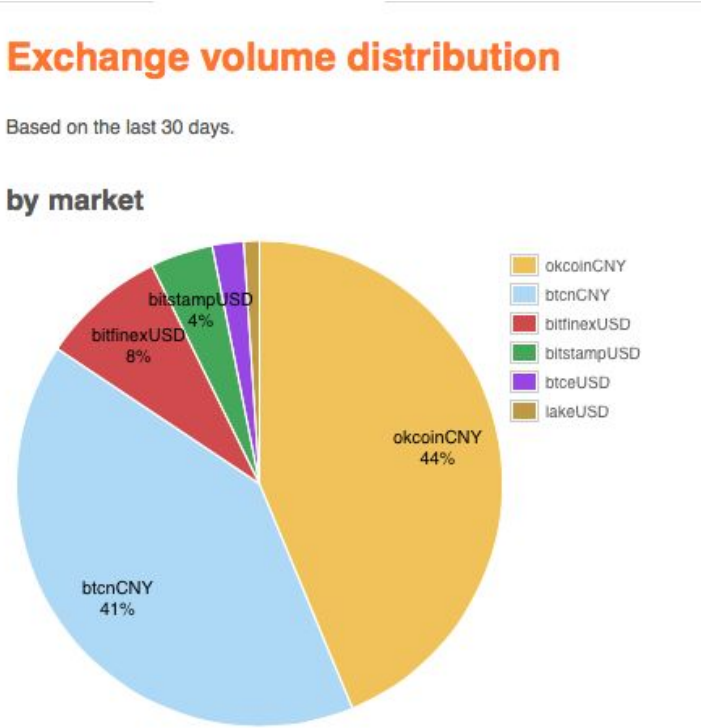
- Bitcoin is a consensus network that enables the exchange of a decentralized and purely digital currency.
- From a user perspective, Bitcoin is just cash on the internet.
- Nobody owns the Bitcoin network much like no one owns the technology behind email.
- Bitcoins are not printed, they are mined.


Number of Transactions excluding Popular Addresses
Source: blockchain.info
Number of Transactions
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
Number of Transactions 100,045
Jan '14
Mar '14
May '14
Jul '14
Sep '14
Nov '14

The Bitcoin Exchange Landscape

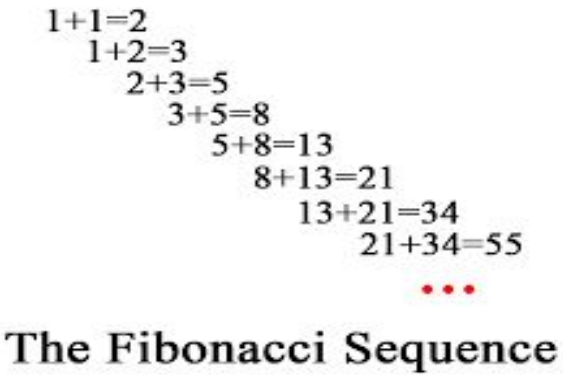
- Third-party exchanges
- Historically high volatility



