UNIVERSITY OF
MICHIGAN

A Fancy metaphor title: Explain what to explore

Novembver 2025

Socio-Economic Background

Williamsburg, Virginia, known for its historical significance and educational institutions, presents a paradox within its socio-economic landscape. Despite a reputation as a peaceful, tourist-driven city, Williamsburg struggles with a significant housing crisis that reflects broader socio-economic challenges. A low poverty rate is offset by a high housing burden, where a substantial portion of residents—especially those working in essential local industries—face steep costs to maintain stable housing. Tourism and education drive the city's economy, yet many workers cannot afford to live within city limits, as high property values and rents cater more to short-term tourist needs than to long-term residents (Trivette 2021).

Exploratory Data Analysis Executive Summary

- **Project Objective**:
- **Data Source**:
- **Data Reliability**:
- **THEME FOUND123**:
- **Limitations of the Analysis**:

Research Questions

-
-

Data Source and Assumptions

Data Cleaning Process

Notable Findings

Finding 1. Finding Theme

State the finding in a few lines (See Figure 1 and Table 1).

Finding 2. (See Figure 2 and Table 2).

Finding 3. (See Figure 3 and Table 3).

Limitations

Visualizations

- Working repo could be fount at:

  https://github.com/zzeng05/ZENG1-LIU2-727FINAL-scaVSeply.git

```r
# Fetch SCA Data
cs_url <- "https://data.sca.isr.umich.edu/data-archive/mine.php#"

#function to fetch any sca table from data site
get_sca_table <- function(table_num,
                               from_year = 2008,
                               to_year   = 2025,
                               freq      = "monthly") {

  body_list <- list(
    table = as.character(table_num),
    format = "html",
    from   = as.character(from_year),
    to     = as.character(to_year),
    freq   = freq
  )

  res <- POST(cs_url, body = body_list, encode = "form")
  stop_for_status(res)

  page <- read_html(res)
  page %>%
    html_node("div.output table") %>%
    html_table(fill = TRUE)
}
```

```
#fetch & clean table1: Consumer Sentiment Index
CS <- get_sca_table(1) %>%
  # same logic as your cs_tables[[2]] cleaning
  rename(
    month_chr = X1,
    year_chr  = X2,
    cs_chr    = X3
  ) %>%
  slice(-1) %>%  # drop the header row inside the table
  mutate(
    month = as.integer(month_chr),
    year  = as.integer(year_chr),
    cs    = as.numeric(cs_chr),
    date  = ymd(sprintf("%04d-%02d-01", year, month))
  ) %>%
  arrange(date) %>%
  select(date, cs, year, month)

head(CS)
```

```
# A tibble: 6 x 4
  date          cs  year month
  <date>     <dbl> <int> <int>
1 2008-01-01  78.4  2008     1
2 2008-02-01  70.8  2008     2
3 2008-03-01  69.5  2008     3
4 2008-04-01  62.6  2008     4
5 2008-05-01  59.8  2008     5
6 2008-06-01  56.4  2008     6
```

```
#fetch & clean table26: Expected change in business condition in a year
ECB <- get_sca_table(26) %>%
  { setNames(., as.character(unlist(.[1, ]))) } %>%
  slice(-1) %>%
  mutate(
    Month        = as.integer(Month),
    Year         = as.integer(Year),
    `Better`= as.numeric(`Better`),
    Same         = as.numeric(Same),
    `Worse` = as.numeric(`Worse`),
    `DK; NA`     = as.numeric(`DK; NA`),
    Relative     = as.numeric(Relative),
    date         = as.Date(sprintf("%04d-%02d-01", Year, Month))
  ) %>%
  relocate(date)

head(ECB)
```

```
# A tibble: 6 x 8
```

```
  date       Month  Year Better  Same Worse `DK; NA` Relative
  <date>     <int> <int>  <dbl> <dbl> <dbl>    <dbl>    <dbl>
1 2008-01-01     1  2008     23    50    26        1       97
2 2008-02-01     2  2008     21    49    28        2       93
3 2008-03-01     3  2008     19    46    32        3       87
4 2008-04-01     4  2008     19    44    35        2       84
5 2008-05-01     5  2008     16    41    41        2       75
6 2008-06-01     6  2008     15    42    41        2       74
```

```
#fetch & clean table30: Expected Change in Unemployment During the Next Year
UNEPLY1 <- get_sca_table(30) %>%
  { setNames(., as.character(unlist(.[1, ]))) } %>%
  slice(-1) %>%
  mutate(
    Month = as.integer(Month),
    Year  = as.integer(Year)
  ) %>%
  mutate(
    across(
      -c(Month, Year),
      ~ suppressWarnings(as.numeric(.))
    ),
    date = as.Date(sprintf("%04d-%02d-01", Year, Month))
  ) %>%
  relocate(date)

head(UNEPLY1)
```

