regression

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outline

intuition of inference (inferential statistics)

multivariate ols: intuition

wages example

interpretation and practice

violations (Wheelan, ch12)

ps4/ps5

- it always helps do define precisely your X, Y, U/A !!
- external validity: need to say if sample was random!
- internal validity: discuss some threats
  - really need experiment or at least a quasi experiment
- don't say increased, large etc–use numbers, esp graphs, be specific!
- INUS again: first be clear X$-$ $>$Y !, and then how is X: I,N,U,S (spell out!)–someone give a good example?

ps4/ps5

- many people talk about experiments that are not!! need random assignment!! (and it needs to be feasable/ethical)
  - intervention or treatment without random assign fine, can still do before/after but don't call it experiment!!

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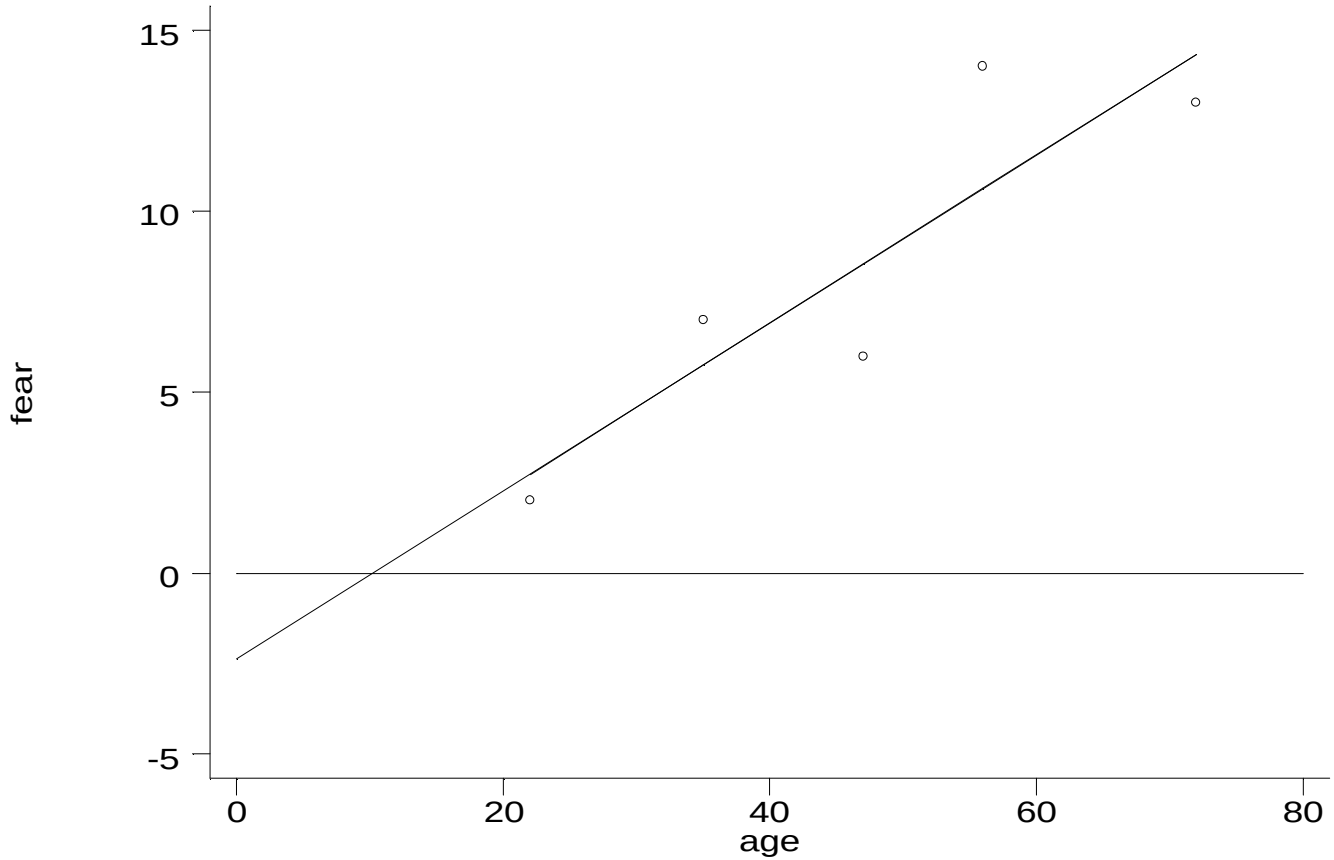
finding answers

