Data Visualization with ggplot2

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Why visualize?

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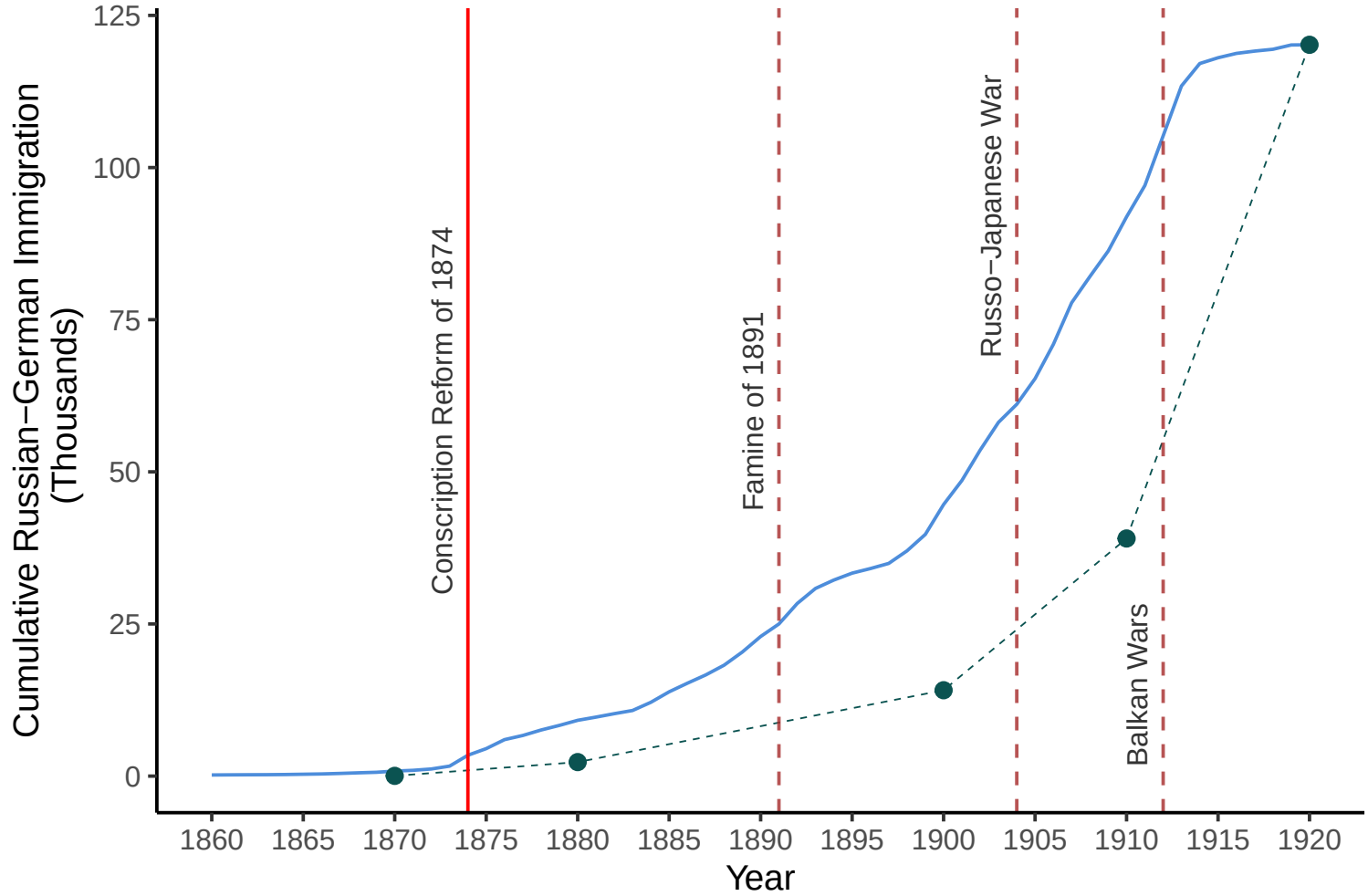
On top of all our struggles with collecting and processing data, why do we need to plot it?

- Representing data in a visual format can help us as researchers to make sense of it
- Clear and well-thought-out plots can help strengthen and deliver your argument

How visualize?



What do you like about this plot? What could have been done better?

Why ggplot2?

- Base R has the set of built-in plotting functions, such as `plot()` or `hist()`, which might be useful when you need to quickly look at your data
- If you need to come up with a highly customized figure, the `ggplot2` package is your choice
- With `ggplot2`, you build up a plot layer by layer, and each layer can come from a different dataset
  - `ggplot2` works with datasets and not with separate vectors as base R does; some people consider it a downside
- Plots made with `ggplot2` can be really pretty

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  - Layers display data on a plot

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- `Scales` that **customize** aesthetic elements
  - Each aesthetic is associated with a separate scale
- A `facet` specifies how to break up and display **subsets** of data
- A `theme` controls elements of the plot not associated with data, such as the font size, background color or the location of a legend
  - `ggplot2` has a large variety of pre-specified themes
  - You can also create your own theme

Base layer

```
ggplot2(data = df,
        aes(x = x, y = y))
```

Geoms

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- `geom_boxplot()` creates a boxplot
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- `geom_histogram()` makes a histogram

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- `geom_polygon()` and `geom_sf()` can be used to draw a map

You can combine different geoms on the same plot; for example, you can add points to a line plot

Adding a geom

```
ggplot2(data = df, aes(x = x, y = y)) +
  geom_line()
```

Scales

Scales control the appearance of different **aes**thetics

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- Position scales control the x and y axes
  - `scale_x_NAME()`, `scale_y_NAME()`
  - `NAME` refers to data type and most often is `continuous` or `discrete`
  - You can specify axes limits, breaks (the locations of the axis tick marks), or the labels of the tick marks

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  - `NAME` refers to data type and most often is `continuous` or `discrete`
  - You can specify axes limits, breaks (the locations of the axis tick marks), or the labels of the tick marks
- Color scales map values to colors and produce legends
  - `scale_color_NAME()`
  - `scale_fill_NAME()`
  - `NAME` is either `manual` or pre-specified palette sets, such as `brewer` for discrete values or `distiller` for continuous values

Controlling scales

```
ggplot2(data = df, aes(x = x, y = y)) +
  scale_x_continuous(limits = c(0, 1)) +
  geom_line()
```

Data for today

AJR (2001) The Colonial Origins of Comparative Development

- `logem4` the logarithm of the settler mortality rates per thousand
- `avexpr` the average value of an index of protection against expropriation between 1985 and 1995
- `f_brit` the dummy variable that takes on a value of one if a country was a British colony
- `muslim80` the fraction of the country population that is Muslim

Link to replication files

Data for today

AJR (2001) The Colonial Origins of Comparative Development

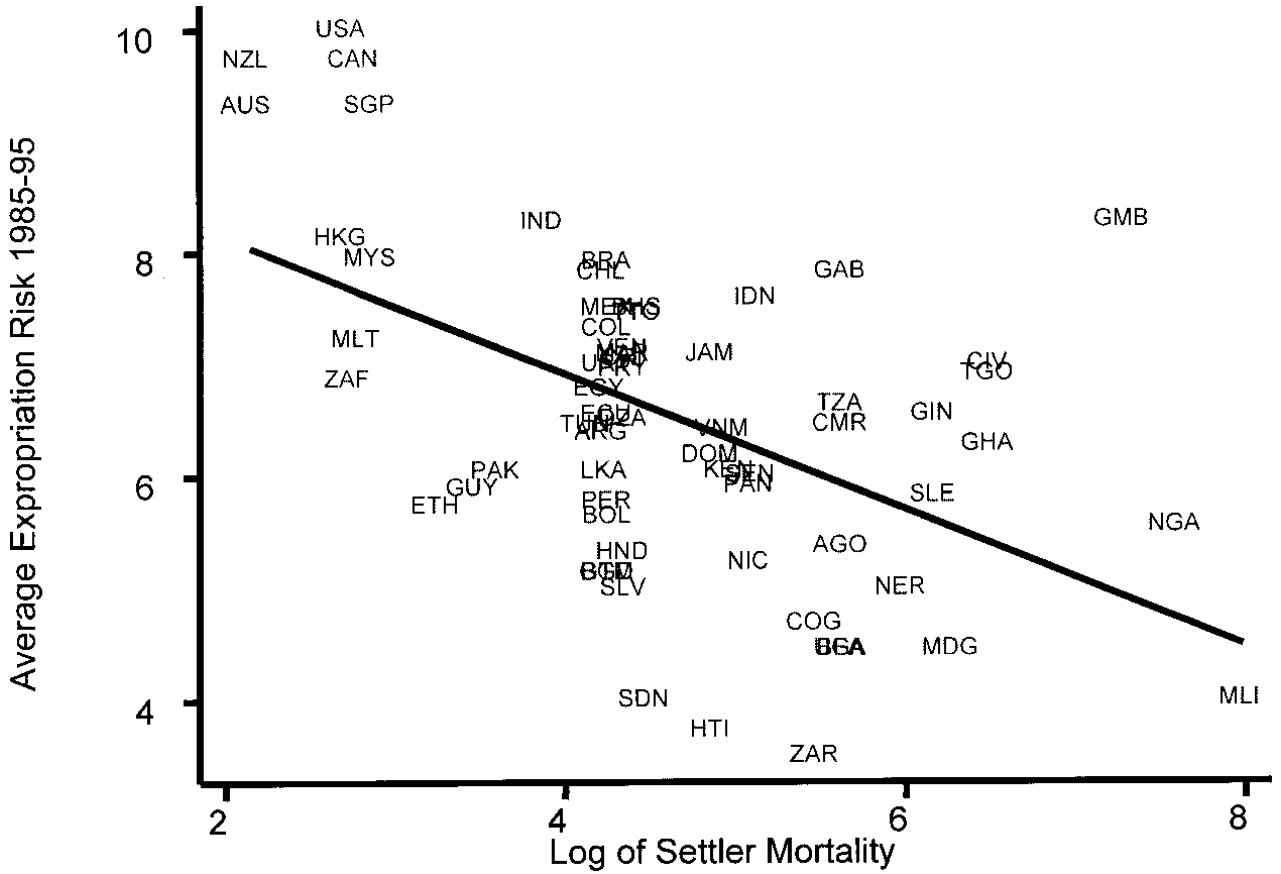


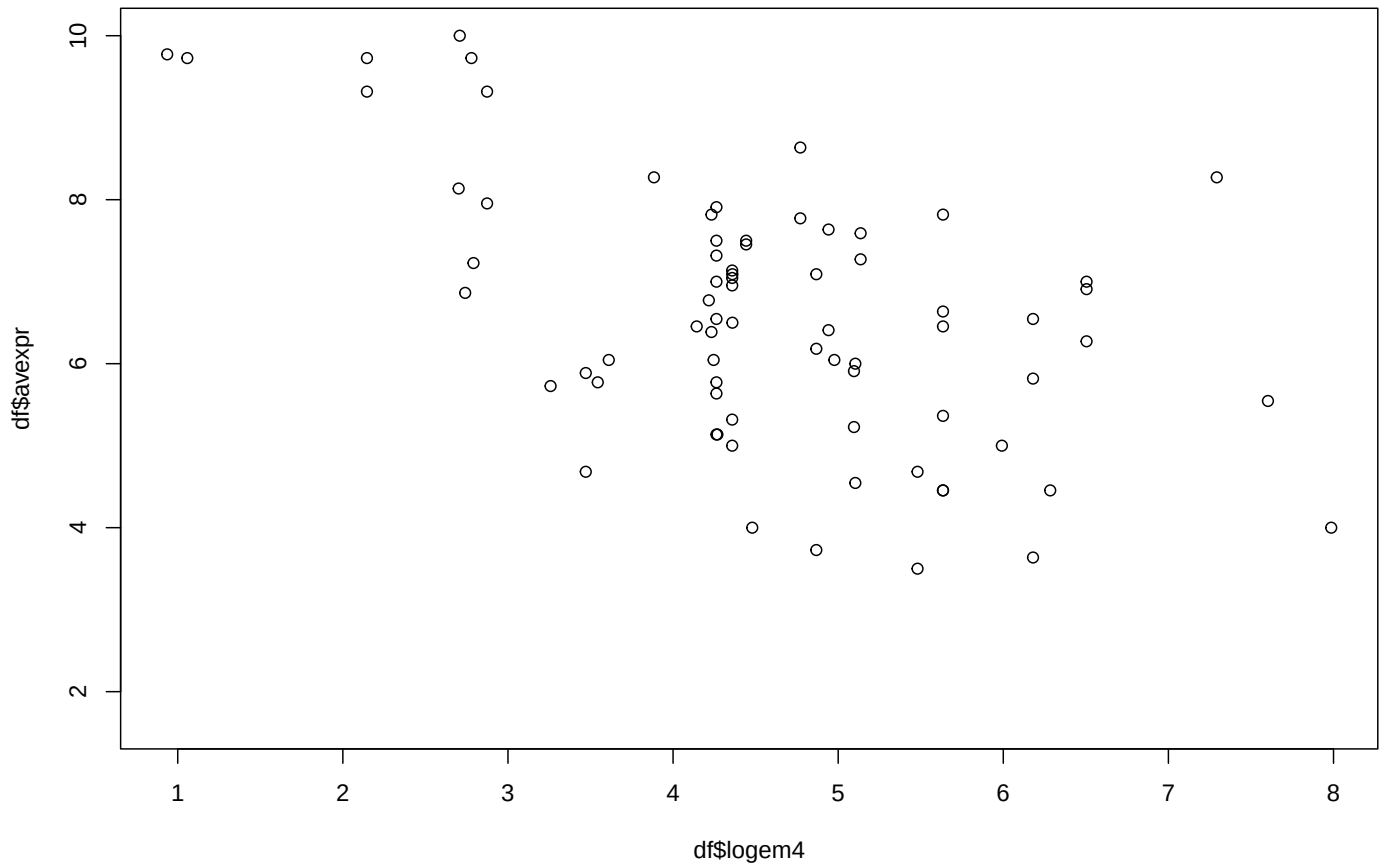
Figure 3: First-Stage Relationship between Settler Mortality and Expropriation Risk

