Today's Agenda

Extending the OLS Regression

1. Dummy predictors
2. Categorical predictors

Dataset: Ross (1990)

Justin Leinaweaver (Spring 2022)

Work, Family, and Well-Being in the United States, 1990 (ICPSR 6666)

Version Date: Jun 10, 1996 Cite this study | Share this page

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Version V1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	height	weight	male	earn	earnk	ethnicity	education	mother_education	father_education	walk	exercise	smokenow	tense	angry	age
2	74	210	1	50000	50	White	16	16	16	3	3	2	0	0	45
3	66	125	0	60000	60	White	16	16	16	6	5	1	0	0	58
4	64	126	0	30000	30	White	16	16	16	8	1	2	1	1	29
5	65	200	0	25000	25	White	17	17	NA	8	1	2	0	0	57
6	63	110	0	50000	50	Other	16	16	16	5	6	2	0	0	91
7	68	165	0	62000	62	Black	18	18	18	1	1	2	2	2	54
8	63	190	0	51000	51	White	17	17	17	3	1	2	4	4	39
9	64	125	0	9000	9	White	15	15	15	7	4	1	4	4	26
10	62	200	0	29000	29	White	12	12	12	2	2	2	0	0	49
11	73	230	1	32000	32	White	17	17	17	7	1	1	0	0	46
12	72	176	1	2000	2	Hispanic	15	15	15	8	1	2	0	0	21
13	72	265	1	35000	35	White	NA	NA	NA	1	1	2	0	0	53
14	72	160	1	27000	27	White	12	12	12	1	2	2	1	1	26
15	70	225	1	6530	6.53	White	16	16	NA	4	1	2	0	0	65
16	63	107	0	0	0	White	14	14	14	7	4	2	2	2	50

Dichotomous Variables (e.g. Dummies)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	height	weight	male	earn	earnk	ethnicity	education	mother_education	father_education	walk	exercise	smokenow	tense	angry	age
2	74	210	1	50000	50	White	16	16	16	3	3	2	0	0	45
3	66	125	0	60000	60	White	16	16	16	6	5	1	0	0	58
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9	64	125	0	9000	9	White	15	15	15	7	4	1	4	4	26
10	62	200	0	29000	29	White	12	12	12	2	2	2	0	0	49
11	73	230	1	32000	32	White	17	17	17	7	1	1	0	0	46
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14	72	160	1	27000	27	White	12	12	12	1	2	2	1	1	26
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16	63	107	0	0	0	White	14	14	14	7	4	2	2	2	50

Dichotomous Variables (e.g. Dummies)

Is their evidence of a gender difference in earned income?

1. Calculate the mean income for each gender
   - Men = ?
   - Women = ?

Dichotomous Variables (e.g. Dummies)

Is their evidence of a gender difference in earned income?

1. Calculate the mean income for each gender
   - Men = \$59.9k
   - Women = \$32.1k

Dichotomous Variables (e.g. Dummies)

Is their evidence of a gender difference in earned income?

2. Fit an OLS regression of income on gender

Dichotomous Variables (e.g. Dummies)

- Men = \$59.9k
- Women = \$32.1k

	Income (Thousands USD)
Male	27.78*
	(1.93)
Constant	32.12*
	(1.18)
Observations	1,815
Adjusted R^2	0.10
Residual Std. Error	39.77 (df = 1813)
F Statistic	206.76* (df = 1; 1813)
Note:	*p<0.05

- Men = \$59.9k
- Women = \$32.1k

	Income (Thousands USD)
Male	27.78*
	(1.93)
Constant	32.12*
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Observations	1,815
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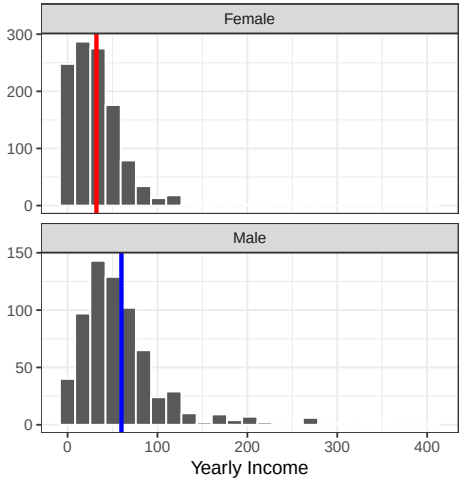
F Statistic	206.76* (df = 1; 1813)
Note:	*p<0.05

Income = 32.12 + 27.78 x (Male)

- P(Male = 1) = 32.12 + 27.78 x 1 = 59.9
- P(Male = 0) = 32.12 + 27.78 x 0 = 32.12

Gender Differences in Income?



