Almond Profit Model

PUBLISHED
January 28, 2026

Almond Profit Model - Informal Sensitivity Analysis

EDS230 Assignment 4

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Load Data and function

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

source(here::here("assignment3","R", "almond_yield_function.R"))

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      3987.586 186.4900
2 1990   8.681270     55.812     9.2906757      3987.586 203.2741
3 1991  10.391468    135.337    68.9130633      3987.586 221.5687
4 1992  11.908525     69.640    15.4280698      3987.586 241.5099
5 1993  10.939464     77.903    20.2083803      3987.586 263.2458
6 1994   9.623710     34.804     2.4820009      3987.586 286.9379
7 1995  12.586270    676.512  1919.9811511      3987.586 312.7623
8 1996  12.040460     40.252     3.5818399      3987.586 340.9109
```

```
9  1997   9.988571    285.296   329.6938750      3987.586  371.5929
10 1998  11.484643     89.762    27.8636956      3987.586  405.0363
11 1999   8.103690      0.000    -0.1436364      3987.586  441.4895
12 2000  11.614732     57.318     9.5999883      3987.586  481.2236
13 2001   8.822143    201.041   159.5119587      3987.586  524.5337
14 2002   7.719107     20.338     0.2450914      3987.586  571.7418
15 2003   9.312381      0.000    -0.2585997      3987.586  623.1985
16 2004   7.889272     14.478    -0.2367722      3987.586  679.2864
17 2005  10.423869    399.034   656.3724121      3987.586  740.4222
18 2006   9.374365     74.930    18.6324135      3987.586  807.0602
19 2007  10.046329     77.724    20.2007396      3987.586  879.6956
20 2008   9.239175    374.396   576.2821943      3987.586  958.8682
21 2009   8.556669     24.892     0.7367438      3987.586 1045.1663
22 2010   9.894963    197.612   153.7655092      3987.586 1139.2313
          yield      revenue       profit
1      0.5447763    2172.343    1985.853
2     10.1906757   40636.198   40432.924
3     69.8130633  278385.608  278164.040
4     16.3280698   65109.586   64868.076
5     21.1083803   84171.486   83908.240
6      3.3820009   13486.020   13199.082
7   1920.8811511 7659679.183 7659366.421
8      4.4818399   17871.723   17530.812
9    330.5938750 1318271.576 1317899.983
10    28.7636956  114697.716  114292.680
11     0.7563636    3016.065    2574.575
12    10.4999883   41869.608   41388.385
13   160.4119587  639656.514  639131.980
14     1.1450914    4566.151    3994.409
15     0.6414003    2557.639    1934.440
16     0.6632278    2644.678    1965.392
17   657.2724121 2620930.405 2620189.983
18    19.5324135   77887.183   77080.122
19    21.1007396   84141.018   83261.323
20   577.1821943 2301563.757 2300604.889
21     1.6367438    6526.657    5481.491
22   154.6655092  616742.051  615602.820
```

Sensitivity Analysis

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