Agenda

1. Scatterplots
2. Histograms
3. Intro to maps

Scatterplot in base R

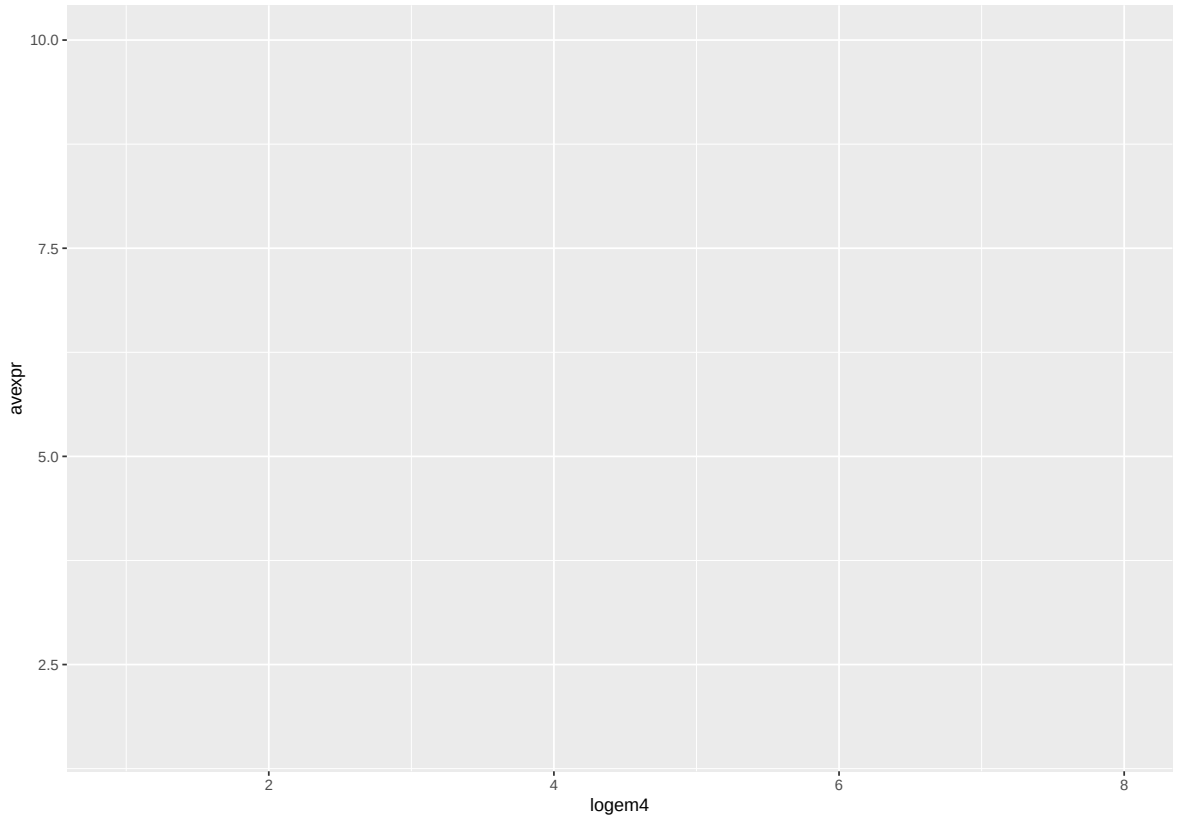
```
library(foreign)
df = read.dta("ajr.dta")
plot(x = df$logem4, y = df$avexpr)
```



Scatterplot

Base layer

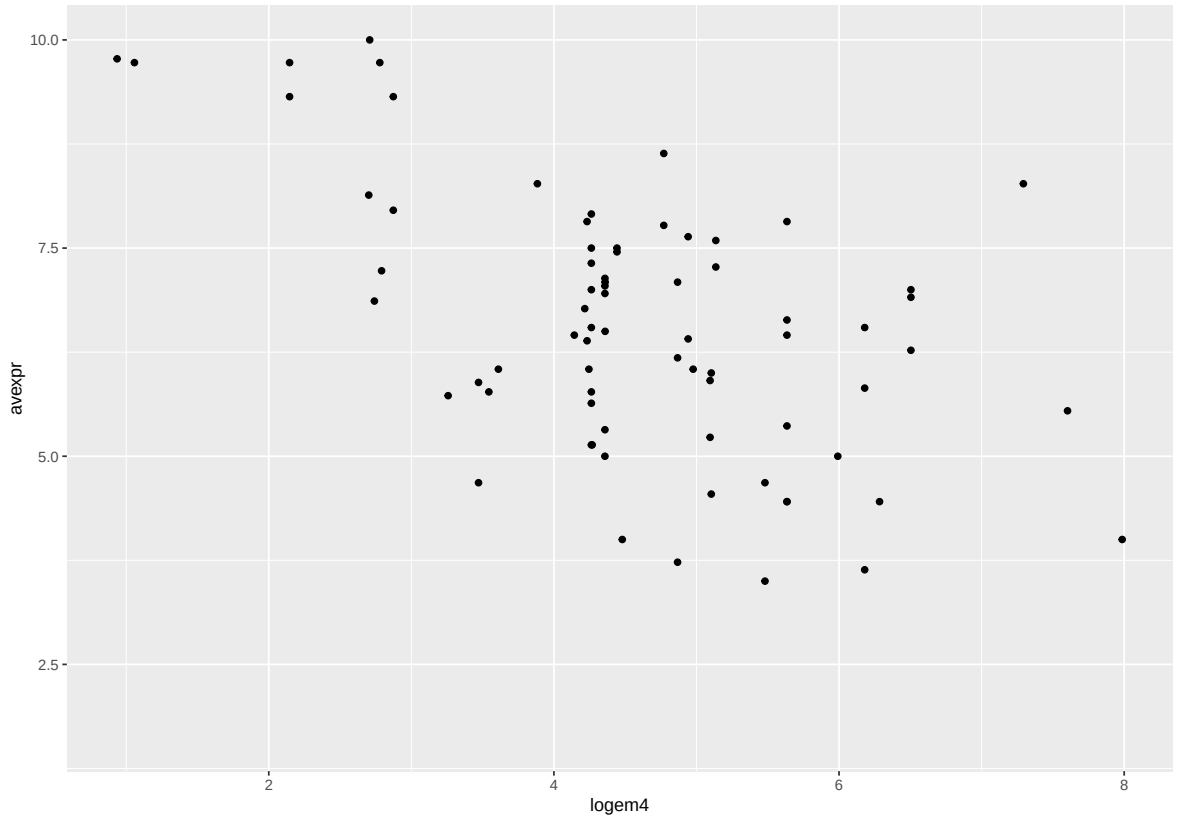
```
library(ggplot2)
ggplot(data = df, aes(x = logem4, y = avexpr))
```



Scatterplot

Adding a geom

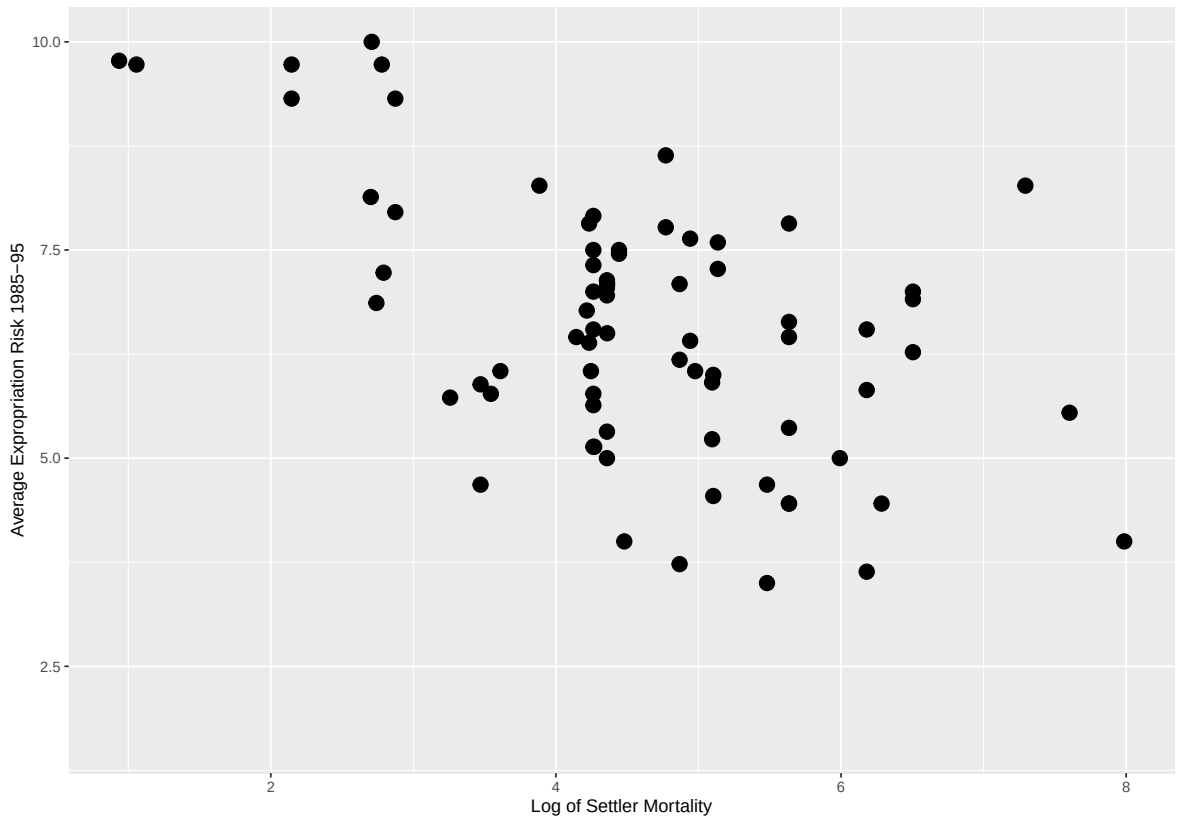
```
ggplot(data = df, aes(x = logem4, y = avexpr)) +
  geom_point()
```



Scatterplot

Labeling axes

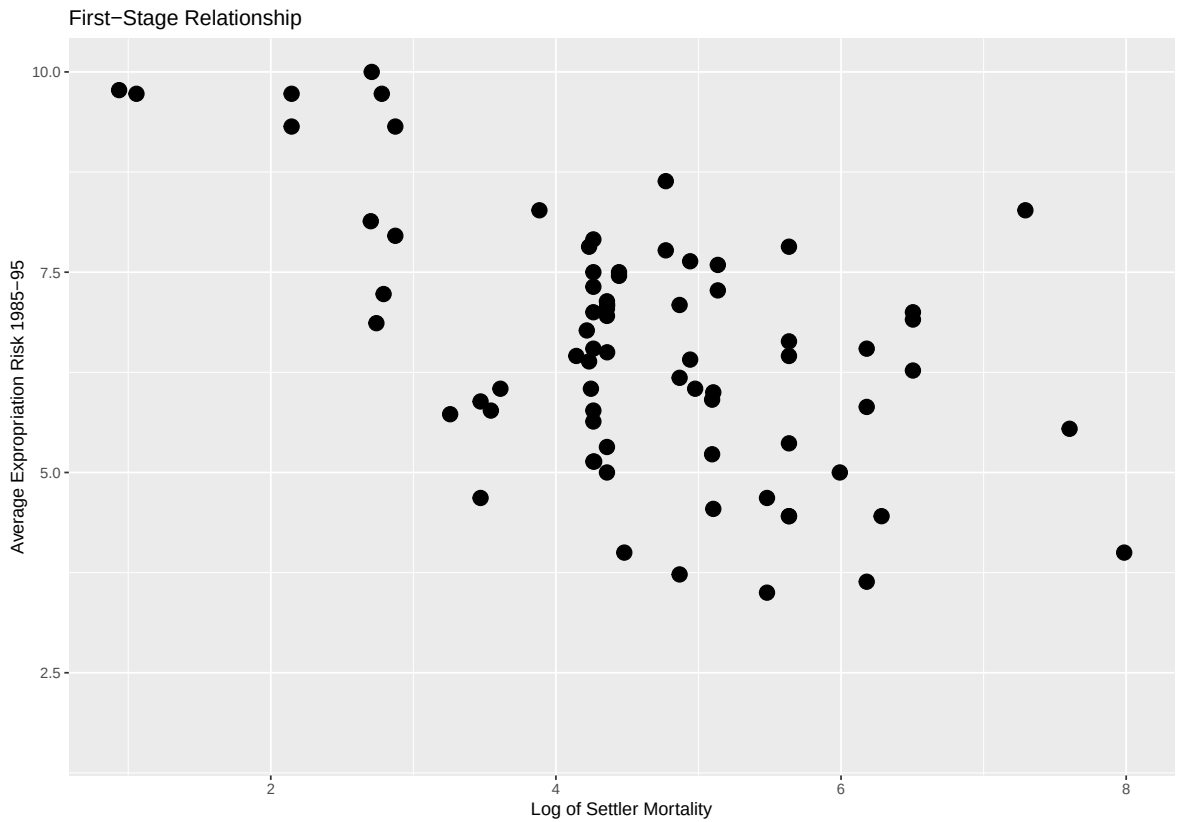
```
ggplot(data = df, aes(x = logem4, y = avexpr)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95")
```



Scatterplot

Adding the title

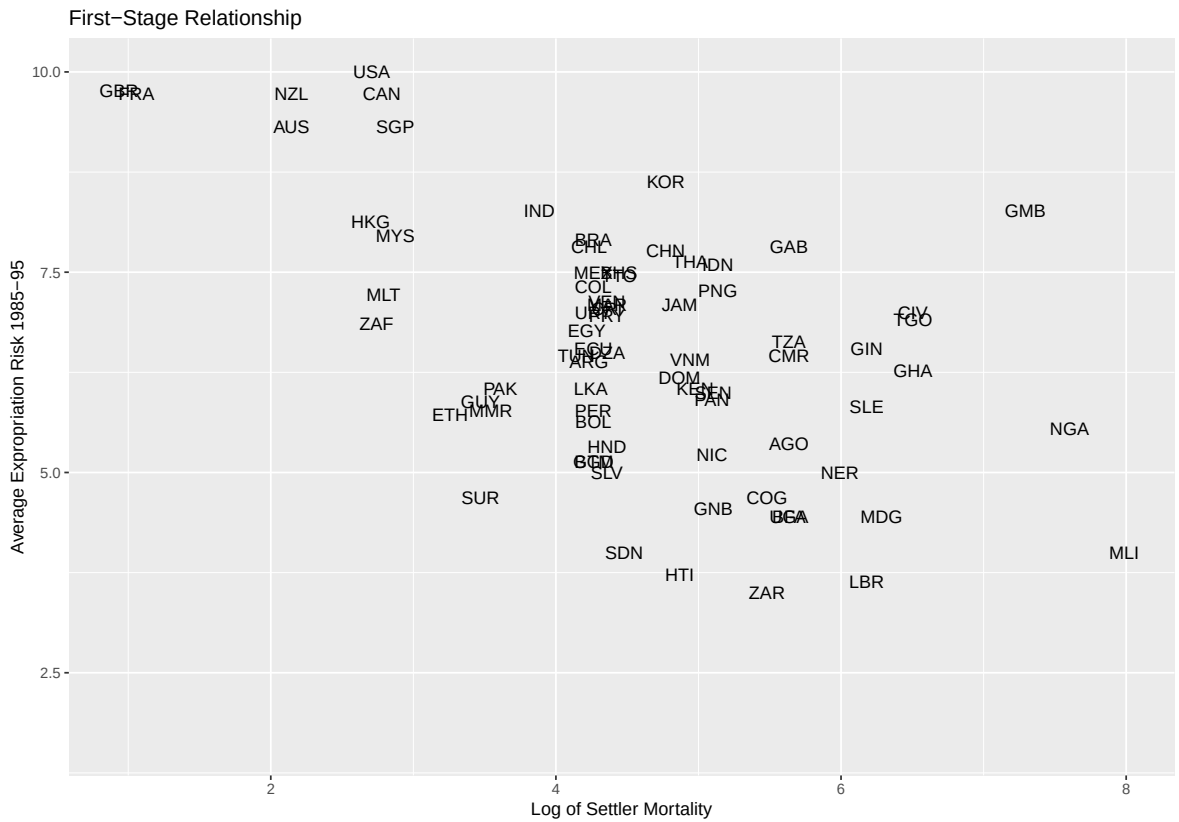
```
ggplot(data = df, aes(x = logem4, y = avexpr)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship")
```



