Human Freedom Index Project

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```
library(tidyverse)
hfi <- read_csv("data/hfi_cc_2019.csv")
```

```
glimpse(hfi)
```

```
## Rows: 1,620
## Columns: 120
## $ year                                <dbl> 2017, 2017, 2017, 2017, 2017, 20...
## $ ISO_code                            <chr> "ALB", "DZA", "AGO", "ARG", "ARM...
## $ countries                           <chr> "Albania", "Algeria", "Angola", ...
## $ region                              <chr> "Eastern Europe", "Middle East &...
## $ hf_score                            <chr> "7.84", "4.99", "5.4", "6.86", "...
## $ hf_rank                             <chr> "38", "155", "151", "77", "54", ...
## $ hf_quartile                         <chr> "1", "4", "4", "2", "2", "1", "1...
## $ pf_rol_procedural                   <chr> "6.7", "-", "-", "7.1", "-", "8....
## $ pf_rol_civil                        <chr> "4.5", "-", "-", "5.8", "-", "7....
## $ pf_rol_criminal                     <chr> "4.7", "-", "-", "4.3", "-", "7....
## $ pf_rol                              <chr> "5.3", "3.8", "3.4", "5.7", "4.9...
## $ pf_ss_homicide                      <chr> "9.1", "9.5", "8.1", "8", "9", "...
## $ pf_ss_disappearances_disap          <chr> "10", "10", "10", "5", "10", "10...
## $ pf_ss_disappearances_violent        <chr> "10", "9.5", "9.7", "10", "10", ...
## $ pf_ss_disappearances_organized      <chr> "10", "5", "7.5", "7.5", "7.5", ...
## $ pf_ss_disappearances_fatalities     <chr> "10", "9.9", "9.9", "10", "10", ...
## $ pf_ss_disappearances_injuries       <chr> "10", "9.9", "7.2", "10", "10", ...
## $ pf_ss_disappearances                <chr> "10", "8.9", "8.9", "8.5", "9.5"...
## $ pf_ss_women_fgm                     <chr> "10", "10", "10", "10", "10", "1...
## $ pf_ss_women_inheritance_widows      <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_ss_women_inheritance_daughters   <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_ss_women_inheritance             <chr> "7.5", "0", "5", "10", "7.5", "1...
## $ pf_ss_women                         <chr> "8.8", "5", "7.5", "10", "8.8", ...
## $ pf_ss                               <chr> "9.3", "7.8", "8.1", "8.8", "9.1...
## $ pf_movement_domestic                <chr> "10", "10", "5", "10", "10", "10...
## $ pf_movement_foreign                 <chr> "10", "5", "5", "10", "5", "10",...
## $ pf_movement_women                   <chr> "10", "2.5", "10", "10", "10", "...
## $ pf_movement                         <chr> "10", "5.8", "6.7", "10", "8.3",...
## $ pf_religion_estop_establish         <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_religion_estop_operate           <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_religion_estop                   <chr> "10", "5", "10", "7.5", "5", "10...
## $ pf_religion_harassment              <chr> "9.6", "6.9", "8.9", "9", "8.6",...
## $ pf_religion_restrictions            <chr> "8", "3", "7.5", "6.9", "5.1", "...
## $ pf_religion                         <chr> "9.2", "4.9", "8.8", "7.8", "6.2...
## $ pf_association_association          <chr> "10", "5", "2.5", "7.5", "7.5", ...
## $ pf_association_assembly             <chr> "10", "5", "2.5", "10", "7.5", "...
## $ pf_association_political_establish <chr> "-", "-", "-", "-", "-", "-", "-...
```

