Forecasting

in Economics, Business, Finance and Beyond

CH 2: Universal Considerations

Universal Considerations

Every forecasting problem has its' own unique considerations, but there are a number of considerations that are relevant for any forecasting task. The following slides highlight some of these considerations.

Byron Gangnes

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Universal Considerations

The forecast object

- What kind of object are we trying to forecast?
  - Event outcome
  - Event timing
  - *Time series

Appropriate forecasting strategies depend on the nature of the object being forecast.

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Universal Considerations

The Information Set

- On what information will the forecast be based?
  - What data is available?
  - What is the quality of the data?
- Appropriate forecasting strategies depend on the information set, broadly interpreted to not only quantitative data but also expert opinion, judgment, and accumulated wisdom.

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Universal Considerations

Model Uncertainty and Improvement

- Does our forecasting model match the true data generating process (DGP)?
  - Of course not!
  - "All models are false; but some are useful." George Box, 1979
  - All models are intentional abstractions of a more complex reality.
  - A model might be useful for certain purposes and poor for others.
  - Models that once worked well may stop working well.
  - The key is to work continuously toward model improvement.

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Universal Considerations

The Forecast Horizon

- How far into the future do we need to predict?
- The *h*-step-ahead forecast; are we interested in forecasting
  - one month ahead?
  - one year ahead?
  - ten years ahead?

- Appropriate forecasting strategies likely vary with the horizon.

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Universal Considerations

Structural Change

- Are the approximations to reality that we use for forecasting stable over time?
- Things can change for a variety of reasons
  - gradually
  - abruptly

- We need methods of detecting and adapting to structural change.

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Universal Considerations

Forecast Statement

- How will our forecasts be stated?
  - a single "best guess" forecast
  - a "reasonable range" of possible future values
  - a full probability distribution of possible future values
- What are the associated costs and benefits?

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Universal Considerations

Forecast Presentation

- What is the best way to present forecasts?
  - a single h-step-ahead point forecast
  - a graph
- Graphical methods are valuable, not only for forecast presentation but also for forecast construction and evaluation.

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Universal Considerations

Decision Environment and Loss Function

- What decision will the forecast guide?
- How do we quantify what we mean by a “good" forecast
- How do we quantify the cost or loss associated with forecast errors of various signs and sizes a single h-step-ahead point forecast?

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Universal Considerations

Model Complexity and the Parsimony Principle

- What sorts of models, in terms of complexity, tend to do best for forecasting in business, finance, economics, and government?
- Bigger forecasting models are not necessarily better
- The “parsimony principle“
  - All else equal, smaller models are generally preferable

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Universal Considerations

Unobserved Components

- Have we modeled everything we can model?
  - Seasonality?
  - Trend?
  - Cycles?
- Some series have all such components, and some not.
- They are driven by very different factors, and each should be given serious attention.

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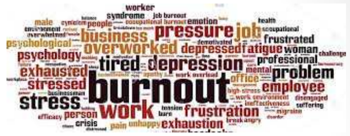
Universal Considerations

Wow!



That's a LOT of stuff to consider!

Let's "zoom in" for a closer look at these considerations.

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The forecast object

What kind of object are we trying to forecast?

Event outcome

- We know when the event will occur, but we want to forecast the result
- e.g. – Who will win the Super Bowl?
- e.g. – Who will chair the Fed next term?

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The forecast object

What kind of object are we trying to forecast?

Event timing

- We know the outcome of the event will occur, but we want to forecast when it will happen
- e.g. – When will the economy hit its next peak?
- e.g. – When will the economy hit its next trough?

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The forecast object

What kind of object are we trying to forecast?

Time Series

- the future value of a time series is of interest and must be projected
  - e.g. – How many widgets will we sell next month?

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The forecast object

What kind of object are we trying to forecast?

Time Series

- Time series forecasts are by far the most frequently encountered in practice because…
  - most business, economic and financial data are time series, so the the general scenario of projecting the future of a series for which we have historical data arises constantly
  - the technology for making and evaluating time-series forecasts is well-developed and the typical time series forecasting scenario is precise, so time series forecasts can be made and evaluated routinely

Event outcome and event timing forecasts arise less frequently and are often less amenable to quantitative treatment

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The Information Set

On what information will the forecast be based?

- Univariate data
  - simple, but not necessarily simplistic
  - they often perform admirably
  - necessary to understand univariate forecasting models before tackling more complicated multivariate models
- Multivariate data
  - potentially provide improvements over univariate models because they exploit more information to produce forecasts
- Expert judgment and opinion
  - Modelling is NOT a "turn the crank" process!