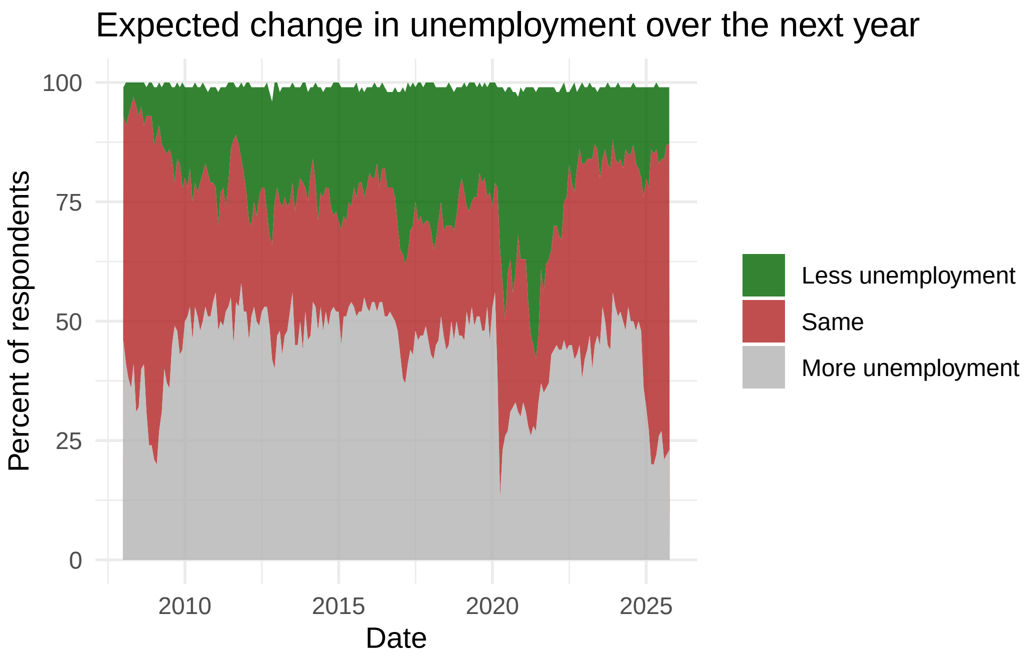
```
# A tibble: 6 x 8
  date       Month  Year  Less  Same  More `DK; NA` Relative
  <date>     <int> <int> <dbl> <dbl> <dbl>    <dbl>    <dbl>
1 2008-01-01     1  2008     6    46    47        1       59
2 2008-02-01     2  2008     9    41    50        0       59
3 2008-03-01     3  2008     7    38    55        0       52
4 2008-04-01     4  2008     5    36    59        0       46
5 2008-05-01     5  2008     3    41    56        0       47
6 2008-06-01     6  2008     5    31    64        0       41
```

```r
UNEPLY_supp <- UNEPLY1 %>%
  transmute(
    date,
    less_unemp  = Less,
    same_unemp  = Same,
    more_unemp  = More,
    dk_unemp    = `DK; NA`,
    rel_unemp   = Relative,
    net_unemp_expect = less_unemp - more_unemp
  )

head(UNEPLY_supp)
```

```
# A tibble: 6 x 7
  date       less_unemp same_unemp more_unemp dk_unemp rel_unemp
  <date>          <dbl>      <dbl>      <dbl>    <dbl>     <dbl>
1 2008-01-01          6         46         47        1        59
```

```
2 2008-02-01          9         41         50        0        59
3 2008-03-01          7         38         55        0        52
4 2008-04-01          5         36         59        0        46
5 2008-05-01          3         41         56        0        47
6 2008-06-01          5         31         64        0        41
# i 1 more variable: net_unemp_expect <dbl>
```

```
UNEPLY_long <- UNEPLY_supp %>%
  select(date, less_unemp, same_unemp, more_unemp) %>%
  pivot_longer(
    cols = -date,
    names_to  = "expectation",
    values_to = "share"
  )

ggplot(UNEPLY_long, aes(x = date, y = share, fill = expectation)) +
  geom_area(alpha = 0.8) +
  scale_fill_manual(
    values = c(
      less_unemp = "darkgreen",
      same_unemp = "grey70",
      more_unemp = "firebrick"
    ),
    labels = c("Less unemployment", "Same", "More unemployment")
  ) +
  labs(
    title = "Expected change in unemployment over the next year",
    x     = "Date",
    y     = "Percent of respondents",
    fill  = NULL
  ) +
  theme_minimal()
```



```
# Fetch BLS Data

bls_key <- "554489bce3f14059aaa2dbb976d62372" #need to change back to path before submission

# BLS series IDs:
# - LNS14000000: Unemployment rate (CPS, seasonally adjusted)
# - CES0000000001: All employees, total nonfarm (CES, thousands, SA)
series_ids <- c("LNS14000000", "CES0000000001")
```

```
# Request monthly data from 2008 to latest
res <- POST(
  url   = "https://api.bls.gov/publicAPI/v2/timeseries/data/",
  body  = list(
  seriesid        = series_ids,
  startyear       = "2008",
  endyear         = "2025",
  registrationkey = bls_key),
  encode = "json"
)

stop_for_status(res)

bls_list <- fromJSON(content(res, as = "text", encoding = "UTF-8"), simplifyDataFrame = TRUE)

# Transform BLS data to long format
series_tbl <- bls_list$Results$series

bls_long <- map_dfr(seq_len(nrow(series_tbl)), function(i) {
  series_id <- series_tbl$seriesID[i]
  dat       <- series_tbl$data[[i]]   # this is a data.frame for that series

  as_tibble(dat) %>%
    transmute(
      series_id = series_id,
      year      = as.integer(year),
```

```r
      period,
      value     = as.numeric(value)
    ) %>%
    # keep monthly observations (M01-M12)
    filter(str_starts(period, "M")) %>%
    mutate(
      month = as.integer(str_remove(period, "M")),
      date  = ymd(sprintf("%04d-%02d-01", year, month))
    )
})

head(bls_long)
```

```
# A tibble: 6 x 6
  series_id    year period value month date
  <chr>       <int> <chr>  <dbl> <int> <date>
1 LNS14000000  2025 M09      4.4     9 2025-09-01
2 LNS14000000  2025 M08      4.3     8 2025-08-01
3 LNS14000000  2025 M07      4.2     7 2025-07-01
4 LNS14000000  2025 M06      4.1     6 2025-06-01
5 LNS14000000  2025 M05      4.2     5 2025-05-01
6 LNS14000000  2025 M04      4.2     4 2025-04-01
```

```r
# CPS unemployment rate
UNEPLOY_R <- bls_long %>%
  filter(series_id == "LNS14000000") %>%
  arrange(date) %>%
  transmute(
    date,
    unrate = value
  )

# CES total nonfarm employment & monthly job change
Job_V <- bls_long %>%
  filter(series_id == "CES0000000001") %>%
  arrange(date) %>%
  transmute(
    date,
    nonfarm_emp = value,
    job_change  = nonfarm_emp - lag(nonfarm_emp)
  )

head(UNEPLOY_R)
```

```
# A tibble: 6 x 2
  date       unrate
  <date>      <dbl>
1 2008-01-01    5  
2 2008-02-01    4.9
3 2008-03-01    5.1
4 2008-04-01    5  
5 2008-05-01    5.4
```