```
## $ pf_association_political_operate   <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_association_political           <chr> "10", "5", "2.5", "5", "5", "10"...
## $ pf_association_prof_establish      <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_association_prof_operate        <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_association_prof                <chr> "10", "5", "5", "7.5", "5", "10"...
## $ pf_association_sport_establish     <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_association_sport_operate       <chr> "-", "-", "-", "-", "-", "-", "-...
## $ pf_association_sport               <chr> "10", "5", "7.5", "7.5", "7.5", ...
## $ pf_association                     <chr> "10", "5", "4", "7.5", "6.5", "1...
## $ pf_expression_killed               <chr> "10", "10", "10", "10", "10", "1...
## $ pf_expression_jailed               <chr> "10", "9.5", "10", "10", "10", "...
## $ pf_expression_influence            <chr> "5", "2.7", "2.7", "5.7", "3.3",...
## $ pf_expression_control              <chr> "5.3", "4", "2.5", "5.5", "4.3",...
## $ pf_expression_cable                <chr> "10", "10", "7.5", "10", "7.5", ...
## $ pf_expression_newspapers           <chr> "10", "7.5", "5", "10", "7.5", "...
## $ pf_expression_internet             <chr> "10", "7.5", "7.5", "10", "7.5",...
## $ pf_expression                      <chr> "8.6", "7.3", "6.5", "8.7", "7.2...
## $ pf_identity_legal                  <chr> "0", "-", "10", "10", "7", "7", ...
## $ pf_identity_sex_male               <chr> "10", "0", "0", "10", "10", "10"...
## $ pf_identity_sex_female             <chr> "10", "0", "0", "10", "10", "10"...
## $ pf_identity_sex                    <chr> "10", "0", "0", "10", "10", "10"...
## $ pf_identity_divorce                <chr> "7.5", "0", "5", "10", "7.5", "1...
## $ pf_identity                        <chr> "5.8", "0", "5", "10", "8.2", "9...
## $ pf_score                           <chr> "8.01", "5.2", "5.98", "8.04", "...
## $ pf_rank                            <chr> "46", "146", "121", "41", "72", ...
## $ ef_government_consumption          <chr> "8.1", "2.7", "6.3", "5.4", "7.2...
## $ ef_government_transfers            <chr> "7.3", "7.8", "8.9", "6.3", "7.3...
## $ ef_government_enterprises          <chr> "8", "0", "6", "6", "8", "10", "...
## $ ef_government_tax_income           <chr> "9", "7", "10", "7", "5", "6", "...
## $ ef_government_tax_payroll          <chr> "7", "2", "9", "1", "5", "5", "3...
## $ ef_government_tax                  <chr> "8", "4.5", "9.5", "4", "5", "5....
## $ ef_government_soa                  <chr> "6.2", "2.9", "3.1", "6.9", "9.5...
## $ ef_government                      <chr> "7.5", "3.6", "6.8", "5.7", "7.4...
## $ ef_legal_judicial                  <chr> "2.5", "4.3", "1.4", "3.6", "4",...
## $ ef_legal_courts                    <chr> "3.1", "4.3", "1.7", "3", "4.2",...
## $ ef_legal_protection                <chr> "4.6", "4.8", "3.3", "4.4", "5.8...
## $ ef_legal_military                  <chr> "8.3", "4.2", "3.3", "7.5", "5.8...
## $ ef_legal_integrity                 <chr> "4.2", "5", "4.2", "3.3", "5", "...
## $ ef_legal_enforcement               <chr> "4.4", "4.4", "2.3", "3.6", "5.2...
## $ ef_legal_restrictions              <chr> "6.6", "6.6", "5.5", "6.9", "9.8...
## $ ef_legal_police                    <chr> "6.8", "6.1", "3.4", "3.7", "5.8...
## $ ef_legal_crime                     <chr> "6.2", "6.7", "4.3", "4.1", "7",...