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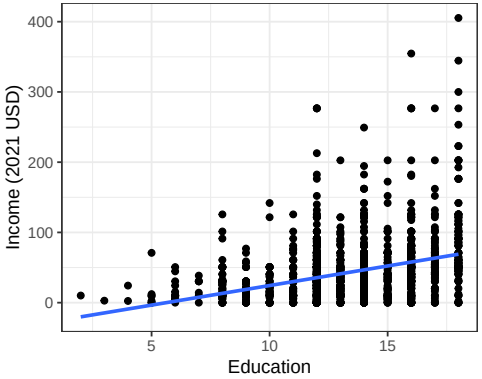
Gender Differences in Income?



	Income (Thousands USD)
Education	5.57*
	(0.36)
Constant	−31.34*
	(4.89)
Observations	1,813
Adjusted R^2	0.11
Residual Std. Error	39.50 (df = 1811)
F Statistic	235.79* (df = 1; 1811)
Note:	*p<0.05

Dummy Variables in OLS Regressions

Regress earnings (2021) on education and gender

	Income (Thousands USD)	
	(1)	(2)
Education	5.57*	5.35*
	(0.36)	(0.34)
Male		26.53*
		(1.82)
Constant	−31.34*	−38.28*
	(4.89)	(4.65)
Observations	1,813	1,813
Adjusted R^2	0.11	0.21
Residual Std. Error	39.50 (df = 1811)	37.38 (df = 1810)
F Statistic	235.79* (df = 1; 1811)	238.09* (df = 2; 1810)
Note:		*p<0.05

Dummy Variables in OLS Regressions

	Income (2021 USD)
Education	5.35*
	(0.34)
Male	26.53*
	(1.82)
Constant	−38.28*
	(4.65)
Observations	1,813
Adjusted R^2	0.21
Residual Std. Error	37.38 (df = 1810)
F Statistic	238.09* (df = 2; 1810)
Note:	*p<0.05

Education	Male	Female
1		
5		
10		
15		

	Income (2021 USD)
Education	5.35*
	(0.34)
Male	26.53*
	(1.82)
Constant	−38.28*
	(4.65)
Observations	1,813
Adjusted R^2	0.21
Residual Std. Error	37.38 (df = 1810)
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Note:	*p<0.05

Education	Male	Female
1		
5		
10		
15		

$$\text{Income} = -38.28 + 5.35 \times \text{Education} + 26.53 \times \text{Male}$$

	Income (2021 USD)
Education	5.35*
	(0.34)
Male	26.53*
	(1.82)
Constant	−38.28*
	(4.65)
Observations	1,813
Adjusted R^2	0.21
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Note:	*p<0.05

Education	Male	Female
1	-6.4	-32.93
5	15	-11.53
10	41.75	15.22
15	68.5	41.97

$$\text{Income} = \text{-38.28} + 5.35 \times \text{Education} + 26.53 \times \text{Male}$$

Dummy Variables in OLS Regressions

	Income (2021 USD)
Education	5.35*
	(0.34)
Male	26.53*
	(1.82)
Constant	−38.28*
	(4.65)
Observations	1,813
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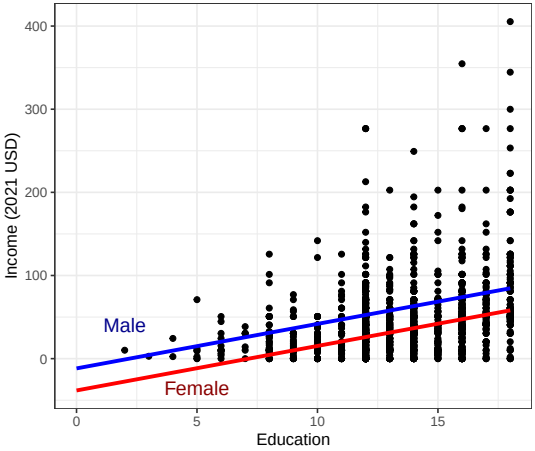

Dummy Variables in OLS Regressions

1. Point estimates produce the group means (with a significance test), and
2. The coefficient on the dummy moves the intercept, not the slope

