

# **Applied Business Research**

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# Preface

This is a Quarto book.

To learn more about Quarto books visit <https://quarto.org/docs/books>.

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# 1 Introduction

This is a work in process website for a potential book on applied business research in R. The goal of the website is to provide tools and examples for reproducible and well-formatted research reports.

This is an example of a Quarto citation Knuth (1984) in a sentence.

## 2 Project Setup

This chapter will have links and explainers on how to get your quarto and other GitHub projects going...

The top finance/accounting/aio journals are about to be flooded with highly reproducible KU research.

### 2.1 Git vs. GitHub

Git is the underlying code that helps manage version control of your projects. You can find more information about the details of Git [here](#). Information about how to install git on your machine can be found [here](#).

GitHub is a web-based user interface that makes Git easier to work with by allowing “point-and-click” version control rather than typing git commands. You will want to set up a GitHub account [here](#). The rest of this chapter will reference the use of GitHub, although everything discussed can also be accomplished through the Git language.

### 2.2 Language of GitHub

It is important to remember that GitHub acts as a version control interface for your research projects. So, while we will discuss the verbiage of GitHub, at its core all that it is doing is keeping track of the changes that you make to your code. It may be helpful to translate the Git language into words you regularly associate with project management.

**Repository** - A repository is where all the code for a specific project lives. You can think of it like the project folder where your code is stored. The benefit of a repository is that it is stored online, allowing you to easily access it from any machine. You will most likely want to make your repository private, so that only you and people you identify as co-authors can access your code.

**Fork** - “Forking” a repository is equivalent to making a copy of someone else’s repository. If a repository is made public, then anyone can fork the repository to have their own copy. This is likely not something that will commonly occur in your own research, as we will discuss next.

You can think of forking a repository as the same as copying someone else's code folder and pasting it onto your computer.

**Clone** - "Cloning" is where the power of GitHub really begins. Cloning a repository is the same as giving your local machine (e.g., computer) access to the code in the repository. Think of it like installing Dropbox on another computer. Now you have access to all the files stored on Dropbox. Cloning a repository is the exact same thing for code. Once you have cloned the repository, you can now work on the code from that machine. The power comes in by being able to clone the repository on multiple computers, and your coauthors doing the same, allowing you all to work on the same set of code.

## 3 Obtaining and Merging Data

This is my first time working on a Quarto book. So, this first post will be very rough for now. I will try to provide a few different examples of ways to obtain and merge data in R, and a few tips of things to keep in mind. Matt test.

We already know how to obtain data from WRDS. Let's use this to obtain some returns for the S&P 500. We could use the formal index data, but let's take a shortcut and just use the popular SPY ETF that tracks the S&P 500. To do this, we need to find the CRSP identifier (PERMNO) for the ticker "SPY." We can look in the WRDS stocknames file for this, and then use the SPY PERMNO to pull data from the CRSP monthly stock file.

```
# Load Libraries [i.e., packages]
library(dbplyr)
library(RPostgres)
library(DBI)
library(glue)
library(arrow)
library(haven)
library(tictoc) #very optional timer, mostly as a teaching example
library(tidyverse) # I like to load tidyverse last to avoid package conflicts

#I have done this in a separate chunk with the options
# results: FALSE
# message: FALSE
#because I don't need to see the messages from loading the packages.
```

```
# Log in to WRDS -----

#before running this block, I used these commands to securely store my WRDS username and pass
# keyring::key_set("WRDS_user")
# keyring::key_set("WRDS_pw")

if(exists("wrds")){
  dbDisconnect(wrds) # because otherwise WRDS might time out
}
```

```

wrds <- dbConnect(Postgres(),
  host='wrds-pgdata.wharton.upenn.edu',
  port=9737,
  user=keyring::key_get("WRDS_user"),
  password=keyring::key_get("WRDS_pw"),
  sslmode='require',
  dbname='wrds')

# Create WRDS Table References -----
crsp.msf <- tbl(wrds,in_schema("crsp","msf"))
stocknames <- tbl(wrds,in_schema("crsp","stocknames"))

#I am collecting this data locally to play with duplicates
spy_permnos <- stocknames |> filter(ticker == "SPY") |> collect()