- got hypotheis?
- now it's time to analyze the data (or critique research)
- that's inference: drawing conclusions (making inferences) from data
- this is what we want to know after all!
- just use regression and "control" for other variables [elaborate later]
- we have research questions, turn them into hypotheses
  - (a brief clear testable statement)
- say have a survey measuring people's fear of crime (0-15)
  - H1: fear of crime increases with age

example: age and fear



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-
- $\hat{Y}_i = \hat{\beta}_1 + \beta_2 X_i = -2.365 + .232 X_i$
- eg pre fear at 40yo

examples

- the regression advantage: use multiple vars at once
- see some of the useful things you can predict
- `http://ianayres.yale.edu/prediction-tools`

  eg life expectancy `http://www.northwesternmutual.com/learning-center/the-longevity-game.aspx`

outline

multivariate OLS

- multiple (multivariate) regression is the most common tool in social science
- it finds effect of a variable of interest (X) on the dependent variable (Y) controlling/holding constant other vars
- it's a statistical trick that makes sample equal on all characteristics that we control for and imitates experimental setting (randomization)
  - again, in experiment you randomize into treatment and control groups so that both groups are on average the same and then we apply treatment (e.g. drug) to treatment group and see if had effect as compared to control group

multivariate OLS

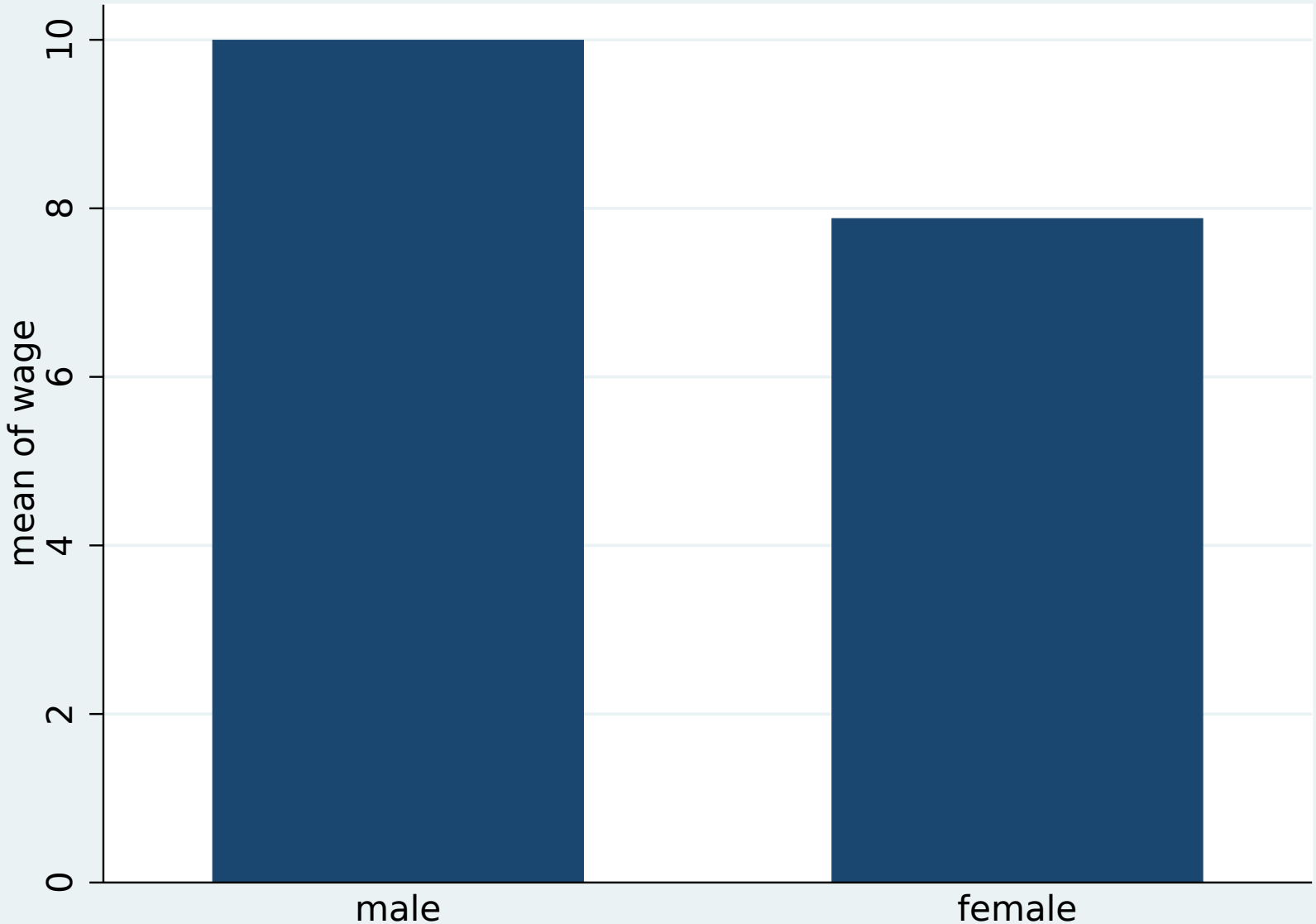
- most of the time cannot do experiment:
  - can't tell some people to smoke and some not
    can't give college to some and not others
- but can use regression!
- eg: study effect of education (X) on income (Y)
  - but it may not be the same for males and females?
  - just control for gender in regression
- and the effect is as if everybody had the same gender!