Scatterplot

Labeling points

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text() +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship")
```



Scatterplot

Increasing label size

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship")
```

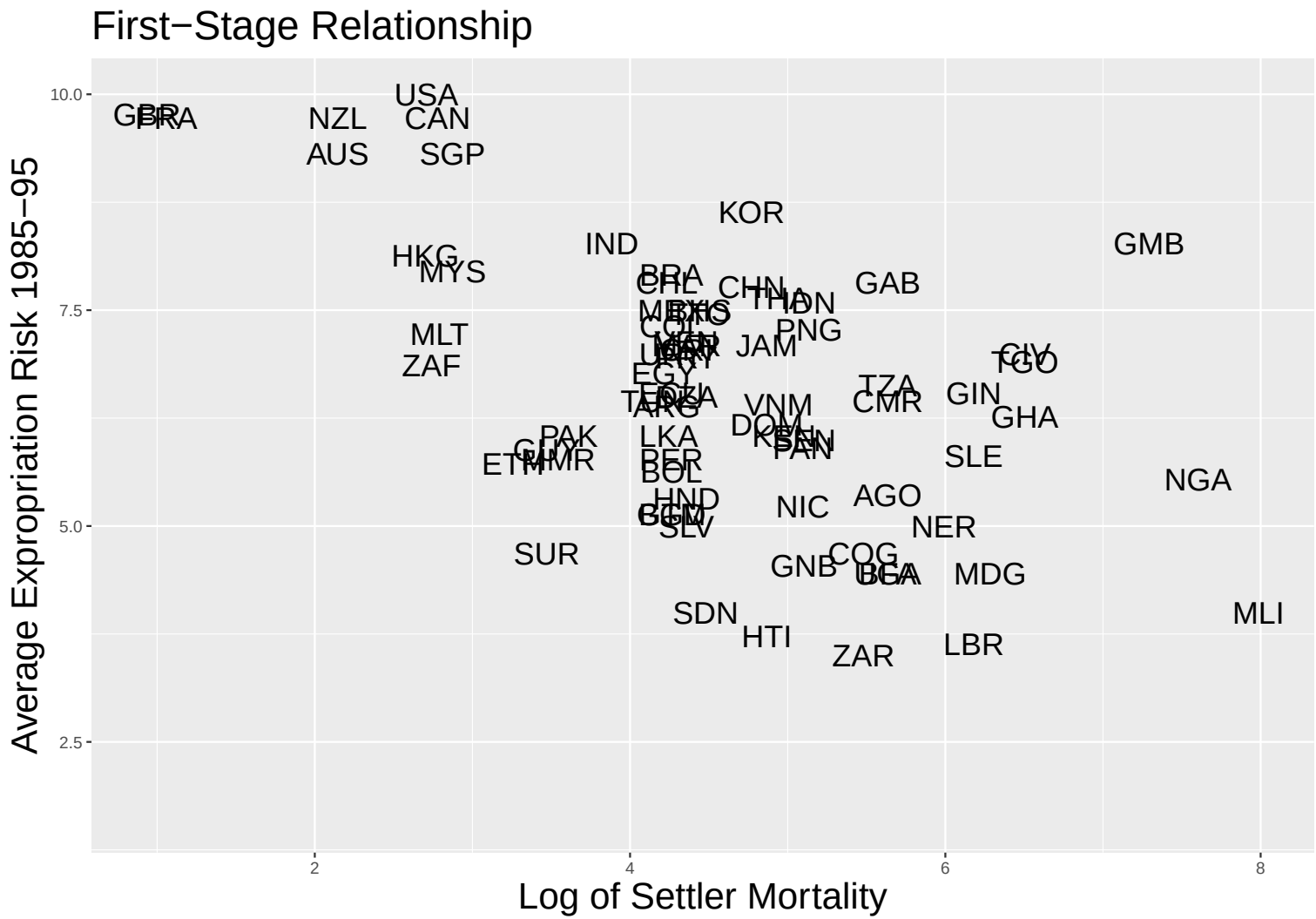
Scatterplot

Increasing title and axes labels font size

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20))
```

Scatterplot

Increasing title and axes labels font size



Scatterplot

Increasing axes tick mark labels font size

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
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  theme(plot.title = element_text(size = 22),
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```

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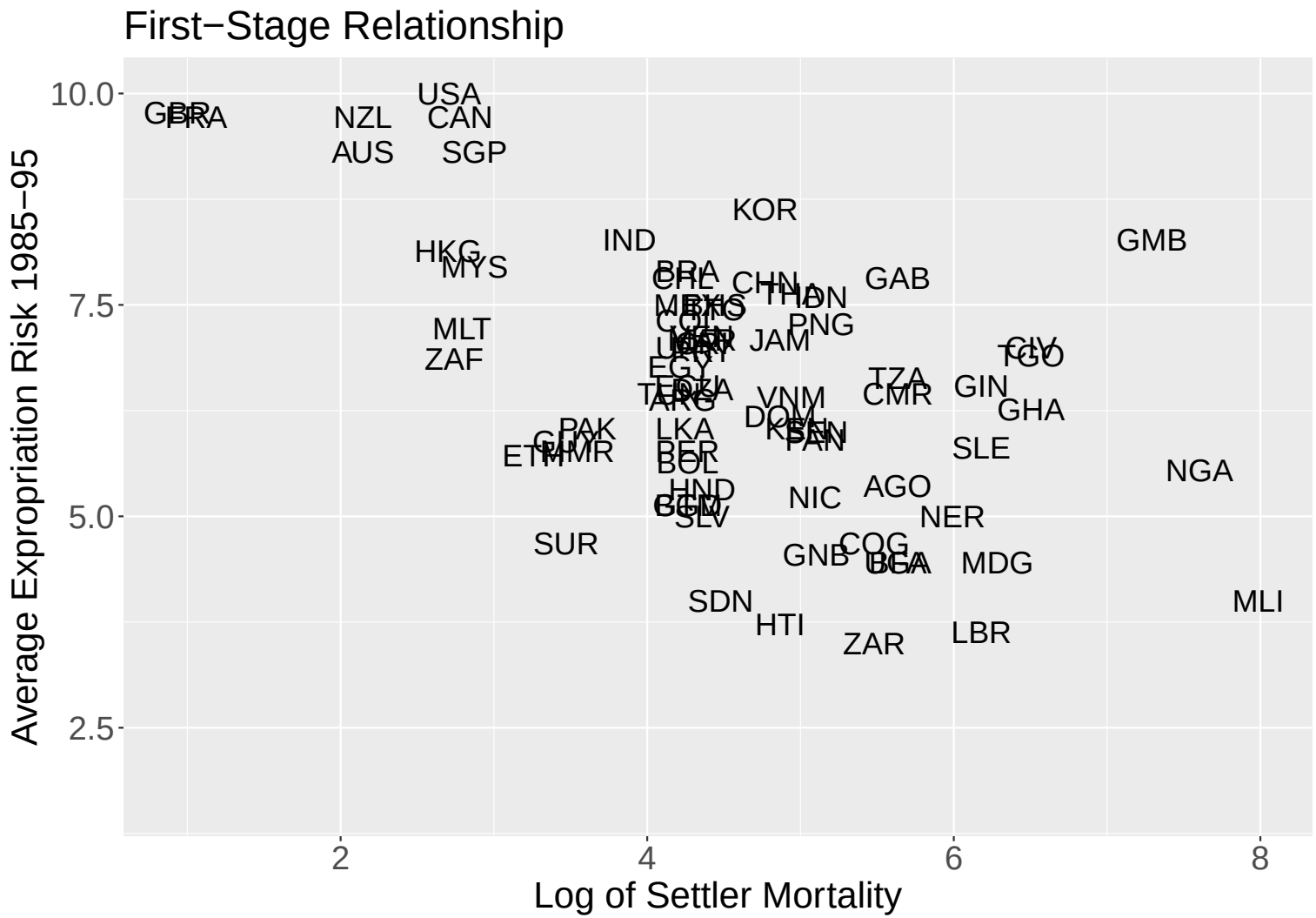
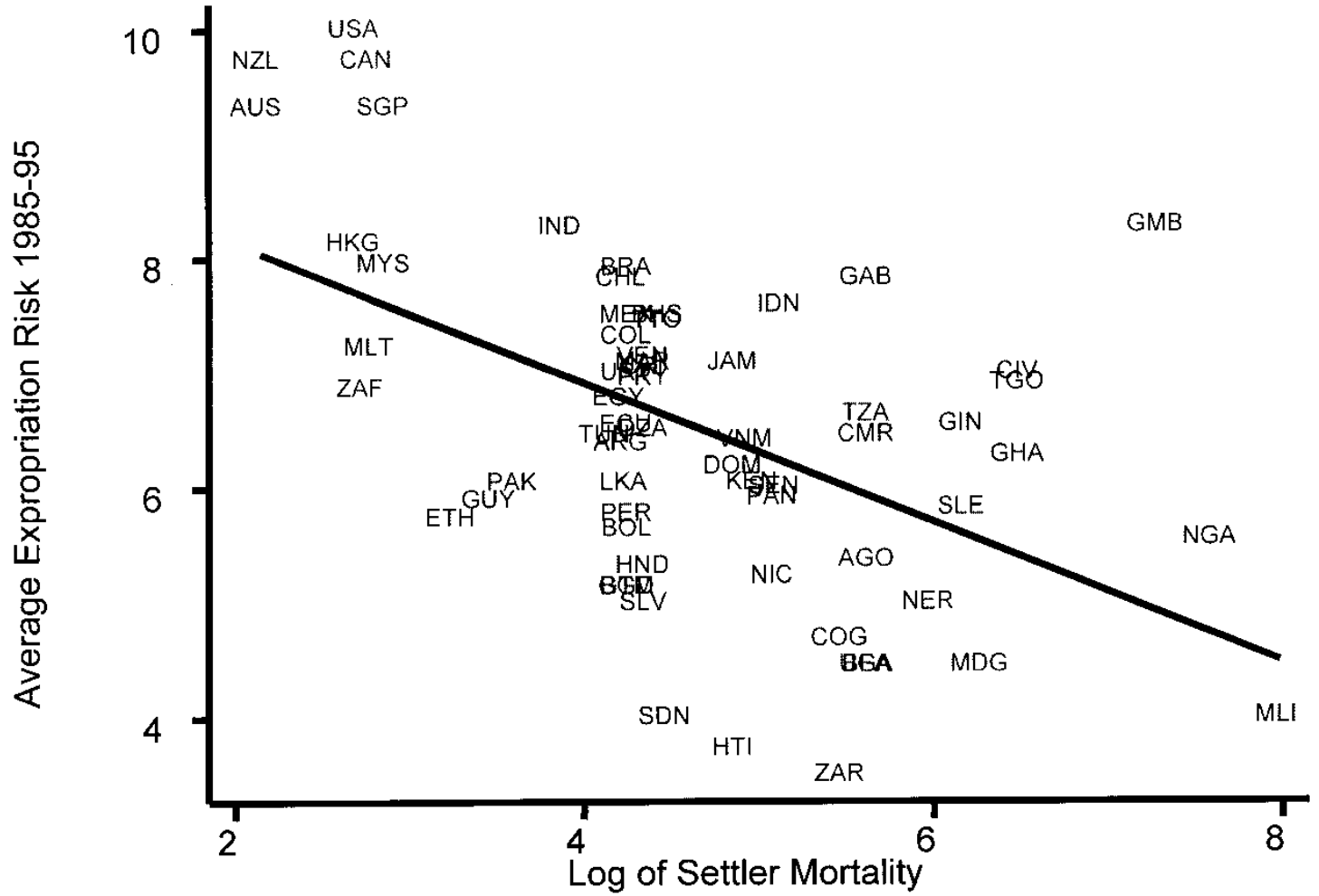
Increasing axes tick mark labels font size



Scatterplot

Working with axes



Scatterplot

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ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
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        axis.text.y = element_text(size = 18)) +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
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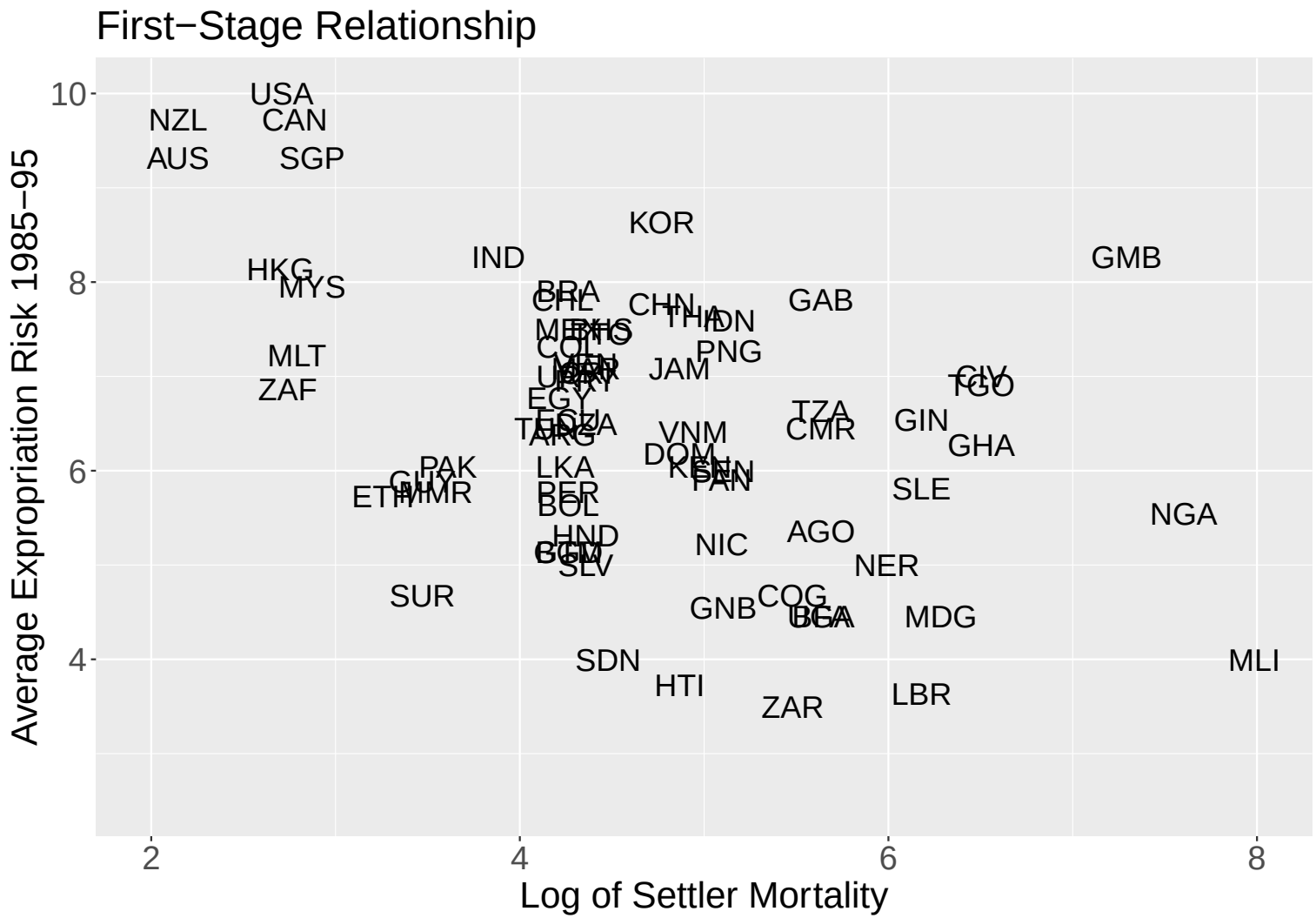
```

