dummies and interactions

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outline

intuition

- dummies and interactions are fun !
- this is one of the most interesting things in regression
- you can test some interesting hypotheses
- and you can contribute to the literature

what is it?

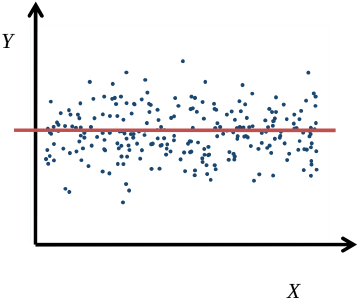
- ◇ dummies identify nominal or ordinal characteristics, such as gender, race, region, religion, or education (measured as highest degree attained)
- ◇ dummies are binary indicators of a specific attribute
  - · you either have the attribute or you do not
  - · 1 if the condition is true and 0 otherwise
  - · say male dummy$=$1 if a guy; 0 if a girl
- ◇ never name a dummy like 'gender', which is impossible to figure out what it means!

what is it?

- can use dummies to create separate intercepts and/or slopes for subgroups within one regression
- dummies must always be interpreted relative to
  - “base case,” “omitted category”, “reference group”

regression on constant only

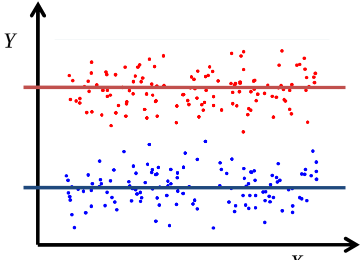
- $\hat{\beta}_2 = 0$
- $\hat{\beta}_1 = \bar{Y} - \hat{\beta}_2 \bar{X} = \bar{Y}$



-
- remember sums of squares discussions?
  - our best bet before regression
  - our best prediction of Y is mean of Y

now add a dummy

- $Y_i = \beta_1 + \beta_2 female_i + u_i$
- if $female_i = 1 \quad \hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2(1) = \hat{\beta}_1 + \hat{\beta}_2$
  - $E[Y|female = 1] = \hat{\beta}_1 + \hat{\beta}_2$
- if $female_i = 0 \quad \hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2(0] = \hat{\beta}_1$
  - $E[Y|female = 0] = \beta_1$
- hence, β_2 is the difference between $\bar{Y}$ for males and females



schematic

- $Y_i = \beta_1 + \beta_2 female_i + u_i$
- $\hat{\beta}_2 = \bar{Y}_{female} - \bar{Y}_{male}$
- this is like a t-test!
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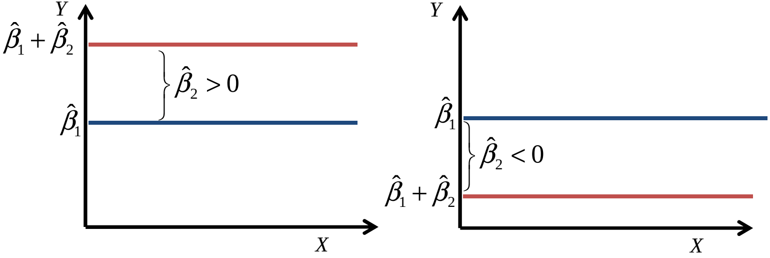
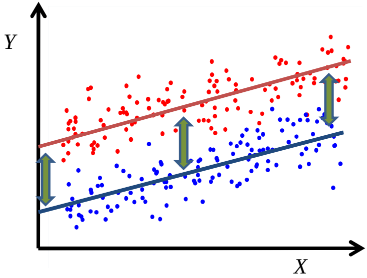


and add a continuous var

- $Y_i = \beta_1 + \beta_2 X_i + \beta_3 female_i + u_i$
- if $female_i = 1 \quad \hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{\beta}_3(1) = (\hat{\beta}_1 + \hat{\beta}_3) + \hat{\beta}_2 X_i$
- if $female_i = 0 \quad \hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{\beta}_3(0) = (\hat{\beta}_1) + \hat{\beta}_2 X_i$



