

# Does Income Associate with Races and Hours of Work per Week?

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## Abstract

We investigate which races have relative higher annual income. We also want to explore whether there is relation between annual income and hours of work per week. We observe 431 individuals who are employed. We found that before 30 hours of work per week, Asian has relative higher annual income on average. After 30 hours of work per week, White has relative higher annual income on average. Companies can select their favorite employees based on this information and set appropriate working hours per week.

## Background and Significance

Does annual income increase as we spending more hours on work per week? Do different races of people have different annual income? These are questions that all the employees and companies need to think about. In this study, we are going to examine whether different races have different annual income on average obtained from from the American Community Survey (ACS) dataset. We also explore the relationship between income and hours of work per week.

Rakesh Kochhar and Anthony Cilluffo (2018) show that although income inequality in the US is greatest among Asians, Asians have the highest income except for lower-income adults. Lawrence Mishel (2013) shows that between 1979 and 2007, employees will spend more time on work than the previous year. Alison Doyle (2019) represents that White American, African American, and Asian American almost have the same amount hours of work per week which is 39 hours per week.

In this paper, we will use data Employed in American Community Survey to investigate the relationship between annual income and hours of work per week for all people in US who are employed. We also investigate whether there are differences of annual income among different races for all people in US who are employed.

## Data

Using EmployedACS in Robin Lock (2017), we obtained data on annual income. We considered the quantitive variables Income, representing the annual income (in \$1,000's) of individuals, and HoursWk representing hours of work per week. We also considered the categorical variable Race. All values in the dataset are useful. The table below displays the mean and standard deviation in annual income and hour of work per week for each race.

Summary Statistics

Race	Mean_Hours	StDev_Hours	Mean_Income	StDev_Income	N
asian	39.41026	13.72228	44.53077	38.53967	39
black	39.06452	10.90240	38.91613	33.37972	31
other	40.27273	12.40653	28.66364	19.62725	22
white	38.27434	12.84310	42.21298	56.30435	339

Figures 1 and 2 display density plots of annual Income and Hours of work per week, while Figure 3 shows a scatterplot of annual income against hours of work per week, with regression lines included for each race.



Figure 1 represents that most of the 431 employees' annual income is below \$100,000, and Asians' annual income slightly higher than the other races relatively. Figure 2 represents that hours of work per week for 431 employees are concentrated around 40 hours per week and black people's hours of work per week are more concentrated around 40 hours than the other races. Figure 3 shows that for all races annual income increases slightly as hours of work per week increase and white people have a larger slope than the other races, which means hours of work per week increase one unit, white people will more extra annual income than other races.

## Model

Since Figure 3 shows that there is linear relationship between annual income and hours of work per week, we fit a model with an interaction term. Table 2 shows the model coefficients.

```
##
## Call:
## lm(formula = Income ~ HoursWk * Race, data = employ)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -121.80  -21.61   -5.22    9.78   479.49
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      17.8777    23.8319   0.750  0.4536
## HoursWk           0.6763     0.5719   1.183  0.2376
## Raceblack        -14.7800    40.5576  -0.364  0.7157
## Raceother        -36.4659    42.9945  -0.848  0.3968
## Racewhite        -42.2790    25.2260  -1.676  0.0945 .
## HoursWk:Raceblack  0.2406     0.9916   0.243  0.8084
## HoursWk:Raceother  0.4970     1.0252   0.485  0.6281
## HoursWk:Racewhite  1.0641     0.6075   1.752  0.0805 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 48.37 on 423 degrees of freedom
## Multiple R-squared:  0.1567, Adjusted R-squared:  0.1428
## F-statistic: 11.23 on 7 and 423 DF,  p-value: 4.564e-13
```

The estimated regression equation is

$$\widehat{\text{Income}} = 17.88 + 0.68 \times \text{Hours} - 14.78 \times I_{\text{Black}} - 36.46 \times I_{\text{Other}} - 42.28 \times I_{\text{White}} + 0.24 \times I_{\text{black}} \times \text{Hours} + 0.49 \times \text{Hours} \times I_{\text{Other}} + 1.06 \times \text{Hours} \times I_{\text{White}}$$

For Asian, this simplifies to  $\widehat{\text{Income}} = 17.88 + 0.68 \times \text{Hours}$ .

For Black, it becomes  $\widehat{\text{Income}} = 3.1 + 0.24 \times \text{Hours}$ .

For White, it becomes  $\widehat{\text{Income}} = -24.4 + 1.06 \times \text{Hours}$ .

For Other, it becomes  $\widehat{\text{Income}} = -18.58 + 0.49 \times \text{Hours}$ .

Thus, we estimate that annual Income of Asian increase by about 0.68 thousand dollars, on average, for each additional hour in Hours per week, compared to an estimated average increase of 0.24 thousand dollars per hours of Hours per week for Black, 1.06 thousand dollars per hours of Hours per week for White, and 0.49 thousand dollars per hours of Hours per week for Other race.

Since the intercepts of these regression lines would theoretically pertain to movies of length zero, they are not meaningful in context, so we will not attempt to state their interpretations.

