Economic Forecasting

Course information

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University of Alberta | E493 | 2023

Outline

Introduction

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Tory 7-11
Friday 10 am to 12 pm [office hours]

Outline

Econometrics

Econometrics is statistics with **non-experimental data** (that is, with observational data).

Distinctive features:

- dependency
- heterogeneity
- endogeneity

Regression models

Regression models form the core of econometrics.

The estimated regression can be used either for:

- **causal inference** (learning about the effect on Y of a change in X)
- **prediction** (predicting the value of Y given X, for an observation not in the data set)

Causal inference and prediction place different requirements on the data—but both use the same regression toolkit.

Correlation is not causation

Correlation is not causation.

Remarks:

- when X is correlated with Y, it is not necessarily causing Y
- we need more information (knowledge) to determine causality

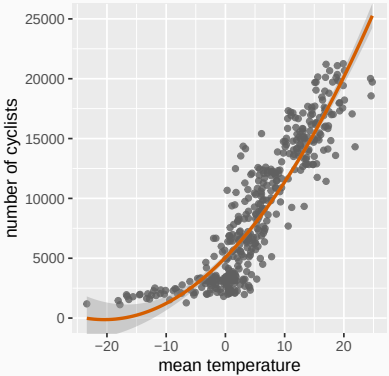
Example: Cyclists and Weather

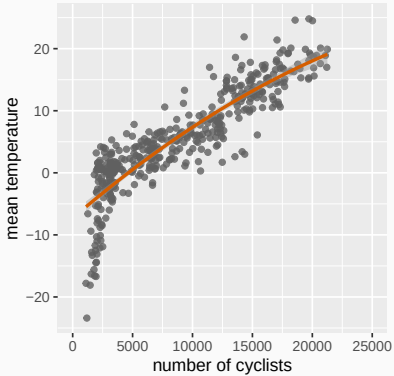
Consider a time series of the number of cyclists in a city and weather variables (mean temperature, minimum temperature, snow depth, and precipitation).

```
# read data
DATA <- read.csv("data/cyclistsTempHKI.csv", header = TRUE)
head(DATA, 4)
```

```
##         date cyclists meanTemp minimumTemp snowDepth.cm. precipitation.mm.
## 1 2014-01-02     3087      0.8         0.3             0                0.0
## 2 2014-01-03     3132      1.4         0.8             0                0.1
## 3 2014-01-13     2352    -10.9       -13.0             4                0.0
## 4 2014-01-14     1980    -14.4       -16.2             4                0.0
```

Example: Cyclists and Weather





Econometrics

We are interested in answering three kinds of questions:

1. How do we test a given scientific hypothesis?
2. How do we measure parameters of interest?
3. What are good methods of forecasting?

Questions (1) and (2) are covered in Econ 399 and Econ 497.

Question (3) is the main focus of Econ 493.

Outline

Prediction and machine learning

We've got a whole class on prediction. Why?

In other econometrics classes we focus on the properties of β, i.e.,

$$y_i = \beta x_i + u_i,$$

meaning we want a precise estimate $\hat{\beta}$.

With prediction, we shift our focus to accurately estimating outcomes.

In other words, how can we best construct $\hat{y}_i$?

Prediction and machine learning

So we want good estimates $\hat{y}$ instead of $\hat{\beta}$.

Q: Can't we just use the same methods (i.e., OLS)?

A: It depends.

How well does your **linear** regression model approximate the underlying data? (and how do you plan to select your model?)

Prediction and machine learning

In prediction, we constantly face many **trade-offs**, e.g.,

- flexibility and parametric structure (and interpretability)
- performance in training and test samples
- variance and bias

We need to balance the additional benefits and costs of adjusting these trade-offs.

Many machine-learning (ML) techniques/algorithms are crafted to optimize with these trade-offs, but the practitioner (you) still needs to be careful.