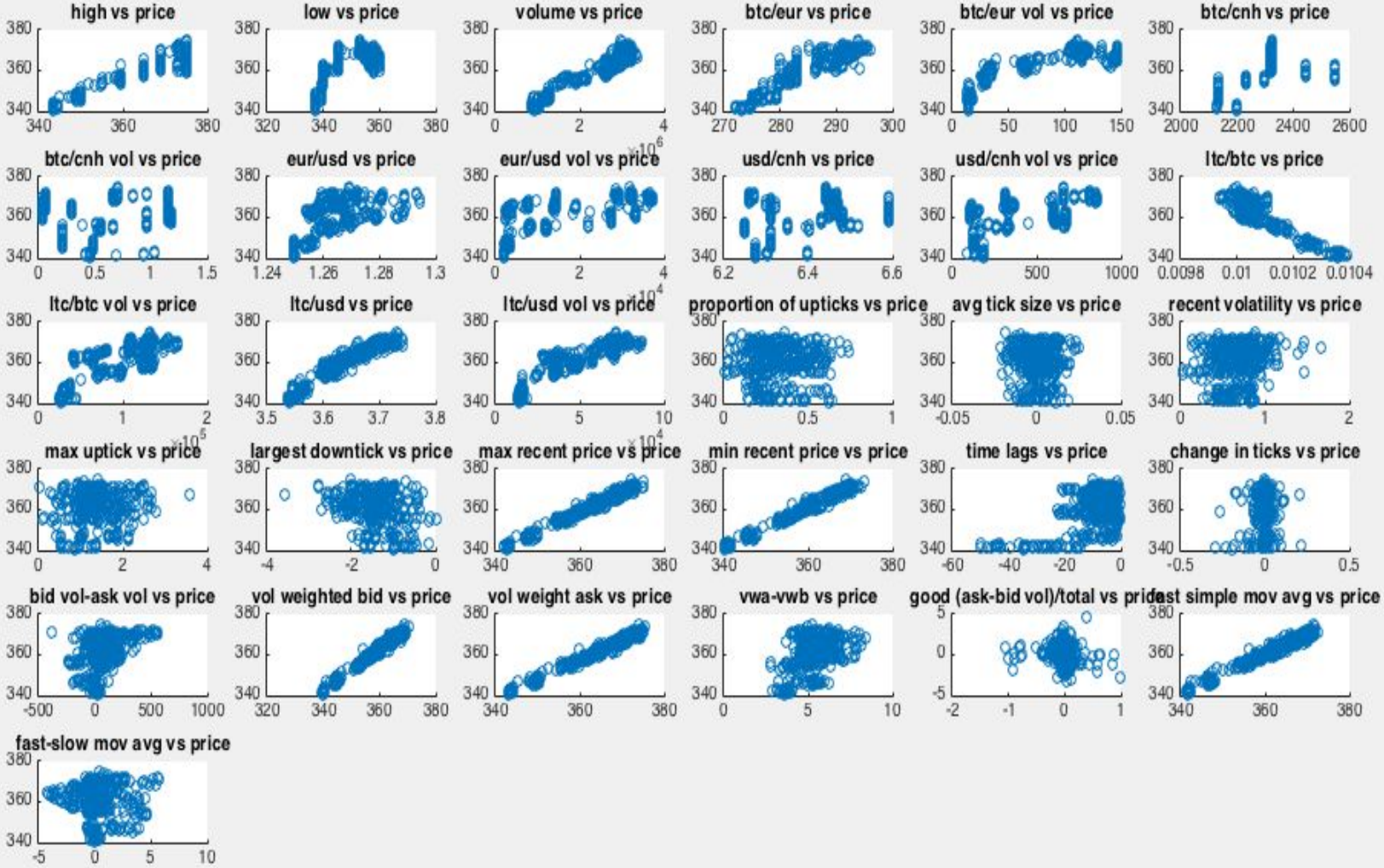


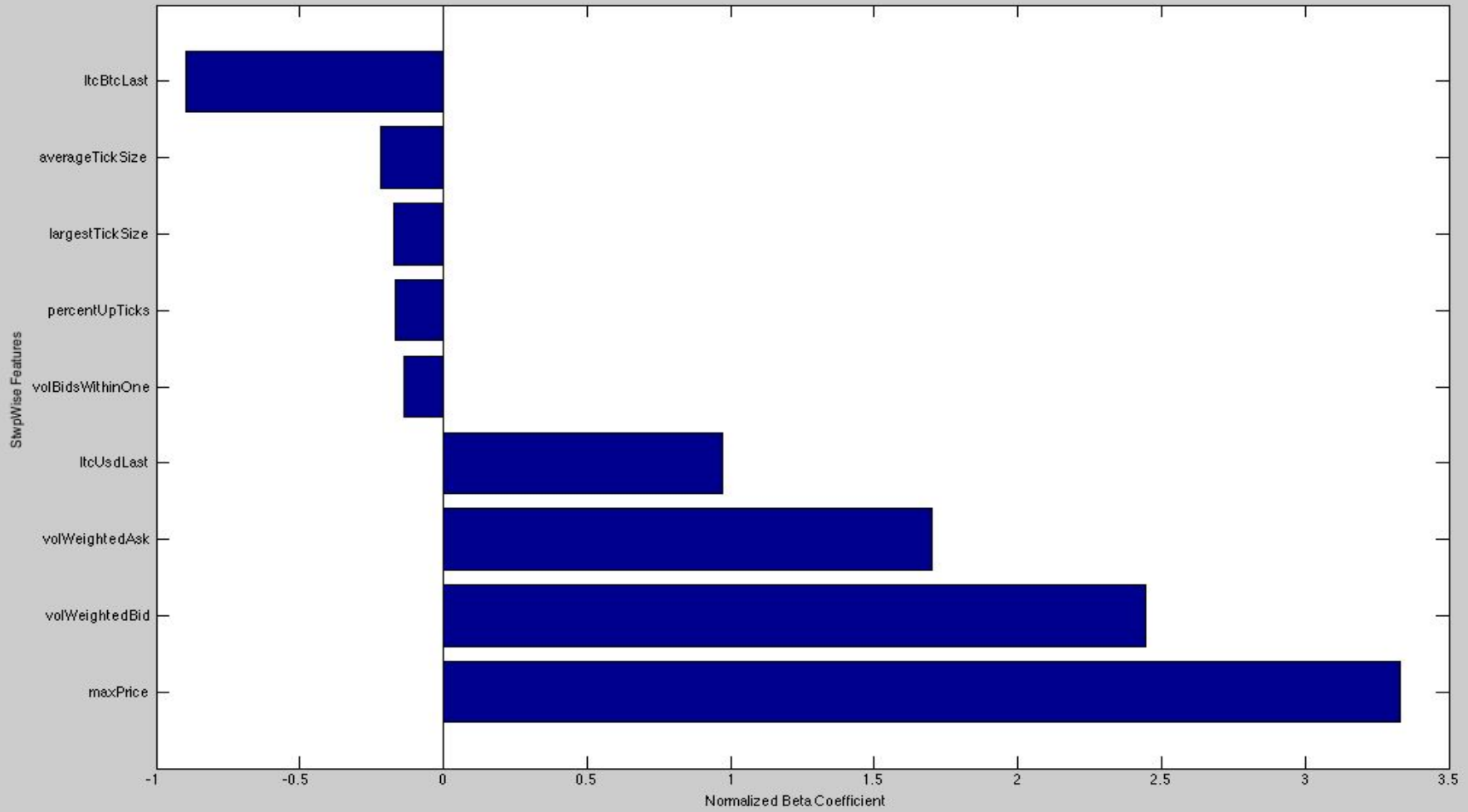
Objectives

- Model Bitcoin price dynamics on 10 minute intervals
  - Look at entire order book
  - Extract features based on technical indicators, correlated markets, and microstructure
- Buy low, sell high



The Fibonacci Sequence


high vs price
low vs price
volume vs price
btc/eur vs price
btc/eur vol vs price
btc/cnh vs price
btc/cnh vol vs price
eur/usd vs price
eur/usd vol vs price
usd/cnh vs price
usd/cnh vol vs price
ltc/btc vs price
ltc/btc vol vs price
ltc/usd vs price
ltc/usd vol vs price
proportion of upticks vs price
avg tick size vs price
recent volatility vs price
max uptick vs price
largest downtick vs price
max recent price vs price
min recent price vs price
time lags vs price
change in ticks vs price
bid vol-ask vol vs price
vol weighted bid vs price
vol weight ask vs price
vwa-vwb vs price
good (ask-bid vol)/total vs price
fast simple mov avg vs price
fast-slow mov avg vs price


ltcBtcLast
averageTickSize
largestTickSize
percentUpTicks
volBidsWithinOne
ltcUsdLast
volWeightedAsk
volWeightedBid
maxPrice
StwpWise Features
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
Normalized Beta Coefficient

Methodology

- for minute=start:10:retirement
  - raw Data= streamFromBTCE();
  - features = extractFeatures(rawData);
  - predictedReturn = predictReturn(features);
  - if predictedReturn>=threshold
    - Long one BTC
  - else if predictedReturn<=-threshold
    - Short one BTC
  - wait 10 minutes
  - close out position