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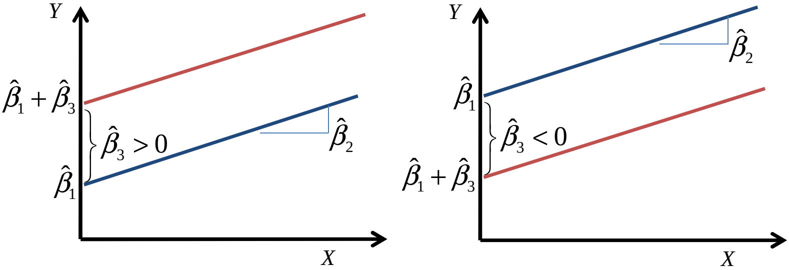
schematic

- $Y_i = \beta_1 + \beta_2 X_i + \beta_3 female_i + u_i$



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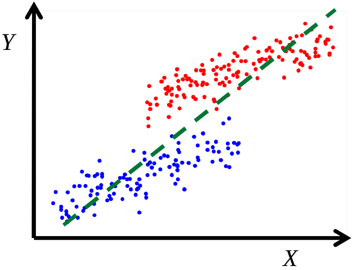
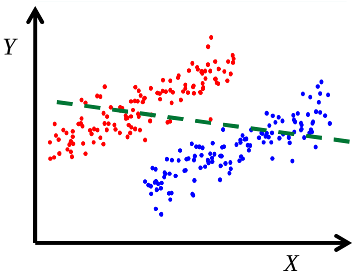
bias from omitting a dummy...

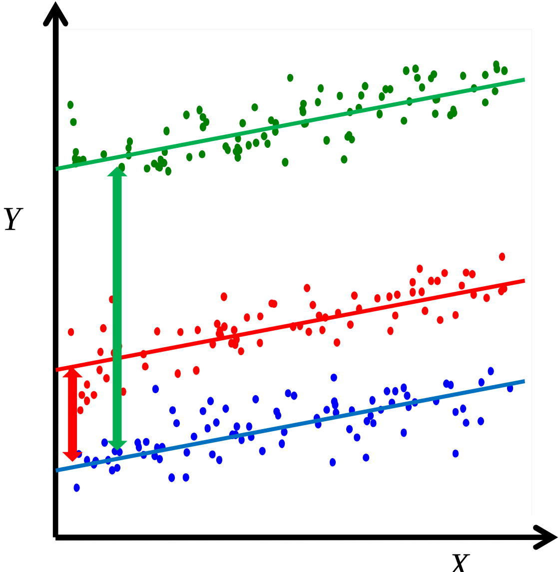




- difficult to know if there should be a dummy or not
- can experiment; and again use theory! it will tell you!

ordinal vars: **blackboard: asst assoc full prof**

- ◇ omit one category (ie pick base case)



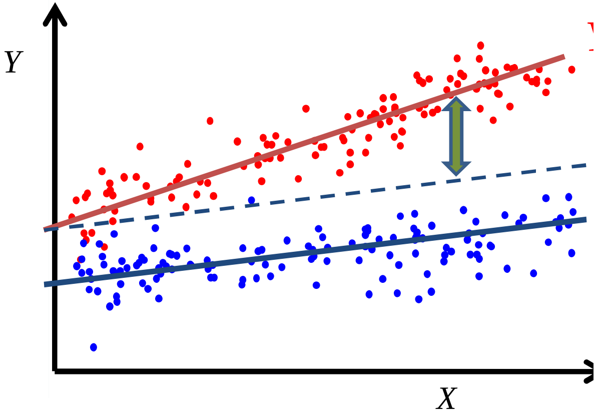
◇

choosing the base case

- ◇ be meaningful, eg pick typical or default situation
  - · eg in my paper on wrk hrs I picked 40,
  - · and dummies are then relative to the typical case
- ◇ think about what hypotheses you are most interested in
- ◇ remember that a different base case can change which coefficients are significant!
- ◇ make your choice(s) clear in your tables **and** text

continuous/dummy interactions

- $Y_i = \beta_1 + \beta_2 X_i + \beta_3 female_i + \beta_4 female_i * X_i + u_i$



