

Fuzzy Knowledge Modelling **for stock market investment decisions**

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Overview

- What is knowledge
- “Knowledge” as in stock market
- Decision making
- Fuzzy Knowledge Framework
- Experiments
- Results
- Conclusions

What is Knowledge?

- **Data = raw material of information**
 - 100110 is binary number? 10 Jan 1910 ? 10 Jan 2010?
 - 27 is age? IQ? Dollar currency? Shoe size?
- **Information = data + metadata**
 - Age: 27 years, 27 years old
- **Knowledge = a set of concepts and/or objects**
 - **Eating** too much causes **health hazards**
- **One person's knowledge is another's raw data** --
Anthony G. Oettinger
 - Accountant's knowledge of Balance Sheets is data to the Investors
 - Capital value = market value - book value

Knowledge Representation / Perception



Knowledge in stock market

- Fundamental analysis
 - Efficient market hypothesis (partly by Eugene Fama)
 - Portfolio optimization (Harry Markowitz)
 - Capital asset pricing model (CAPM)
 - Random walk theory (Maurice Kendall)
 - Determined by risks v. estimated future worth/returns, etc.
- Technical analysis
 - Any theory? --- none
 - Based on observations, experience, etc.
 - Determined by supply and demand

Analysis tools - fundamental

- Earnings per share (EPS)
- Price to earnings ratio (P/E)
- Projected earnings growth (PEG)
- Dividend payout ratio
- Book value
- Return on equity, ..., etc.
- Concerns the “basics” of a business
- Good for selecting potential high performers

Analysis tools - technical

- Momentum
- Bollinger bands
- Moving average
- Relative strength index
- Double tops and bottoms
- Triangles
- Support and resistance, ... , etc.
- Concerns trading patterns, trends, etc.
- Does not concern business basics
- Claimed to be good at timing buy/sell

Decision making

- Ultimately an investor have to decide
 - When to buy or sell
 - At what price
- Expectation pricing
 - Kolmogorov's law of large numbers
 - Threshold = mean of events
 - Bias threshold
 - No threshold?
- The time factor
 - We do not have unlimited time

Difficulty of prediction



Decision making

- Technical analysis
 - Pattern recognition
 - Triangle formation
 - Cup formation, etc.
 - Cycles
 - Seasonal
 - Business, etc.
 - Support and resistance thresholds
- Artificial intelligence
 - Neural networks
 - Pattern recognition, etc.
 - Fuzzy logic

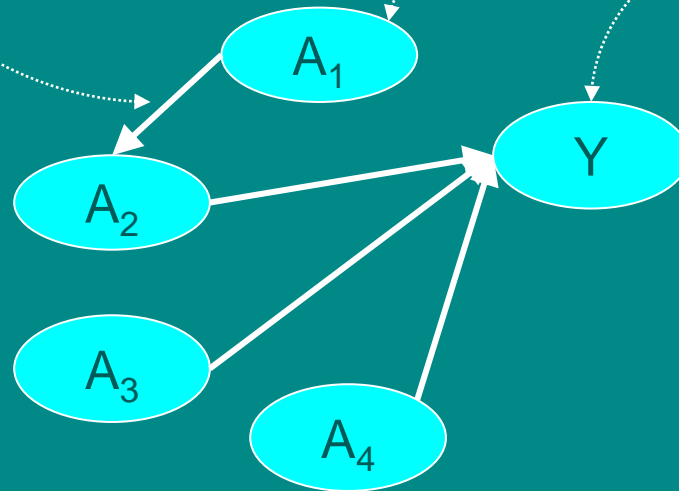
Reasoning with fuzzy logic

- Vagueness or imprecision inherent in many human concepts of input factors
 - The lawn is **wet**, therefore the sprinkler must be on last night.
 - The body temperature is **very high**, he must be having fever.
- Cardinality of decision
 - Boolean – either false or true
 - Trivalent – false, true, indecision
 - Multi-valent (= Choices) – Company A, B, C, D; Buy, sell, hold.