```

Notice that there are six observations in the stocknames table that all share the same ticker “SPY.” I am going to use this as a toy example to play with duplicates. My goal is for this data to be unique at the level of ticker-permno links. First, I can check whether this is true.

```

#check whether there are duplicates
#this simple logic is useful in general
#group by the level I want to make unique,
#count within each group
#sort by descending count so that if there are duplicates
#they will show up at the top.
spy_permnos |>
  group_by(ticker,permno) |>
  count() |>
  arrange(-n)

```

```

# A tibble: 3 x 3
# Groups:   ticker, permno [3]
  ticker permno     n
  <chr>   <int> <int>
1 SPY     84398     3
2 SPY     33910     1
3 SPY     60716     1

```

There are multiple permnos connected to the SPY ticker and some duplicate entries for permno 84398 so I better just look at the data. Also this tells me that there are only a few rows so it doesn’t hurt to just print the data.



```
#| #note that we can use the kable command to embed a simple table in the quarto document
knitr::kable(spy_permnos)
```

| permno | name       | namees     | shrt | exchcd | cdncusip | ticker | comnam                          | shrcls | permno | boxcd | cusip | st_date    | end_date   | medum |
|--------|------------|------------|------|--------|----------|--------|---------------------------------|--------|--------|-------|-------|------------|------------|-------|
| 33910  | 1962-07-02 | 1966-05-24 | 10   | 2      | 2893     | NA     | SPY SPEEDRY CHEMI-CAL PRODS INC | A      | 2751   | 3     | 55914 | 1962-07-02 | 1979-01-22 | 2     |
| 60716  | 1978-10-03 | 1987-07-01 | 10   | 1      | 3811     | 84756  | SPY SPECTRA PHYSICS INC         | NA     | 4215   | 1     | 84756 | 1978-12-14 | 1987-07-01 | 2     |
| 84398  | 1993-01-29 | 2009-02-23 | 73   | 2      | 6726     | 78462  | SPY SPDR TRUST                  | NA     | 46699  | 4     | 78462 | 1993-01-29 | 2024-12-31 | 2     |
| 84398  | 2009-02-24 | 2010-01-26 | 73   | 4      | 6726     | 78462  | SPY SPDR TRUST                  | NA     | 46699  | 4     | 78462 | 1993-01-29 | 2024-12-31 | 2     |
| 84398  | 2010-01-27 | 2024-12-31 | 73   | 4      | 6726     | 78462  | SPY SPDR S & P 500 E T F TRUST  | NA     | 46699  | 4     | 78462 | 1993-01-29 | 2024-12-31 | 2     |

Looking at the data, the company name for permno 84398 matches the SPDR S&P 500 ETF I am looking for. It looks like the duplicate entries might have to do with a change in the listing exchange for the ETF (exchcd) and then a slight name change in 2010 to make the name of the trust more descriptive. Let's keep using this toy example to demonstrate some other functions for dealing with duplicates:

```
#if I want to just collapse the duplicates, I can use "distinct" across the groups that I can
spy_permnos |>
  select(ticker,permno) |>
  distinct()
```

```
# A tibble: 3 x 2
  ticker permno
  <chr>   <int>
1 SPY     33910
2 SPY     60716
3 SPY     84398
```

