Managerial Economics CHAPTER 5

Business and Economic Forecasting

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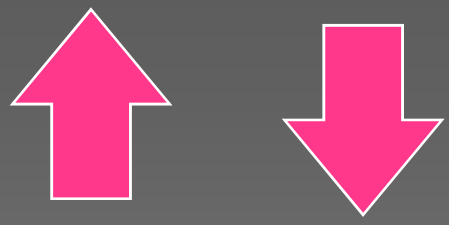
Chapter 5

Demand Forecasting is a critical managerial activity which comes in two forms:

- Qualitative Forecasting

  Gives the Expected Direction



- Quantitative Forecasting

  Gives the precise Amount

2.7654 %

Why Forecast Demand?

- Both public and private enterprises operate under conditions of uncertainty.
- Management wishes to limit this uncertainty by predicting changes in cost, price, sales, and interest rates.
- Accurate forecasting can help develop strategies to promote profitable trends and to avoid unprofitable ones.
- A forecast is a prediction concerning the future. Good forecasting will reduce, but not eliminate, the uncertainty that all managers feel.

Hierarchy of Forecasting

- The selection of forecasting techniques depends in part on the level of economic aggregation involved. The hierarchy of forecasting is:
- ***National Economy*** ***(GDP, interest rates, inflation, etc.)***
  - › ***sectors of the economy*** ***(durable goods)***
    - ↗ ***industry forecasts*** ***(automobile manufacturers)***
      - • ***firm forecasts*** ***(Ford Motor Company)***

Forecasting Criteria

The choice of a particular forecasting method depends on several criteria:

- **costs** *of the forecasting method compared with its gains*
- **complexity** *of the relationships among variables*
- **time** *period involved*
- **accuracy** *needed in forecast*
- *the* **lead time** *between receiving information and the decision to be made*

Significance of Forecasting

- *The accuracy of a forecasting model is measured by how close the actual variable, Y, ends up to the forecasting variable, $\hat{Y}$.*
- **Forecast error** *is the difference. $(Y - \hat{Y})$*
- *Models differ in accuracy, which is often based on the square root of the average squared forecast error over a series of N forecasts and actual figures*
- *Called a root mean square error, RMSE.*

> $$\text{RMSE} = \sqrt{\{ \Sigma (Y - \hat{Y})^2 / N \}}$$

Qualitative Forecasting

ADVANTAGES

- Flexibility --
  - easily altered as economy changes
- Early Signals --
  - can catch changes and anomalies in data

LIMITATIONS

- Complex --
  - hard to keep track of interactions in the primary variables
- Lack of Tests for Accuracy --
  - can't easily test the accuracy in prior periods.

Quantitative Forecasting and the Use of Models

Advantages

- Organize relationships
- Behavioral relationships
- Tests of reliability

Limitations

- Economy changes
- Data mining of same information
- Only a crude approximation

Alan Greenspan --
Chairman of the Board of Governors of the Federal Reserve

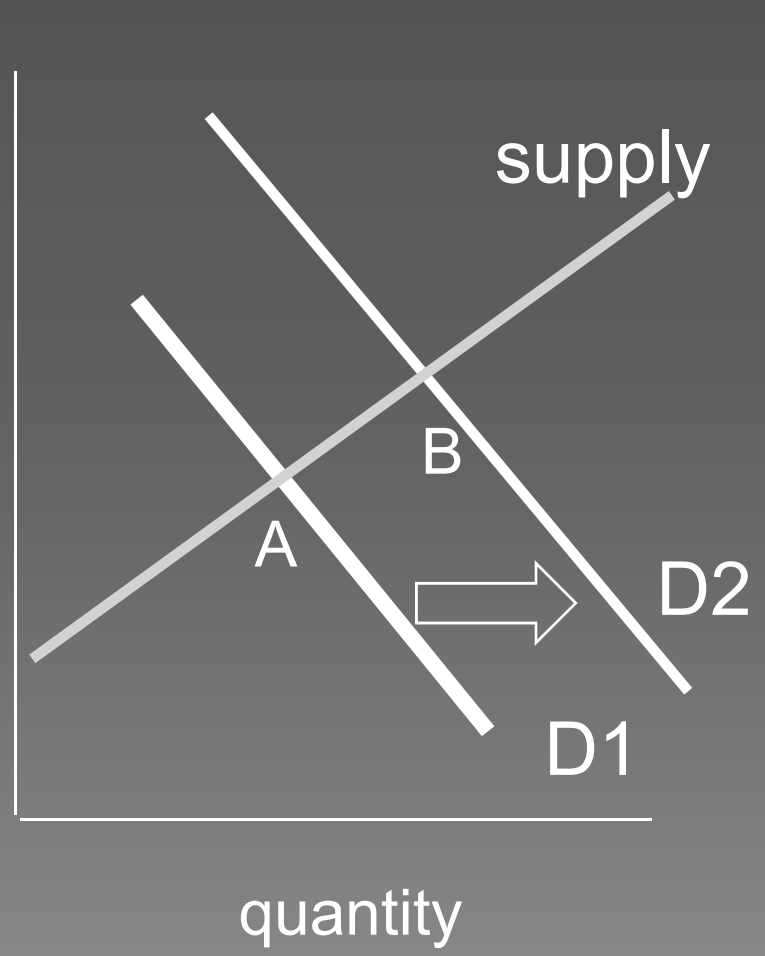
"Economic forecasting is really the art of identifying tensions or imbalances in the economic process and understanding in what manner they will be resolved." **-A. Greenspan**