Scatterplot

Working with axes



Scatterplot

Overlaying linear fit

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
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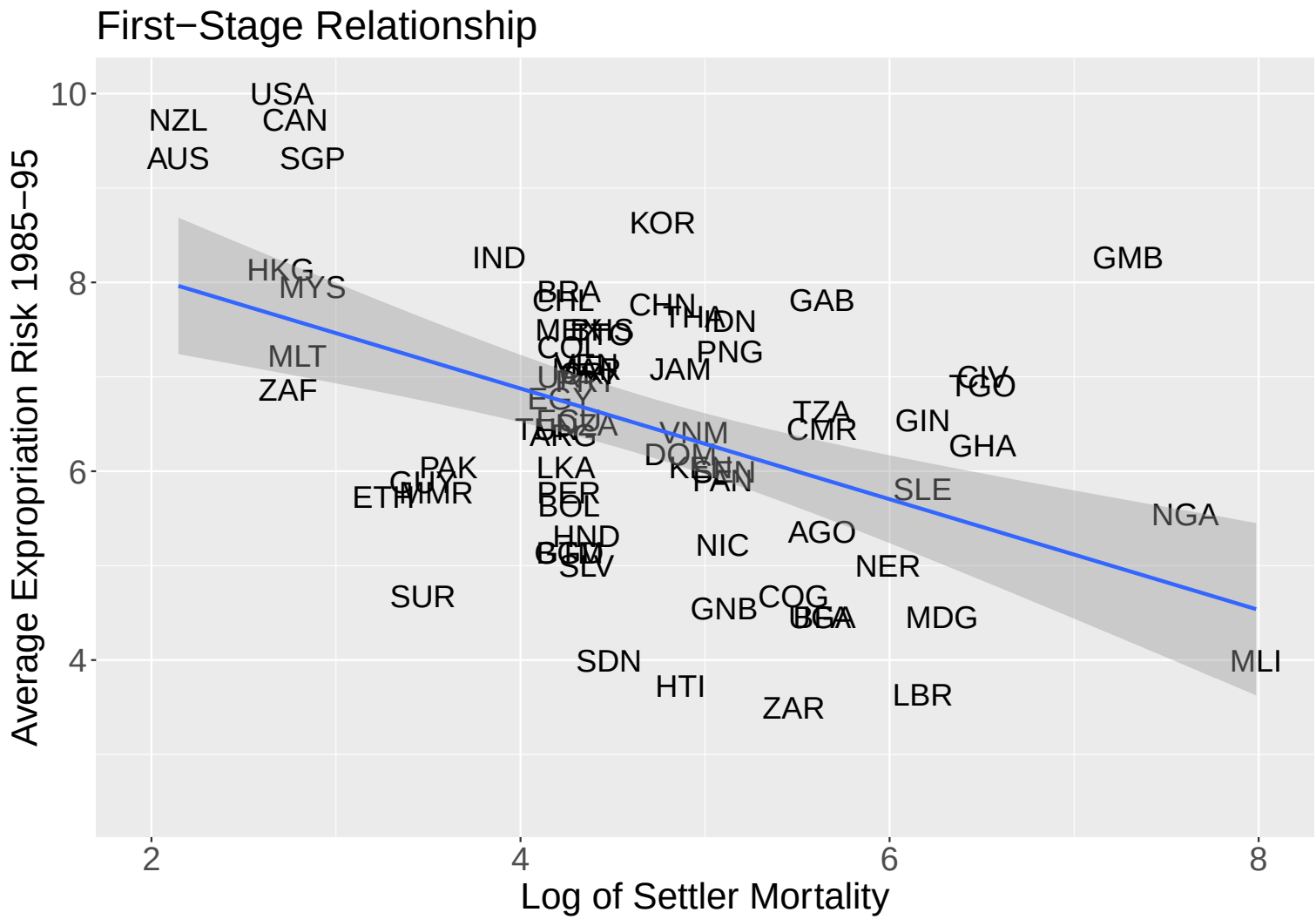
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18)) +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm)
```

Scatterplot

Overlaying linear fit



Scatterplot

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ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
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  scale_y_continuous(limits = c(2.5, 10),
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  geom_smooth(method = lm, se = FALSE)
```
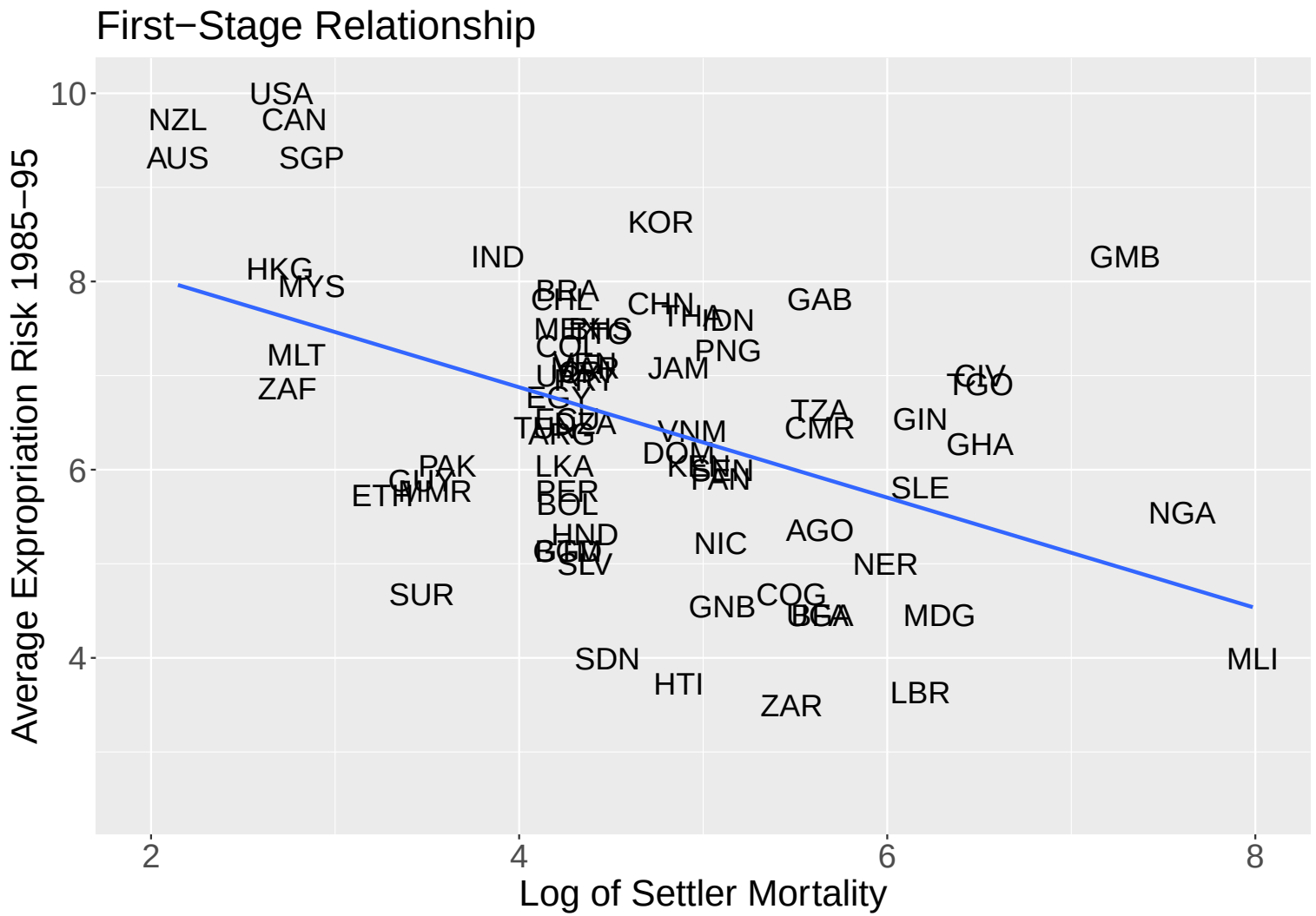