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Model Uncertainty and Improvement

Does our forecasting model match the true data generating process (DGP)?

- "All models are false; some are useful." George Box 1979
- This does NOT mean that our models are useless!
- The uninitiated may be suspicious of models
  - Lack of understanding
  - Unreasonable expectations
- Models may be useful for certain purposes, but not others
- Models that have worked well may stop working well!
- Always think about how to *improve* the model
  - Assess empirical performance
  - Assess consistency with theory
- It takes a model to beat a model!

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The Forecast Horizon

How far into the future do we need to predict ?

- *h*-step-ahead forecasts
  - The meaning of a step depends on the frequency of observation of the data
- The horizon is important because…
  - The forecast changes with the forecast horizon
  - the form of the best forecasting model may change with the forecast horizon
- Forecasting models are approximations to the underlying dynamic patterns in the series we forecast

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The Forecast Horizon

How far into the future do we need to predict ?

- *h*-step-ahead **path** forecasts
  - The horizon includes all steps from 1 to *h*

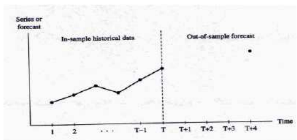

Figure 2.1: 4-Step-Ahead Point Forecast

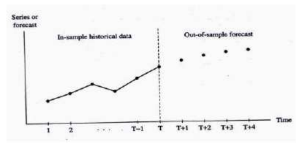

Figure 2.2: 4-Step-Ahead Path Forecast

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Structural Change

Are the approximations to reality that we use for forecasting stable over time ?

- In time series, we rely on the future being like the present/past in terms of dynamic relationships
  - Not always true
  - Structural change can be gradual or abrupt
- In cross sections, we rely on fitted relationships being relevant for new cases from the original population, and often even for new populations
  - Not always true
  - Structural change can be gradual or abrupt

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Structural Change

Are the approximations to reality that we use for forecasting stable over time ?

- Structural change can affect any or all parameters of a model
  - Breaks can be large or small
- Structural change is a type of non-linearity
  - abrupt structural change is often handled with dummy variable models
  - gradual structural change is often handled with smoothly-time-varying parameter models

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Forecast Statement

How will our forecasts be stated?

Time Series

- point forecast
  - a single number
  - Simple
  - easily-digested guide to the future
  - Affected by random and unpredictable “shocks“
    - The uncertainty surrounding point forecasts suggests the usefulness of an interval forecast

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Forecast Statement

How will our forecasts be stated?

Time Series

- Interval forecast
- A range of values in which we expect the realized value of the series to fall with some (prespecified) probability
  - The length (size) of the intervals conveys information regarding forecast uncertainty
  - interval forecasts convey more information than point forecasts

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Forecast Statement

How will our forecasts be stated?

Time Series

- Density forecast
- Gives the entire density (or probability distribution) of the future value of the series of interest.
- Density forecasts convey more information than interval forecasts
  - Given a density, interval forecasts at any desired condence level are readily constructed

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Forecast Statement

How will our forecasts be stated?

Time Series

- Density forecasts convey more information than interval forecasts, which in turn convey more information than point forecasts
- So, are density forecasts "preferred", the most common, and therefore the main focus of our attention?
- No.
- Point forecasts most common, interval forecasts a distant second and density forecasts are rare. Why?
- Interval and density forecasts require…
  - additional and possibly incorrect assumptions
  - advanced and computer-intensive methods
- Point forecasts are easier to understand and act upon

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Forecast Statement

How will our forecasts be stated?

Events

- Probability Forecast
  - e.g. election winner
    - "X" will win; point forecast
    - "X" will win with probability 0.6; probability point forecast
    - "X" will win with probability 0.6 + - 0.05; probability interval forecast
  - e.g. bank assesses the probability of default on a new loan
  - e.g. macroeconomist assesses the probability that a business cycle turning point will occur in the next six months

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Forecast Presentation

What is the best way to present forecasts?

- Nothing new to say here
- Just letting you know I didn't forget this one!

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Decision Environment

What decision will the forecast guide?

- Recognize that forecasts are made to guide decisions!
- Good forecasts -> Good decisions

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Loss Function

How do we measure the "goodness" of a forecast?