Qualitative Forecasting

1. **Comparative Statics**
   - Shifts in Demand
   - Shifts in Supply

   Forecast Changes in Prices and Quantities

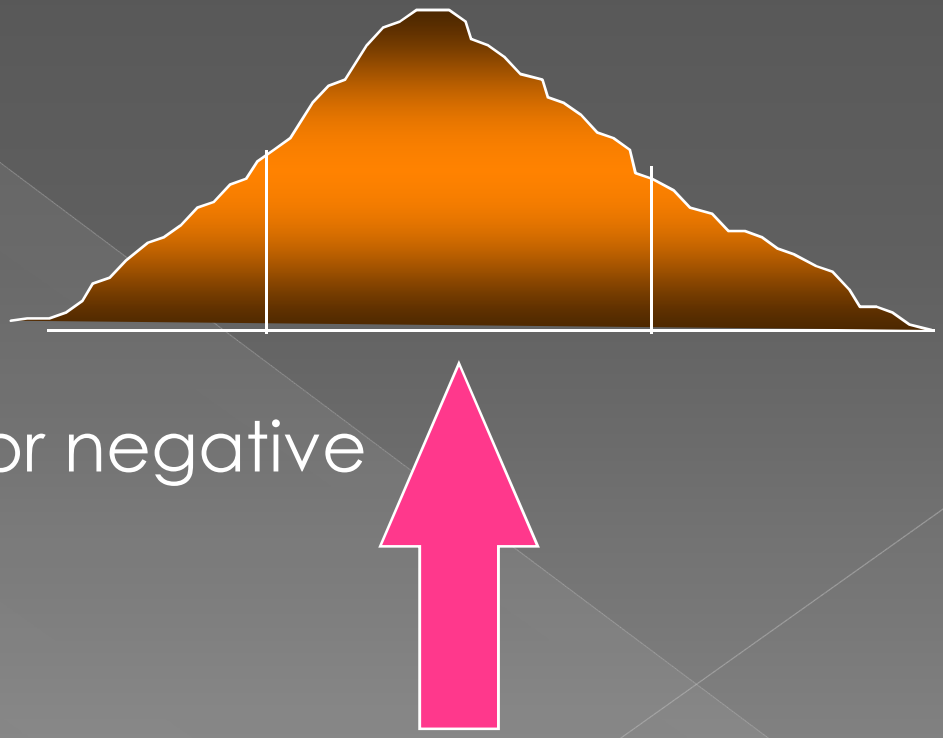
- **Suppose Income Shifts**
  - Price Rises
  - Quantity Rises



2. Expert Opinion

The **average forecast** from several experts is a **Consensus Forecast.**

- Mean
- Median
- Mode
- Truncated Mean
- Proportion positive or negative



EXAMPLES:

- **IBES and Zacks Investment** -- earnings forecasts of stock analysts

- **Conference Board** -- macroeconomic predictions

- **Livingston Surveys**--macroeconomic forecasts of 50-60 economists

- **Delphi Technique**--panel of diverse experts.

    1. Write out forecasts
    2. Show them to other panelists
    3. meet to arrive at consensus

    Note: problems of expense and intransigence

Chicago Daily News Sportswriters

Ranking of NFL predictions of 16 forecasters

	Year 1	Year 2	Year 3
Carmichael	1	8	16
Biondo	7	1	6
Duck	8	10	1
Concensus	1(tie)	2	2

The consensus predicted better over time than any 1 writer.

