Almond Profit Model

Load Data and function

```
almonds <- read.table(here::here("assignment3", "clim.txt"),
           header = TRUE)

source(here::here("assignment3","R", "almond_profit_function.R"))
```

Prices

Create a list of almond prices over the years

From *United States Department of Agriculture National Agricultural Statistics Service: 2024 California Almond Objective Measurement Report*

```
p <- c(2.48, 2.08, 1.56, 1.41, 0.86, 0.97, 0.91, 1.11, 1.57, 2.21, 2.81, 2.06, 1.75, 1.45
```

Run function

```
almond_profit_function(almond_df = almonds, prices = p)
```

```
   year avg_tmin_c sum_precip yield_anomaly avg_price_ton      cost
1  1989   8.640417      2.798    -0.3552237      398.7586  186.4900
2  1990   8.681270     55.812     9.2906757      398.7586  203.2741
3  1991  10.391468    135.337    68.9130633      398.7586  221.5687
4  1992  11.908525     69.640    15.4280698      398.7586  241.5099
5  1993  10.939464     77.903    20.2083803      398.7586  263.2458
6  1994   9.623710     34.804     2.4820009      398.7586  286.9379
7  1995  12.586270    676.512  1919.9811511      398.7586  312.7623
8  1996  12.040460     40.252     3.5818399      398.7586  340.9109
9  1997   9.988571    285.296   329.6938750      398.7586  371.5929
10 1998  11.484643     89.762    27.8636956      398.7586  405.0363
11 1999   8.103690      0.000    -0.1436364      398.7586  441.4895
12 2000  11.614732     57.318     9.5999883      398.7586  481.2236
13 2001   8.822143    201.041   159.5119587      398.7586  524.5337
14 2002   7.719107     20.338     0.2450914      398.7586  571.7418
15 2003   9.312381      0.000    -0.2585997      398.7586  623.1985
16 2004   7.889272     14.478    -0.2367722      398.7586  679.2864
17 2005  10.423869    399.034   656.3724121      398.7586  740.4222
18 2006   9.374365     74.930    18.6324135      398.7586  807.0602
19 2007  10.046329     77.724    20.2007396      398.7586  879.6956
20 2008   9.239175    374.396   576.2821943      398.7586  958.8682
21 2009   8.556669     24.892     0.7367438      398.7586 1045.1663
```

```
22 2010   9.894963    197.612   153.7655092      398.7586 1139.2313
          yield     revenue      profit
1     0.5447763    217.2343     30.7443
2    10.1906757   4063.6198   3860.3457
3    69.8130633  27838.5608  27616.9921
4    16.3280698   6510.9586   6269.4487
5    21.1083803   8417.1486   8153.9028
6     3.3820009   1348.6020   1061.6641
7  1920.8811511 765967.9183 765655.1560
8     4.4818399   1787.1723   1446.2614
9   330.5938750 131827.1576 131455.5647
10   28.7636956  11469.7716  11064.7353
11    0.7563636    301.6065   -139.8831
12   10.4999883   4186.9608   3705.7372
13  160.4119587  63965.6514  63441.1177
14    1.1450914    456.6151   -115.1267
15    0.6414003    255.7639   -367.4346
16    0.6632278    264.4678   -414.8186
17  657.2724121 262093.0405 261352.6183
18   19.5324135   7788.7183   6981.6581
19   21.1007396   8414.1018   7534.4063
20  577.1821943 230156.3757 229197.5075
21    1.6367438    652.6657   -392.5006
22  154.6655092  61674.2051  60534.9738
```

Sensitivity Analysis

1. Varies the temperature and precipitation inputs + price + discount rate
2. Runs function for various simulations
3. Extracts mean profit