```
# 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)
```

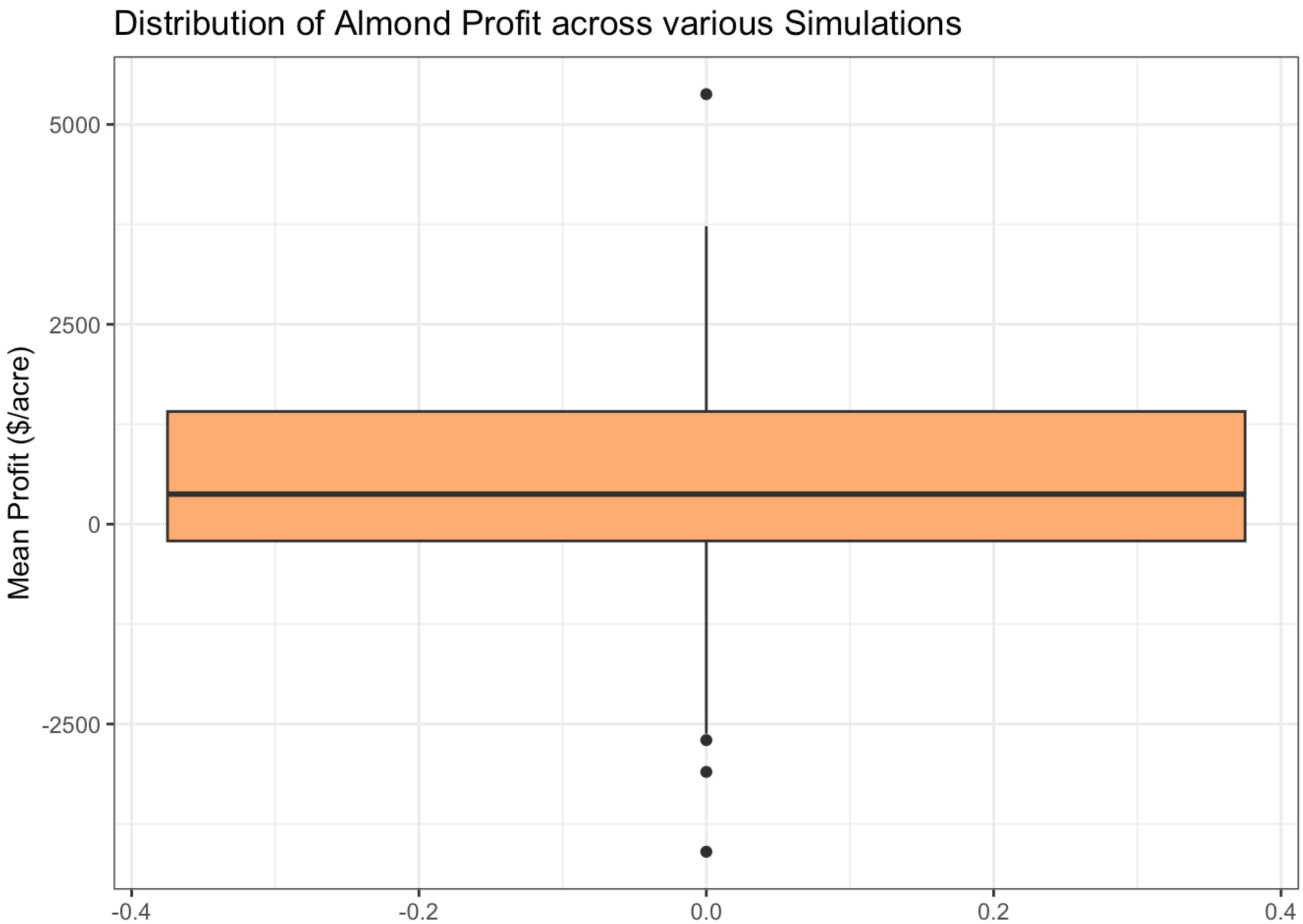
```
dis_rate <- rnorm(mean = 0.08, sd = 0.015, n = nsamples)

price_base <- 1.80
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)


# RUN THE SIMULATION OVER THE 300 SAMPLES
# Use pmap with wrapper (because the `almond_profit_function` needs a dataframe, not scal
# `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 to the profit results
mean_profit <- cbind.data.frame(mean_profit, parms)

head(mean_profit)
```

```
  mean_profit mean_tmin mean_precip   dis_rate        p
1   -152.4104  13.37059   1.5575669 0.08074992 2.605456
2   1429.9731   9.24457   0.9680531 0.07686803 1.441741
3   -467.6304  14.20012   0.6684347 0.07756649 1.784267
4   2064.5519  10.87261   1.2553644 0.07961465 2.827675
[illegible]
6    308.9328  11.17399   1.0319823 0.10475015 0.803181
```

Graphs