Now there are only three observations, which is what I asked for, but sometimes it might matter which of the duplicate observations I keep. For example, perhaps what I should do is keep the most recent observation from the `spy_permno` dataset, in terms of `nameenddt`.

```
#select the max data within each group as more advanced way to keep one obs per
#group
spy_permnos |>
  group_by(ticker, permno) |>
  filter(nameenddt == max(nameenddt))
```

```
# A tibble: 3 x 16
# Groups:   ticker, permno [3]
  permno namedt      nameenddt shrcd exchcd siccd ncusip  ticker comnam shrcls
  <int> <date>      <date>      <int> <int> <int> <chr>   <chr> <chr> <chr>
1  33910 1962-07-02 1966-05-24     10     2  2893 <NA>   SPY    SPEEDR~ A
2  60716 1978-10-03 1987-07-01     10     1  3811 84756710 SPY    SPECTR~ <NA>
3  84398 2010-01-27 2024-12-31     73     4  6726 78462F10 SPY    SPDR S~ <NA>
# i 6 more variables: permco <int>, hexcd <int>, cusip <chr>, st_date <date>,
#   end_date <date>, namedum <dbl>
```

#ultimately we can assign the permno of the current observation, which we already know from r

```
spy_permno <- spy_permnos |>
  group_by(ticker, permno) |>
  filter(nameenddt == max(nameenddt)) |>
  ungroup() |>
  filter(nameenddt == max(nameenddt)) |>
  select(permno) |>
  as.numeric()

spy_permno
```

```
[1] 84398
```

Now we can use the SPY permno to pull monthly returns for SPY:

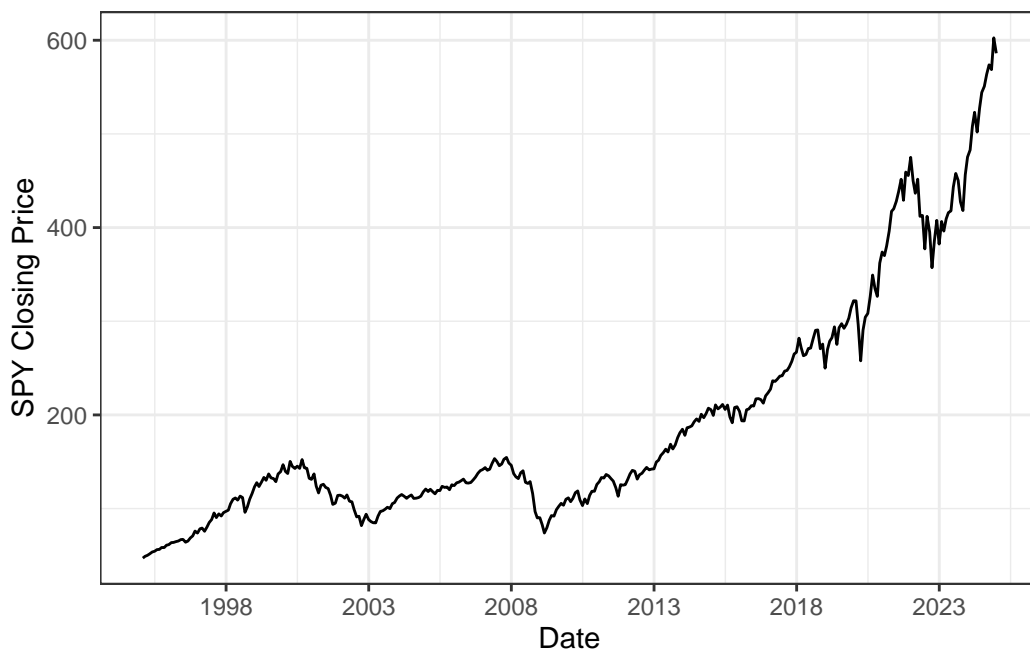
```
# Pull CRSP MSI Data -----
#Data seems to begin in feb 1993, lets start in 1995 as a nice round number
#notice that this implicitly feeds the permno I calculated locally back up to WRDS in my crsp
mkt_index <- crsp.msfi |>
```

```

filter(date >= "1995-01-01",
       permno == spy_permno) |>
select(date,ret,prc) |>
collect() |>
mutate(month = month(date),
       year = year(date))

```

Then I can plot them, note that if you look at the source code for this page, I do this in a chunk with `echo=false` so that I only see the output and not the code. This would be useful for creating an actual paper rather than coding examples:



This plot would look nice with recessions shaded. We can get recession dates from FRED. FRED data can be accessed from an API, there is a custom package to work with FRED data in R called `fredr`. First you need to obtain a FRED API key by signing up here: [https://fred.stlouisfed.org/docs/api/api\\_key.html](https://fred.stlouisfed.org/docs/api/api_key.html)

```

#load the fredr package
library(fredr)

#Unblock the below and run to set your password
#keyring::key_set("fred_api_key")

#set my API key which is saved in keyring

```

```

fredr_set_key(keyring::key_get("fred_api_key"))

#collect the data from the series USRECD
# https://fred.stlouisfed.org/series/USRECD

fred_data<-fredr(series_id = "USRECD",
                 observation_start = as.Date("1995-01-01"),
                 observation_end = as.Date("2024-12-31"),
                 frequency = "m") |>
  #I am going to add month and year variables because I think this is
  #easier for linking
  mutate(month = month(date),
         year = year(date))

# show the first few rows which has a value of 0 or 1 where 1 is recession
fred_data |> head() |> knitr::kable()

```

| date       | series_id | value | realtime_start | realtime_end | month | year |
|------------|-----------|-------|----------------|--------------|-------|------|
| 1995-01-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 1     | 1995 |
| 1995-02-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 2     | 1995 |
| 1995-03-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 3     | 1995 |
| 1995-04-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 4     | 1995 |
| 1995-05-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 5     | 1995 |
| 1995-06-01 | USRECD    | 0     | 2025-03-12     | 2025-03-12   | 6     | 1995 |

Now we need to merge the SPY data with the recession data.

```

merged_data <- mkt_index |>
  #I am going to select only the columns I need from #the FRED data
  inner_join(fred_data |>
    select(month,year,recession=value),
    by=join_by(month,year))

# check to make sure it is still unique by month
merged_data |>
  group_by(month,year) |>
  count() |>
  arrange(-n)

```

```
# A tibble: 360 x 3
```

```
# Groups:   month, year [360]
  month year    n
  <dbl> <dbl> <int>
1     1  1995     1
2     1  1996     1
3     1  1997     1
4     1  1998     1
5     1  1999     1
6     1  2000     1
7     1  2001     1
8     1  2002     1
9     1  2003     1
10    1  2004     1
# i 350 more rows
```

Now we can make the plot with shades for recession months

```
#turns out the merged data was not the preferred way to do this kind of plot

#here is some code I found online to reshape the recession data and add it to the plot

#rename/assign fred data to recession because
#that was the name in the example I found
recession<-fred_data

#load a package they used
library(ecm)

#reshape the recession data for the way
#geom_rect likes the data shaped
recession$diff<-recession$value-lagpad(recession$value,k=1)
  recession<-recession[!is.na(recession$diff),]
  recession.start<-recession[recession$diff==1,]$date
  recession.end<-recession[recession$diff==(-1),]$date

  if(length(recession.start)>length(recession.end))
  {recession.end<-c(recession.end,Sys.Date())}
  if(length(recession.end)>length(recession.start))
  {recession.start<-c(min(recession$date),recession.start)}
```

```

recs<-as.data.frame(cbind(recession.start,recession.end))
recs$recession.start<-as.Date(as.numeric(recs$recession.start),origin=as.Date("1970-01-01"))
recs$recession.end<-as.Date(recs$recession.end,origin=as.Date("1970-01-01"))

#look at the reshaped data
recs