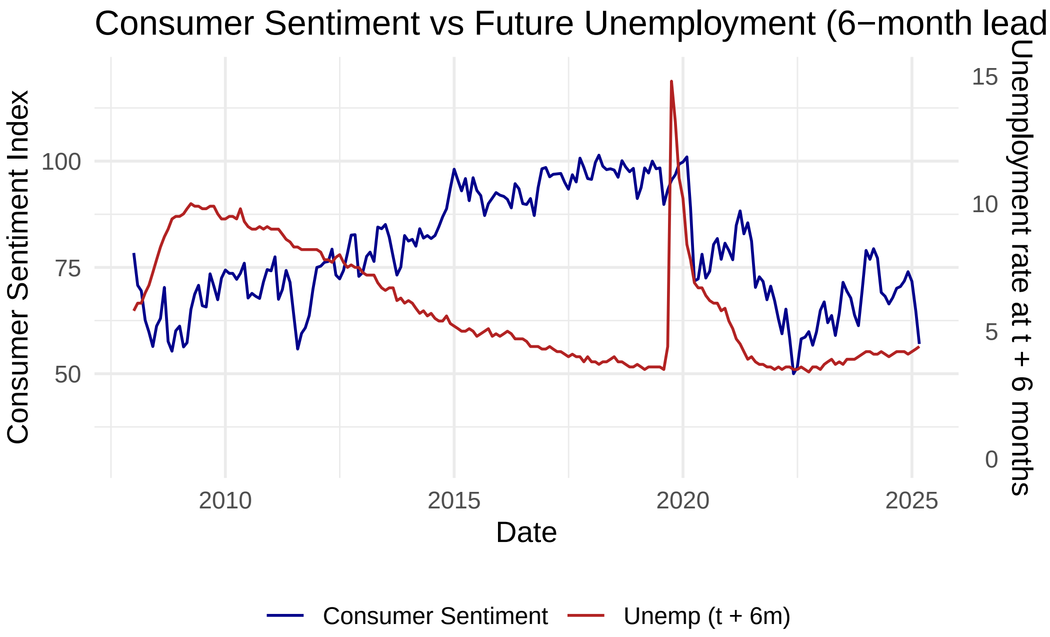
```
6 2008-06-01    5.6
```

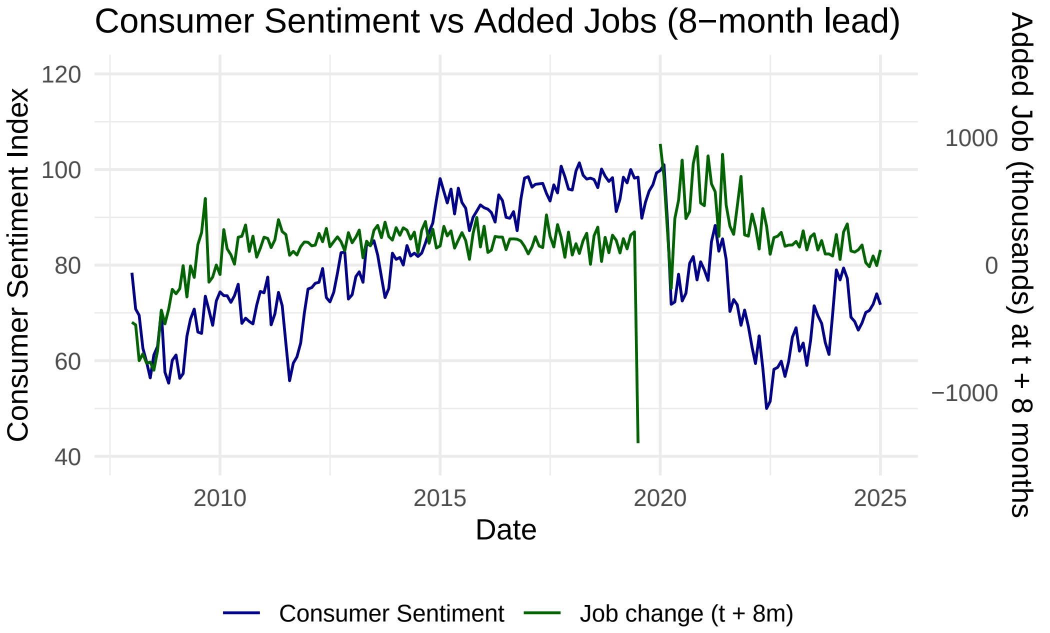
```
head(Job_V)
```

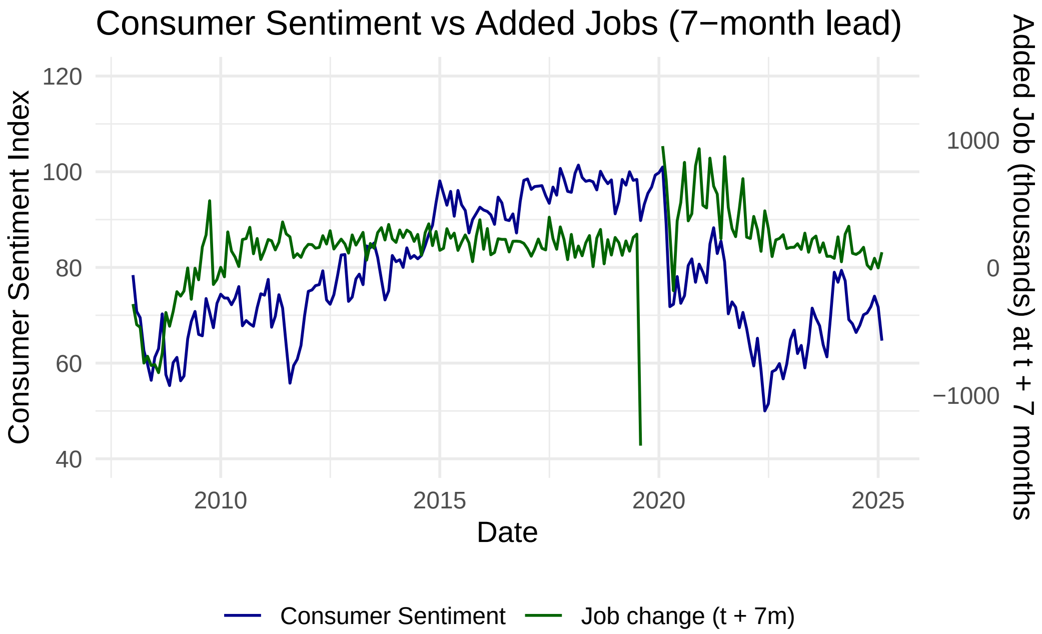
```
# A tibble: 6 x 3
  date       nonfarm_emp job_change
  <date>           <dbl>      <dbl>
1 2008-01-01      138391         NA
2 2008-02-01      138327        -64
3 2008-03-01      138257        -70
4 2008-04-01      138038       -219
5 2008-05-01      137851       -187
6 2008-06-01      137698       -153
```