3. Surveys

New Products have no historical data -- Surveys can assess interest in new ideas.

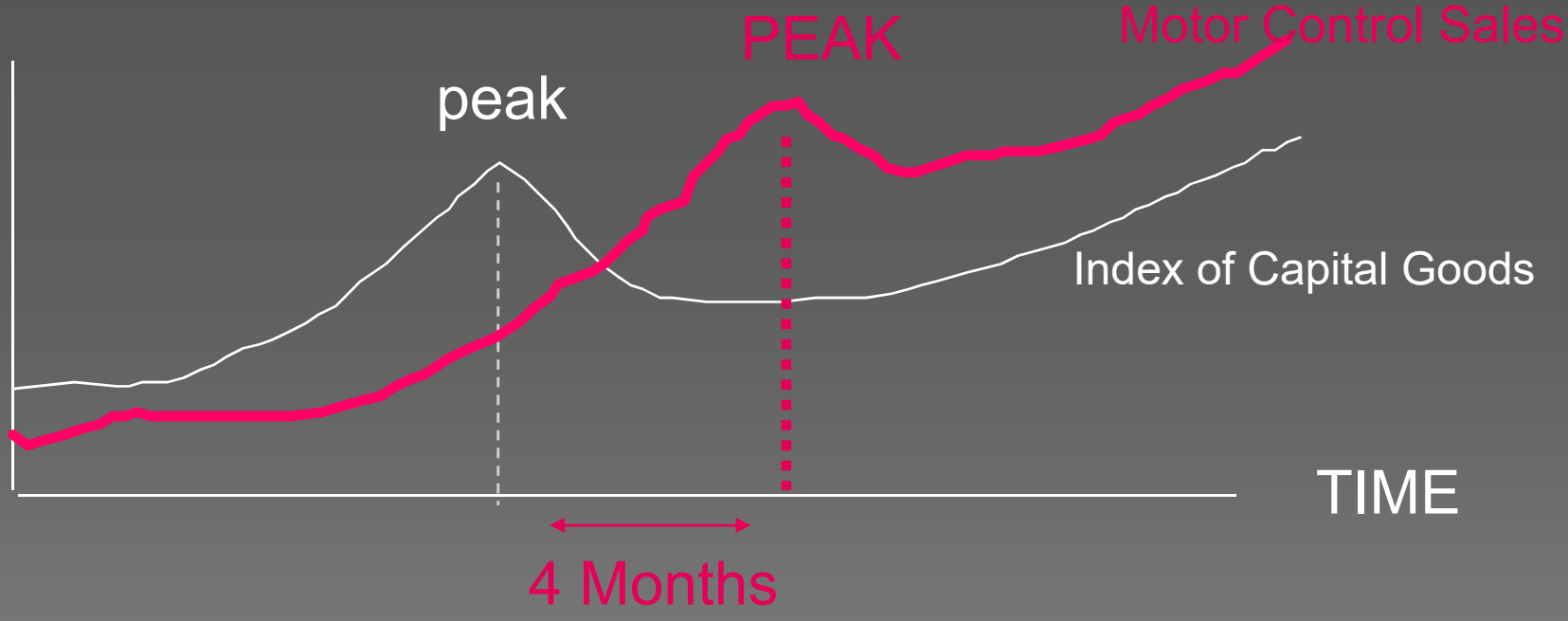
Survey Research Center of U. of Mich. does repeat surveys of households on Big Ticket items (Autos)

Common Survey Problems

- Sample bias--
  - telephone, magazine
- Biased questions--
  - advocacy surveys
- Ambiguous questions
- Respondents may lie on questionnaires

4. Economic Indicators *(Barometric Forecasting)*

Direction of sales can be indicated by other variables.

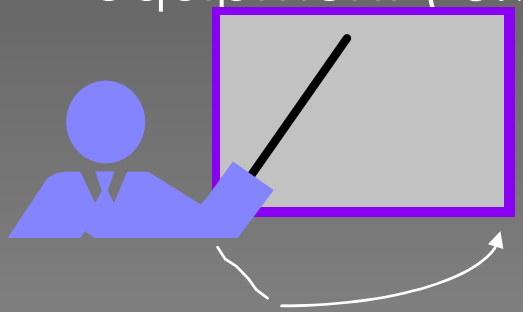


Example: Index of Capital Goods is a "leading indicator"
There are also lagging indicators and coincident indicators

Time given in months from change

LEADING INDICATORS*

- M2 money supply (-10.9)
- S&P 500 stock prices (-6.9)
- New housing permits(-10.1)
- Initial unemployment claims (-7.3)
- Orders for plant and equipment (-3.9)



COINCIDENT INDICATORS

- Nonagricultural employment (+.9)
- Index of industrial production (-.6)
- Personal income less transfer payment (-.6)

LAGGING INDICATORS

- Prime rate (+12.2)
- Duration of unemployment (+4.4)

***Handbook of Cyclical Indicators, 1984**

Questions

Why are contracts and orders for plant and equipment appropriate leading indicators?