Categorical Variables

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	height	weight	male	earn	earnk	ethnicity	education	mother_education	father_education	walk	exercise	smokenow	tense	angry	age
2	74	210	1	50000	50	White	16	16	16	3	3	2	0	0	45
3	66	125	0	60000	60	White	16	16	16	6	5	1	0	0	58
4	64	126	0	30000	30	White	16	16	16	8	1	2	1	1	29
5	65	200	0	25000	25	White	17	17	NA	8	1	2	0	0	57
6	63	110	0	50000	50	Other	16	16	16	5	6	2	0	0	91
7	68	165	0	62000	62	Black	18	18	18	1	1	2	2	2	54
8	63	190	0	51000	51	White	17	17	17	3	1	2	4	4	39
9	64	125	0	9000	9	White	15	15	15	7	4	1	4	4	26
10	62	200	0	29000	29	White	12	12	12	2	2	2	0	0	49
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12	72	176	1	2000	2	Hispanic	15	15	15	8	1	2	0	0	21
13	72	265	1	35000	35	White	NA	NA	NA	1	1	2	0	0	53
14	72	160	1	27000	27	White	12	12	12	1	2	2	1	1	26
15	70	225	1	6530	6.53	White	16	16	NA	4	1	2	0	0	65
16	63	107	0	0	0	White	14	14	14	7	4	2	2	2	50

Categorical Variables

Ethnicity	Income
Black	$34.73k
Hispanic	$32k
Other	$42.9k
White	$44.08k

Using Categorical Variables in Excel: Make Dummies

	A	B	C	D
1	male	earnk	ethnicity	education
2	1	50	White	16
3	0	60	White	16
4	0	30	White	16
5	0	25	White	17
6	0	50	Other	16
7	0	62	Black	18
8	0	51	White	17
9	0	9	White	15
0	0	29	White	12
1	1	32	White	17
2	1	2	Hispanic	15
3	1	35	White	NA
4	1	27	White	12
5	1	6.53	White	16
6	0	0	White	14

	A	B	C	D
1	male	earnk	ethnicity	education
2	0	62	Black	18
3	0	7	Black	12
4	1	53	Black	13
5	0	5	Black	12
6	0	5	Black	12
7	0	10	Black	12
8	0	30	Black	14
9	1	13	Black	8
0	0	5	Black	12
1	0	0	Black	13
2	1	15	Black	11
3	0	15	Black	14
4	0	21	Black	17
5	0	15	Black	12
6	1	15	Black	14

1. Sort data by categorical predictor

Using Categorical Variables in Excel: Make Dummies

	male	earnk	ethnicity	education	Black	Hispanic	Other
	0	62	Black	18	1	0	0
	0	7	Black	12	1	0	0
	1	53	Black	13	1	0	0
	0	5	Black	12	1	0	0
	0	5	Black	12	1	0	0
	0	10	Black	12	1	0	0
	0	30	Black	14	1	0	0
	1	13	Black	8	1	0	0
	0	5	Black	12	1	0	0
	0	0	Black	13	1	0	0
	1	15	Black	11	1	0	0
	0	15	Black	14	1	0	0
	0	21	Black	17	1	0	0
	0	15	Black	12	1	0	0
	1	15	Black	14	1	0	0
	1	43	Black	13	1	0	0
	0	32	Black	14	1	0	0
	0	25	Black	12	1	0	0

2. Create dummies for each category (omit baseline)

Using Categorical Variables in Excel: Make Dummies

male	earnk	ethnicity	education	Black	Hispanic	Other
0	62	Black	18	1	0	0
0	7	Black	12	1	0	0
1	53	Black	13	1	0	0
0	5	Black	12	1	0	0
0	5	Black	12	1	0	0
0	10	Black	12	1	0	0
0	30	Black	14	1	0	0
1	13	Black	8	1	0	0
0	5	Black	12	1	0	0
0	0	Black	13	1	0	0
1	15	Black	11	1	0	0
0	15	Black	14	1	0	0
0	21	Black	17	1	0	0
0	15	Black	12	1	0	0
1	15	Black	14	1	0	0
1	43	Black	13	1	0	0
0	32	Black	14	1	0	0
0	25	Black	12	1	0	0

Regress income on the three dummy predictors

Ethnicity	Income
Black	$34.73k
Hispanic	$32k
Other	$42.9k
White	$44.08k

	Income (2021)
Ethnicity: Black	−9.34*
	(3.30)
Ethnicity: Hispanic	−12.07*
	(4.24)
Ethnicity: Other	−1.18
	(6.87)
Constant	44.08*
	(1.08)
Observations	1,815
Adjusted R^2	0.01
Residual Std. Error	41.83 (df = 1811)
F Statistic	4.96* (df = 3; 1811)
Note:	*p<0.05