multivariate OLS

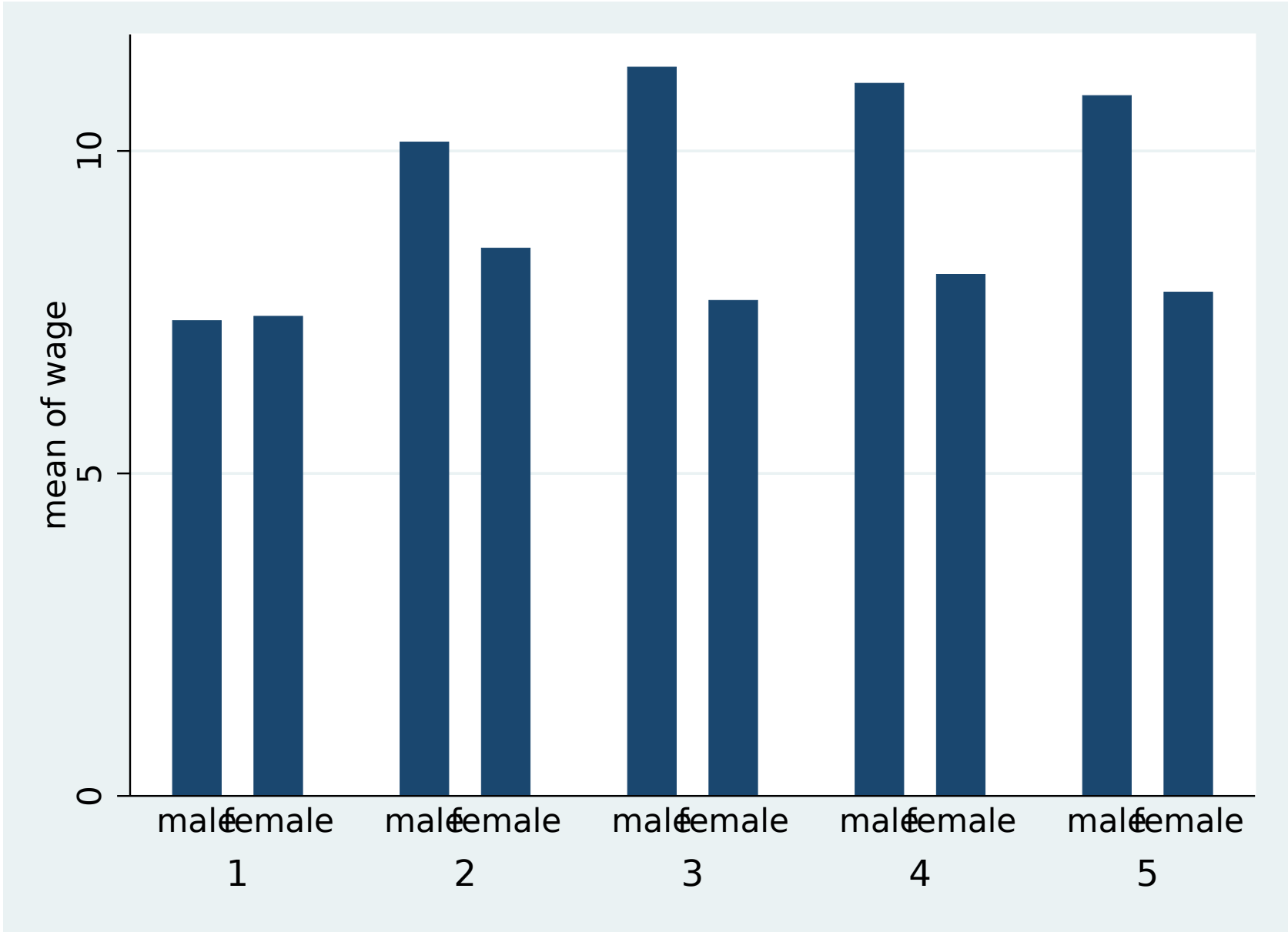
- $X \rightarrow Y$ can say that X affects Y
- $Y = f(X)$ or: Y is is a function of X (same thing)
- $Y = f(X_1, X_2, ..., X_n, u)$
- in soc sci **always** many Xs