```

```

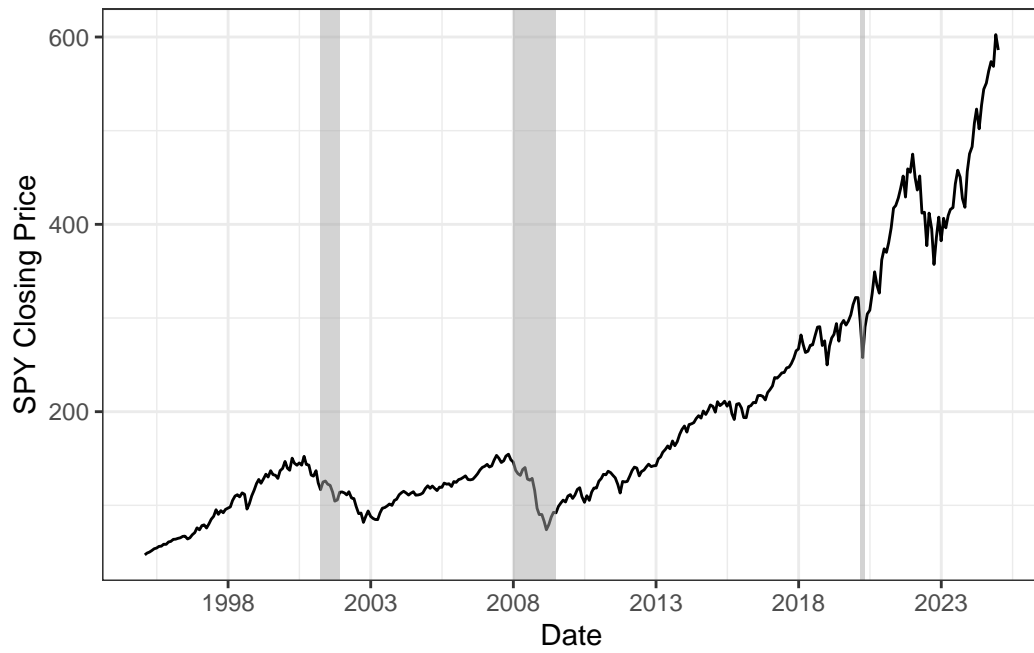
      recession.start recession.end
1      2001-04-01      2001-12-01
2      2008-01-01      2009-07-01
3      2020-03-01      2020-05-01

```

```

#plot the new plot with recession bars
merged_data |>
  ggplot(aes(x=date,y=abs(prc))) +
  geom_line() +
  scale_x_date(name = "Date",
               date_breaks= "5 years",
               date_labels = "%Y") +
  scale_y_continuous(name = "SPY Closing Price") +
  geom_rect(data=recs, inherit.aes=F,
            aes(xmin=recession.start, xmax=recession.end, ymin=-Inf, ymax=+Inf),
            fill="darkgrey", alpha=0.5)+
  theme_bw()

```



## 4 Regression Tables

Test of embedding a regression in Quarto.



Table 4.1

|                     | Base                 | No FE                 | Year FE               | Two-Way FE             | With Controls          |
|---------------------|----------------------|-----------------------|-----------------------|------------------------|------------------------|
| $ROA_t$             | 0.839***<br>(62.732) | 0.756***<br>(48.155)  | 0.769***<br>(48.621)  | 0.639***<br>(38.634)   | 0.624***<br>(35.596)   |
| $LOSS$              |                      | -0.030***<br>(-7.949) | -0.028***<br>(-7.755) | -0.015***<br>(-7.556)  | -0.017***<br>(-8.111)  |
| $ROA_t \times LOSS$ |                      | 0.032<br>(1.470)      | 0.012<br>(0.535)      | -0.285***<br>(-13.307) | -0.294***<br>(-12.620) |
| Year FE             |                      |                       | X                     | X                      | X                      |
| Firm FE             |                      |                       |                       | X                      | X                      |
| Controls            |                      |                       |                       |                        | X                      |
| N                   | 163,298              | 163,298               | 163,298               | 161,635                | 161,635                |
| $R^2$               | 0.594                | 0.597                 | 0.603                 | 0.707                  | 0.707                  |
| $R^2$ Within        |                      |                       | 0.580                 | 0.184                  | 0.186                  |

## 5 Summary

In summary, this book has no content whatsoever.

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## References

Knuth, Donald E. 1984. “Literate Programming.” *Comput. J.* 27 (2): 97–111. <https://doi.org/10.1093/comjnl/27.2.97>.