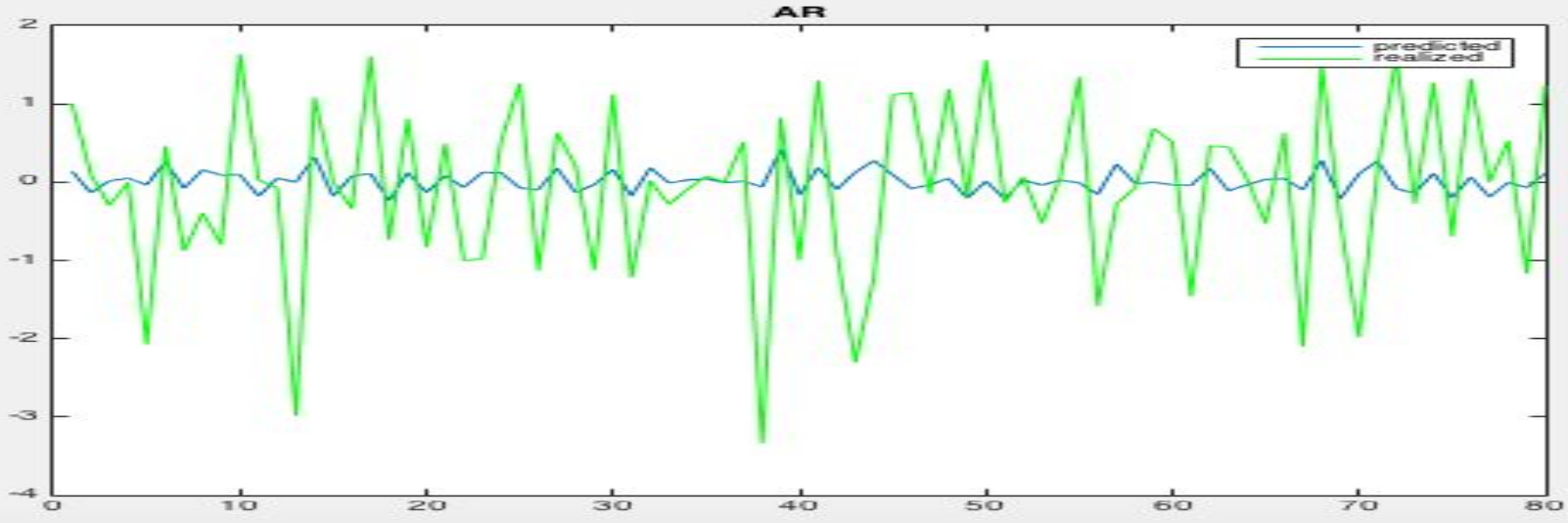
  end

Implementation

- Auto-Regressive Model
- Auto-Regressive Model with Exogenous Inputs
- Adaptive ARX
- NARX
- KNN

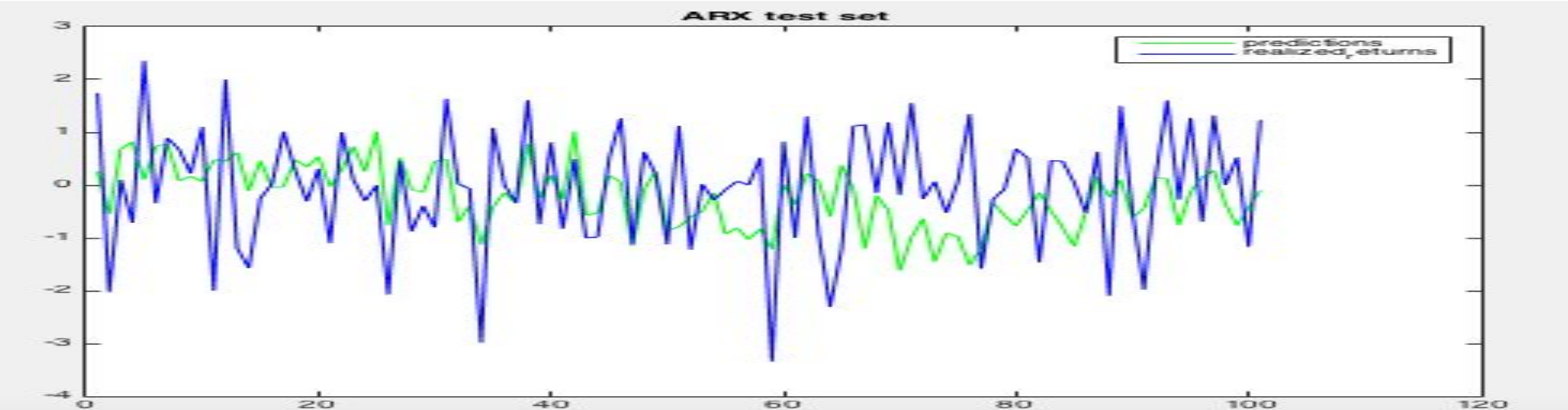
AR

- No exogenous inputs
- Very simple--low variance, high bias
- Non-adaptive; fit via Least Squares
- Cross-validate over model order