Fuzzy Knowledge Map (FKM)

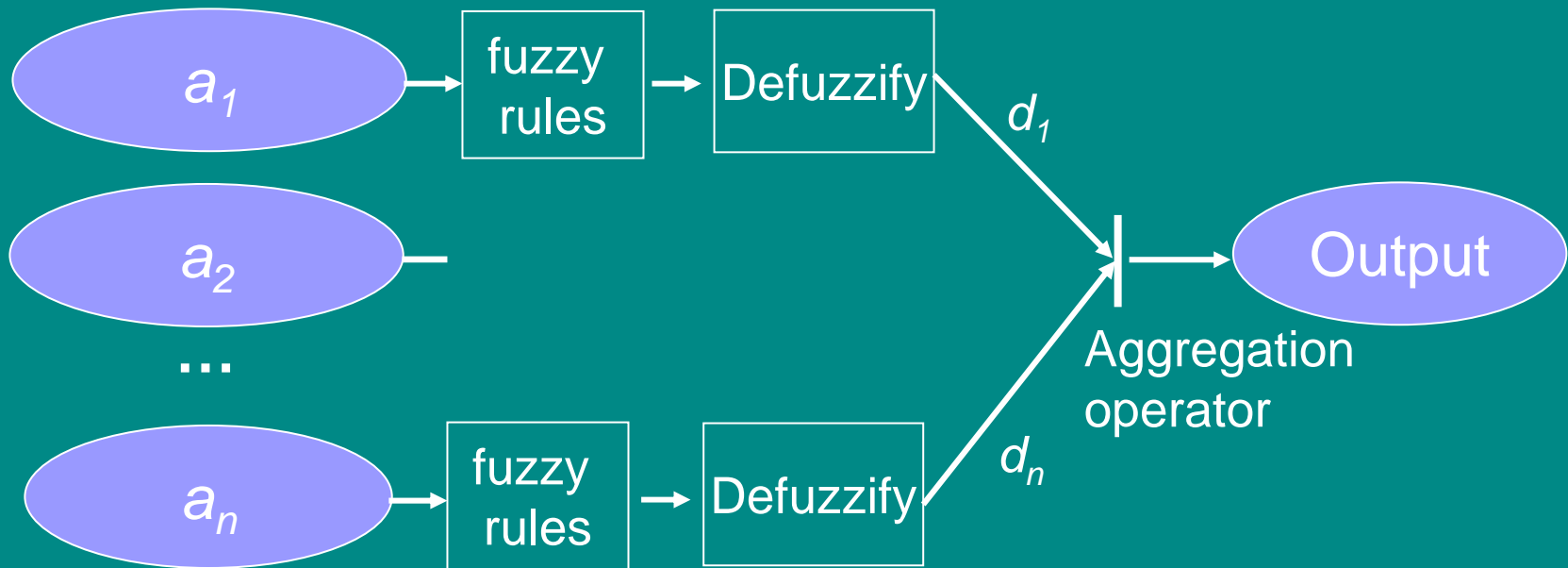
Edges – representing relation
(a set of fuzzy rules)