Why is the index of industrial production an appropriate coincident indicator?

Why is the prime rate an appropriate lagging indicator?

Examples of Indicators

Composite Example: One indicator rises 4% and another rises 6%

The Composite Index is a **5%** increase.

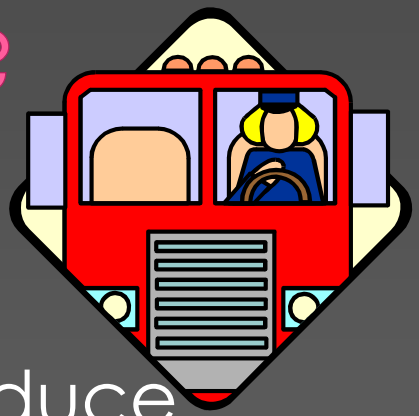
Diffusion Example: Wall Street Week with eleven analysts, where 4 are negative about stocks and 7 are positive:

The Diffusion Index is 7/11, or 63.3%.

Interpreting and Using Indices

- **composite index** - weighted average index of individual indicators
  - index interpreted in terms of % change
  - composite index of leading economic indicators: sustained increase indicates economic growth
- **diffusion index** - measure of the proportion of individual time series that increase
  - for diffusion index of leading economic indicators, if index > 50%, improved conditions are expected

What Went Wrong With SUVs at Ford Motor Co?



- Chrysler introduced the Minivan
  - in the 1980's
- Ford expanded its capacity to produce the Explorer, its popular SUV
- Explorer's price raised in 1995 substantially
  - at same time as Chrysler's Jeep Cherokee
  - and GM expanded its Chevrolet SUV
- Must consider response of rivals in pricing decisions