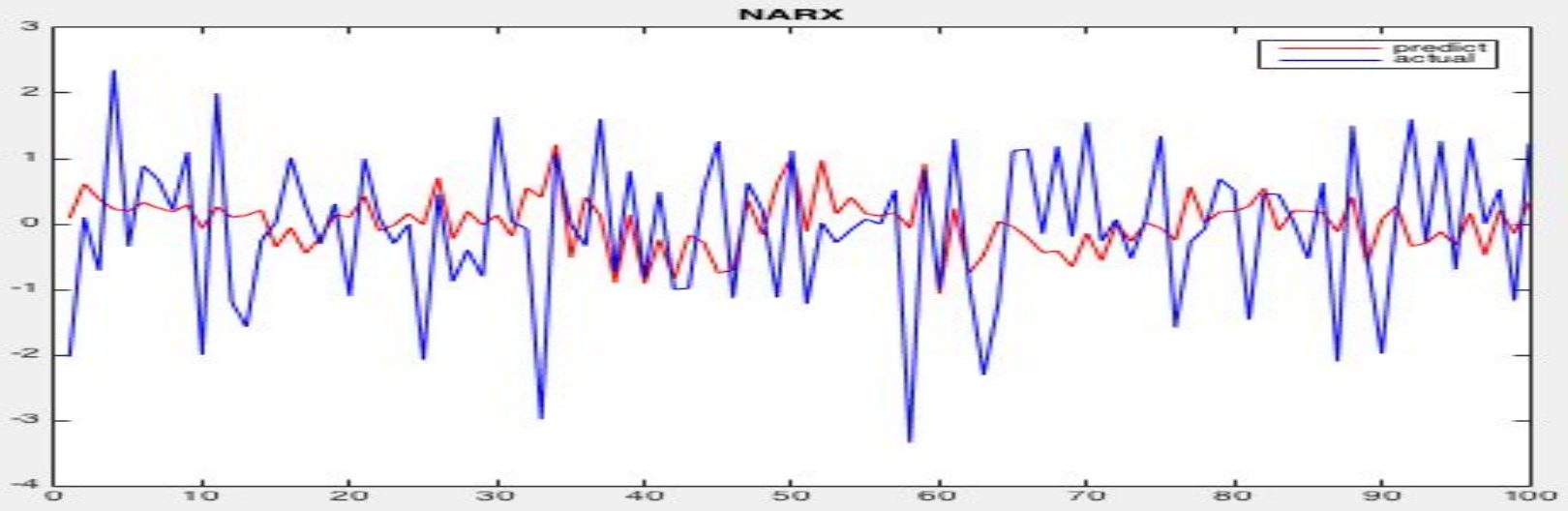
ARX

- Fit via least square
- Non-adaptive



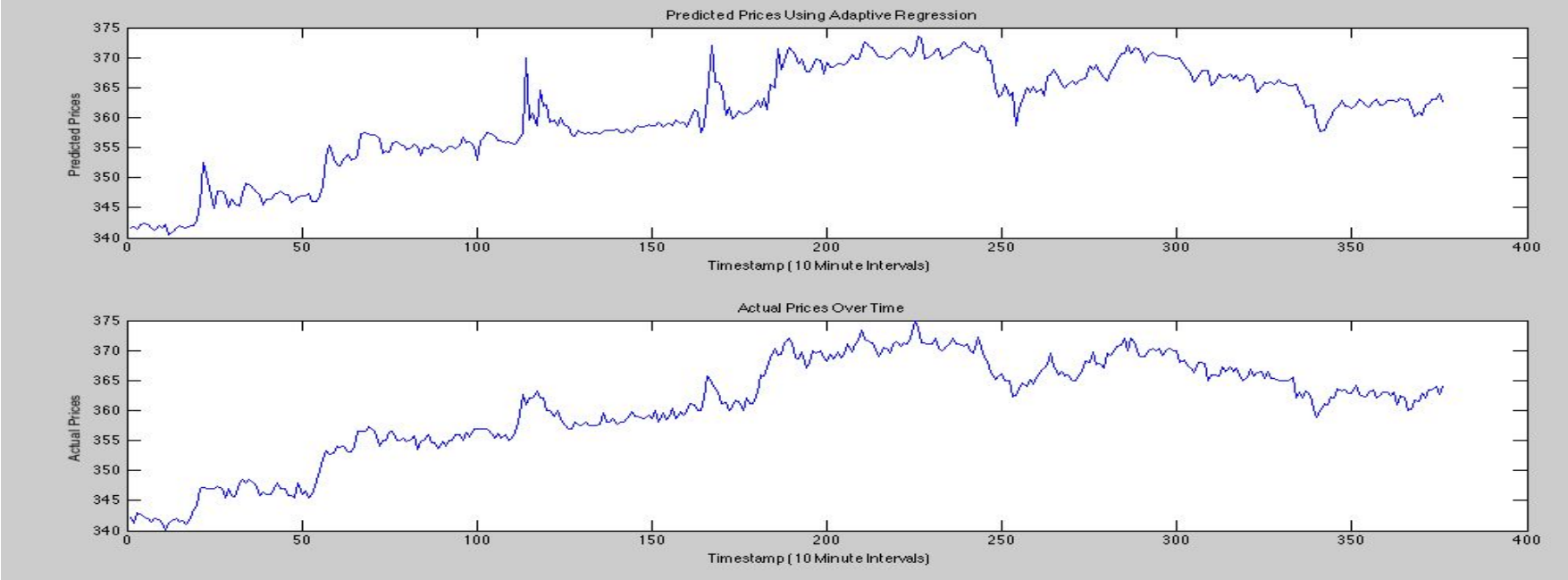
NARX

- Neural net with tap delay
- Adaptive



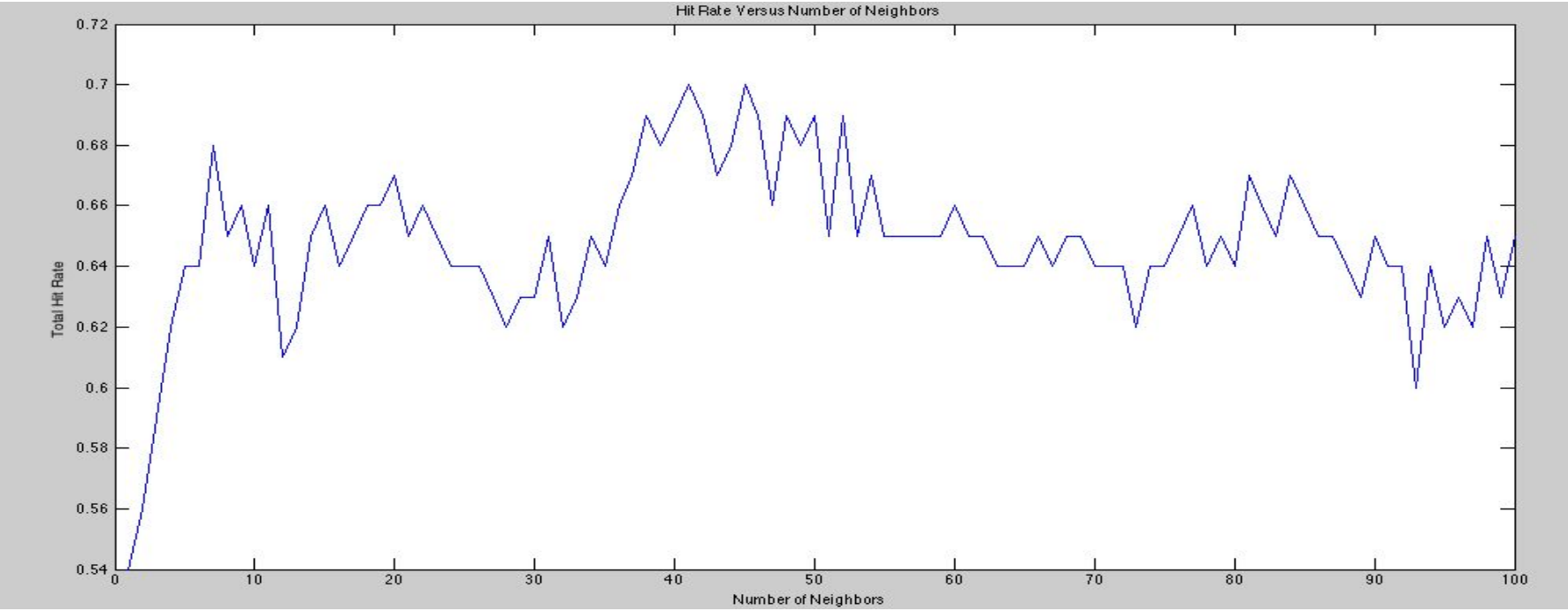
Adaptive Least Squares