Nodes – representing
concepts/objects



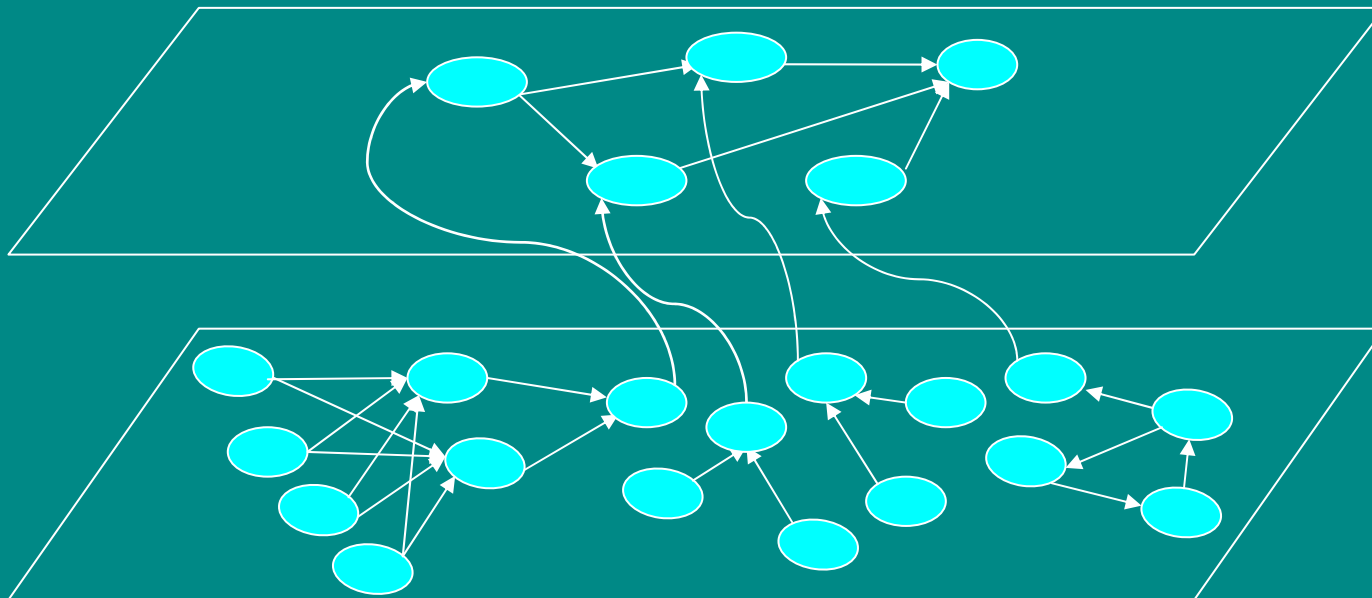
A simple example

Computation of FKM output



Fuzzy Knowledge Modelling Framework

- A two-layered FKM model for decision support in share trading.
- Inferences derived at the lower layer using market indicators utilized at the higher layer to make recommendations.



FKM framework

- cont'd

- Bottom layer:
 - Each indicator represented by an FKM
 - The output at the consequent nodes represents strengths of BUY and SELL inferences
 - Number of antecedent nodes depends on number of inputs required for corresponding indicator
- Top layer:
 - Makes recommendation based on outputs from bottom layer consequent nodes

Experiment

- Two sets of experiments:
 - One with 4 indicators
 - One with 5 indicators
- Two data sets:
 - Commonwealth Bank of Australia Ltd.
 - Telstra Corporation Ltd.
- Study period:
 - 3 years (Jan 2002 to Dec 2004)
- Indicators used:
 - Momentum (EM)
 - Relative strength index (RSI)
 - Bollinger bands (UB, MB & LB)
 - Moving averages (MA)
 - Stochastic (%K & %D)

Experiment

- cont'd

- Share transactions simulated based on strengths of *BUY* and *SELL* outputs from the FKM
- Simplifications and assumptions
 - Only studied alternating *BUY* and *SELL* transactions of shares.
 - Shares worth A\$10,000 bought initially
 - All stocks in hand sold at each *SELL*.
 - Shares bought back and sold off at day's closing price.
 - Each transaction costs \$30 for brokerage and GST

1) RSI indicator

- Relative strength index (RSI) measures recent strength of a stock relative to its past strength
- Based on relative number of ups and downs over a period:

$$RSI = 1 - 1/(1 + RS)$$

Where,

$$RS = (U / n) / (D / n)$$

U = no. of days *up* (closing price higher than that of previous day)

D = no. of days *down* (closing price lower than that of previous day)

n = number of days under consideration (15 days)

2) Momentum

- *Measures how fast the price of a share moves over a period* , given by:
- $EM(t) = WM(t) + WM(t-1)$

where WM is the weighted momentum, given by:

$$WM(t) = M(t) * \beta \text{ at time } t$$

$$WM(t-1) = EM(t-1) * (1 - \beta) \text{ at time } (t - 1)$$

$$\beta = 2/(n + 1)$$

$$M(t) = P(t) - P(t-n)$$

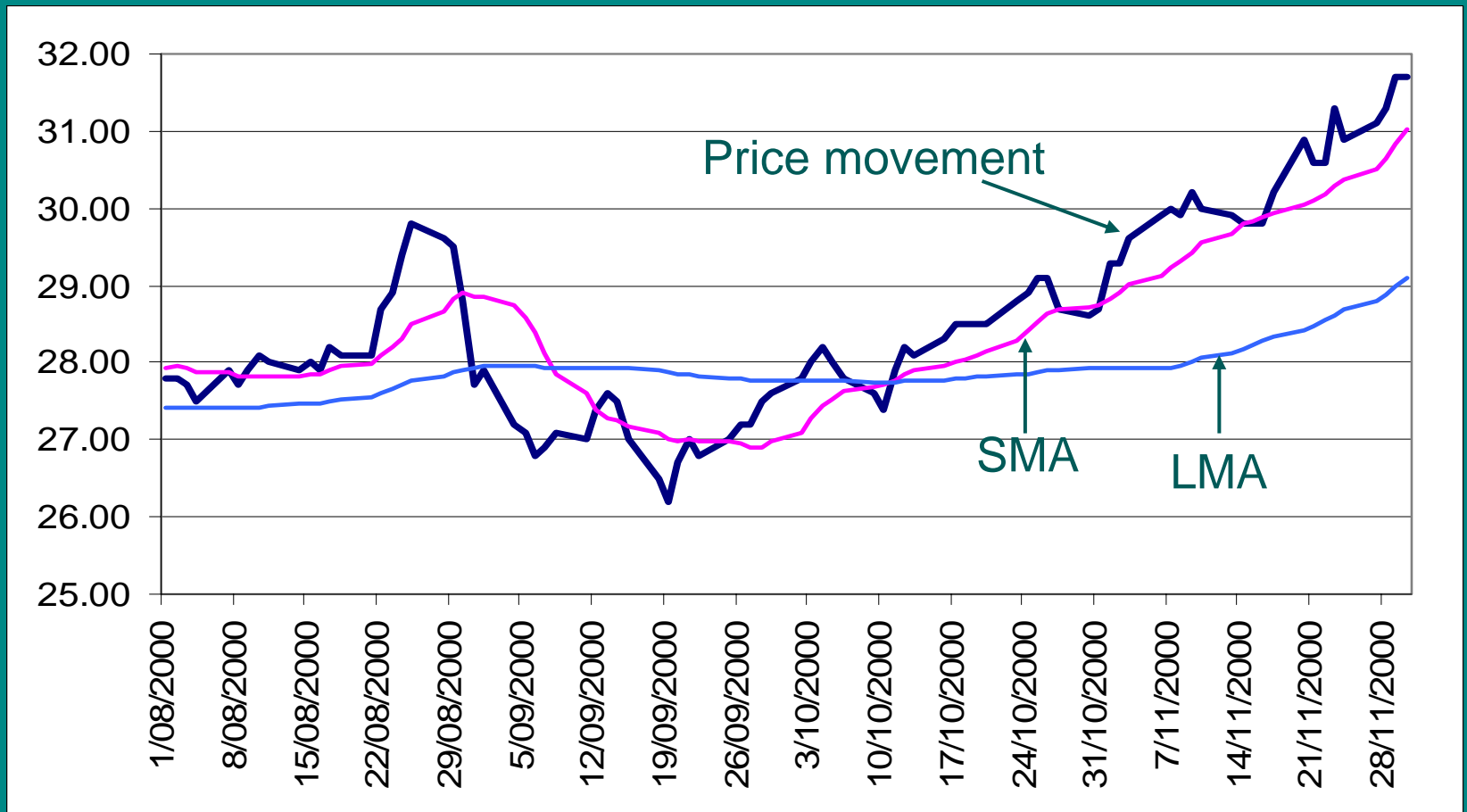
$$n = 15 \text{ days}$$

3) Moving averages

- Measures trading trend over a period
- Short-term MA (10-20 days) (or SMA) measures trend of short-term traders
- Long-term (50 or more days) MA (or LMA) measures trend of long-term investors
- Traders and investors are in agreement when the two trends converge