Prediction and machine learning

In addition, we may face more complex problems…

Multi-class **classification problems**

- rather than {0,1}, we need to classify y_i into 1 of K classes
- e.g., ER patients: {heart attack, drug overdose, stroke, nothing}

Text analysis and **image recognition**

- comb though sentences (pixels) to glean insights
- e.g., detect sentiments in tweets

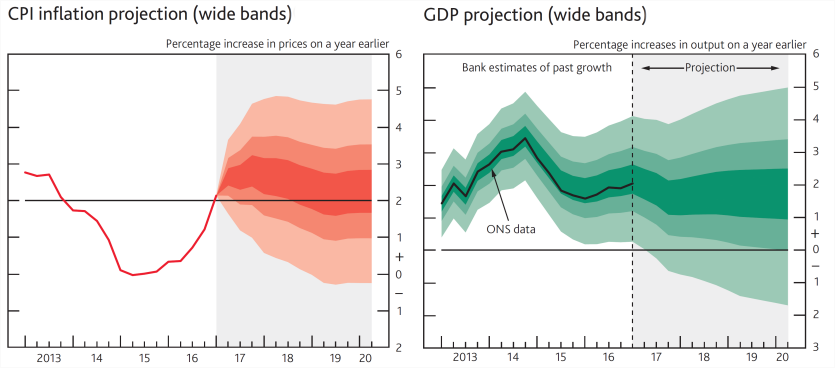
Unsupervised learning

- you don't know groupings
- e.g., classify spatial data into groups

Time series forecasting

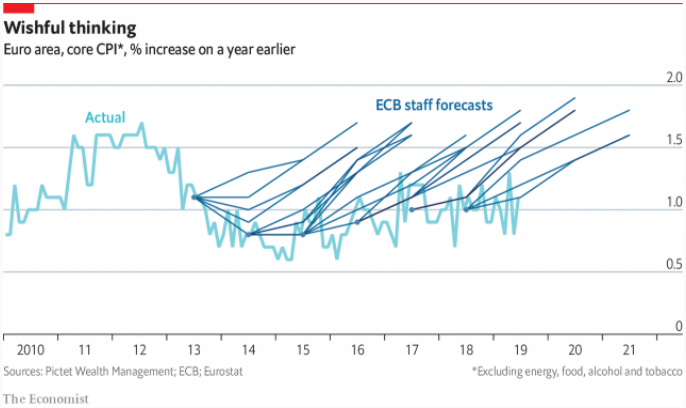
Time series forecasting: estimating how the sequence of observations will continue into the future.

Time series forecasting



Outline

Forecasting is difficult



What can we forecast?

What can we forecast?

What can we forecast?

Which is easiest to forecast?

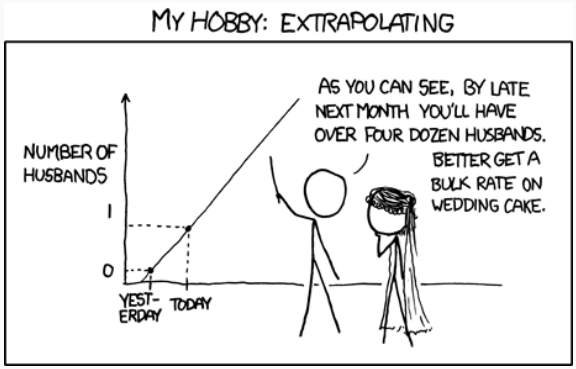
1. daily electricity demand in 3 days time
2. time of sunrise this day next year
3. Google stock price tomorrow
4. Google stock price in 6 months time
5. maximum temperature tomorrow

What makes something easy/difficult to forecast?

Something is easier to forecast if:

- we have a good understanding of the factors that contribute to it
- there is lots of data available
- the forecasts cannot affect the thing we are trying to forecast
- there is relatively low natural/unexplainable random variation
- the future is somewhat similar to the past

Your turn


MY HOBBY: EXTRAPOLATING
NUMBER OF HUSBANDS
1
0
YEST-ERDAY
TODAY
AS YOU CAN SEE, BY LATE NEXT MONTH YOU'LL HAVE OVER FOUR DOZEN HUSBANDS.
BETTER GET A BULK RATE ON WEDDING CAKE.

Outline

Learning goals

1. To understand common statistical methods used in business and economic forecasting.
2. To develop the computer skills required to forecast business and economics data.
3. To gain insights into the problems of implementing forecasting methods for use in business and economics.

Our class

Lectures

- Monday and Wednesday 9:30 am to 10:50 am
- Tory 1-083
- emphasis on building intuition through examples
- lectures will not be recorded

Outline

Topics to be covered in our **lectures**:

1. An introduction to R, data cleaning, and plotting with R
2. Forecasting with regression models
3. Shrinkage methods
4. Time series data
5. Forecasting with time series data
6. Regression models with time series data
7. ARIMA models
8. Seasonal ARIMA models
9. Dynamic regression models
10. Other topics

Assessment

Homework assignments: four assignments mixing theory and applications in R (worth 10% in total).

Exams: two midterm exams mixing theory and applications in R (worth 30% each).