Ethnicity	Income
Black	$34.73k
Hispanic	$32k
Other	$42.9k
White	$44.08k

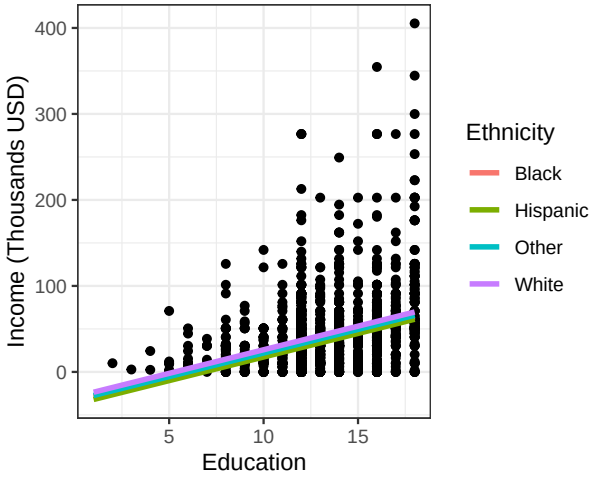
	Income (2021)
Ethnicity: Black	−9.34*
	(3.30)
Ethnicity: Hispanic	−12.07*
	(4.24)
Ethnicity: Other	−1.18
	(6.87)
Constant	44.08*
	(1.08)
Observations	1,815
Adjusted R^2	0.01
Residual Std. Error	41.83 (df = 1811)
Note:	*p<0.05

$$\text{Income} = 44.08 + \text{-}9.34(\text{Black}) + \text{-}12.07(\text{Hispanic}) + \text{-}1.18(\text{Other})$$

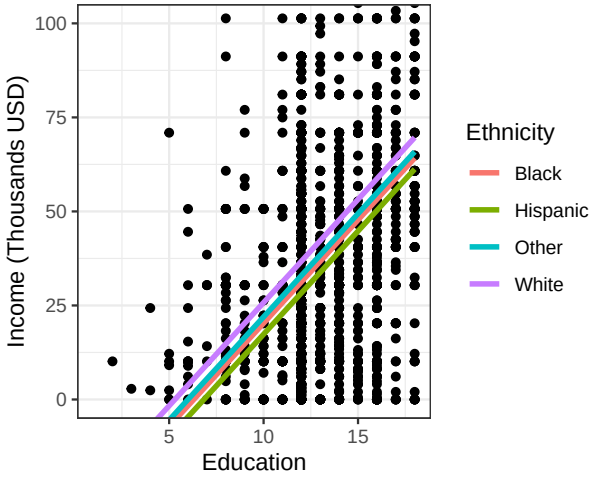
Categorical Variables in OLS Regressions

Regress earnings (2021) on education and the ethnicity dummies

	Income (2021)		
	(1)	(2)	(3)
Education	5.57*		5.49*
	(0.36)		(0.36)
Ethnicity: Black		−9.34*	−5.47
		(3.30)	(3.13)
Ethnicity: Hispanic		−12.07*	−8.43*
		(4.24)	(4.01)
Ethnicity: Other		−1.18	−3.80
		(6.87)	(6.48)
Constant	−31.34*	44.08*	−29.11*
	(4.89)	(1.08)	(4.97)
Observations	1,813	1,815	1,813
Adjusted R^2	0.11	0.01	0.12
Residual Std. Error	39.50 (df = 1811)	41.83 (df = 1811)	39.46 (df = 1808)
F Statistic	235.79* (df = 1; 1811)	4.96* (df = 3; 1811)	60.85* (df = 4; 1808)
Note:			*p<0.05



	Income (2021)
Education	−5.47
	(3.13)
Ethnicity: Black	−8.43*
	(4.01)
Ethnicity: Hispanic	−3.80
	(6.48)
Ethnicity: Other	5.49*
	(0.36)
Constant	−29.11*
	(4.97)
Observations	1,813
Adjusted R^2	0.12
Residual Std. Error	39.46 (df = 1808)
F Statistic	60.85* (df = 4; 1808)
Note:	*p<0.05



	Income (2021)
Education	−5.47
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Ethnicity: Black	−8.43*
	(4.01)
Ethnicity: Hispanic	−3.80
	(6.48)
Ethnicity: Other	5.49*
	(0.36)
Constant	−29.11*
	(4.97)
Observations	1,813
Adjusted R^2	0.12
Residual Std. Error	39.46 (df = 1808)
F Statistic	60.85* (df = 4; 1808)
Note:	*p<0.05