Scatterplot

Overlaying linear fit



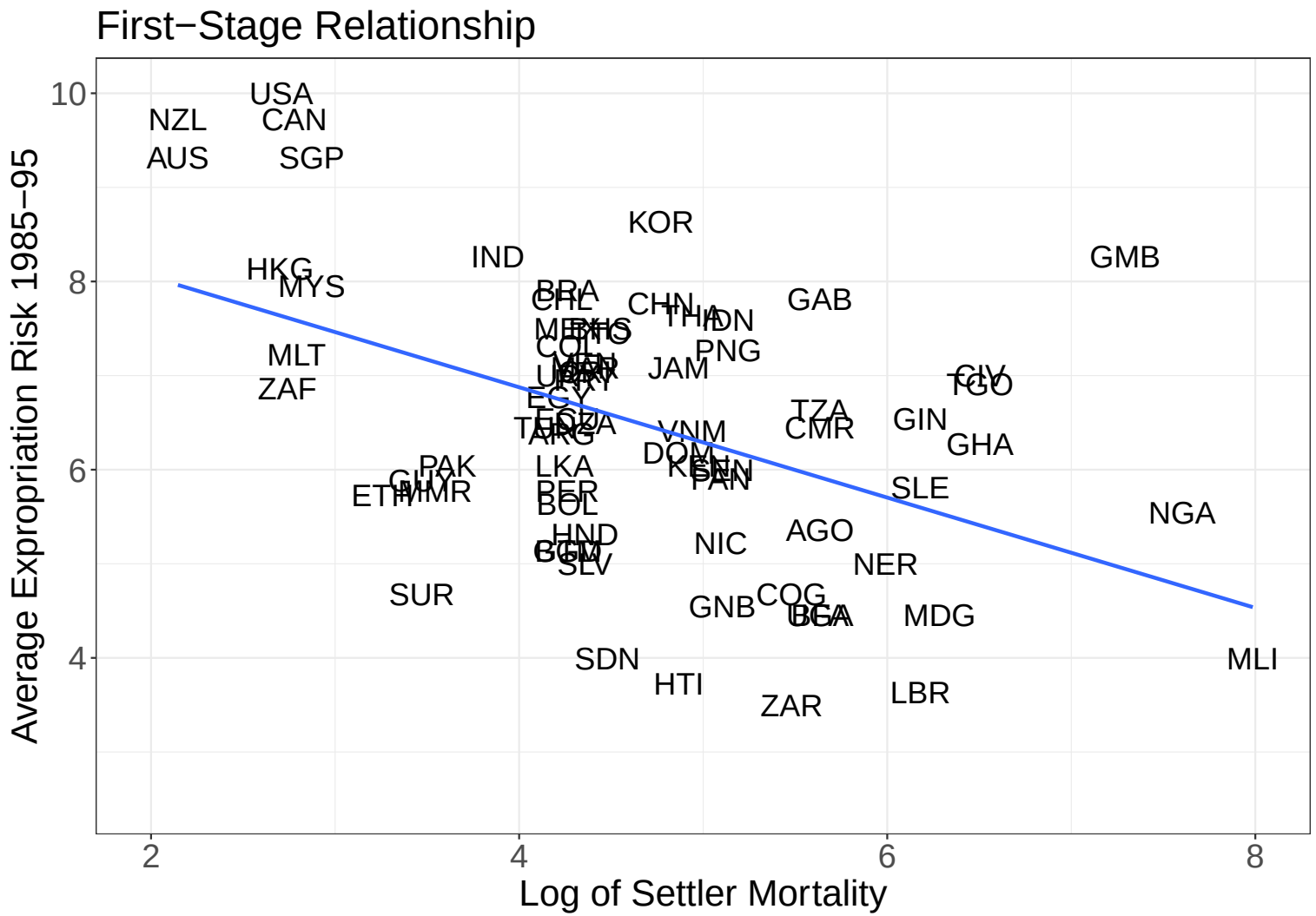
Scatterplot

Themes: `theme_bw()`

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Themes: `theme_bw()`



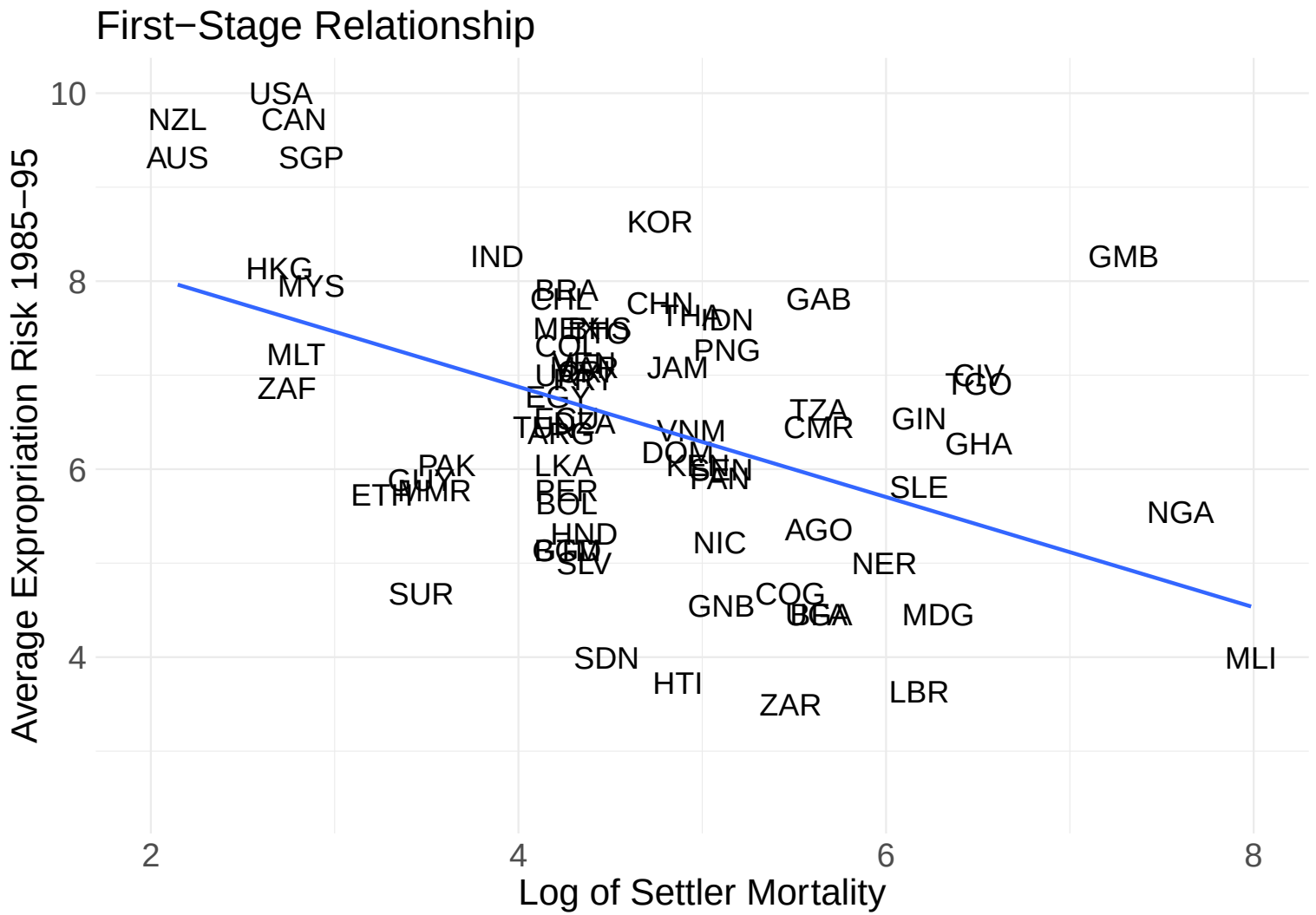
Scatterplot

Themes: `theme_minimal()`

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_minimal() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Themes: `theme_minimal()`



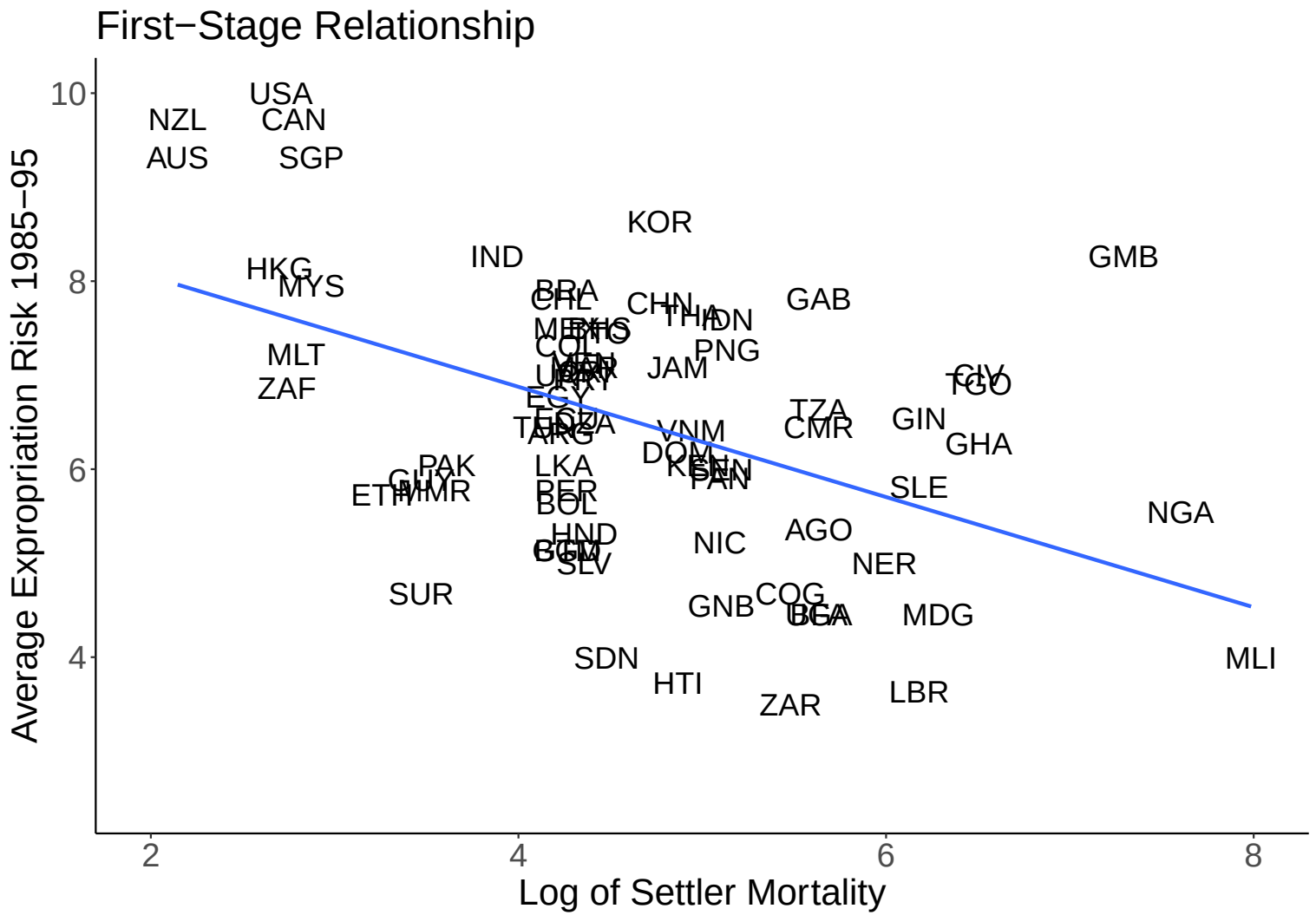
Scatterplot

Themes: `theme_classic()`

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_classic() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Themes: `theme_classic()`



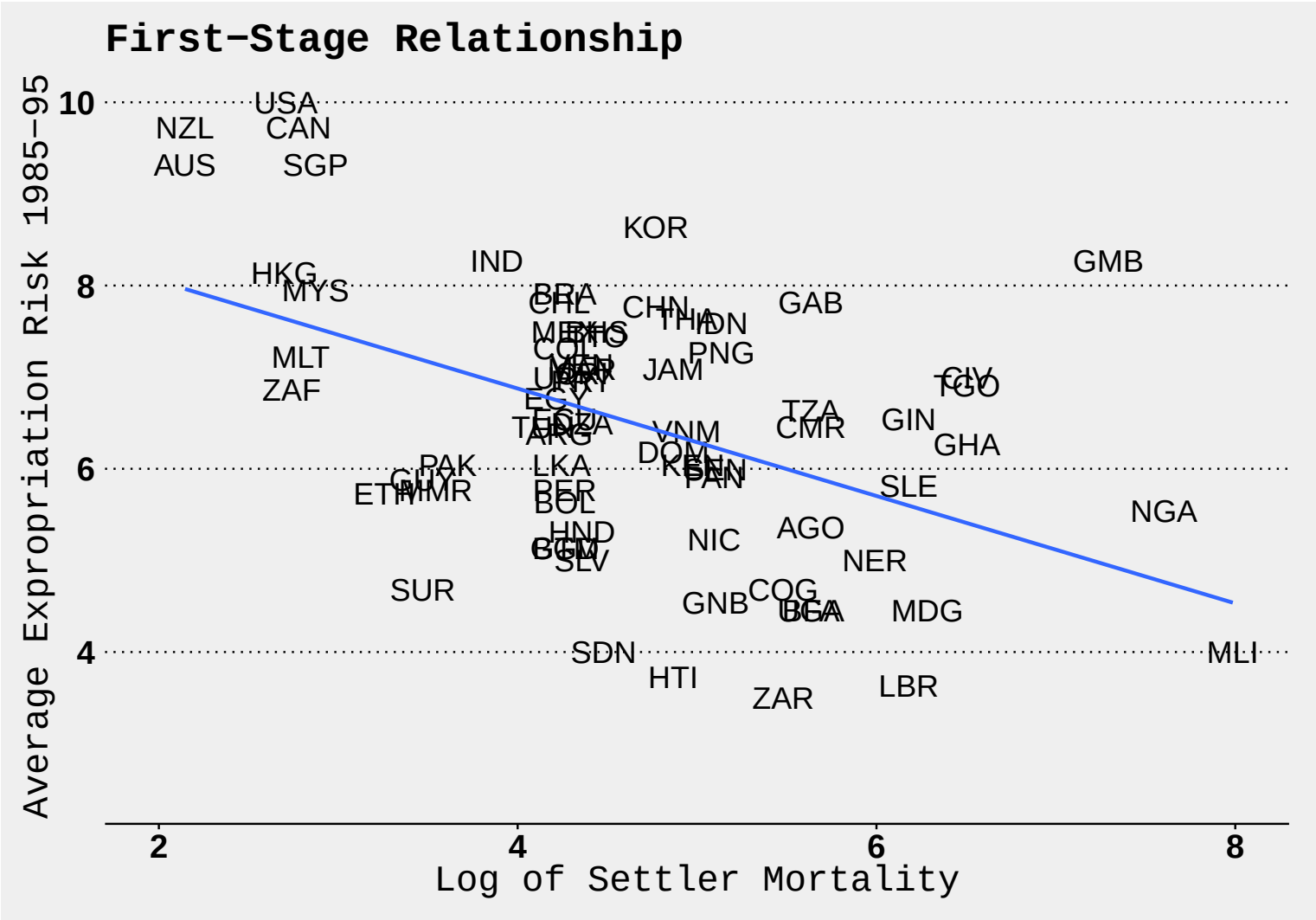
Scatterplot

Themes: `theme_wsj()`

```
library(ggthemes)

ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_wsj(color='gray') +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Themes: `theme_wsj()`



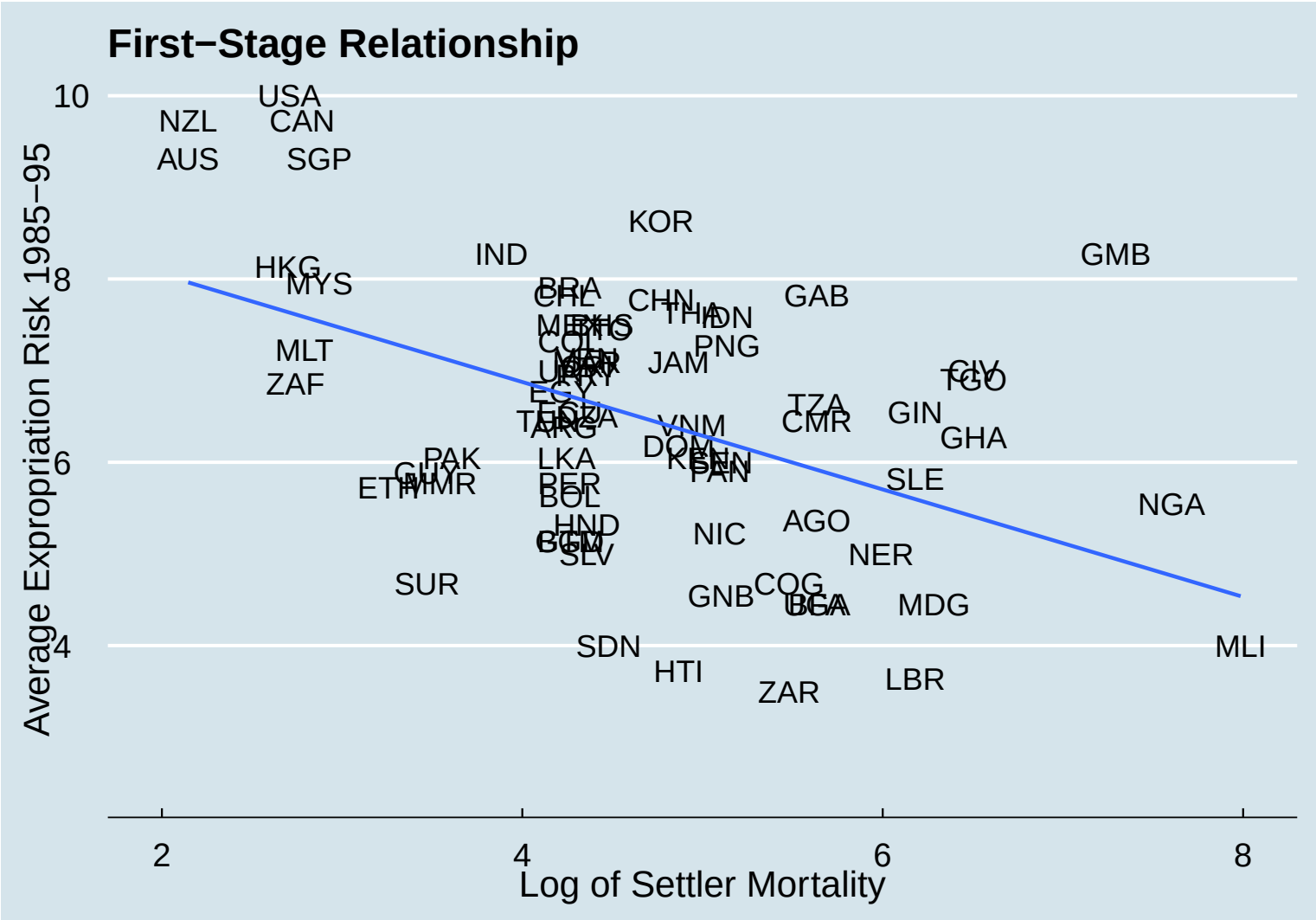
Scatterplot

Themes: `theme_economist()`