3) Moving averages

- con't



4) Bollinger Bands

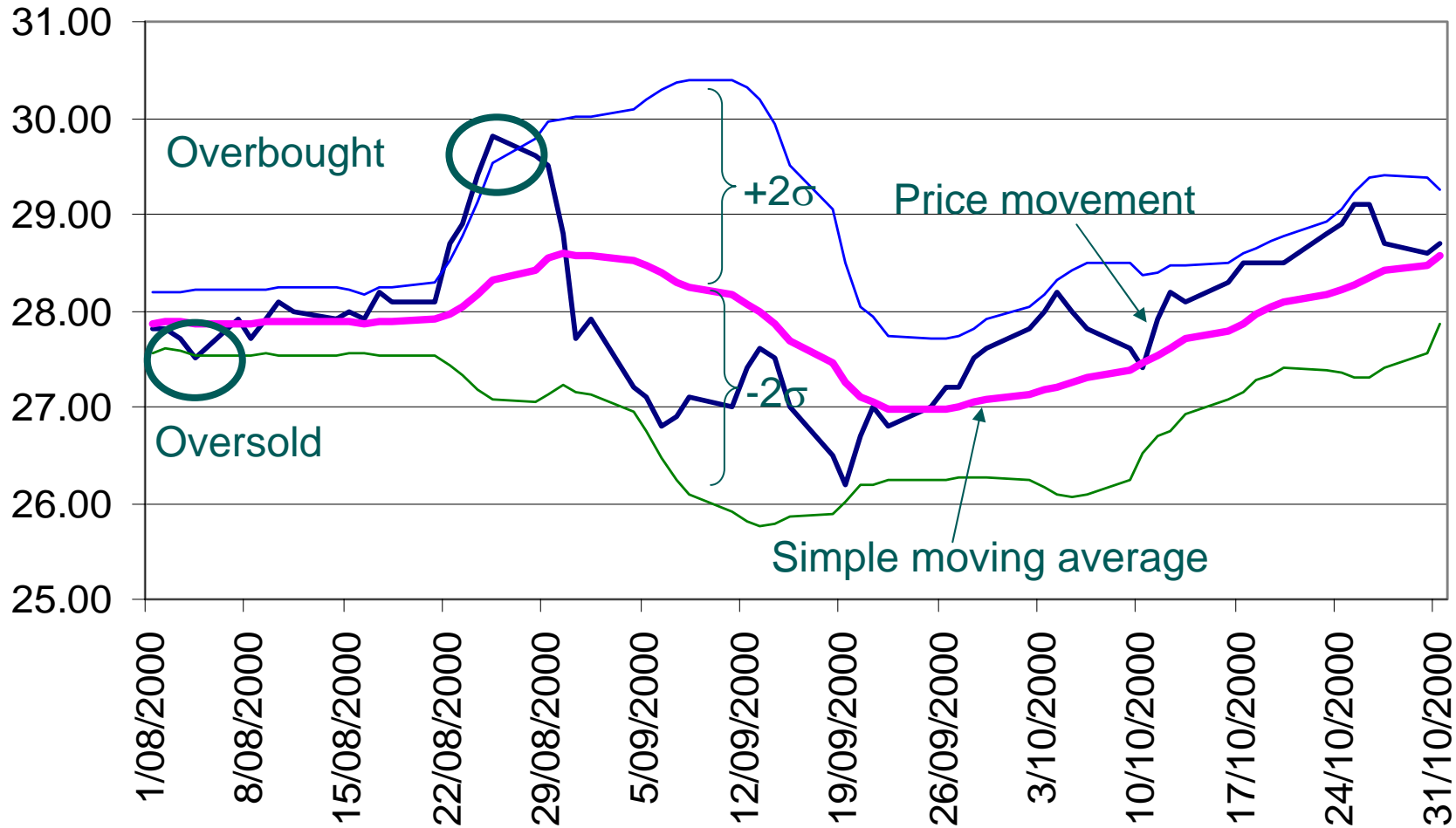
- Consists of three bands
 - Middle band: A simple moving average (15 days)

$$MB = \sum_{i=0}^n P_i / n$$

- Upper band: $UB = MB + 2 * \sigma$
 - Lower band: $LB = MB - 2 * \sigma$
- The more a stock is close to LB , the more it is oversold – the stronger is the BUY signal
- The more a stock is close to UB , the more it is overbought – the stronger is the SELL signal

4) Bollinger Bands

- con't



5) Stochastic indicator

- Stocks tend to close higher in its range during a bull run, and lower during a bear slide.
- Consists of two types:

1) Fast stochastic:

$$\%K_t = \frac{P_t - \text{Min}(L_{t-n} \dots L_t)}{\text{Max}(H_{t-n} \dots H_t) - \text{Min}(L_{t-n} \dots L_t)}$$