- Forecast error: the difference between the realization and the previously-made forecast, denoted

$$e = y - \hat{y}$$

- Loss functions $L(e)$ are functions of the forecast error. This means that the loss associated with a forecast depends only on the size of the forecast error.
- 3 conditions on $L(e)$:
  - $L(0) = 0$
  - $L(e)$ is continuous
  - $L(e)$ is increasing on each side of 0.
    - the bigger the absolute value of the error, the bigger the loss

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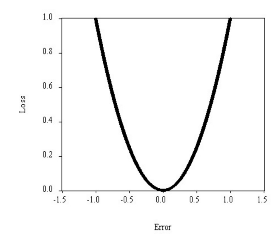
Loss Function

Quadratic (squared error) Loss

- Arguably reasonable to realistic loss structures
- Mathematically convenient
- Given by $L(e) = e^2$
- Symmetric about 0



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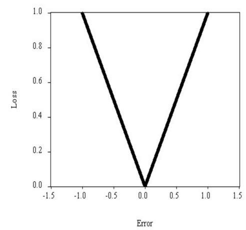
Loss Function

Absolute Loss

- Arguably reasonable to realistic loss structures
- Mathematically convenient
- Given by $L(e) = |e|$
- Symmetric about 0



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Loss Function

Lin-lin Loss

- Assymmetric about 0
- Linear on each side of 0, but with different slopes
- Given by $L(e) = \begin{cases} a|e| & if\, e > 0 \\ b|e| & if\, e \le 0 \end{cases}$

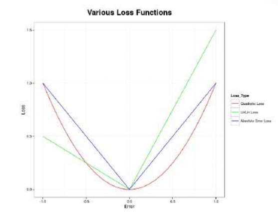

Figure 2.5: Quadratic, Absolute, and Linlin Loss Functions

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Loss Function

Optimal Forecasts

- the forecast with smallest conditionally expected loss
- Under quadratic loss, the optimal forecast is the conditional mean

$$\hat{y}(x)^* = E(y|x)$$

- Under absolute loss, the optimal forecast is the conditional median

$$\hat{y}(x)^* = Q_{0.5*100\%}(y|x)$$

- Under lin-lin loss, the optimal forecast is the conditional d 100% quantile

$$\hat{y}(x)^* = Q_{d*100\%}(y|x) \quad \text{where} \quad d = \frac{b}{a+b}$$

- Quite generally under asymmetric L(e) loss (e.g., linlin), optimal forecasts are biased because we can gain on average by pushing the forecasts in the direction such that we make relatively few errors of the more costly sign

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State-Dependent Loss

loss actually depends on the state of the world (y), as opposed to just depending on e

- the cost of a given error may be higher or lower in different states of the world as indexed by y.

e.g. Direction of Change Forecast

- if you predict the direction of change correctly, you incur no loss; but if your prediction is wrong, you're penalized
- Under direction-of-change loss, the optimal forecast is the conditional mode $\hat{y}(x)^* = Mode(y|x)$

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Model Complexity and the Parsimony Principle

What sorts of models, in terms of complexity, tend to do best for forecasting in business, finance, economics, and government?

- The specifics of the situation typically indicate the desirability of a specific method
- a variety of forecasting applications use a small set of common tools and models
- Real-world phenomena may be incredibly complex, but simple models tend to be best for forecasting

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Model Complexity and the Parsimony Principle

The Parsimony Principle

- other things the same, simple models are usually preferable to complex models
- we can estimate the parameters of simpler models more precisely
- simpler models are more easily interpreted, understood and scrutinized, so anomalous behavior is more easily spotted
- it's easier to communicate an intuitive feel for the behavior of simple models
- enforcing simplicity lessens the scope for “data mining" (tailoring a model to maximize its fit to historical data)

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Model Complexity and the Parsimony Principle

Data Mining

- often results in models that fit historical data beautifully
- but perform miserably
- because it tailors models in part to the idiosyncrasies of historical data, which have no relationship to unrealized future data

- Simple models should not be confused with naive models
- The KISS principle - Keep it Sophisticatedly Simple

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Unobserved Components

Have we modeled everything we can model?

$$\begin{aligned} y_t &= Pattern + Noise \\ &= Trend + Seasonality + Cycles + Noise \\ &= T_t + S_t + C_t + \varepsilon_t \end{aligned}$$

Or maybe

$$y_t = T_t * S_t * C_t * \varepsilon_t \Rightarrow \ln(y_t) = \ln(T_t) + \ln(S_t) + \ln(C_t) + \ln(\varepsilon_t)$$

Anything not modeled as “pattern” becomes part of the noise.

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Concluding Remarks

In this chapter the author gave us the "flavor" of modeling.

The rest of the text "drills down" more deeply into the details of HOW we do WHAT we do!

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CH 2 HW

Try the HW problems on page 42 of the text
yes, all 8 of them!

4, 6 and 8 are really just FYI

If you do not know how to do some of the others, don't worry about it!

Due in 1 week via Canvas upload (Word doc)

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