Education and Income

EMBA – B7114 Applied Regression Analysis, Fall 2013
Course project

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- Motivation:

  Income inequality, upward mobility, college degrees…

- Purpose:

  How much do academic degrees impact individual income?
  Any differential effect depending on race? Sex?

- Data and scope:

  Current Population Survey (U.S. Census Bureau + U.S. Bureau of Labor Statistics)
  Only New York City, 2011 (PPP, apples to apples)

INPUT DATA

Current Population Survey - New York City, 2011

Available variables:

- Individual income
- Education
- Race
- Marital status
- Sex
- Age

Missing (and potentially important) variables:

- Academic major
- Interpersonal skills
- Network/connections
- Original family income
- etc.

ANALYSIS

First model:

Income = β0 + β1*high school + β2*bachelor + β3*master + β4*PhD + β5*black + β6*married + β7*male + β8*age

- β1 = 11,943 = premium income of high school diploma above no high school.
- β2 - β1 = 37,098 = premium income of bachellor's degree above high school diploma.
- β3 – β2 = 15,935 = premium income of master's degree above bachellor's degree.
- β4 – β3 = 11,239 = premium income of doctoral degree above master's degree.

What about differential effects?? Is bachelor/no-bachelor different for men and women? Black/non-black?

Regression Statistics	
Multiple R	0.41242
R Square	0.17009
Adjusted R Square	0.16976
Standard Error	69724
Observations	20429

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	2.0345E+13	2.54312E+12	523.1277177	0
Residual	20420	9.92693E+13	4861375962		
Total	20428	1.19614E+14			

Variables	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-14702	2199	-6.7	2.36E-11	-19012	-10392	-19012	-10392
highschool	11943	1722	6.9	4.15E-12	8568	15318	8568	15318
bachelor	49041	1786	27.5	5.37E-163	45539	52542	45539	52542
masters	64976	1984	32.7	3.26E-229	61086	68866	61086	68866
PhD	76215	3639	20.9	2.09E-96	69083	83347	69083	83347
black	-9384	1156	-8.1	4.94E-16	-11650	-7119	-11650	-7119
married	15566	1151	13.5	1.81E-41	13310	17823	13310	17823
male	23756	989	24.0	8.38E-126	21818	25695	21818	25695
age	520	40	13.1	8.37E-39	442	598	442	598

ANALYSIS

Heterogeneous effects?

	high school	bach	Δ	% Δ
no black	39,512	77,309	37,797	96%
black	29,670	50,893	21,223	72%
Δ	-9,843	-26,417		
% Δ	-25%	-34%		

	Bach/Master	PhD	Δ	% Δ
no black	83,744	114,205	30,461	36%
black	57,394	86,535	29,141	51%
Δ	-26,350	-27,670		
% Δ	-31%	-24%		

	high school	bach	Δ	% Δ
women	28,617	55,283	26,665	93%
men	42,031	90,227	48,196	115%
Δ	13,413	34,944		
% Δ	47%	63%		

	Bach/Master	PhD	Δ	% Δ
women	60,967	82,671	21,704	36%
men	99,955	135,642	35,687	36%
Δ	38,988	52,971		
% Δ	64%	64%		

ANALYSIS

Heterogeneous effects?

Second model → bachelor's degree with interactions:

Income = β0 + β1*bachellor + β2*black + β3*married + β4*male + β5*age + β6* bachxmale + β7* bachxblack

Expected income premium for Bachellor's…

…if non-black woman	= β1	= $31,124
…if non-black man	= β1+β6	= $49,708
…if black woman	= β1+β7	= $14,960
…if black man	= β1+β6+β7	= $33,544

Regression Statistics	
Multiple R	0.392
R Square	0.154
Adjusted R Square	0.153
Standard Error	62908
Observations	14572