outline

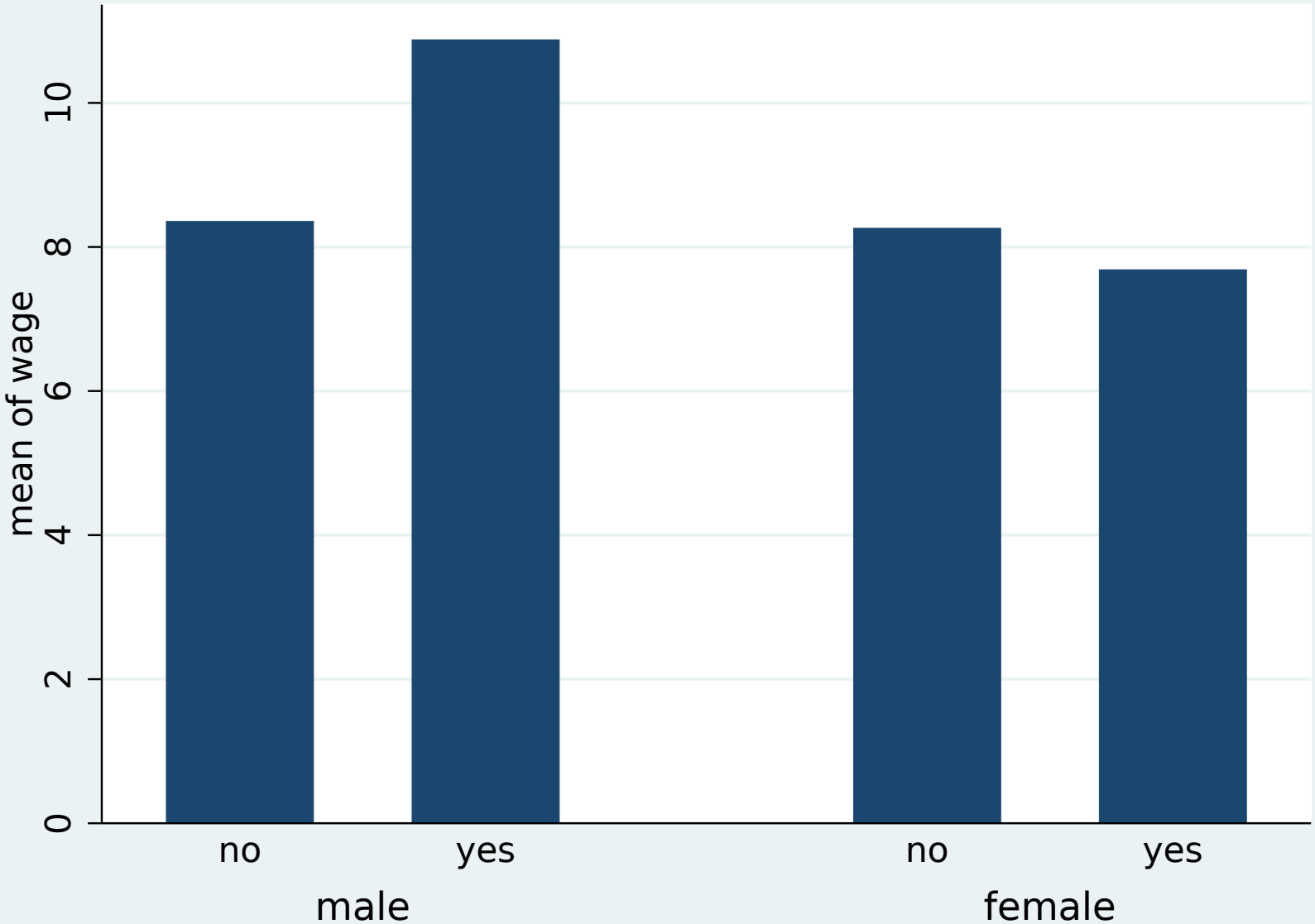
wages (never do reg w/o des sta)