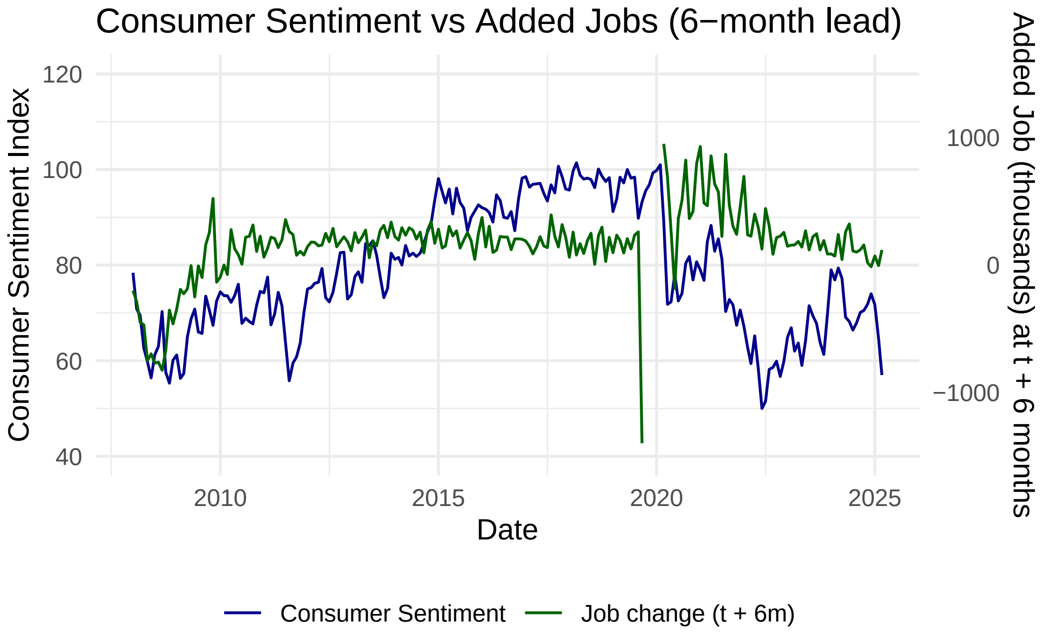
Figure 1. Lagged Time-Series of Consumer Sentiment and Unemployment Rate/Job Change

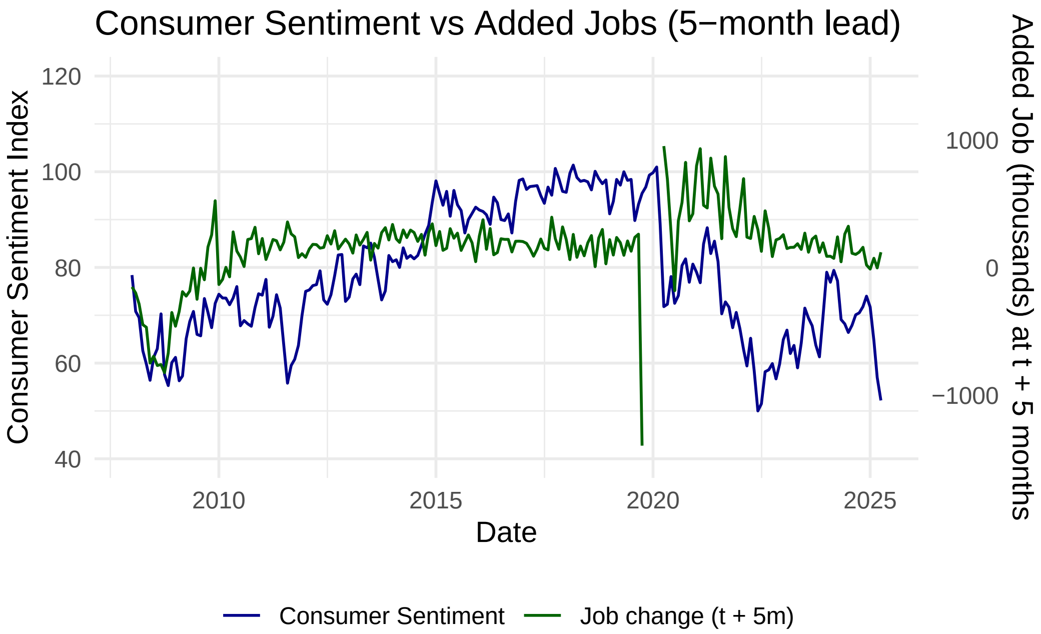
```
# A tibble: 6 x 5
  date          cs unrate nonfarm_emp job_change
  <date>     <dbl>  <dbl>       <dbl>      <dbl>
1 2008-01-01  78.4    5        138391         NA
2 2008-02-01  70.8    4.9      138327        -64
3 2008-03-01  69.5    5.1      138257        -70
4 2008-04-01  62.6    5        138038       -219
5 2008-05-01  59.8    5.4      137851       -187
6 2008-06-01  56.4    5.6      137698       -153
```