```
# 1) box or violin of mean_profit
ggplot(mean_profit) +
  geom_boxplot(aes(y = mean_profit), fill = "#ffad76") +
```

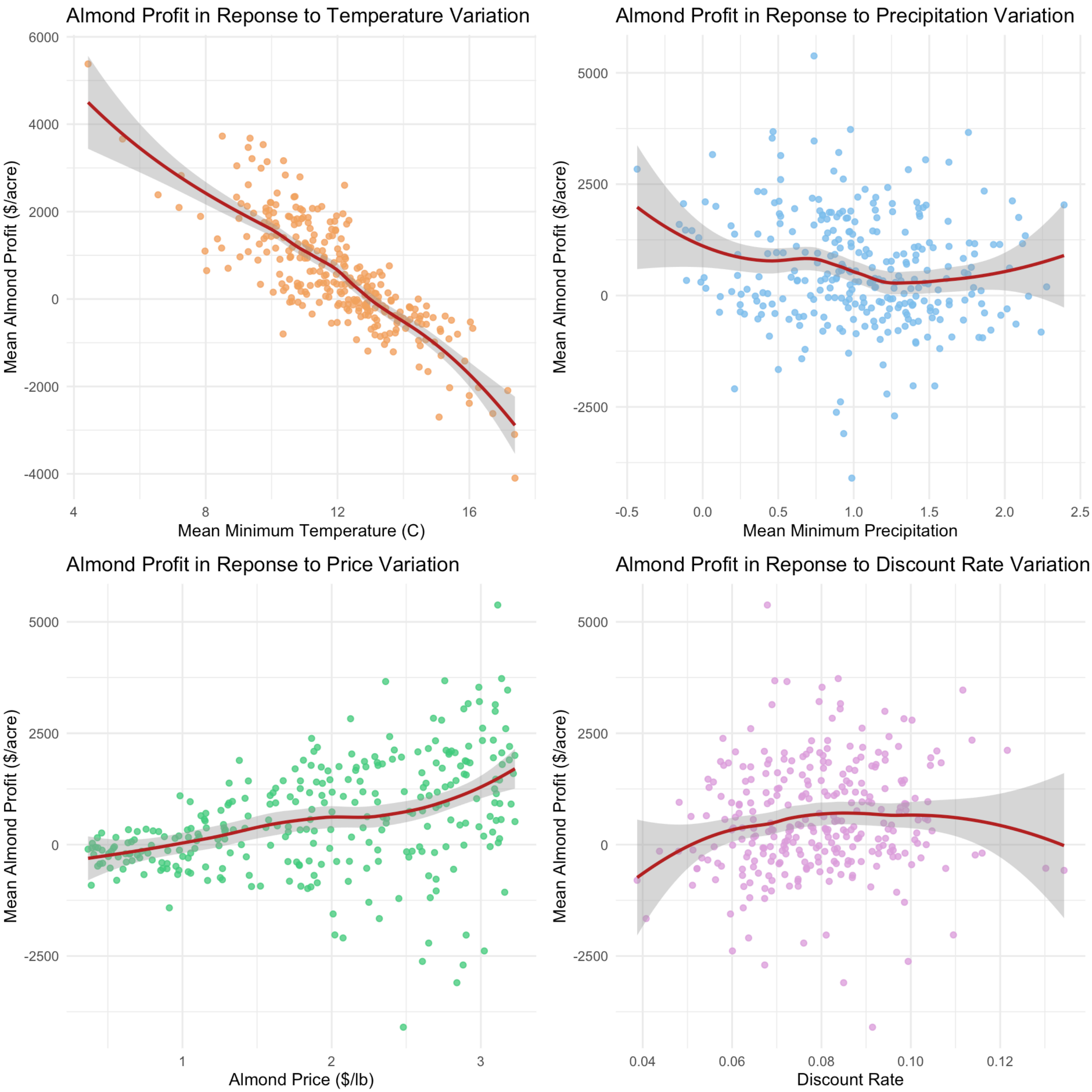
```
  labs(y = "Mean Profit ($/acre)",
       title = "Distribution of Almond Profit across various Simulations") +
  theme_bw()
```




```
# 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)",
```

```r
       title = "Almond Profit in Reponse to Precipitation Variation")


# 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")
```

```r
main_plot <- (plot_tmin + plot_precip) / (plot_price + plot_discount)
main_plot
```




```r
ggsave(here::here("figs", "assignment4_sensitive_analysis.png"), height = 10, width = 10)
```