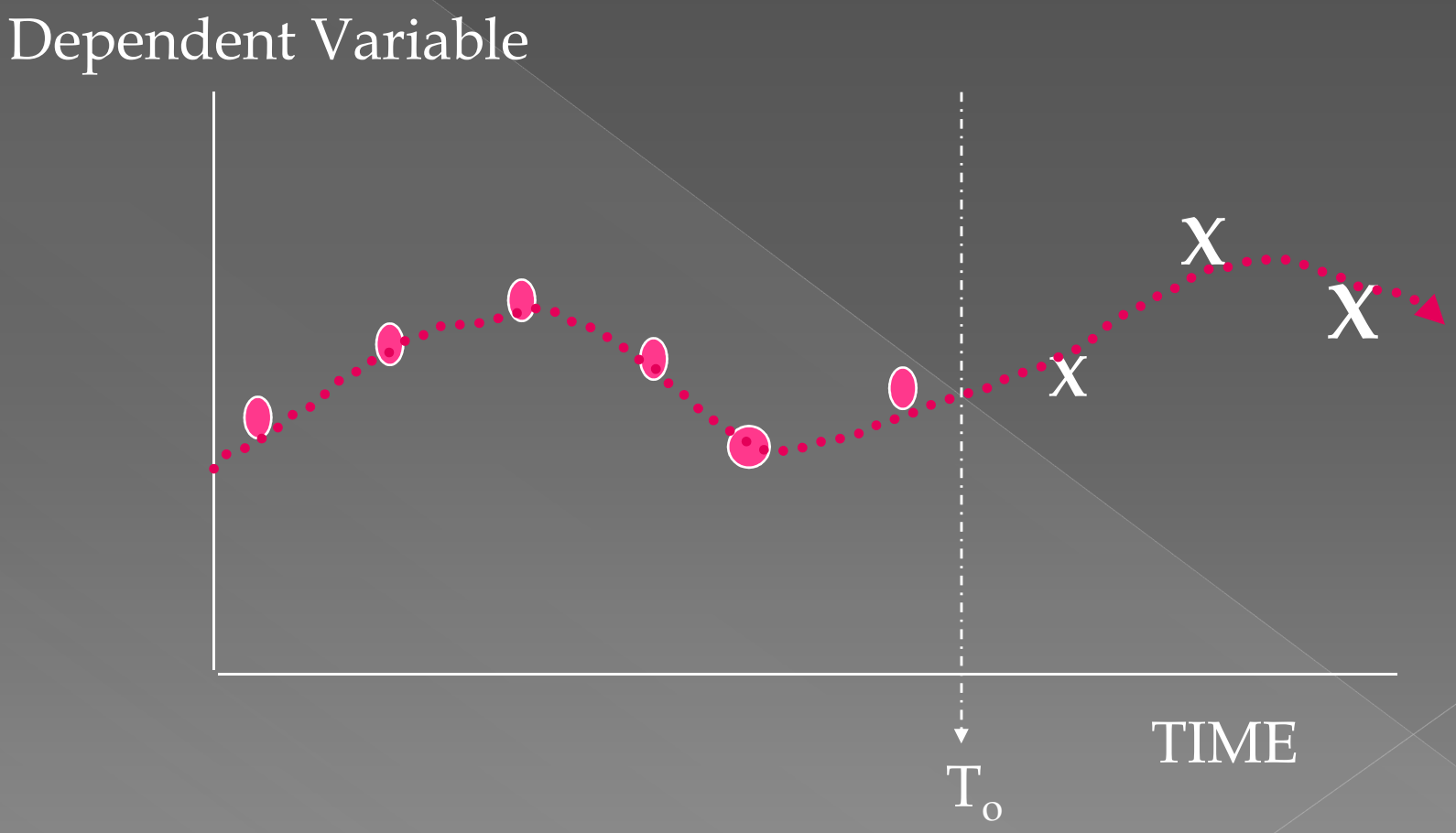
Quantitative Forecasting

- **Time Series**
  - Looks For Patterns
  - Ordered by Time
  - No Underlying Structure
- **Econometric Models**
  - Explains relationships
  - Supply & Demand
  - Regression Models

Like technical security analysis

Like fundamental security analysis

Time Series
Examine Patterns in the Past



- **Time Series**
  - is a quantitative forecasting method
  - Uses past data to project the future
  - looks for highest ACCURACY possible
- Accuracy

  (MSE & MAD)
  - Mean Squared Error & Mean Absolute Deviation

- $F_{t+1} = f(A_t, A_{t-1}, A_{t-2}, \ldots)$

  Let **F** = forecast and

  Let **A** = actual data

$$\mathbf{MSE} = \Sigma^{N}_{t=1} [F_t - A_t]^2 / N$$

The LOWER the MSE or MAD, the greater the accuracy

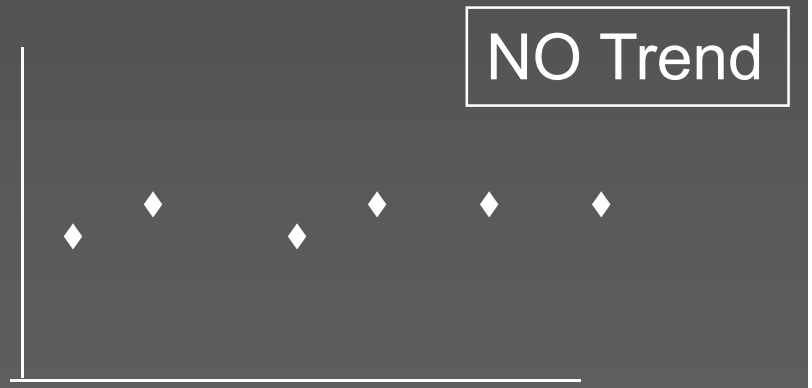
$$\mathbf{MAD} = \Sigma^{N}_{t=1} |(F_t - A_t)| / N$$

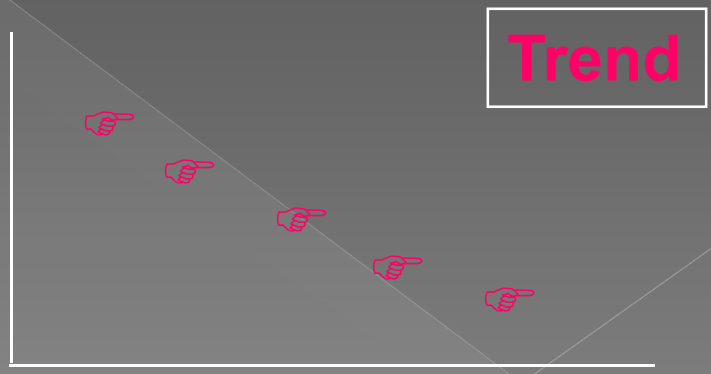
Methods of Time Series Analysis for Economic Forecasting