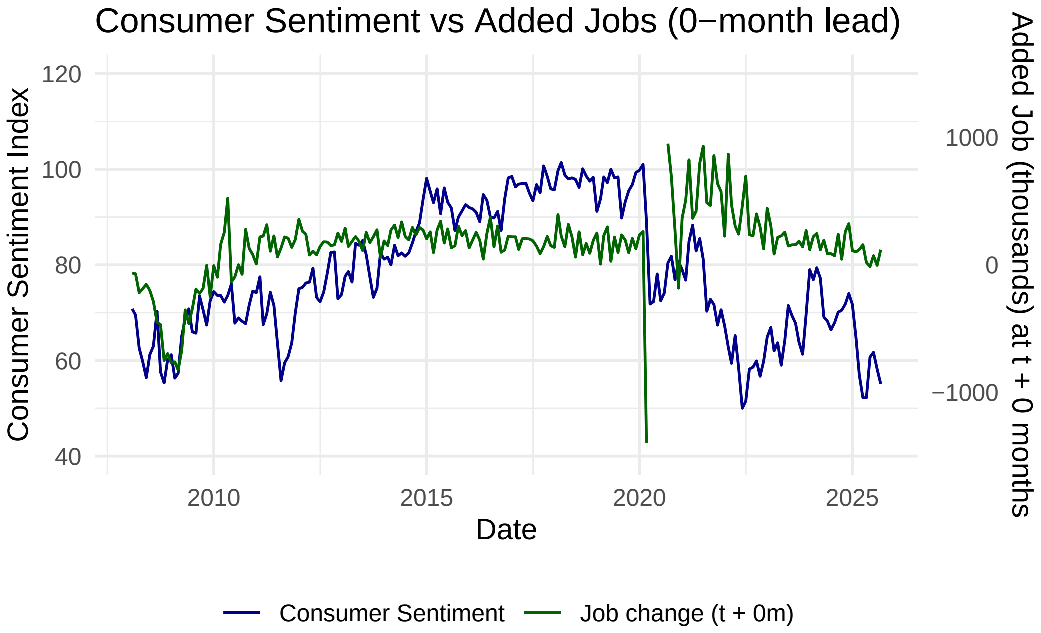

Consumer Sentiment vs Future Unemployment (6−month lead
Consumer Sentiment Index
100
75
50
15
10
5
0
Unemployment rate at t + 6 months
2010
2015
2020
2025
Date
Consumer Sentiment
Unemp (t + 6m)


Consumer Sentiment vs Added Jobs (8−month lead)
Consumer Sentiment Index
120
100
80
60
40
1000
0
−1000
Added Job (thousands) at t + 8 months
2010
2015
2020
2025
Date
Consumer Sentiment
Job change (t + 8m)


Consumer Sentiment vs Added Jobs (7−month lead)
Consumer Sentiment Index
120
100
80
60
40
2010
2015
2020
2025
Date
Added Job (thousands) at t + 7 months
1000
0
−1000
Consumer Sentiment
Job change (t + 7m)


Consumer Sentiment vs Added Jobs (6−month lead)
Consumer Sentiment Index
120
100
80
60
40
2010
2015
2020
2025
Date
Added Job (thousands) at t + 6 months
1000
0
−1000
Consumer Sentiment
Job change (t + 6m)





```
## Main dual-axis plot: CS vs future job creation

## with unemployment extremes overlaid (no separate y-axis)


lag_months  <- 3                    # choose 3, 6, or 12
```

```r
cs_limits   <- c(40, 120)          # left axis (CS)
jobs_limits <- c(-1000, 1000)      # right axis (job change, thousands)
unemp_limits <- c(2, 12)           # used only for scaling unemployment vertically

df <- macro %>%
  arrange(date) %>%
  mutate(
    jobchg_lead = lead(job_change, lag_months),
    unrate_lead = lead(unrate,      lag_months)
  ) %>%
  filter(!is.na(cs), !is.na(jobchg_lead), !is.na(unrate_lead))

# unpack limits
cs_min   <- cs_limits[1];  cs_max <- cs_limits[2]
jb_min   <- jobs_limits[1]; jb_max <- jobs_limits[2]
ur_min   <- unemp_limits[1]; ur_max <- unemp_limits[2]

cs_range <- cs_max - cs_min
jb_range <- jb_max - jb_min
ur_range <- ur_max - ur_min

# scale job change & unemployment into CS vertical space for plotting
df <- df %>%
  mutate(
    jobchg_scaled = cs_min + (jobchg_lead - jb_min) * (cs_range / jb_range),
    unrate_scaled = cs_min + (unrate_lead - ur_min) * (cs_range / ur_range)
  )


# pick a few extreme unemployment values (e.g., 3 highest & 3 lowest)
top3 <- df %>% slice_max(order_by = unrate_lead, n = 3)
bottom3 <- df %>% slice_min(order_by = unrate_lead, n = 3)


unemp_extremes <- bind_rows(top3, bottom3) %>%
  arrange(date) %>%
  distinct(date, .keep_all = TRUE)


# legend labels
cs_label    <- "Consumer Sentiment"
job_label   <- paste0("Job change (t + ", lag_months, "m)")
unemp_label <- "Unemployment (no axis)"


ggplot(df, aes(x = date)) +
  # main series: Consumer Sentiment (left axis)
  geom_line(aes(y = cs, color = cs_label), linewidth = 0.7) +


  # main series: job creation (right axis, scaled onto CS scale)
  geom_line(aes(y = jobchg_scaled, color = job_label),
            linewidth = 0.7) +


  # overlay unemployment (same lag), no axis - dashed grey line
  geom_line(aes(y = unrate_scaled, color = unemp_label),
            linewidth = 0.4, alpha = 0.5, linetype = "dashed") +
  # label only extreme high/low unemployment months
  geom_point(
    data = unemp_extremes,
    aes(y = unrate_scaled),
    color = "black", size = 1.8
  ) +
  geom_text(
    data = unemp_extremes,
    aes(y = unrate_scaled,
        label = sprintf("%.1f%%", unrate_lead)),
    vjust = -0.4,
    size  = 3,
    color = "black"
  ) +

  # dual y-axes: left = CS, right = job change
  scale_y_continuous(
    name   = "Consumer Sentiment Index",
    limits = cs_limits,
    sec.axis = sec_axis(
      trans = ~ (.- cs_min) * (jb_range / cs_range) + jb_min,
      name  = paste0("Monthly change in nonfarm employment (thousands), t + ",
                     lag_months, " months")
    )
  ) +
```

```r
  scale_color_manual(
    values = setNames(
      c("steelblue", "darkgreen", "grey50"),
      c(cs_label, job_label, unemp_label)
    )
  ) +
  labs(
    title = paste0("Consumer Sentiment vs Future Job Creation (", lag_months, "-month lead)"
    subtitle = "Unemployment rate at the same horizon is shown as a dashed line; extremes ar
    x = "Date",
    color = NULL
  ) +
  theme_minimal() +
  theme(
    legend.position = "bottom"
  )
```