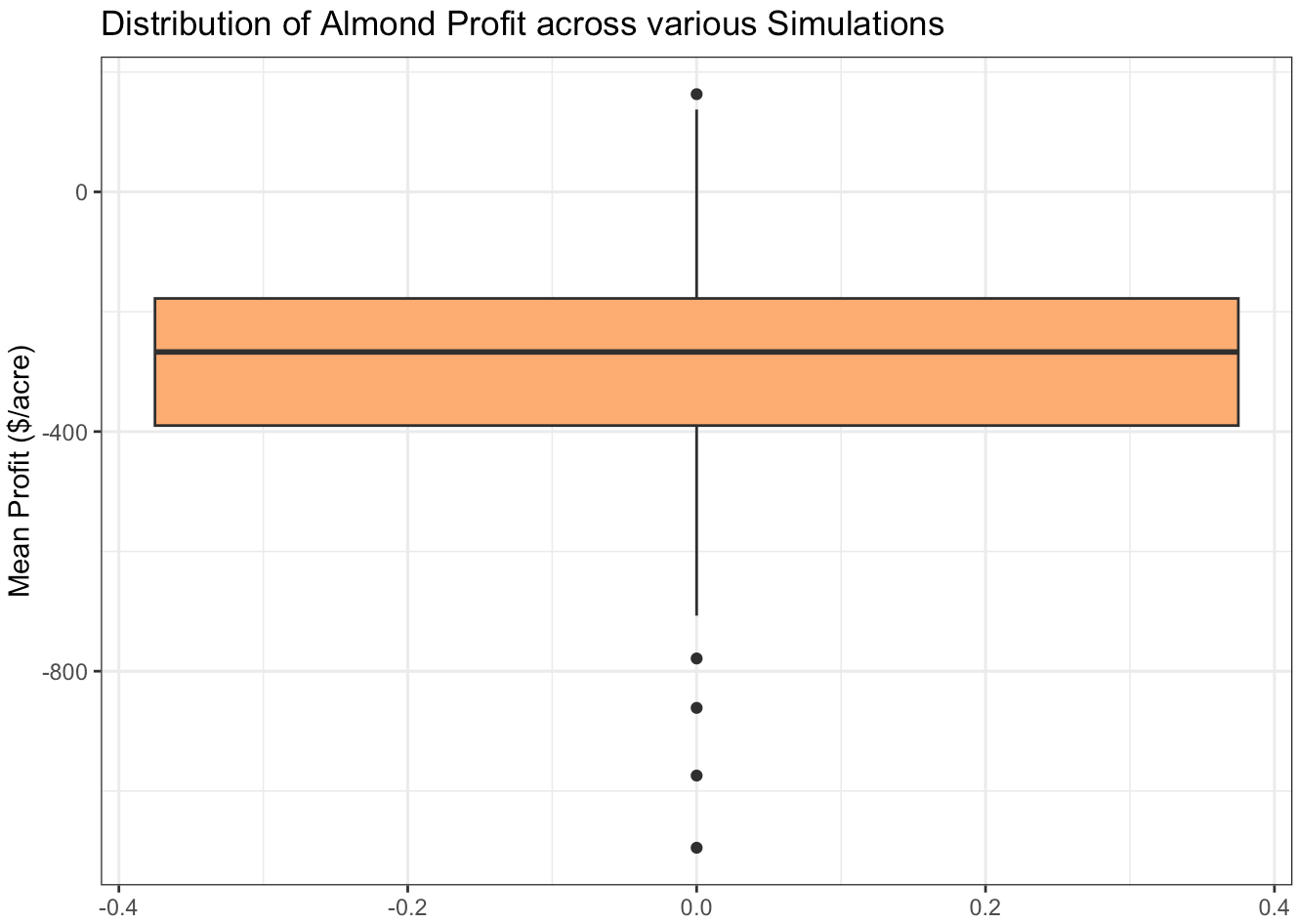
```r
# Generate parameter samples: tmin, precip, discount rate, and price
nsamples <- 300 # number of samples
mean_tmin <- rnorm(mean = 12, sd = 2, n = nsamples)
mean_precip <- rnorm(mean = 1, sd = 0.5, n = nsamples)

dis_rate <- rnorm(mean = 0.08, sd = 0.015, n = nsamples)

price_base <- 1.50
price_sd <- 0.80
p <- runif(max = price_base + price_sd * price_base,
           min = price_base - price_sd * price_base,
           n = nsamples)


# Put samples together
parms <- cbind.data.frame(mean_tmin, mean_precip, dis_rate, p)
```

```r
# RUN THE SIMULATION OVER THE 300 SAMPLES
# Use pmap with wrapper (because your function needs a dataframe, not scalars like the so
# `results` is results of 300 different simulations
results <- parms %>%
  pmap(function(mean_tmin, mean_precip, dis_rate, p) {
    almond_df <- data.frame(
      tmin_c = rnorm(mean = mean_tmin, sd = 3, n = 40),
      precip = rnorm(mean = mean_precip, sd = 2, n = 40),
      month = c(rep(1, 20), rep(2, 20)),
      year = rep(1981:2000, times = 2)
      )
    almond_profit_function(almond_df, prices = p, discount_rate = dis_rate)
})

# Extract mean profit column from each simulation result
mean_profit <- map_dbl(results, ~mean(.x$profit, na.rm = TRUE))
#mean_profit <- map_df(results, `[`, c("mean"))

# Add parameter values
mean_profit <- cbind.data.frame(mean_profit, parms)

head(mean_profit)
```

```
  mean_profit mean_tmin mean_precip   dis_rate         p
1   -592.8489  13.45948   0.9007771 0.05735710 0.8356465
2   -276.7906  14.16916   0.9484371 0.08052137 2.0279835
3   -380.3388  11.37955   1.0528844 0.06833736 0.8003206
4   -250.0258  11.38050   0.8721128 0.07585540 1.2090900
5   -178.1990  10.27800   1.0230229 0.07195415 2.5893118
6   -230.1505  10.56779   1.0619769 0.08640853 0.6348713
```