```
ggplot(data = df, aes(x = logem4, y = avexpr, label = shortnam)) +
  geom_text(size = 6) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_economist() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Themes: `theme_economist()`



Scatterplot

Annotating

```
p = ggplot(data = df, aes(x = logem4, y = avexpr)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  geom_smooth(method = lm, se = FALSE) +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

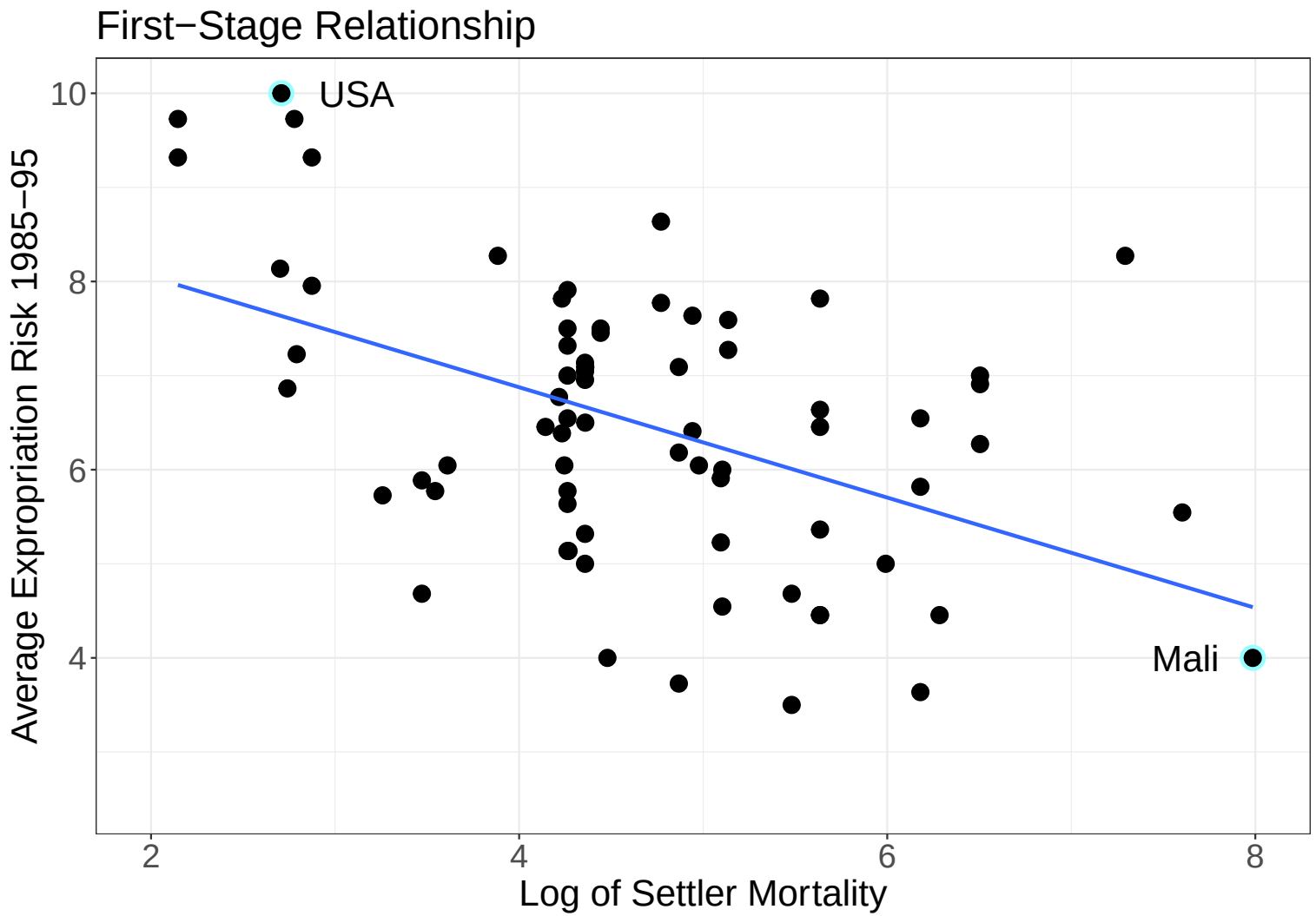
Scatterplot

Annotating

```
usa = df %>% filter(shortnam == "USA") %>%
  select(avexpr, logem4) %>% unlist()
mali = df %>% filter(shortnam == "MLI") %>%
  select(avexpr, logem4) %>% unlist()

p +
  # USA
  annotate(geom = "point", x = usa["logem4"], y = usa["avexpr"],
           colour = "darkslategray1", size = 8) +
  annotate(geom = "point", x = usa["logem4"], y = usa["avexpr"],
           size = 4) +
  annotate(geom = "text", x = usa["logem4"], y = usa["avexpr"],
           label = "USA", size = 7, hjust = -0.5) +
  # Mali
  annotate(geom = "point", x = mali["logem4"], y = mali["avexpr"],
           colour = "darkslategray1", size = 8) +
  annotate(geom = "point", x = mali["logem4"], y = mali["avexpr"],
           size = 4) +
  annotate(geom = "text", x = mali["logem4"], y = mali["avexpr"],
           label = "Mali", size = 7, hjust = 1.5)
```

Scatterplot

Annotating



Scatterplot

Coloring by group

```
ggplot(data = df, aes(x = logem4, y = avexpr,
                      color = f_brit)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Scatterplot

Coloring by group

Scatterplot

Coloring by group

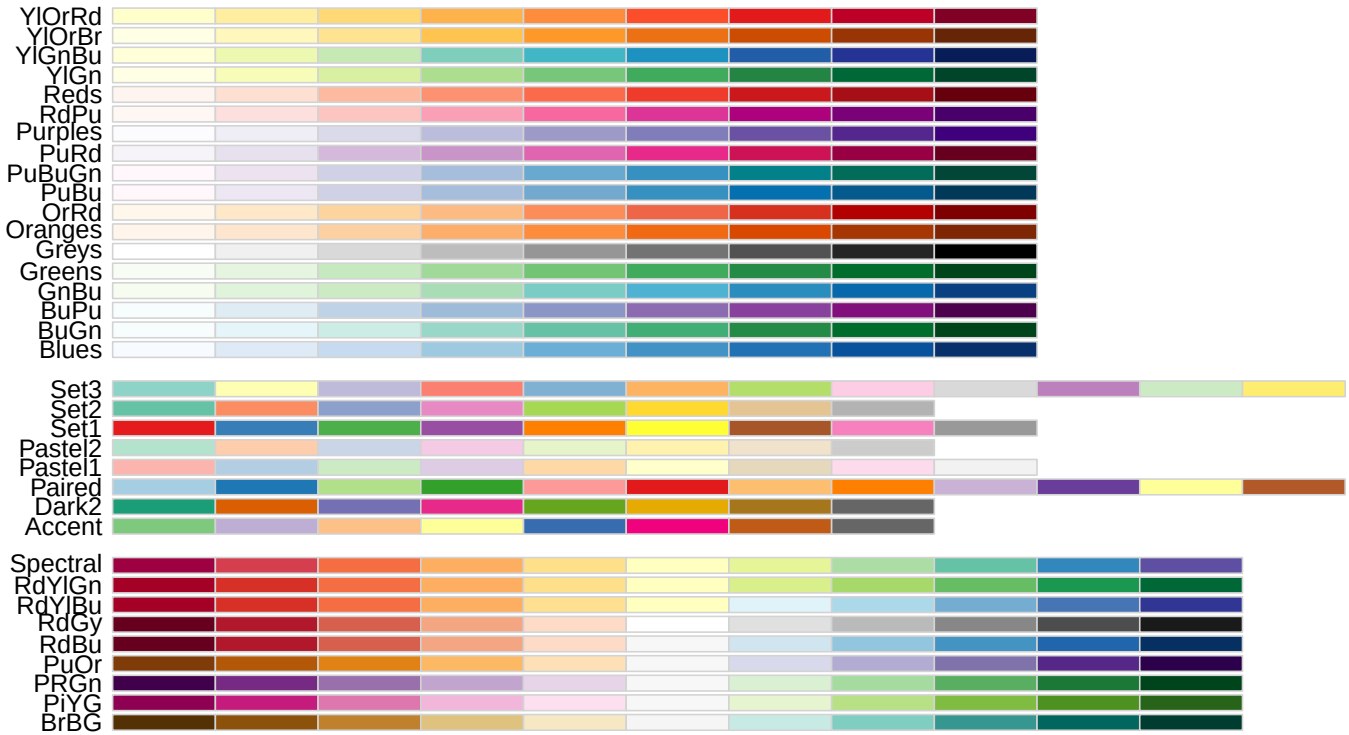
```
ggplot(data = df %>% filter(is.na(f_brit) == FALSE),
       aes(x = logem4, y = avexpr, color = f_brit)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  # MANUAL
  scale_color_manual(
    name = "British colony", # ADDS LEGEND TITLE
    values = c("0" = "red", "1" = "blue")) +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Scatterplot

Coloring by group

RColorBrewer

```
RColorBrewer::display.brewer.all()
```



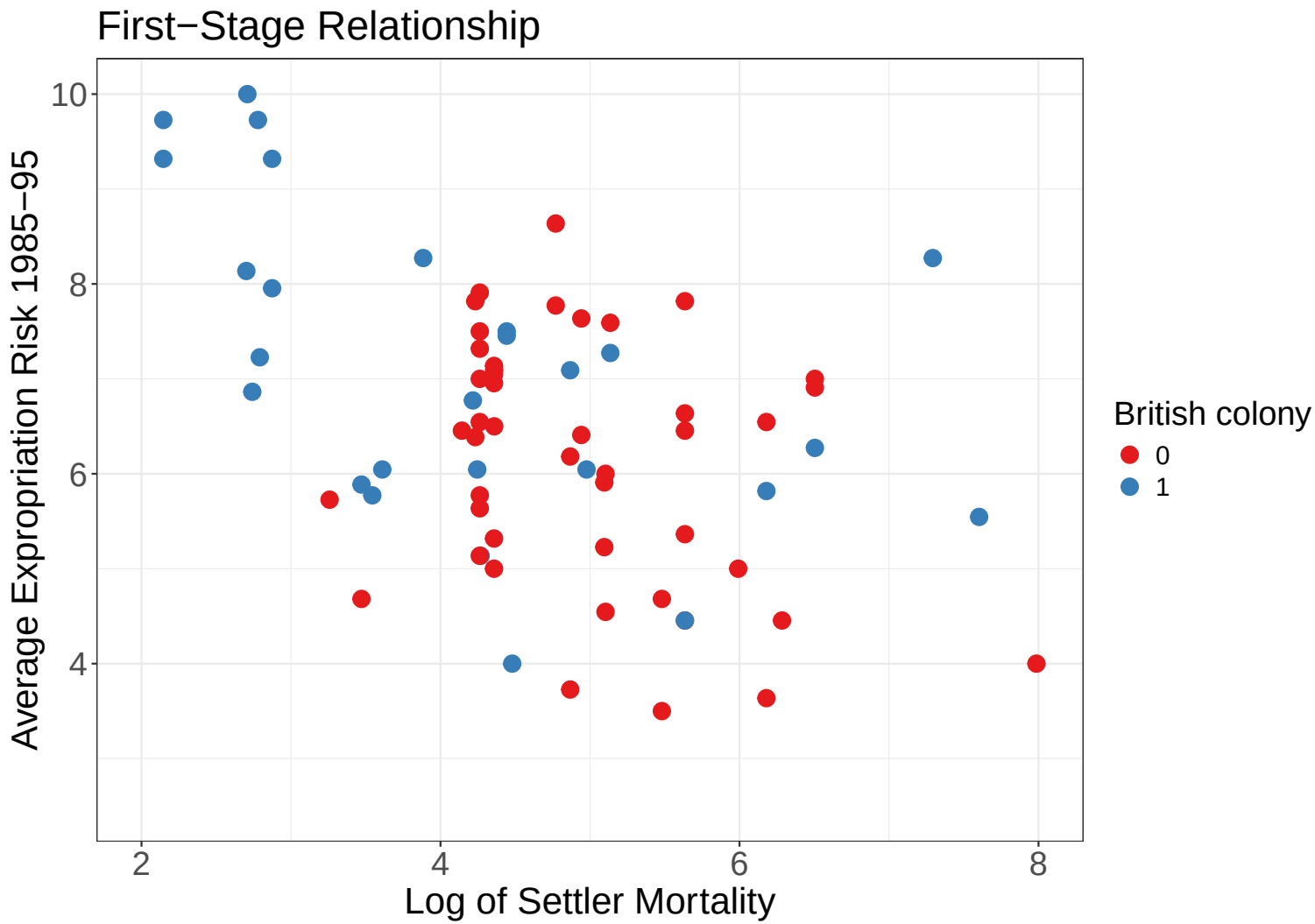
Scatterplot

Coloring by group

```
ggplot(data = df %>% filter(is.na(f_brit) == FALSE),
       aes(x = logem4, y = avexpr, color = f_brit)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  # BREWER
  scale_color_brewer(name = "British colony",
                     palette = "Set1") +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Scatterplot