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_text()`).
```

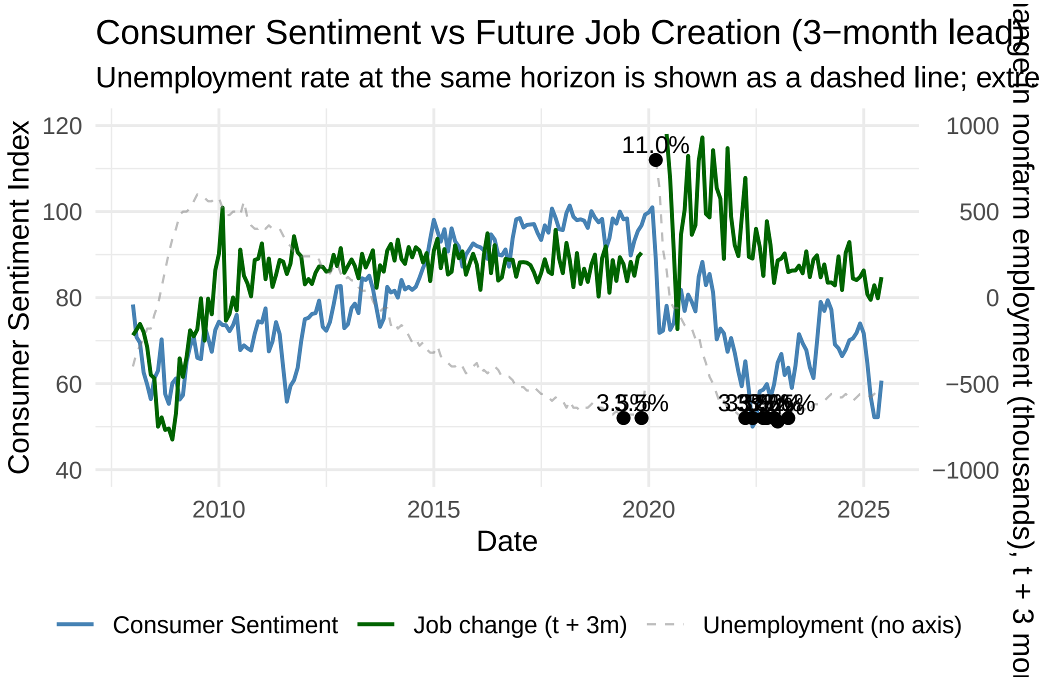
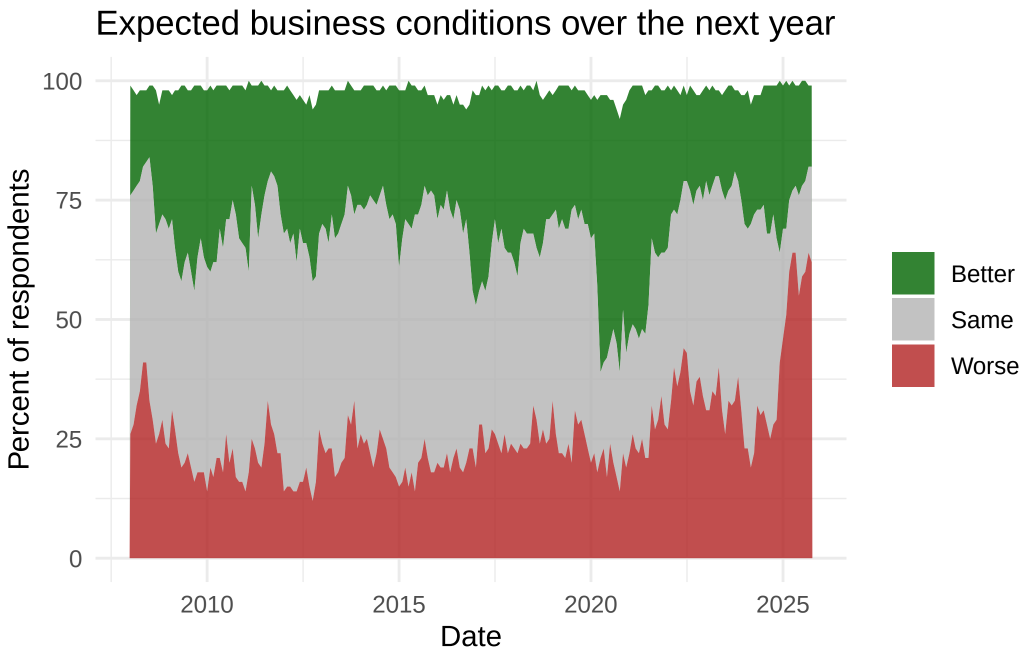

Consumer Sentiment vs Future Job Creation (3−month lead)
Unemployment rate at the same horizon is shown as a dashed line; exter
Consumer Sentiment Index
120
100
80
60
40
ange in nonfarm employment (thousands), t + 3 mo
1000
500
0
−500
−1000
11.0%
3.5%
3.5%
3.5%
2010
2015
2020
2025
Date
Consumer Sentiment
Job change (t + 3m)
Unemployment (no axis)

Figure 2.Time series: net business conditions vs consumer sentiment