P_t is current price

$L_{t-n} \dots L_t$ is the daily lows for period $t-n$ to t

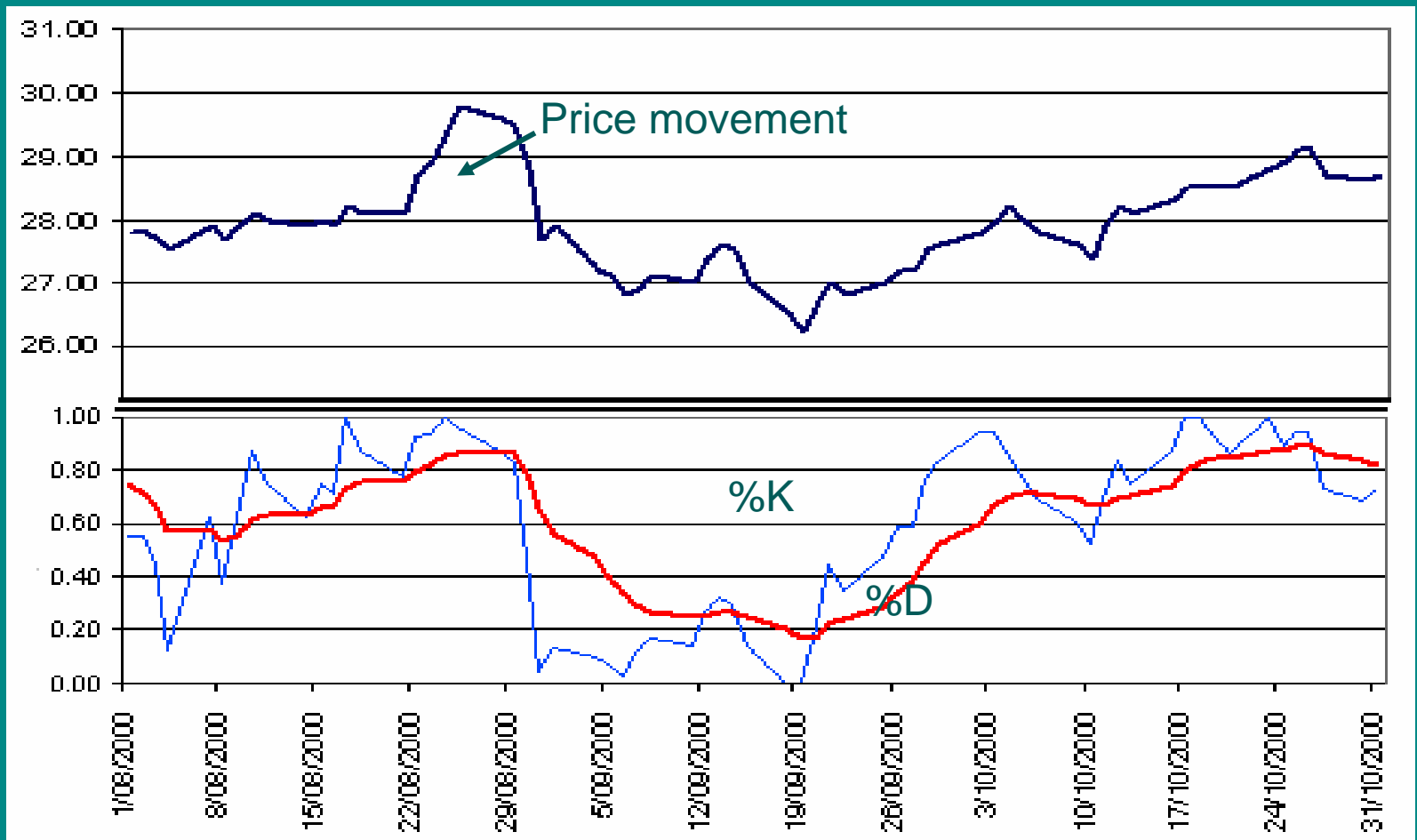
$H_{t-n} \dots H_t$ is the daily highs for period $t-n$ to t

n is a constant (15 days)