## $ ef_legal_gender                    <chr> "1", "0.8", "0.8", "0.8", "1", "...
## $ ef_legal                           <chr> "5.1", "4.7", "3", "4", "5.9", "...
## $ ef_money_growth                    <dbl> 9.3, 7.0, 9.4, 5.0, 8.6, 9.0, 8....
## $ ef_money_sd                        <chr> "9.7", "8.5", "4.2", "6", "9.5",...
## $ ef_money_inflation                 <dbl> 9.6, 8.9, 3.7, 4.9, 9.8, 9.6, 9....
## $ ef_money_currency                  <chr> "10", "5", "5", "10", "10", "10"...
## $ ef_money                           <chr> "9.6", "7.3", "5.6", "6.5", "9.5...
## $ ef_trade_tariffs_revenue           <chr> "9.6", "8.5", "9.2", "6.7", "9",...
## $ ef_trade_tariffs_mean              <chr> "9.3", "6.2", "7.7", "7.3", "8.8...
## $ ef_trade_tariffs_sd                <chr> "8.1", "5.9", "4.3", "5.9", "8.1...
## $ ef_trade_tariffs                   <chr> "9", "6.9", "7.1", "6.6", "8.6",...
## $ ef_trade_regulatory_nontariff      <chr> "6", "4.8", "4.9", "4.6", "5.7",...
```

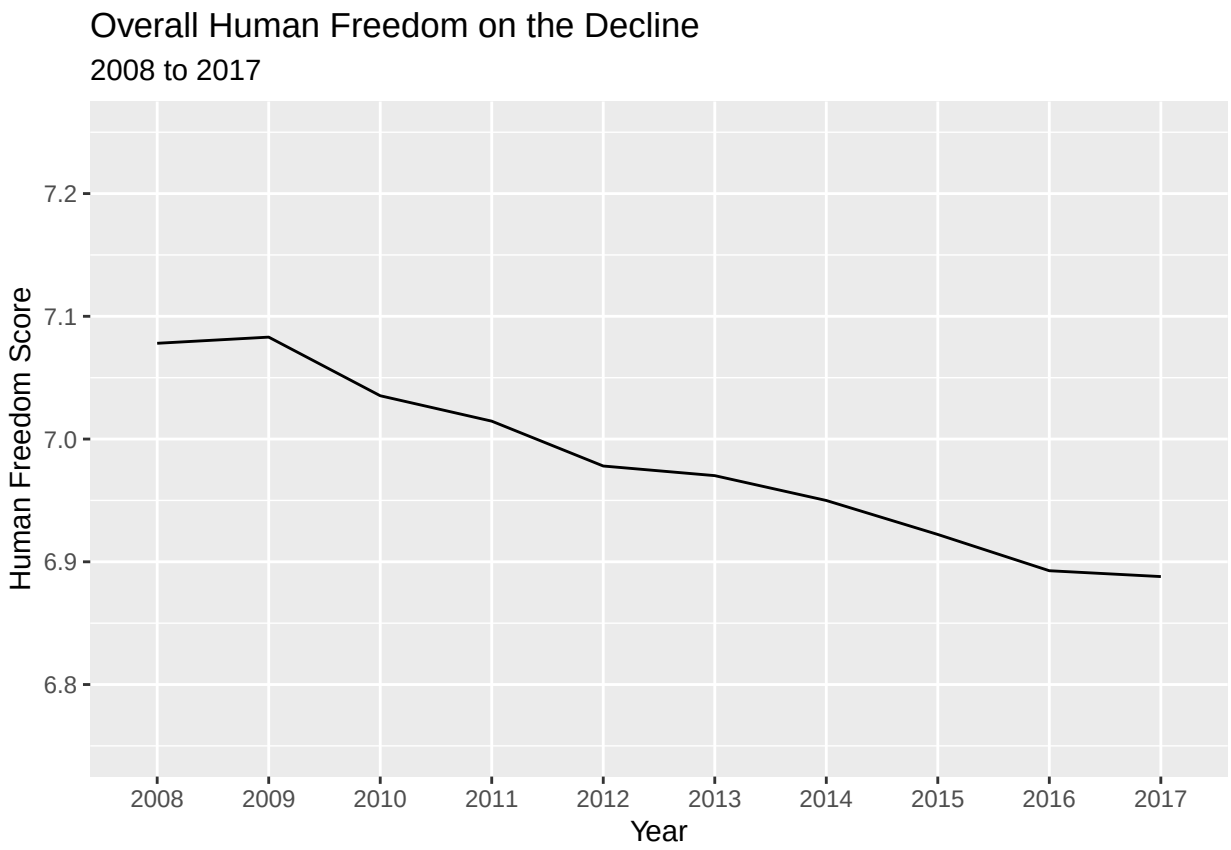
```
## $ ef_trade_regulatory_compliance     <chr> "9.4", "0.5", "2.5", "5.2", "9",...
## $ ef_trade_regulatory                <chr> "7.7", "2.6", "3.7", "4.9", "7.4...
## $ ef_trade_black                     <chr> "10", "0", "0", "10", "10", "10"...
## $ ef_trade_movement_foreign          <chr> "6.3", "3.7", "2.9", "5.4", "5.1...
## $ ef_trade_movement_capital          <chr> "5.4", "0", "3.1", "0.8", "5.4",...
## $ ef_trade_movement_visit            <chr> "8.3", "1.1", "0.1", "8", "10", ...
## $ ef_trade_movement                  <chr> "6.7", "1.6", "2", "4.7", "6.8",...
## $ ef_trade                           <chr> "8.3", "2.8", "3.2", "6.5", "8.2...
## $ ef_regulation_credit_ownership     <chr> "10", "0", "5", "5", "10", "10",...
## $ ef_regulation_credit_private       <chr> "9.1", "5.3", "9.2", "4.3", "7.8...
## $ ef_regulation_credit_interest      <chr> "10", "10", "6", "9", "10", "10"...
## $ ef_regulation_credit               <chr> "9.7", "5.1", "6.7", "6.1", "9.3...
## $ ef_regulation_labor_minwage        <chr> "5.6", "5.6", "10", "2.8", "6.7"...
## $ ef_regulation_labor_firing         <chr> "5.4", "4.1", "4.4", "2.2", "5.7...
## $ ef_regulation_labor_bargain        <chr> "6.4", "6", "7.2", "3.3", "6.8",...
## $ ef_regulation_labor_hours          <chr> "8", "6", "4", "10", "10", "10",...
## $ ef_regulation_labor_dismissal      <chr> "6.3", "7.8", "6.6", "2.5", "9.3...
## $ ef_regulation_labor_conscription   <chr> "10", "3", "0", "10", "0", "10",...
## $ ef_regulation_labor                <chr> "6.9", "5.4", "5.4", "5.1", "6.4...
## $ ef_regulation_business_adm         <chr> "6.3", "3.7", "2.4", "2.5", "4.6...
## $ ef_regulation_business_bureaucracy <chr> "6.7", "1.8", "1.3", "7.1", "6.2...
## $ ef_regulation_business_start       <chr> "9.7", "9.3", "8.7", "9.6", "9.9...
## $ ef_regulation_business_bribes      <chr> "4.1", "3.8", "1.9", "3.3", "4.6...
## $ ef_regulation_business_licensing   <chr> "6", "8.7", "8.1", "5.4", "9.3",...
## $ ef_regulation_business_compliance  <chr> "7.2", "7", "6.8", "6.5", "7.1",...
## $ ef_regulation_business             <chr> "6.7", "5.7", "4.9", "5.7", "6.9...
## $ ef_regulation                      <chr> "7.8", "5.4", "5.7", "5.6", "7.5...
## $ ef_score                           <chr> "7.67", "4.77", "4.83", "5.67", ...
## $ ef_rank                            <chr> "30", "159", "158", "147", "27",...
```

Question 1

How has overall freedom around the world changed over time?