```
# From ECB (Table 26: Expected change in business conditions in a year)
ECB_supp <- ECB %>%
  transmute(
    date,
    better_exp = `Better`,    # % expecting better business conditions
    same_exp   = Same,            # % expecting same
    worse_exp  = `Worse`,     # % expecting worse
    dk_exp     = `DK; NA`,
    rel_exp    = Relative,
    net_biz_expect = better_exp - worse_exp  # net % expecting improvement
  )

head(ECB_supp)
```

```
# A tibble: 6 x 7
  date       better_exp same_exp worse_exp dk_exp rel_exp net_biz_expect
  <date>          <dbl>    <dbl>     <dbl>  <dbl>   <dbl>          <dbl>
1 2008-01-01         23       50        26      1      97             -3
2 2008-02-01         21       49        28      2      93             -7
3 2008-03-01         19       46        32      3      87            -13
4 2008-04-01         19       44        35      2      84            -16
5 2008-05-01         16       41        41      2      75            -25
6 2008-06-01         15       42        41      2      74            -26
```

```r
ECB_long <- ECB_supp %>%
  select(date, better_exp, same_exp, worse_exp) %>%
  pivot_longer(
    cols = -date,
    names_to  = "expectation",
    values_to = "share"
  )

ggplot(ECB_long, aes(x = date, y = share, fill = expectation)) +
  geom_area(alpha = 0.8) +
  scale_fill_manual(
    values = c(
      better_exp = "darkgreen",
      same_exp   = "grey70",
      worse_exp  = "firebrick"
    ),
    labels = c("Better", "Same", "Worse")
  ) +
  labs(
    title = "Expected business conditions over the next year",
    x     = "Date",
    y     = "Percent of respondents",
    fill  = NULL
  ) +
  theme_minimal()
```



```r
plot_cs_vs_exp_biz_dual <- function(data_macro, data_ecb,
                                    cs_limits  = c(40, 120),
                                    net_limits = c(-90, 30)) {
  df <- data_macro %>%
    select(date, cs) %>%
    left_join(data_ecb %>% select(date, net_biz_expect), by = "date") %>%
    filter(!is.na(cs), !is.na(net_biz_expect)) %>%
    arrange(date)

  cs_min <- cs_limits[1]
  cs_max <- cs_limits[2]
  nb_min <- net_limits[1]
  nb_max <- net_limits[2]
```

```r
cs_rng <- cs_max - cs_min
nb_rng <- nb_max - nb_min

df <- df %>%
  mutate(
    net_biz_scaled = cs_min + (net_biz_expect - nb_min) * (cs_rng / nb_rng)
  )

ggplot(df, aes(x = date)) +
  geom_line(aes(y = cs, color = "Consumer Sentiment")) +
  geom_line(aes(y = net_biz_scaled,
                color = "Net expected business conditions (Better-Worse)")) +
  scale_y_continuous(
    name   = "Consumer Sentiment Index",
    limits = cs_limits,
    sec.axis = sec_axis(
      trans = ~ (.- cs_min) * (nb_rng / cs_rng) + nb_min,
      name  = "Net % expecting better minus worse business conditions"
    )
  ) +
  scale_color_manual(
    values = setNames(
      c("steelblue", "darkorange"),
      c("Consumer Sentiment", "Net expected business conditions (Better-Worse)")
    )
  ) +
    labs(
      title = "Consumer sentiment vs. expected business conditions in a year",
      x     = "Date",
      color = NULL
    ) +
    theme_minimal() +
    theme(legend.position = "bottom")
}