The value of  $R^2$  was 0.1567. This indicates that approximately 16% of the variability in annual Income is explained by Hours of work per week.

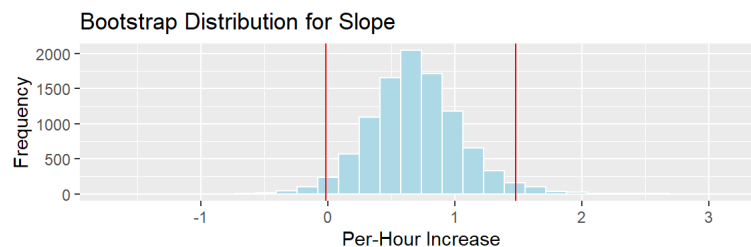
## Inference

In this section, we use this sample of 431 employees to draw broader conclusions about all workers in the US. First, we calculate a confidence interval for the expected increase in annual Income for each additional hour in hours per week for Asians. Then, we compare the expected annual income for 40 hours per week Asian to that of 40 hours of work per week White.

The general form of the regression equation is

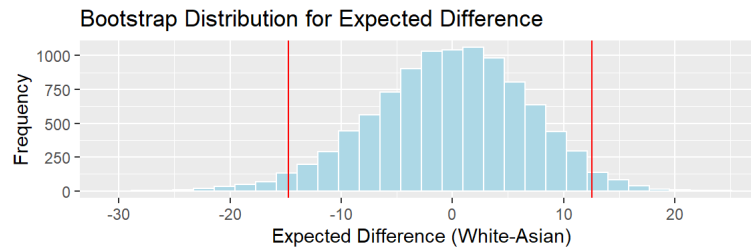
$$\widehat{\text{Income}} = b_0 + b_1 \times \text{Hours} + b_2 \times I_{\text{Black}} + b_3 \times I_{\text{Other}} + b_4 \times I_{\text{White}} + b_5 \times I_{\text{black}} \times \text{Hours} + b_6 \times \text{Hours} \times I_{\text{Other}} + b_7 \times \text{Hours} \times I_{\text{White}}$$

The expected change in Income for Asian workers is given by  $b_1$ . We use bootstrapping to find a 95% confidence interval for this quantity, as it pertains to all Asian workers in the US. Figure 4 displays the bootstrap distribution and a 95% bootstrap percentile confidence interval. We are 95% confident that annual Income for Asian increase between 0 and 15 hundred dollars, on average, for each additional hour of work per week.



Bootstrap Distribution for Per-Hour Increase in Annual Income for Asian

Next, we compare expected annual Income for White and Asian who working for 40 hours per week. The expected annual Income for a 40-Hours of Asian workers is given by  $b_0 + 40b_1$ . The expected score for movie with a rating of R is  $b_0 + 40b_1 + b_4 + 40b_7$ . The difference in these expected scores is  $b_4 + 40b_7$ . Figure 5 gives a 95% bootstrap percentile confidence interval for this expected difference.



Bootstrap Distribution for Expected Difference in annual Income for Asian and White

We are 95% confident that the average annual Income among all 40-hour White workers is between 146 hundred dollars lower and 129 hundred dollars higher than the average annual Income among all 40-hour Asian workers.

## Discussion and Conclusions

We have found evidence that annual income increases if workers spend more hours on work in each week. The regression lines relating annual income and hours of work per week had a positive slope for White, Asian, Black, and other races. The increase rate was found to be steepest among White, with an estimated increase of approximately 1500 dollars in annual income if they work one more hour each week. However, a confidence interval for this expected increase ranges from 0 to 1.5 (in 1000's dollars). Since this interval contains 0, in some situations, workers' annual income will not increase even though they spend more hours on work for each week.

There are signs of an intersection between hours of work per week and annual income, as Asian has a relatively higher annual income if workers work less than 25 hours per week, but White's annual income is higher when workers work 25 hours or more per week.

We found that if employees work for 40 hours per week, the mean difference in annual income between White and Asian could be plausible anywhere from -15 to 13 (in thousand) dollars. This is a wide range, making it difficult to conclusively address the difference in annual income for hours of work per week.

The fact that our model only explained 16% of the variability in annual income is not surprising. The finance department is likely to consider some other factors when paying for employees. Still, this result does suggest that hours of work per week are predictive of annual income, at least in a small part.

There are several limitations that we should be aware of. The annual income of employees is not only related to working hours but also other factors. If the company's performance is good, even if the employees work a little less time, their annual income will be higher than those who work longer than them. Our study pertained only to annual income without considering factors like age, job position, part-time, and so on. Although we found that people who spend more hours per week tend to have higher annual income, we should not extrapolate this result beyond our data range, which includes most 60 hours per week or less. Indeed, most of the employees would not work 80 hours per week.

Our study provides guidance to companies as they consider hours of work to maximize the profit. Our findings are consistent with prior research, showing that Asian has relative higher annual income, but hours of work per week can also decide the income. This potential interaction is worth exploring more in future research. Our study shows that if work hours less than 30 hours, companies will pay more for Asians on average; if work hours greater than 30 hours, companies are going to pay more for White. Since there are still some limitations we don't consider, companies may also pay Black or other races more.

## Bibliography

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