```
hfscore_by_year <- hfi %>%
  filter(hf_score != "-") %>%
  group_by(year) %>%
  summarize(mean_hf = mean(as.numeric(hf_score)))

ggplot(data = hfscore_by_year,
       aes(x = as.factor(year), y = mean_hf, group = 1)) +
  geom_line(stat = "identity") +
  ylim(6.75, 7.25) +
  labs(x = "Year", y = "Human Freedom Score",
       title = "Overall Human Freedom on the Decline",
       subtitle = "2008 to 2017")
```

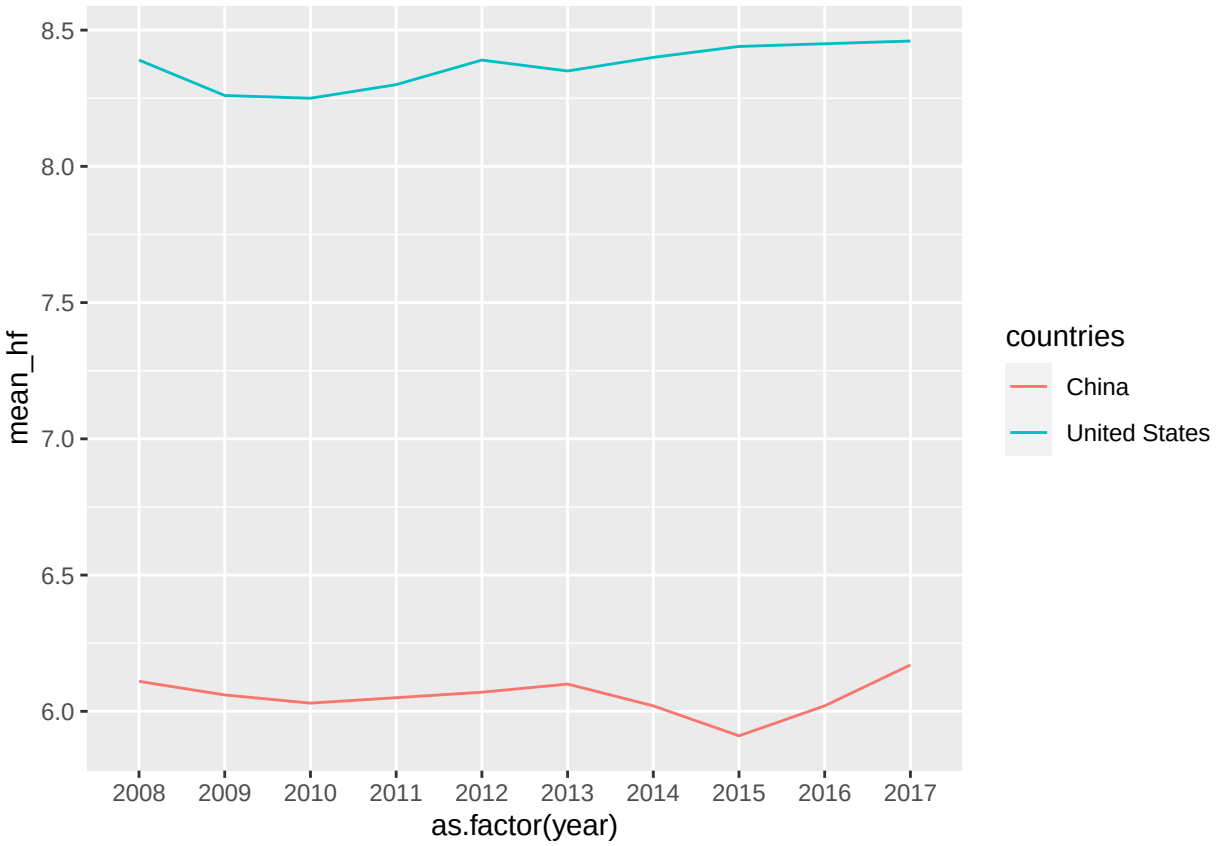


Question 2

How has overall freedom in the U.S. and China changed over time?