1. **Naive Forecast**

$$F_{t+1} = A_t$$

- Method best when there is no trend, only random error
- Graphs of sales over time with and without trends

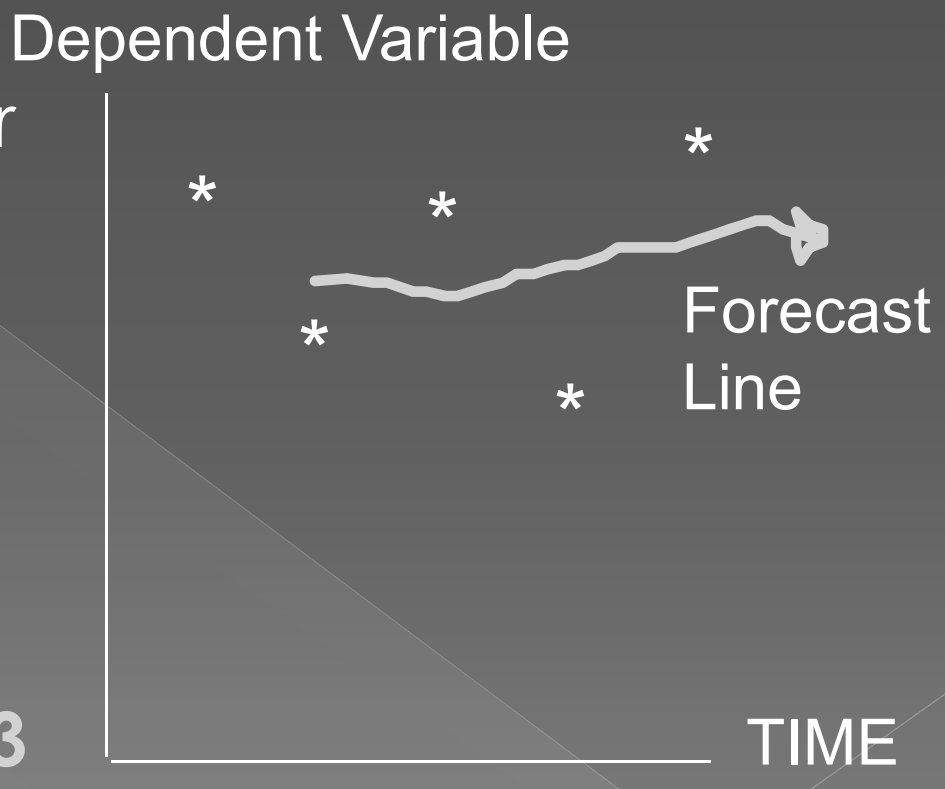




2. Moving Average

- A smoothing forecast method for data that jumps around
- Best when there is no trend
- 3-Period Moving Ave.

$F_{t+1} = [A_t + A_{t-1} + A_{t-2}]/3$



3. Exponential Smoothing

- A hybrid of the Naive and Moving Average methods
- $F_{t+1} = \alpha \cdot A_t + (1-\alpha)F_t$
- A weighted average of past actual and past forecast.
- Each forecast is a function of all past observations
- Can show that forecast is based on geometrically declining weights.

  $F_{t+1} = \alpha \cdot A_t + (1-\alpha)\cdot\alpha\cdot A_{t-1} + (1-\alpha)^2\cdot\alpha\cdot A_{t-1} + \ldots$

  Find lowest MSE to pick the best alpha.

4. Linear & 5. Semi-log

Linear Trend Regression

- Used when trend has a constant AMOUNT of change

  $A_t = a + b \cdot T$, where

  A_t are the actual observations and

  T is a numerical time variable

Semi-log Regression

- Used when trend is a constant PERCENTAGE rate

  $\text{Log } A_t = a + b \cdot T$,

  where **b** is the continuously compounded growth rate

More on Semi-log Form
a proof

- Suppose: $\mathbf{Sales_t = Sales_0(1 + G)^t}$ where G is the annual growth rate
- Take the natural log of both sides:
  - $\mathbf{Ln\ S_t = Ln\ S_0 + t \bullet Ln\ (1 + G)}$
  - but Ln (1 + G) = g, the equivalent ***continuously compounded*** growth rate
  - SO: $Ln\ S_t = Ln\ S_0 + t \bullet g$

$$\mathbf{Ln\ S_t = a + g \bullet t}$$

Numerical Examples: 6 observations

MTB > Print c1-c3.