Coloring by group



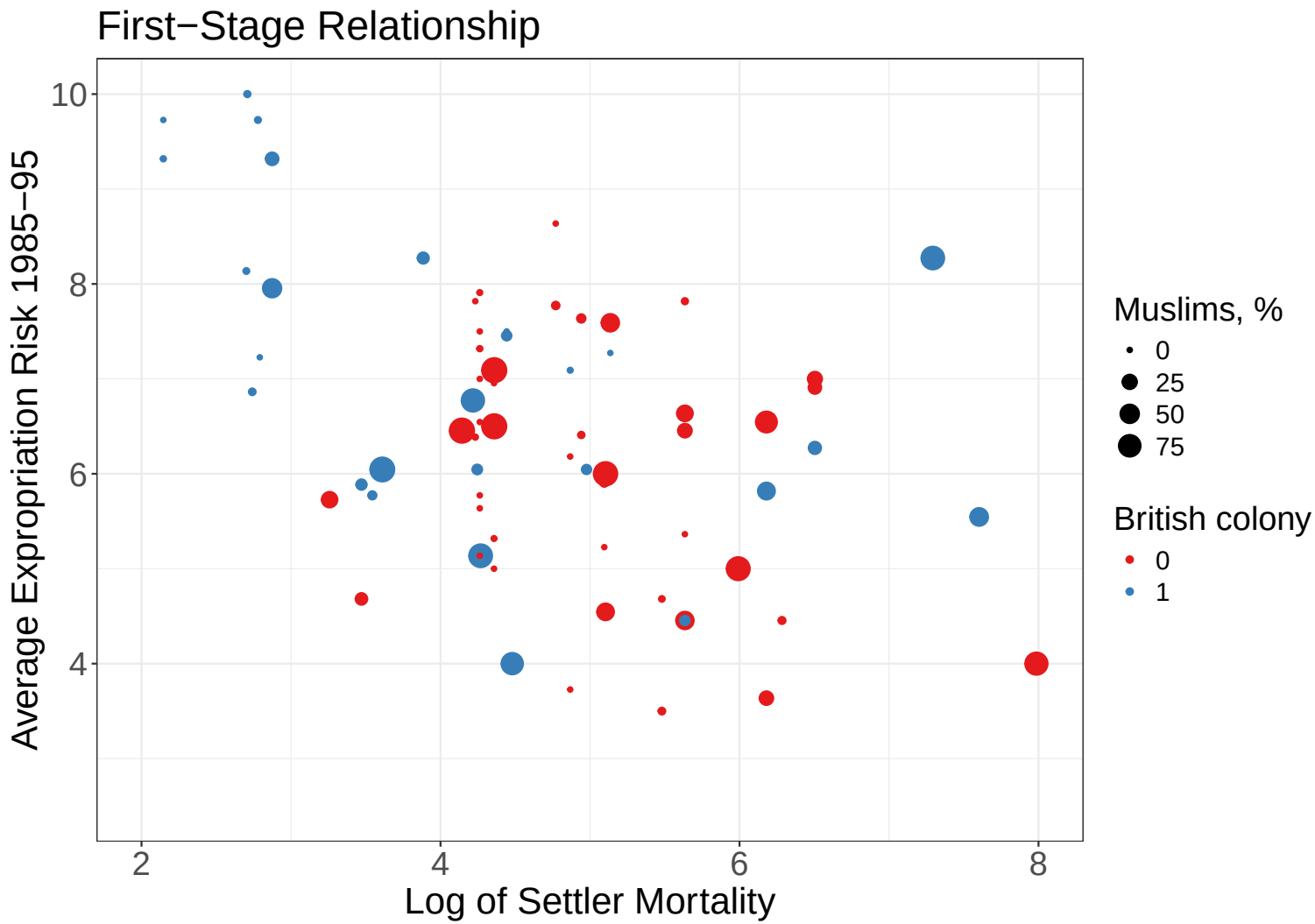
Scatterplot

Size by value

```
ggplot(data = df %>% filter(is.na(f_brit) == FALSE),
       aes(x = logem4, y = avexpr,
           color = f_brit, size = muslim80)) +
  geom_point() +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  scale_color_brewer(name = "British colony",
                     palette = "Set1") +
  scale_size_continuous(name = "Muslims, %") +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Scatterplot

Size by value



Scatterplot

Faceting

- Faceting generates and displays subsets of data defined by a categorical variable (or combination of multiple categorical variables)
- To create a faceted plot, you need to add a new layer with `facet_wrap()`
  - Specify a name of a grouping variable after the~ sign
- Faceted plots are displayed in a table
  - You can control the number of rows and columns using the `nrow` and `ncol` arguments
  - `dir` controls the direction of wrap: `"h"` for horizontal or `"v"` for vertical

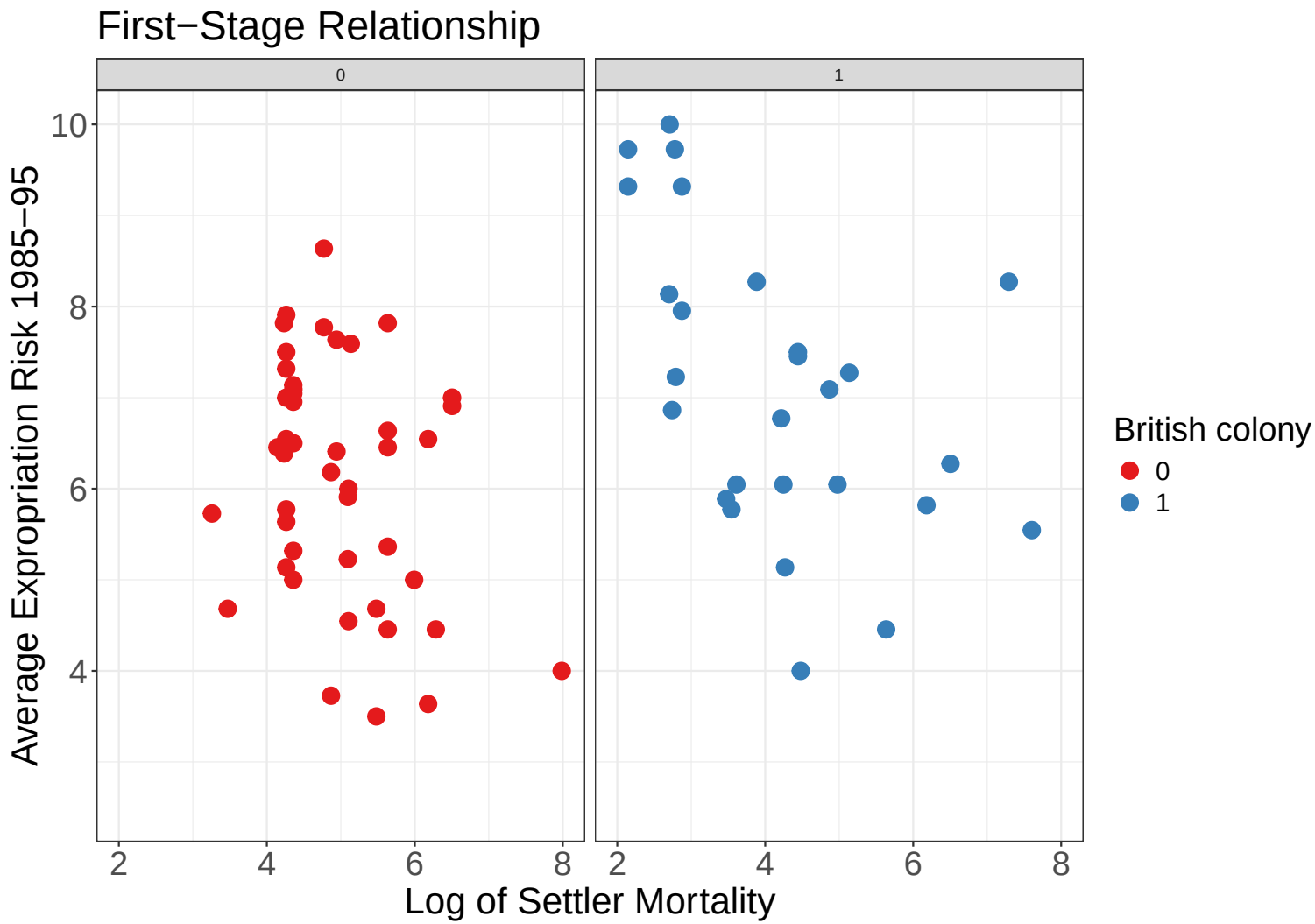
Scatterplot

Faceting

```
ggplot(data = df %>% filter(is.na(f_brit) == FALSE),
       aes(x = logem4, y = avexpr,
           color = f_brit)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  scale_color_brewer(name = "British colony",
                     palette = "Set1") +
  scale_size_continuous(name = "Muslims, %") +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14)) +
  facet_wrap(~factor(f_brit))
```

Scatterplot

Faceting



Scatterplot

Positioning a legend

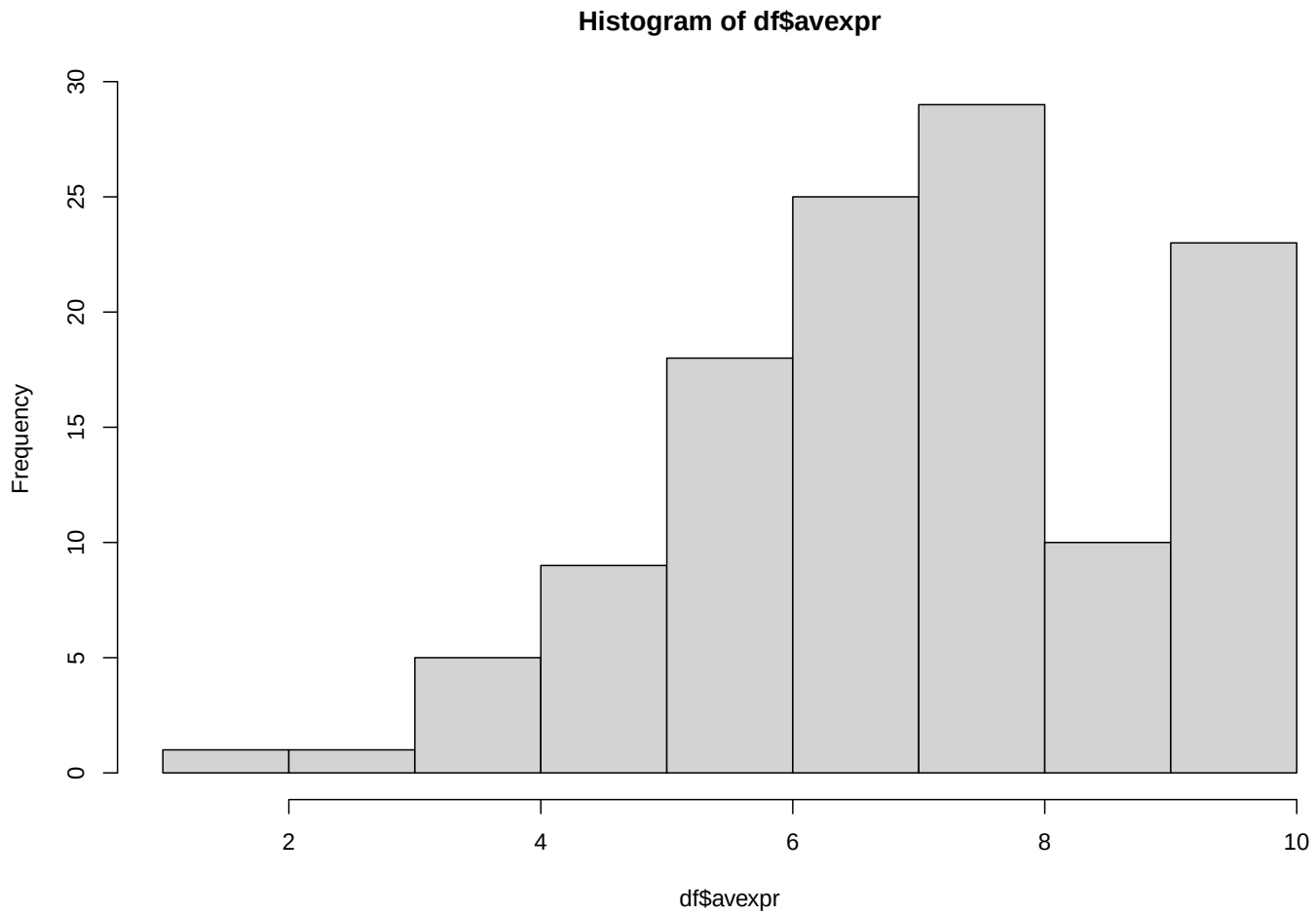
```
ggplot(data = df %>% filter(is.na(f_brit) == FALSE),
       aes(x = logem4, y = avexpr, color = f_brit)) +
  geom_point(size = 4) +
  labs(x = "Log of Settler Mortality",
       y = "Average Expropriation Risk 1985-95",
       title = "First-Stage Relationship") +
  scale_x_continuous(limits = c(2, 8)) +
  scale_y_continuous(limits = c(2.5, 10),
                     breaks = c(4, 6, 8, 10)) +
  scale_color_brewer(name = "British colony",
                     palette = "Set1") +
  scale_size_continuous(name = "Muslims, %") +
  theme_bw() +
  theme(plot.title = element_text(size = 22),
        axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14)) +
  facet_wrap(~factor(f_brit)) +
  theme(legend.position = "bottom")
```

Scatterplot

Positioning a legend

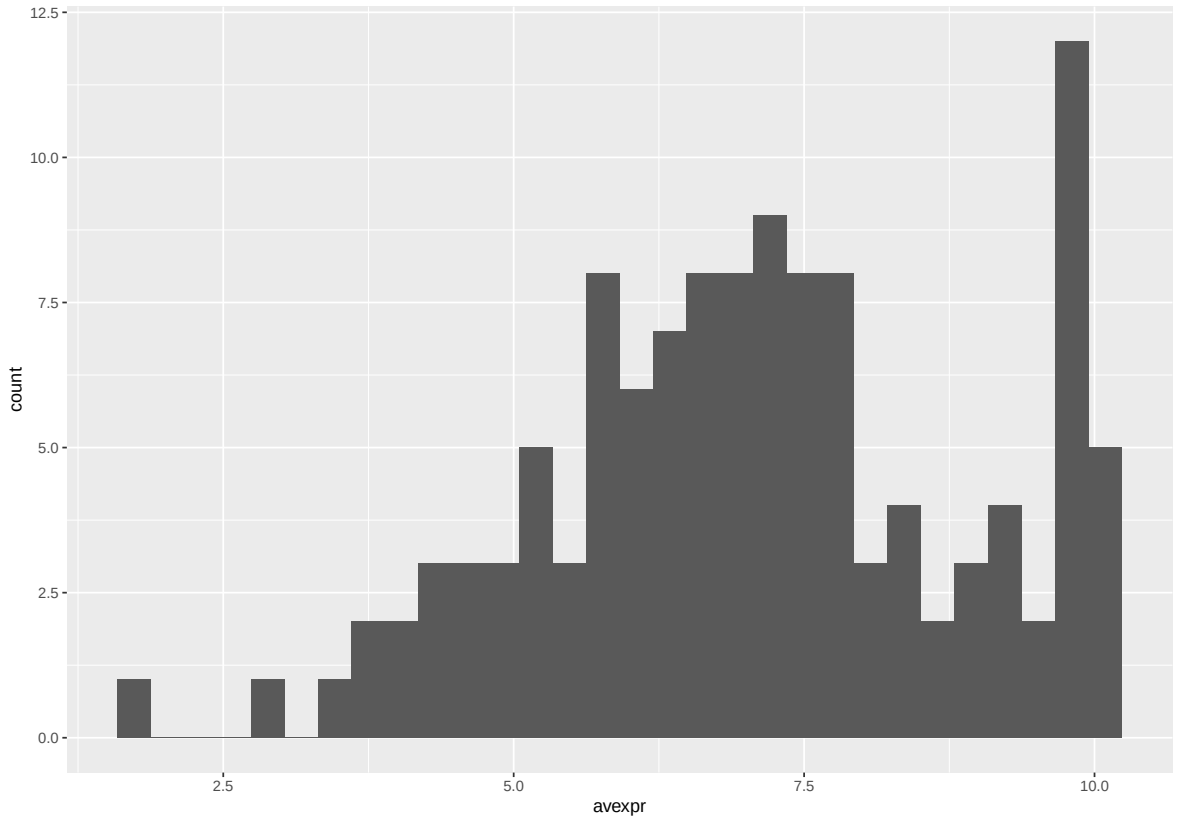
Histogram in base R