```
hfscore_china_us <- hfi %>%
  filter(hf_score != "-" &
           (countries == "China" | countries == "United States")) %>%
  group_by(year, countries) %>%
  summarize(mean_hf = mean(as.numeric(hf_score)))

ggplot(data = hfscore_china_us,
       aes(x = as.factor(year), y = mean_hf, group = countries, color = countries)) +
  geom_line(stat = "identity")
```



Question 3

In countries with the highest overall freedom scores, which freedoms are particularly high?

```
hfi %>%
  filter(hf_rank != "-") %>%
  group_by(countries) %>%
  mutate(avg_rank = mean(as.numeric(hf_rank))) %>%
  distinct(countries, avg_rank) %>%
  arrange(desc(avg_rank)) %>%
  summarize(countries, avg_rank)
```

```
## # A tibble: 162 x 2
##    countries  avg_rank
##    <chr>         <dbl>
##  1 Albania        47.4
##  2 Algeria       148.
##  3 Angola        142.
##  4 Argentina      88
##  5 Armenia        53.4
##  6 Australia       5.1
##  7 Austria        13.2
##  8 Azerbaijan    121.
##  9 Bahamas        46.9
## 10 Bahrain        90.6
## # ... with 152 more rows
```

Question 4

What is the correlation between economic and personal freedom?

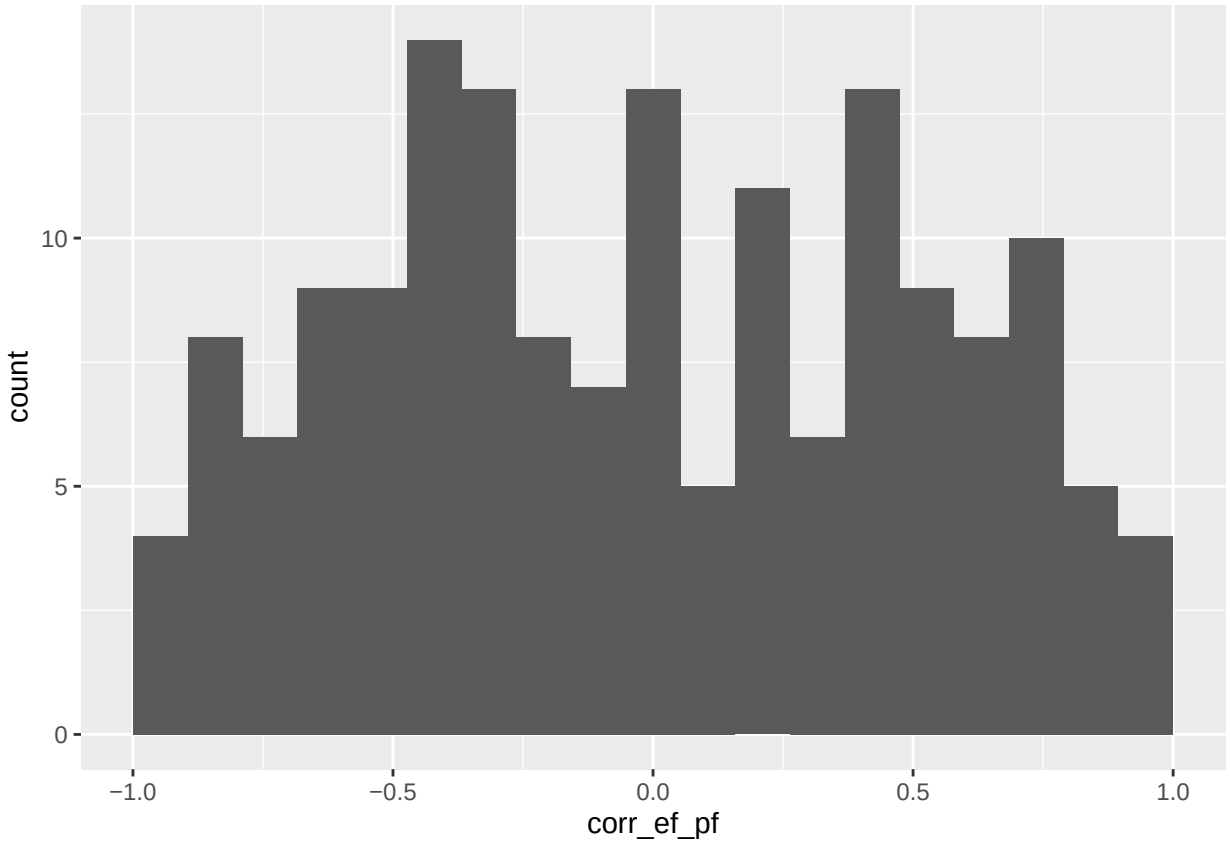
```
hfi %>%
  filter(pf_score != "-" & ef_score != "-") %>%
  summarize(cor = cor(as.numeric(ef_score), as.numeric(pf_score)))
```

```
## # A tibble: 1 x 1
##     cor
##   <dbl>
## 1 0.674
```

```
corr_efpf <- hfi %>%
  filter(pf_score != "-" & ef_score != "-") %>%
  group_by(countries) %>%
  mutate(corr_ef_pf = cor(as.numeric(ef_score), as.numeric(pf_score))) %>%
  distinct(countries, corr_ef_pf) %>%
  summarize(countries, corr_ef_pf)
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
ggplot(data = corr_efpf, aes(x = corr_ef_pf)) +
  geom_histogram(bins = 20)
```



==========

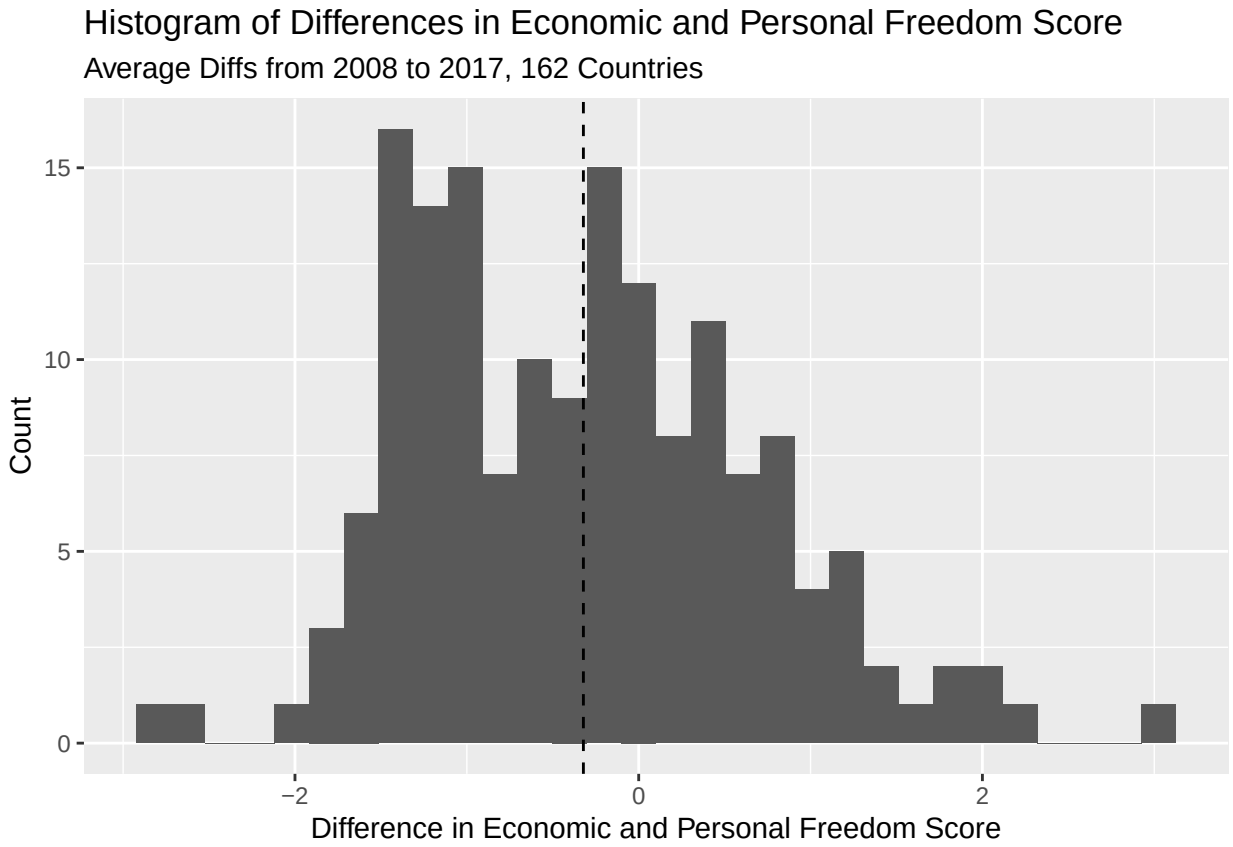
Economic and Personal Freedom