wages by quintile of experience



wages by marital status and experience



descriptive stats

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Variable	Obs	Mean	Std. Dev.	Min	Max
wage	534	9.02	5.1	1	44.5
educ	534	13.01	2.6	2	18
exp	534	17.82	12.3	0	55

	wage	educ	exp
wage	1.00		
educ	0.38	1.00	
exp	0.08	-0.35	1.00

interpreting coefficients

- pretty much only one way to interpret reg correctly
- 1 unit ($ % etc) increase in X leads to β unit ($ % etc) increase/decrease in Y ($> 1X$: remember ceteris paribus!)
-
- and as per Wheelan ch11: focus on:
- sign
- size
- significance:
  - t-stat, t=coeff/se, sig if $|t| > 2$
  - p is prob of getting this result or larger if no assoc (Wheelan p198), sig if $p < .05$
  - $95\% CI = \pm 2 * se$

multivariate ols

-

wage	Coef.	Std. Err.	t	P>|t|
educ	.9188352	.081526	11.27	0.000
exp	.0986602	.0178812	5.52	0.000
married	.5704847	.4357421	1.31	0.191
_cons	-5.07037	1.224631	-4.14	0.000

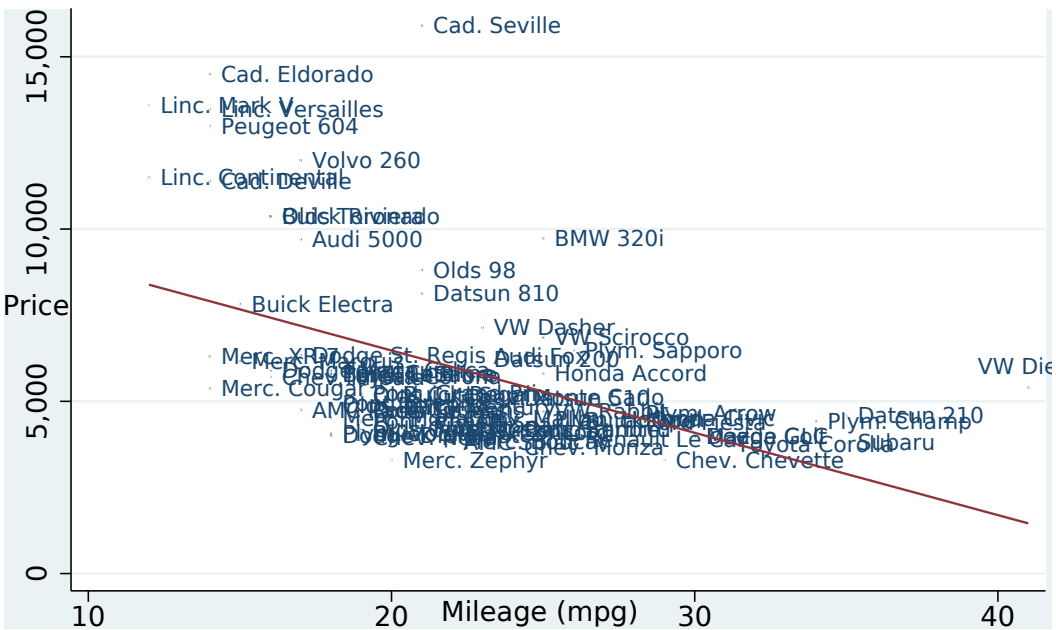
now let's turn to cars!