# Example call
p_exp_biz <- plot_cs_vs_exp_biz_dual(macro, ECB_supp,
                                     cs_limits  = c(40, 120),
                                     net_limits = c(-90, 30))
p_exp_biz
```

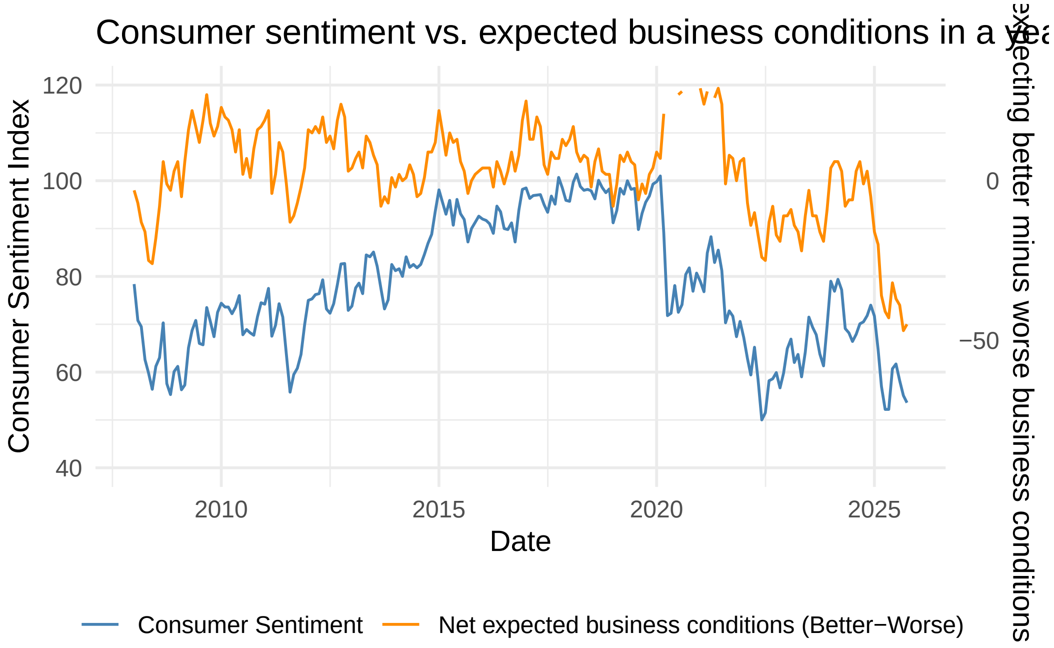


Figure 3. Scatter: net expectations vs subsequent unemployment change

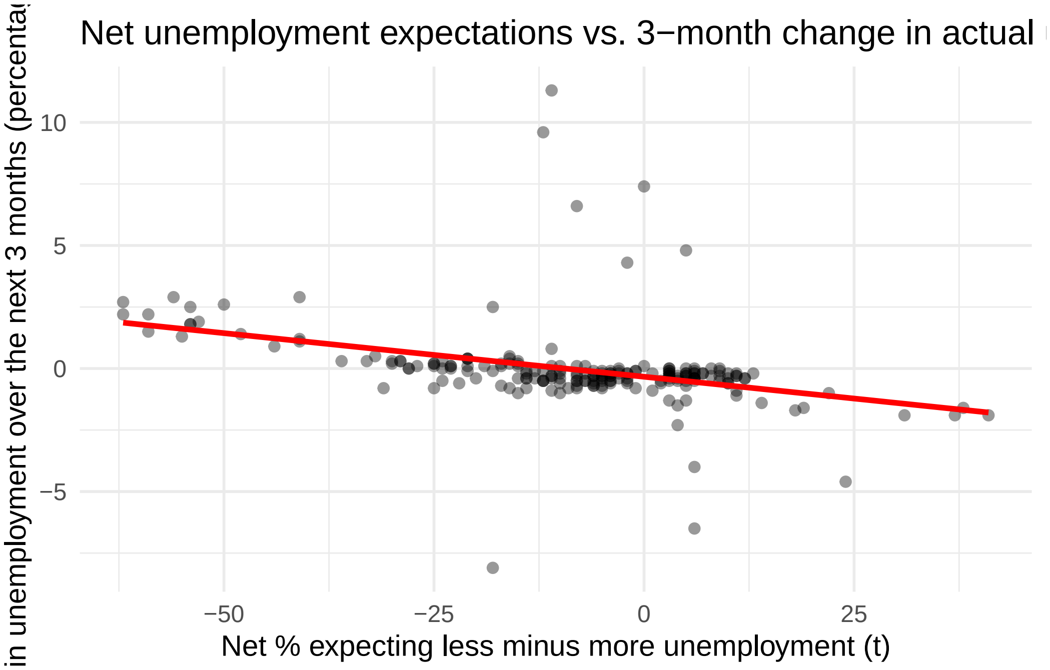
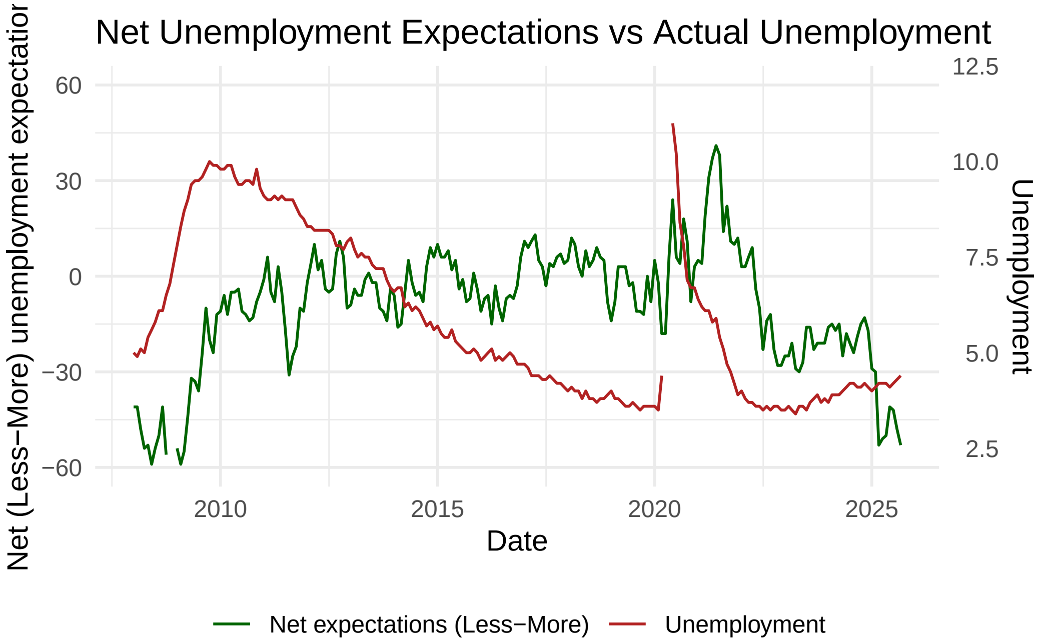


Figure 4. Time series: net expectations vs actual unemployment (dual axis)

```
plot_expect_vs_unemp_dual <- function(data_macro2,
                                      cs_limits   = c(-60, 60),   # for net expectations
                                      unemp_limits= c(2, 12)) {

  df <- data_macro2 %>%
    filter(!is.na(net_unemp_expect), !is.na(unrate)) %>%
    arrange(date)

  ex_min <- cs_limits[1]
```

```r
ex_max <- cs_limits[2]
ur_min <- unemp_limits[1]
ur_max <- unemp_limits[2]

ex_rng <- ex_max - ex_min
ur_rng <- ur_max - ur_min

df <- df %>%
  mutate(
    unrate_scaled = ex_min + (unrate - ur_min) * (ex_rng / ur_rng)
  )

ggplot(df, aes(x = date)) +
  geom_line(aes(y = net_unemp_expect, color = "Net expectations (Less-More)")) +
  geom_line(aes(y = unrate_scaled,    color = "Unemployment")) +
  scale_y_continuous(
    name   = "Net (Less-More) unemployment expectations",
    limits = cs_limits,
    sec.axis = sec_axis(
      trans = ~ (.- ex_min) * (ur_rng / ex_rng) + ur_min,
      name  = "Unemployment"
    )
  ) +
  scale_color_manual(
    values = setNames(
      c("darkgreen", "firebrick"),
        c("Net expectations (Less-More)", "Unemployment")
      )
    ) +
    labs(
      title = "Net Unemployment Expectations vs Actual Unemployment",
      x     = "Date",
      color = NULL
    ) +
    theme_minimal() +
    theme(legend.position = "bottom")
}


plot_expect_vs_unemp_dual(macro2)
```



Indications

Strengthening Tenant Protections.

Conclusion & Outlook

References

https://data.sca.isr.umich.edu/data-archive/mine.php https://www.bls.gov/cps

https://www.bls.gov/ces