```
clean_hfi <- hfi %>%
  filter(pf_score != "-" & ef_score != "-") %>%
  group_by(countries) %>%
  mutate(mean_pf = mean(as.numeric(pf_score)),
         mean_ef = mean(as.numeric(ef_score))) %>%
  mutate(diff_ef_pf = mean_ef - mean_pf) %>%
  slice(1) %>%
  summarize(countries, mean_ef, mean_pf, diff_ef_pf)
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
mean_diff <- clean_hfi %>%
  summarize(mean_diff = mean(diff_ef_pf))

ggplot(data = clean_hfi, aes(x = diff_ef_pf)) +
  geom_histogram(bins = 30) +
  geom_vline(linetype = "dashed", xintercept = c(mean_diff$mean_diff)) +
  labs(x = "Difference in Economic and Personal Freedom Score",
       y = "Count",
       title = "Histogram of Differences in Economic and Personal Freedom Score",
       subtitle = "Average Diffs from 2008 to 2017, 162 Countries")
```



Null Hypothesis: the difference between mean economic freedom score and mean personal freedom score is greater than or equal to zero.

Alternative Hypothesis: the difference between mean economic freedom score and mean personal freedom score is less than zero.

H_0: $\mu \geq 0$

H_A: $\mu < 0$

```
set.seed(10)
n_sims <- 500
boot_dist = numeric(n_sims)
for(i in 1:n_sims){
  indices <- sample(1:nrow(clean_hfi), replace = T)
  boot_mean <- clean_hfi %>%
    slice(indices) %>%
    summarize(boot_mean = mean(diff_ef_pf)) %>%
    pull()
  boot_dist[i] <- boot_mean
}

boot_means = tibble(boot_dist)
mu_0 <- 0
offset <- boot_means %>%
  summarize(mu_0 - mean(boot_dist)) %>%
  pull()
boot_means <- boot_means %>%
  mutate(shifted_means = boot_dist + offset)
boot_1 <- boot_means%>%
  summarize(lower = quantile(shifted_means, 0.025),
            upper = quantile(shifted_means, 0.975))
boot_1
```

```
## # A tibble: 1 x 2
##    lower upper
##    <dbl> <dbl>
## 1 -0.153 0.148
```