Term paper: a term paper due at the end of the semester (worth 30%).

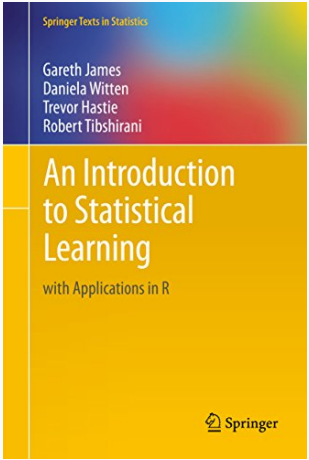
Assessment

Task	Date	Weight
Assignments	TBD	10%
Midterm exam 1	Wednesday February 15	30%
Midterm exam 2	Wednesday March 29	30%
Paper proposal	Monday February 27	—
Term paper	Friday April 14	30%

Textbooks

James, G., Witten, D., Hastie, T., and Tibshirani, R. (2021)
An Introduction to Statistical Learning: with Applications in R
2nd edition

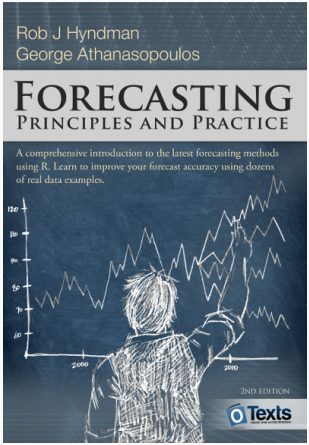
- available for free here: https://www.statlearning.com
- R code for examples



Textbooks

Hyndman, R., and Athanasopoulos, G. (2018)
Forecasting: Principles and Practice
2nd edition

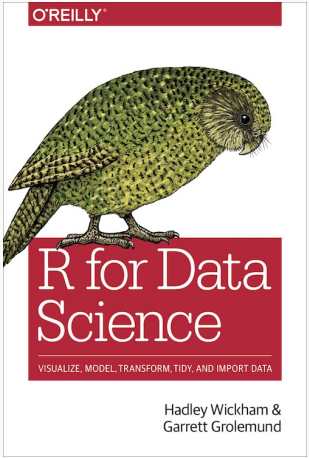
- available for free here: https://otexts.com/fpp2/
- R code for examples



Textbooks

Wickham, H., and Grolemund, G. (2017)
R for Data Science

- available for free here: https://r4ds.had.co.nz
- R code for examples



Other textbooks

Békés, G., and Kézdi G. (2021): Data Analysis for Business, Economics, and Policy.

Hyndman, R., and Athanasopoulos, G. (2021): Forecasting: Principles and Practice, 3rd edition.

Taddy, M. (2019): Business Data Science: Combining Machine Learning and Economics to Optimize, Automate, and Accelerate Business Decisions, 1st edition.

Other readings

You should all read the following papers:

- Athey, S., and Imbens, G. (2019): Machine Learning Methods That Economists Should Know About, Annual Review of Economics
- Mullainathan, S., and Spiess, J. (2017): Machine Learning: An Applied Econometric Approach, Journal of Economic Perspectives
- Schwabish, J. (2014): An Economist's Guide to Visualizing Data, Journal of Economic Perspectives

R and RStudio

Installing R and RStudio

1. Download and install R.
2. Download and install RStudio Desktop.
3. Run RStudio.
4. On the “Packages” tab, click on “Install packages” and install packages (make sure “install dependencies” is checked).

That’s it! You should now be ready to go.

Packages

Packages contain functions (and sometimes data) created by the community. The real power of R is found in add-on packages!

To load a package, use `library()`:

```
library(fpp2)
```

This loads:

- data for examples and econometrics functions
- package for graphics functions
- many other packages will be used later

Motivation

Q: Your job sounds extremely interesting. What jobs would you recommend to a young person with an interest, and maybe a bachelors degree, in economics?

A: If you are looking for a career where your services will be in high demand, you should find something where you provide a scarce, complementary service to something that is getting ubiquitous and cheap. So what's getting ubiquitous and cheap? Data. And what is complementary to data? Analysis. So my recommendation is to take lots of courses about how to manipulate and analyze data: databases, machine learning, econometrics, statistics, visualization, and so on.

- Google chief economist Hal Varian: full interview here

Outline

Acknowledgments

The slides for this course are based on lecture notes by:

- Charles Lanfear, University of Washington
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- Rob Hyndman, Monash University
- Grant McDermott, University of Oregon

Thanks!