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	1.04668E+13	1.49525E+12	377.8409174	0
Residual	14564	5.7635E+13	3957361530		
Total	14571	6.81018E+13			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-591.7	1943.0	-0.3	0.760727914	-4400	3217	-4400	3217
bachelor	31124.1	1690.7	18.4	7.88213E-75	27810	34438	27810	34438
black	-4581.0	1467.4	-3.1	0.001801194	-7457	-1705	-7457	-1705
married	15034.8	1239.5	12.1	1.07045E-33	12605	17464	12605	17464
male	11752.0	1401.3	8.4	5.46671E-17	9005	14499	9005	14499
age	592.2	43.5	13.6	5.12547E-42	507	677	507	677
bachxmale	18583.9	2116.6	8.8	**1.81632E-18**	14435	22733	14435	22733
bachxblack	-16164.3	2532.4	-6.4	**1.78931E-10**	-21128	-11200	-21128	-11200

ANALYSIS

Heterogeneous effects?

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ANALYSIS

Heterogeneous effects?

Third model → PhD's degree with interactions:

Income = β0 + β1*PhD + β2*black + β3*married + β4*male + β5*age + β6* PhDxmale + β7* PhDxblack

Regression Statistics	
Multiple R	0.295
R Square	0.087
Adjusted R Squa	0.086
Standard Error	90489
Observations	10175

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	7.93821E+12	1.13403E+12	138.494	1.051E-195
Residual	10167	8.32503E+13	8188283314		
Total	10174	9.11885E+13			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	29079.9	3039.9	9.6	1.37E-21	23121	35039	23121	35039
PhD	12032.8	6650.9	1.8	7.04E-02	-1004	25070	-1004	25070
black	-18085.4	2481.5	-7.3	3.38E-13	-22950	-13221	-22950	-13221
married	23988.4	2056.2	11.7	3.00E-31	19958	28019	19958	28019
male	34091.9	1857.8	18.4	5.03E-74	30450	37733	30450	37733
age	586.3	76.4	7.7	1.80E-14	437	736	437	736
PhDxblack	109.3	14729.4	0.0	9.94E-01	-28763	28982	-28763	28982
PhDxmale	10586.1	8725.2	1.2	2.25E-01	-6517	27689	-6517	27689

PhD interactions do not seem to be statistically significant.
Let's check…

ANALYSIS

Heterogeneous effects?

Fourth (and last) model → PhD's degree without interactions:

Income = β0 + β1*PhD + β2*black + β3*married + β4*male + β5*age

SSE (RM)	8.32624E+13
SSE (FM)	8.32503E+13
n	10175
p	7
k	5
d.f.(num)	3
d.f.(den)	10167
alpha	0.05
Critical F	2.606
Observed F	0.492
p-value	0.688

Observed F < Critical F → accept null hypothesis β6 = β7 = 0

Expected income premium for a PhD degree is β1=$17,768 regardless of race and sex

Regression Statistics	
Multiple R	0.29482
R Square	0.08692
Adjusted R Squa	0.08647
Standard Error	90487
Observations	10175

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	7.92613E+12	1.58523E+12	193.606746	1.1284E-197
Residual	10169	8.32624E+13	8187860888		
Total	10174	9.11885E+13			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	28750	3027	9	2.6444E-21	22816	34683	22816	34683
PhD	17768	4384	4	5.08818E-05	9175	26360	9175	26360
black	-18043	2446	-7	1.76569E-13	-22839	-13248	-22839	-13248
married	23999	2056	12	2.81225E-31	19968	28029	19968	28029
male	34559	1817	19	2.81615E-79	30998	38121	30998	38121
age	589	76	8	1.37478E-14	439	738	439	738

RECAP/CONCLUSIONS

- Increasing levels of education lead to increasing levels of individual income. Specifically, the first model predicts:

  - 11,943 = high school premium
  - 37,098 = bachellor's degree premium
  - 15,935 = master's degree premium
  - 11,239 = doctoral degree premium

- Heterogeneous effects: premium income from a bachellor's degree is less for women and black individuals than for men and non-black individuals, respectively:

  - non-black woman = $31,124
  - non-black man = $49,708
  - black woman = $14,960
  - black man = $33,544

- Expected premium income from a PhD is $17,768 regardless of race and sex.

- Further refinement: include academic major, interpersonal skills, etc.