Graphs

```r
# 1) box or violin of mean_profit
ggplot(mean_profit) +
  geom_boxplot(aes(y = mean_profit), fill = "#ffad76") +
  labs(y = "Mean Profit ($/acre)",
       title = "Distribution of Almond Profit across various Simulations") +
  theme_bw()
```




```r
# 2). Parameter SENSITIVITY - profit responds to each parameter
# Temperature sensitivity (and mean_profit)
plot_tmin <- ggplot(mean_profit, aes(x = mean_tmin, y = mean_profit)) +
  geom_point(col = "sandybrown",
             alpha = 0.8) +
  geom_smooth(col = "firebrick") +
  theme_minimal() +
  labs(x = "Mean Minimum Temperature (C)",
       y = "Mean Almond Profit ($/acre)",
       title = "Almond Profit in Reponse to Temperature Variation")


# Precipitation sensitivity (and mean_profit)
plot_precip <- ggplot(mean_profit, aes(x = mean_precip, y = mean_profit)) +
  geom_point(col = "skyblue2",
             alpha = 0.8) +
  geom_smooth(col = "firebrick") +
  theme_minimal() +
  labs(x = "Mean Minimum Precipitation",
       y = "Mean Almond Profit ($/acre)",
       title = "Almond Profit in Reponse to Precipitation Variation")
```

```r
# Price sensitivity (and mean_profit)
plot_price <- ggplot(mean_profit, aes(x = p, y = mean_profit)) +
  geom_point(col = "seagreen3",
             alpha = 0.8) +
  geom_smooth(col = "firebrick") +
  theme_minimal() +
  labs(x = "Almond Price ($/lb)",
       y = "Mean Almond Profit ($/acre)",
       title = "Almond Profit in Reponse to Price Variation")

# Discount Rate sensitivity (and mean_profit)
plot_discount <- ggplot(mean_profit, aes(x = dis_rate, y = mean_profit)) +
  geom_point(col = "plum",
             alpha = 0.8) +
  geom_smooth(col = "firebrick") +
  theme_minimal() +
  labs(x = "Discount Rate",
       y = "Mean Almond Profit ($/acre)",
       title = "Almond Profit in Reponse to Discount Rate Variation")


main_plot <- (plot_tmin + plot_precip) / (plot_price + plot_discount)
ggsave(here::here("figs", "assignment4_sensitive_analysis.png"), height = 10, width = 10)
```