- What if we fit a “new” model at every timestamp and use this model to predict the price at time t+1?
- Sliding window regression
- It looks good. But...



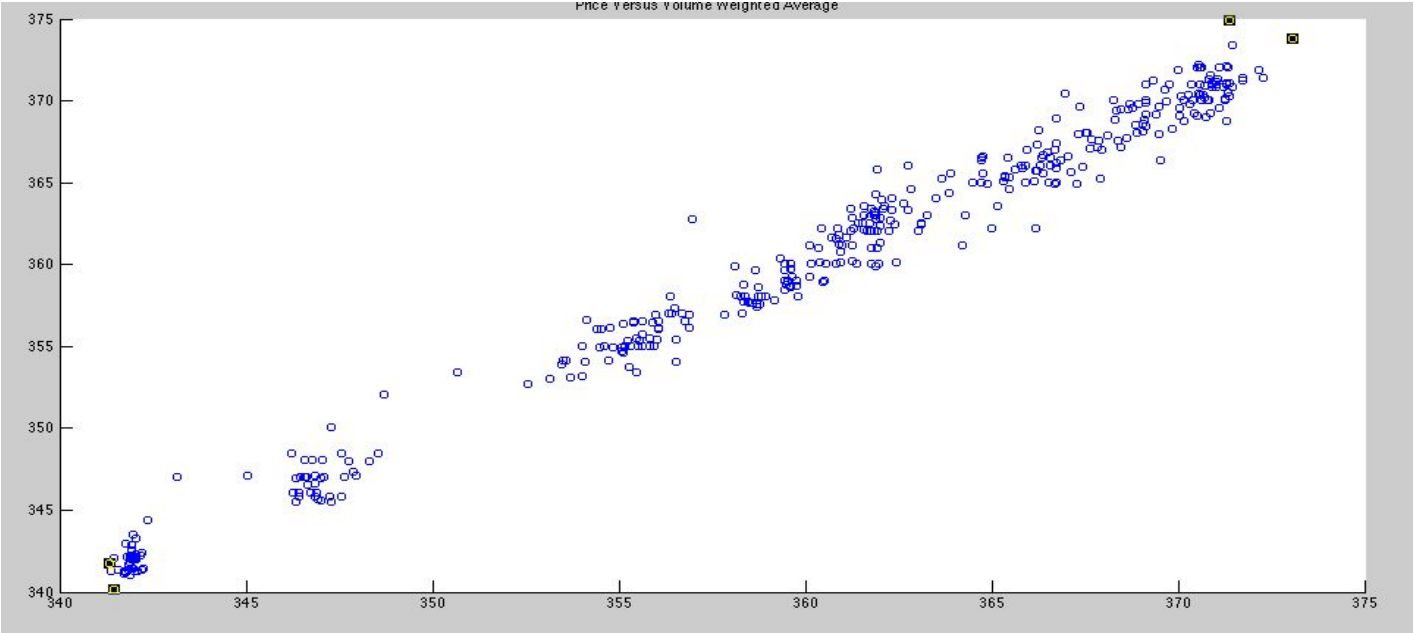
A classification approach: KNN

- In predicting up or down movements, can we turn this into a classification problem?



Conclusions

- Microstructure matters
- Must adapt
- Performance doesn’t necessarily increase with model complexity



Future Work

- Collecting more data
- Adaptive filtering
- Practical market considerations