Sales	Time	Ln-sales
100.0	1	4.60517
109.8	2	4.69866
121.6	3	4.80074
133.7	4	4.89560
146.2	5	4.98498
164.3	6	5.10169

Using this sales data, estimate sales in period 7 using a linear and a semi-log functional form

The regression equation is
Sales = 85.0 + 12.7 Time

Predictor	**Coef**	**Stdev**	**t-ratio**	**p**
Constant	84.987	2.417	35.16	0.000
Time	12.6514	0.6207	20.38	0.000

s = 2.596 R-sq = 99.0% R-sq(adj) = 98.8%

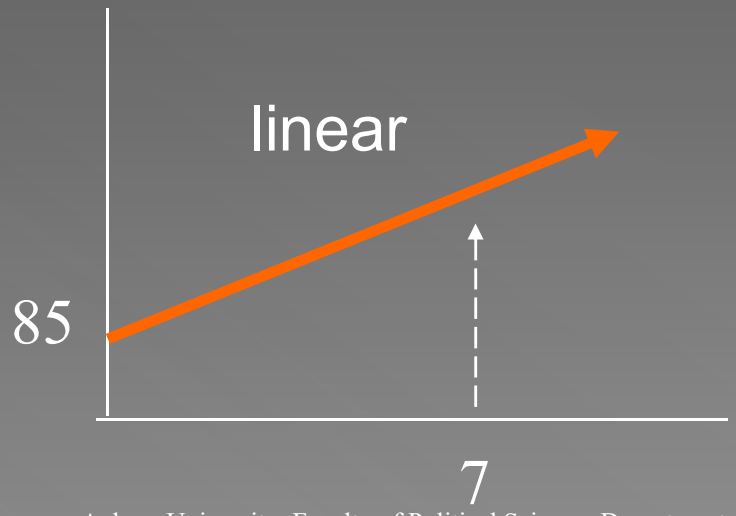
The regression equation is
Ln-sales = 4.50 + 0.0982 Time

Predictor	**Coef**	**Stdev**	**t-ratio**	**p**
Constant	4.50416	0.00642	701.35	0.000
Time	0.098183	0.001649	59.54	0.000

s = 0.006899 R-sq = 99.9% R-sq(adj) = 99.9%

Forecasted Sales @ Time = 7

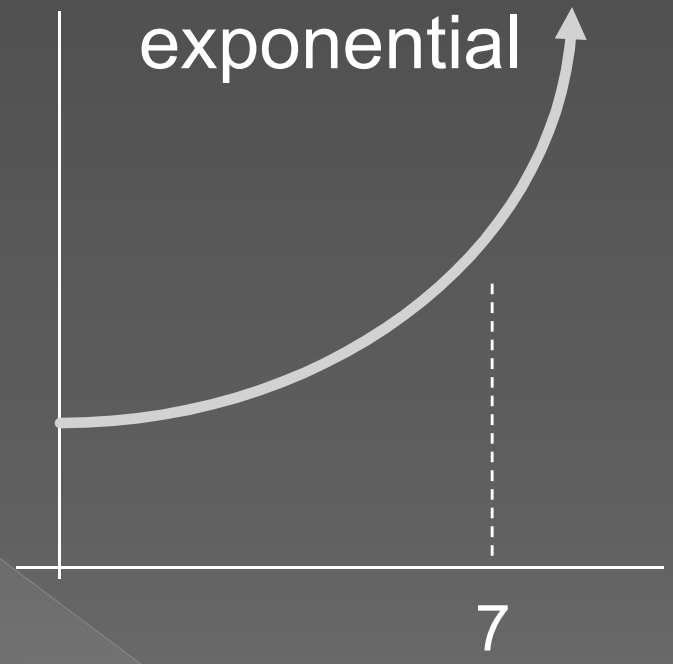
- **Linear Model**
- **Sales = 85.0 + 12.7 Time**
- Sales = 85.0 + 12.7 **(7)**
- **Sales = 173.9**



- **Semi-Log Model**
- **Ln-sales = 4.50 + 0.0982 Time**
- Ln-sales = 4.50 + 0.0982 **(7)**
- **Ln-sales = 5.1874**
- **To anti-log:**
  - $e^{5.1874} = 179.0$