- let's say we want to explain price with mpg and weight
- research Q: fuel efficient cars don't have to cost a fortune
- hypothesis: the higher the mpg, the lower the price
- but the problem with fuel efficient cars is that they are tiny
  - and cannot really use them for much

interpret: β, p, t, CI; predict price for 10mpg

-

```
------------------------------------------------------------------------------
       price |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mpg |  -238.8943   53.07669    -4.50   0.000    -343.8925   -133.8961
       _cons |   11253.06   1170.813     9.61   0.000     8932.528    13573.59
------------------------------------------------------------------------------
```

- 

interpret:β, p, t, CI; predict price for 10mpg

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```
------------------------------------------------------------------------------
       price | Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mpg |  -49.5186   .15    -0.57   0.567    -221, 122
      weight |   1.746     .64     2.72   0.008     .46, 3
       _cons |   1946       3597   0.54   0.590   -5226, 9118
------------------------------------------------------------------------------
```

predicted values (p200 Wheelan, 2013)

- weight=-118+4.3*(height in)+.12*(age)-4.8*(female)
- 53yo female who is 5'5:
- -118+(4.3*65)+(.12*53)-(4.8*1)=163
- 35yo male who is 6'3:
- -118+(4.3*75)+(.12*35)-(4.8*0)=209
- remember life expectancy game? same thing!!
  - `https://www.northwesternmutual.com/learning-center/tools/the-longevity-game`
- banks, insurance companies, etc
  - use models like this to predict whether you'll repay loan
  - and hence how risky you are, and whether you should get one

a "complete" explanation

- wage=f(native ability, education, family background, age, gender, race, height, weight, strength, attitudes, neighborhood influences, family connections, interactions of the above, chance encounters,...)
- multiple regression will tell you the effect of one variable while controlling for the effect of other variables (again, as if everybody was the same on other vars)
- $wage_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + ... + \beta_n X_{ni} + u_i$

outline

practice regressions interpretations

- Happy Tourists, Unhappy Locals `http`:

  `//link.springer.com/article/10.1007/s11205-016-1436-9`

ps6: flip the class!

- was it difficult?
- any challenges?
- need to cover anything about regression again?

do scatterplots

- it is useful to produce a scatterplot
  - you'd see outliers
    and whether the relationship is due to them
  - blackboard: relationships biased due to outliers
  - say marriage rate and divorce rate across states

think about it

- always interpret results!
- give it some thought
- ask yourself whether results make sense and why
- think about measurement and what it means
  - eg does marriage cause divorce or sth about NV?
- and as always, remember design principles:
  - INUS condition
  - threats to validity
- and note that in addition to regression
  - it is critical to have theory/logic/mechanism
  - see Wheelan (2013, p207)

Wheelan in ch11 mentions Whitehall studies

- fascinating stuff!
- high status causes better health!
  - great book 'Status Syndrome' http://a.co/jaUuwT7
- say nobel prize or oscar boosts one's health and longevity
  - these successful folks live longer and in better health
  - than exact same people (income, lifestyle, etc) but without status

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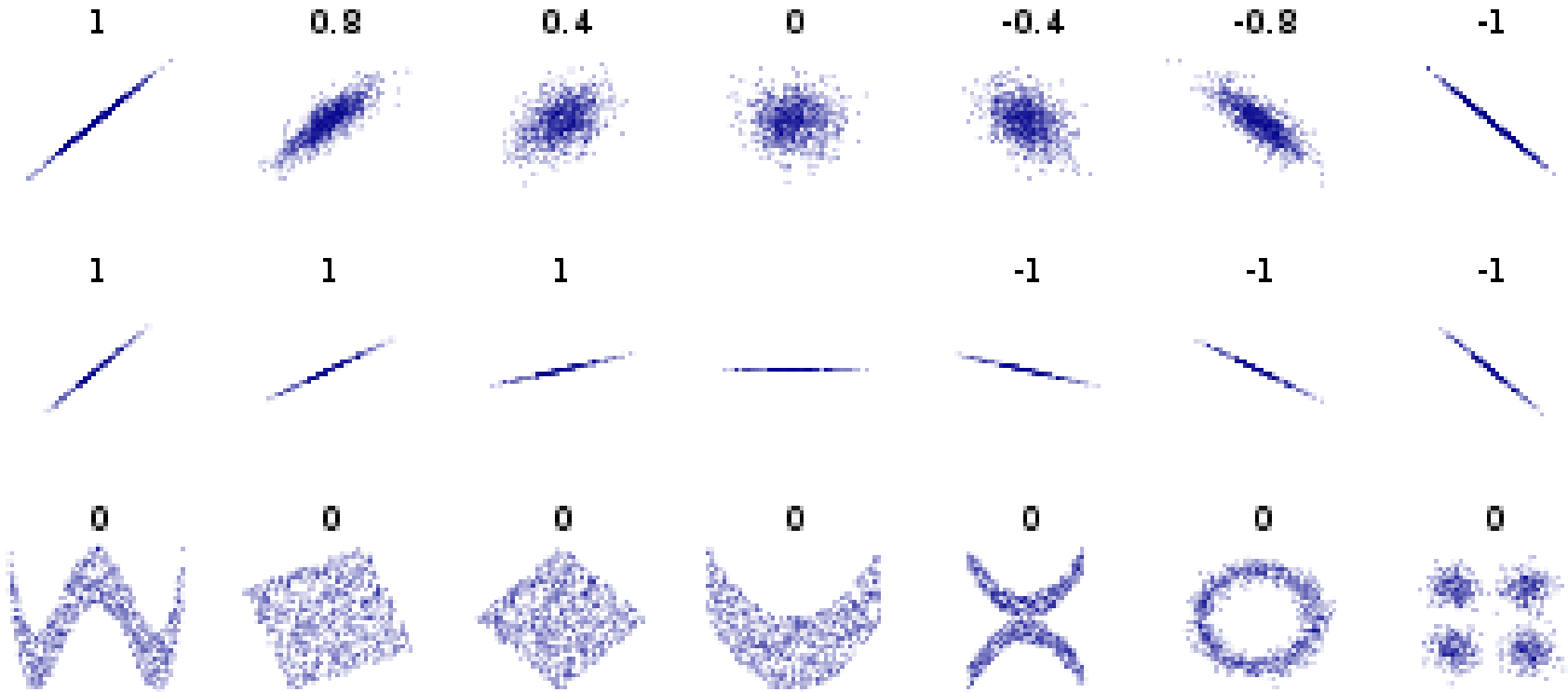
do not kill people with regressions (p212 Wheelan, 2013)

- recently tens of thousands of females
  were killed or made sick with estrogen,
  because regressions showed that estrogen was good
- regression estimates are never causal by themselves!
- remember the gold standard: experiment!
  - again, INUS, unknown unknowns, corr$\neq$causation, etc

nonlinear relationships



- like corr, won't detect nonlinear relationships!
- example of nonlinear rel? extra credit!

what to do about nonlinear rel?

- just break it up into subsets/subsamples! dig deeper!
  - say for males and females separately
  - say for low and hi val separately

  that's a quick way to see nonlinear relationship!

  eg it may first rise and then fall

reverse causality (p216 Wheelan, 2013)

- more lessons−− >bad golf, or
- bad golf−− >more lessons
- solution:
  - lag variable: bad golf last month−− >more lessons now
  - use exogenous shock–remember from res_des.pdf:
  - (terrorist attack−− >)policing−− >crime
- or think about it! miserable people choose cities?
  - then i looked at only people who were born in urban/rural

omitted variable bias (p217 Wheelan, 2013)

- golf$-$ $>$heart disease and cancer?
- control for age!
- age is killing people, not golf!

extrapolate beyond data (p220 Wheelan, 2013)

- only interpret within range of data!
- remember regression of fear on age?
  - and reg line hits y-axis at -3

data mining (p221 Wheelan, 2013)

- if you torture your data enough, it will confess
- likewise, if you throw enough variables, you will find significant relationships
- but remember: you need theory, causal mechanism/path, story!

run it

- excel
  - http://www.westmont.edu/~phunter/ma5/excel/regression.html
  - http://www3.wabash.edu/econometrics/EconometricsBook/Basic%20Tools/ExcelAddIns/OLSRegression.htm
  - http://finance.wharton.upenn.edu/~bodnarg/courses/readings/regression
- python
  - http://www.learndatasci.com/predicting-housing-prices-linear-regression-using-python
  - https://stackoverflow.com/questions/19991445/run-an-ols-regression-with-pandas-data-frame

ps6

- how's ps6 going? anyone show what you have so far?
- troubles frinding reg tables?

Levitt, S. D. and S. J. Dubner (2010): Freakonomics, vol. 61, Sperling & Kupfer.

Wheelan, C. (2013): Naked statistics: stripping the dread from the data, WW Norton & Company.