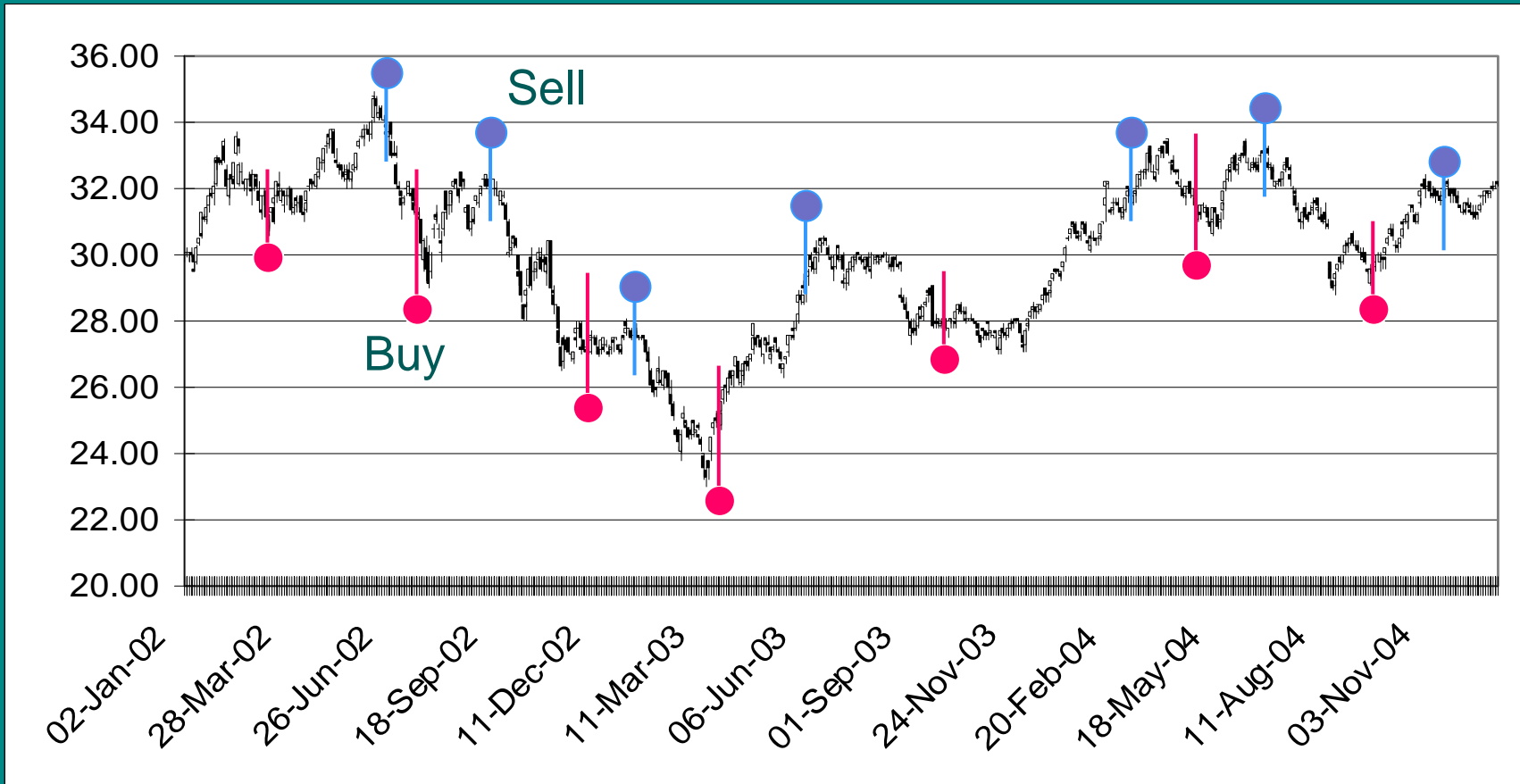
2) Slow stochastic:

$$\%D_t = P_t * 2/n + \%K_{t-1} * (1 - 2/n)$$

5) Stochastic indicator - con't



Results



Commonwealth Bank of Australia Ltd. (Jan 2002 to Dec 2004) – using 5 indicators

Results (cont'd)



Telstra Corporation Ltd. (Jan 2002 to Dec 2004) --
using 5 indicators

Results (cont'd)

	FKM (4 Indicators)	FKM (5 Indicators)	Buy & Hold
Security	Profit/Loss	Profit/Loss	Profit/Loss
Commonwealth Bank Ltd.	17%	38%	11%
Telstra Corp. Ltd.	3%	3%	11%

Performance of the FKM model over the 3-year study period compared with that of a simple 'Buy and hold' strategy

Conclusions

- FKM made better BUY/SELL recommendations for Commonwealth bank shares than with Telstra shares.
- FKM recommendations resulted in better profit/loss performance compared with a buy and hold strategy
- Further investigations required with different indicators to establish validity of proposed framework.

Questions? Comments?

Thank you!