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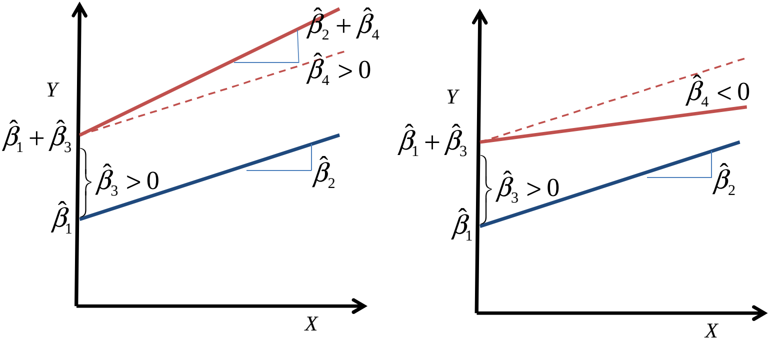
schematic

- $Y_i = \beta_1 + \beta_2 X_i + \beta_3 female_i + \beta_4 female_i * X_i + u_i$

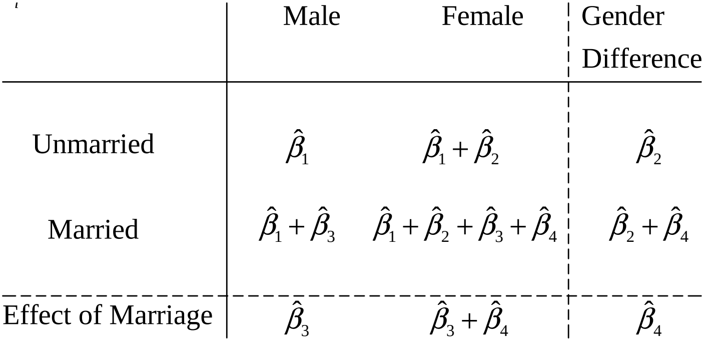


interaction of dummies

- ◇ if there is an interaction effect between two variables, the effect of one variable depends on the level of the other
- ◇ eg the effect of marriage on wage depends on gender.
- ◇ interactions go both ways:
- · the effect of gender depends on marital status, too

interaction of dummies

- $Y_i = \beta_1 + \beta_2 female + \beta_3 married + \beta_4 female * married + u_i$



	Male	Female	Gender Difference
Unmarried	$\hat{\beta}_1$	$\hat{\beta}_1 + \hat{\beta}_2$	$\hat{\beta}_2$
Married	$\hat{\beta}_1 + \hat{\beta}_3$	$\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4$	$\hat{\beta}_2 + \hat{\beta}_4$
Effect of Marriage	$\hat{\beta}_3$	$\hat{\beta}_3 + \hat{\beta}_4$	$\hat{\beta}_4$

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example [let’s calc tab from reg]

```
. table married female, c(mean wage) row col f(%7.2f)
----------------------------------
          |         Gender
  Married |    male  female   Total
----------+-----------------------
       no |    8.35    8.26    8.31
      yes |   10.88    7.68    9.40
          |
    Total |    9.99    7.88    9.02
----------------------------------
```

```
. gen femxmar = female*married
. reg wage female married femxmar
------------------------------------------------------------------------------
        wage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
$\hat{\beta}_2$  female |  -.0951892   .7350367    -0.13   0.897    -1.539132    1.348754
$\hat{\beta}_3$ married |   2.521222   .6120814     4.12   0.000     1.318819    3.723626
$\hat{\beta}_4$ femxmar |   -3.09704   .9072785    -3.41   0.001    -4.879344   -1.314737
$\hat{\beta}_1$   _cons |   8.354677   .4936728    16.92   0.000     7.384882    9.324473
------------------------------------------------------------------------------
```

dummy practice

- in addition to the dofile, see the links on the website for the code
- let's especially focus on the dummy variables
- we'll do it in the class if we have time...

interactions of continuous variables

- ◇ $Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 (X_{2i} X_{3i}) + u_i$
- ◇ $\frac{\Delta Y_i}{\Delta X_{2i}} = \beta_2 + \beta_4 X_{3i}$
- ◇ $\frac{\Delta Y_i}{\Delta X_{3i}} = \beta_3 + \beta_4 X_{2i}$

interactions links

- again, interactions are a great way to contribute
- see sections 3.7 and 3.8 `https://stats.idre.ucla.edu/stata/webbooks/reg/chapter3/regression-with-statachapter-3-regression-with-categorical-predictors/`
- `http://www.stata.com/support/faqs/stat/anoregcoef.html`
- `http://nd.edu/~rwilliam/stats2/l51.pdf`
- `http://www.stata.com/manuals13/rmarginsplot.pdf`: scroll down to examples
  - it is terrific command!