Sales	Time	Ln-sales
100.0	1	4.60517
109.8	2	4.69866
121.6	3	4.80074
133.7	4	4.89560
146.2	5	4.98498
164.3	6	5.10169
179.0	**7**	**semi-log**
173.9	**7**	**linear**

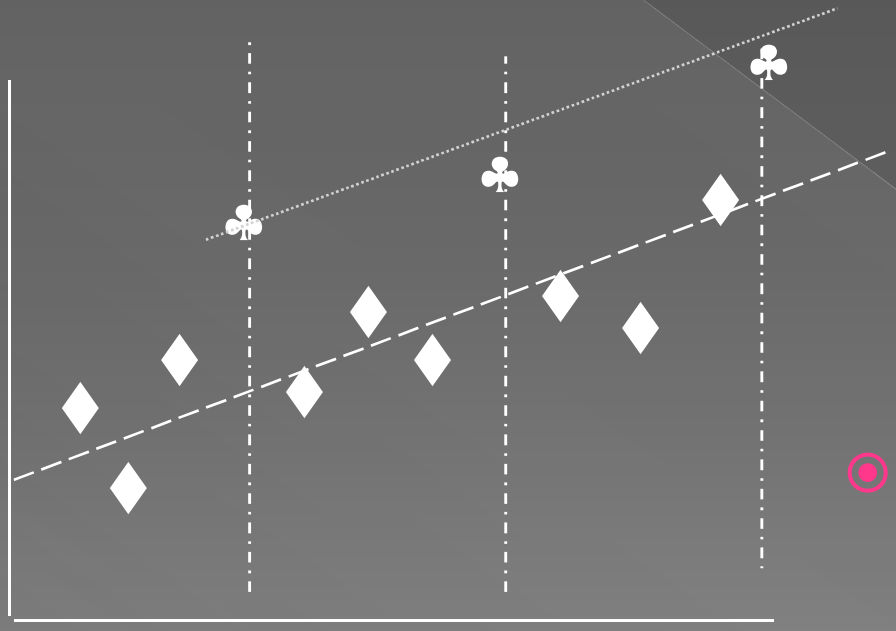
Semi-log is exponential



Which prediction do you prefer?

6. Procedures for Seasonal Adjustments

12 -quarters of data



I II III IV I II III IV I II III IV

Quarters designated with roman numerals.

- Take ratios of A/F for past years. Find the average ratio. Adjust by this percentage
  - If average ratio is **1.02**, adjust forecast upward 2%
- Use Dummy Variables in a regression: D = 1 if 4th quarter; 0 otherwise

Dummy Variables for Seasonal Adjustments

- Let **D = 1**, if 4th quarter and **0** otherwise
- Run a new regression:
  - $A_t = a + b \cdot T + c \cdot D$
  - the "c" coefficient gives the amount of the adjustment for the fourth quarter. It is an ***Intercept Shifter***.
- EXAMPLE: **Sales = 300 + 10•T + 18•D**

  12 Observations, 1999-I to 2001-IV, Forecast all of 2002.

  Sales(2002-I) = 430; Sales(2002-II) = 440; Sales(2002-III) = 450; Sales(2002-IV) = 478

Dummy Variable Interactions

- Can introduce a ***slope shifter*** by "interacting" two variables
  - **$A_t = a + b \cdot T + c \cdot D + d \cdot D \cdot T$**
  - **c** is the intercept shifter
  - **d** is the slope shifter
- *E.g.,* **Sales = 300 + 10•T + 18•D - 3•D•T**
  - implies that the Intercept is 318, when D = 1
  - implies that the slope is 7, when D = 1

Econometric Models

- Specify the variables in the model
- Estimate the parameters
  - single equation or perhaps several stage methods
  - $Q_d = a + b \cdot P + c \cdot I + d \cdot P_s + e \cdot P_c$
- But forecasts require estimates for future prices, future income, *etc.*
- Often combine econometric models with time series estimates of the independent variable.
  - **Garbage in** **Garbage out**

example

- $Q_d = 400 - .5 \cdot P + 2 \cdot Y + .2 \cdot P_s$
  - anticipate pricing the good at P = $20
  - Income is growing over time, the estimate is: **Ln $Y_t = 2.4 + .03 \cdot T$**, and next period is T = 17.
  - The prices of substitutes are likely to be P = $18.
- Find Q_d
- $Y = e^{2.910} = 18.357$
- Hence **$Q_d = 430.31$**