```
obs_mean <- clean_hfi %>%
  summarize(mean(diff_ef_pf)) %>%
  pull()
obs_mean
```

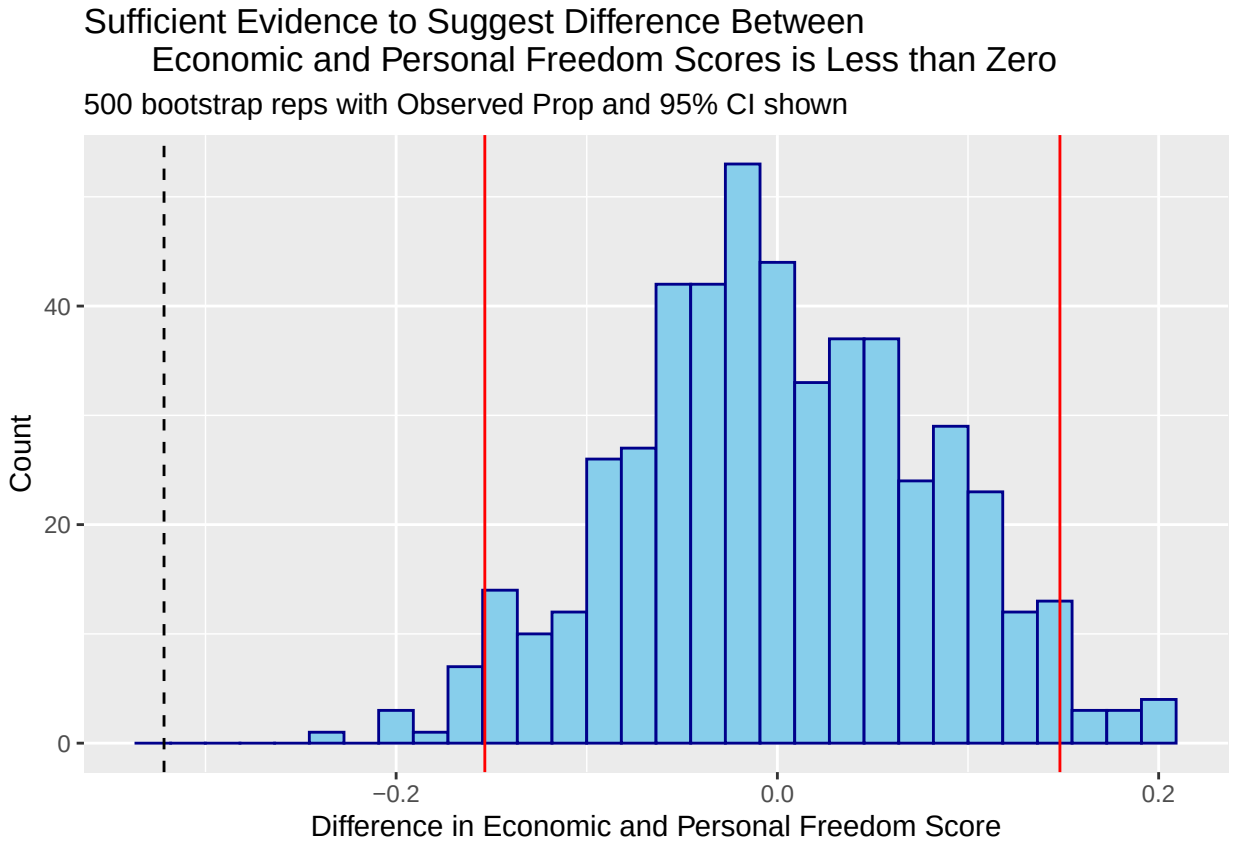
```
## [1] -0.3217562
```

```
obs_diff <- mu_0 - obs_mean
boot_means %>%
  mutate(extreme = ifelse(shifted_means <= mu_0 - obs_diff |
                          shifted_means >= mu_0 + obs_diff, 1, 0)) %>%
  summarize(p_val = mean(extreme))
```

```
## # A tibble: 1 x 1
##   p_val
##   <dbl>
## 1     0
```

```
ggplot(data = boot_means, aes(x = shifted_means)) +
  geom_histogram(color = "darkblue", fill = "skyblue") +
  labs(x = "Difference in Economic and Personal Freedom Score", y = "Count",
       title = "Sufficient Evidence to Suggest Difference Between
```

```
      Economic and Personal Freedom Scores is Less than Zero",
      subtitle = "500 bootstrap reps with Observed Prop and 95% CI shown") +
geom_vline(xintercept = c(boot_1$lower, boot_1$upper),
           color = "red") +
geom_vline(linetype = "dashed", xintercept = c(mean_diff$mean_diff))
```



Our p-value is 0, and so we reject the null hypothesis at the $\alpha = 0.05$ significance level. There is sufficient evidence to suggest that the difference between mean economic freedom score and mean personal freedom score is less than zero. In other words, on average, economic freedom scores tend to be lower than personal freedom scores around the world.