```
hist(df$avexpr)
```



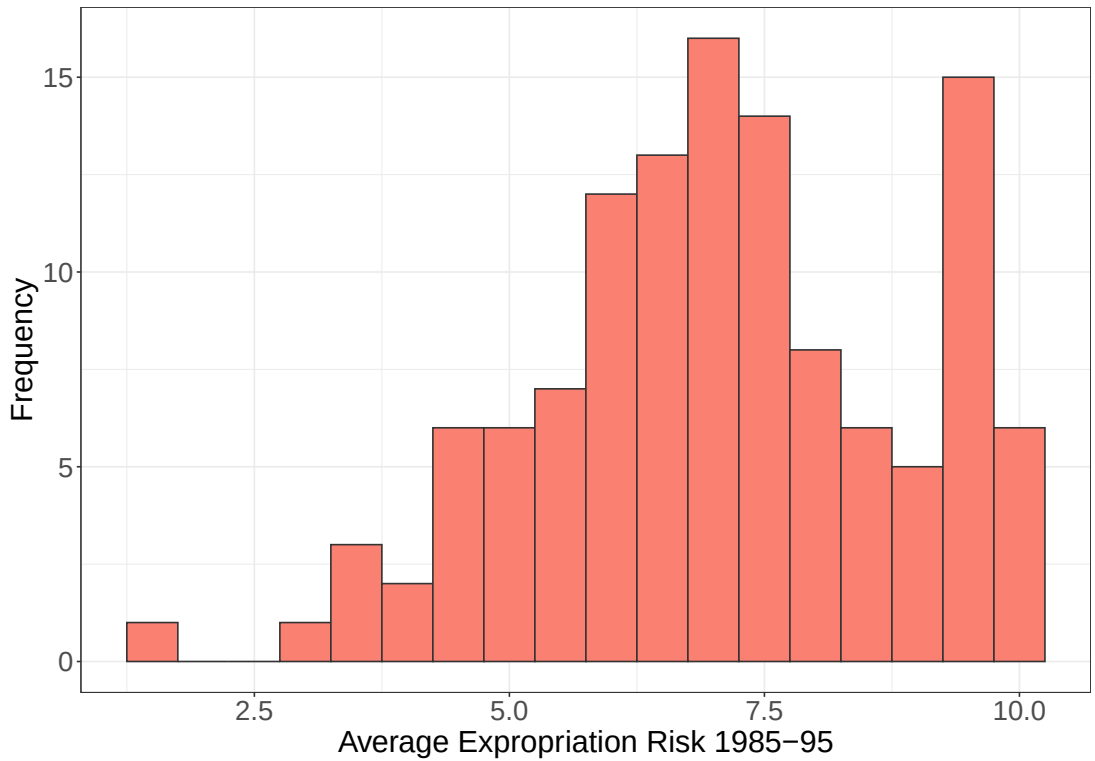
Histogram

```
ggplot(data = df, aes(x = avexpr)) +
  geom_histogram()
```



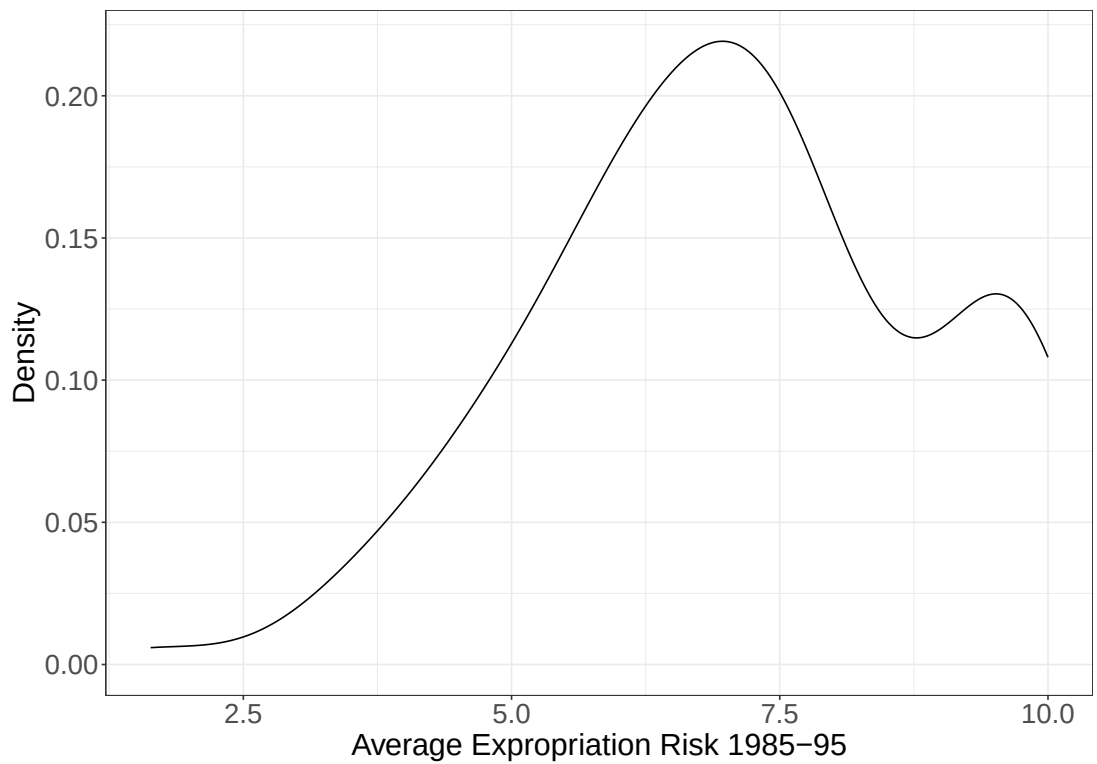
Histogram

```
ggplot(data = df, aes(x = avexpr)) +
  geom_histogram(binwidth = 0.5, fill = "salmon", color = "gray20") +
  labs(x = "Average Expropriation Risk 1985-95", y = "Frequency") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```



Density plot

```
ggplot(data = df, aes(x = avexpr)) +
  geom_density() +
  labs(x = "Average Expropriation Risk 1985-95", y = "Density") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```



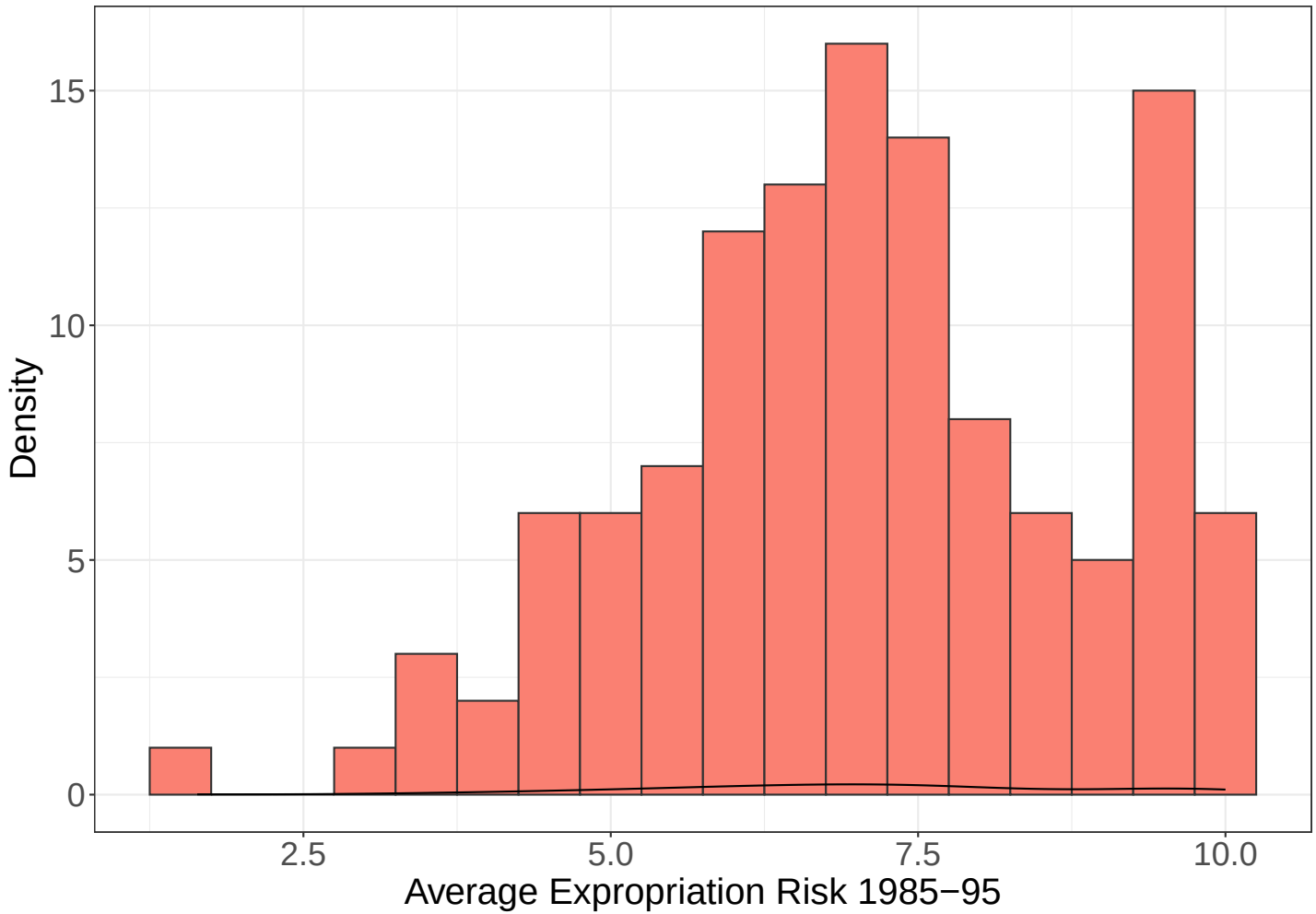
Overlaying histogram and density

We have a problem

```
ggplot(data = df, aes(x = avexpr)) +
  geom_histogram(binwidth = 0.5, fill = "salmon", color = "gray20") +
  geom_density() +
  labs(x = "Average Expropriation Risk 1985-95", y = "Density") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Overlaying histogram and density

We have a problem



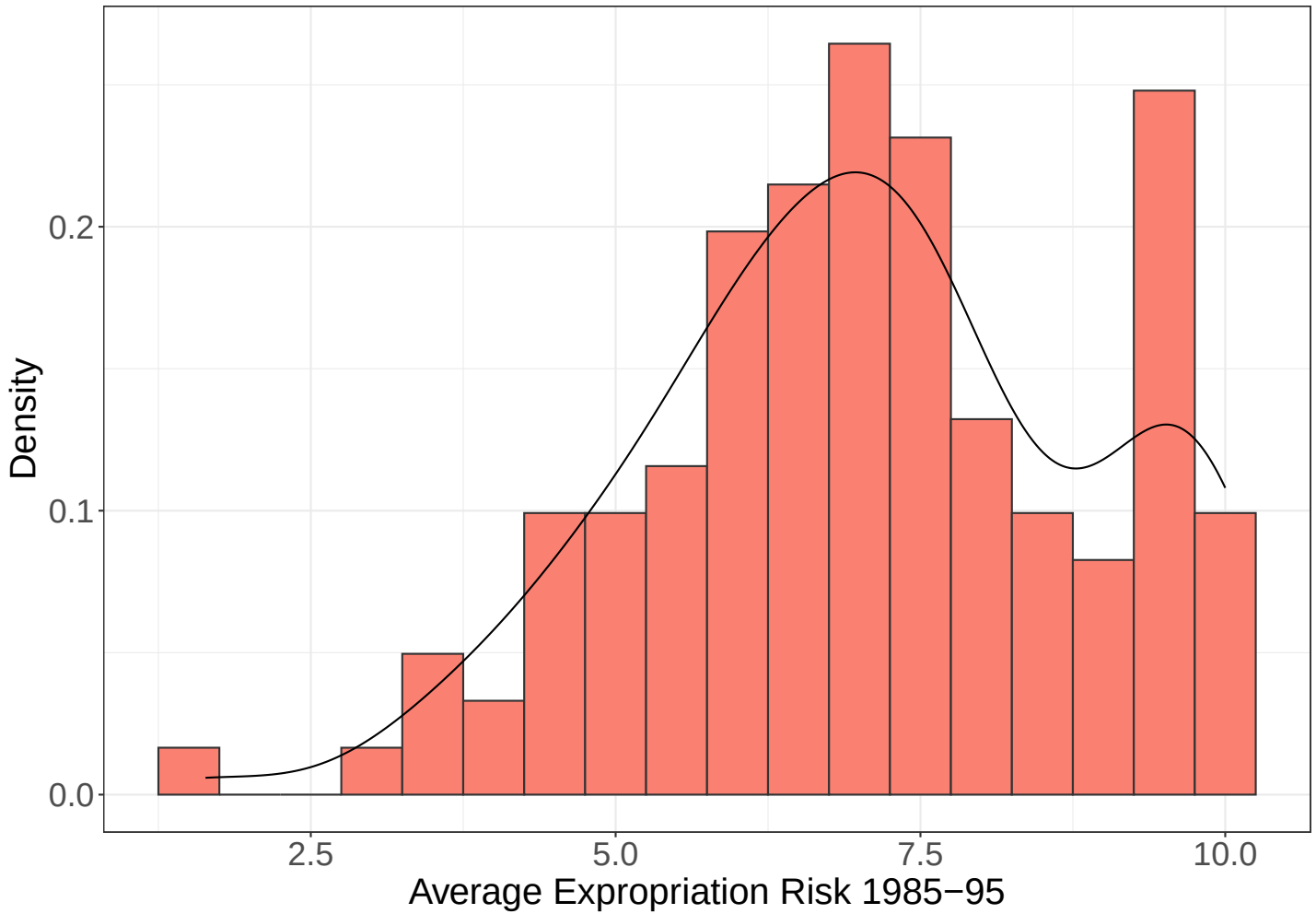
Overlaying histogram and density

Updating y-axis

```
ggplot(data = df, aes(x = avexpr, y = after_stat(density))) +
  geom_histogram(binwidth = 0.5, fill = "salmon", color = "gray20") +
  geom_density() +
  labs(x = "Average Expropriation Risk 1985-95", y = "Density") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18))
```

Overlaying histogram and density

Updating y-axis



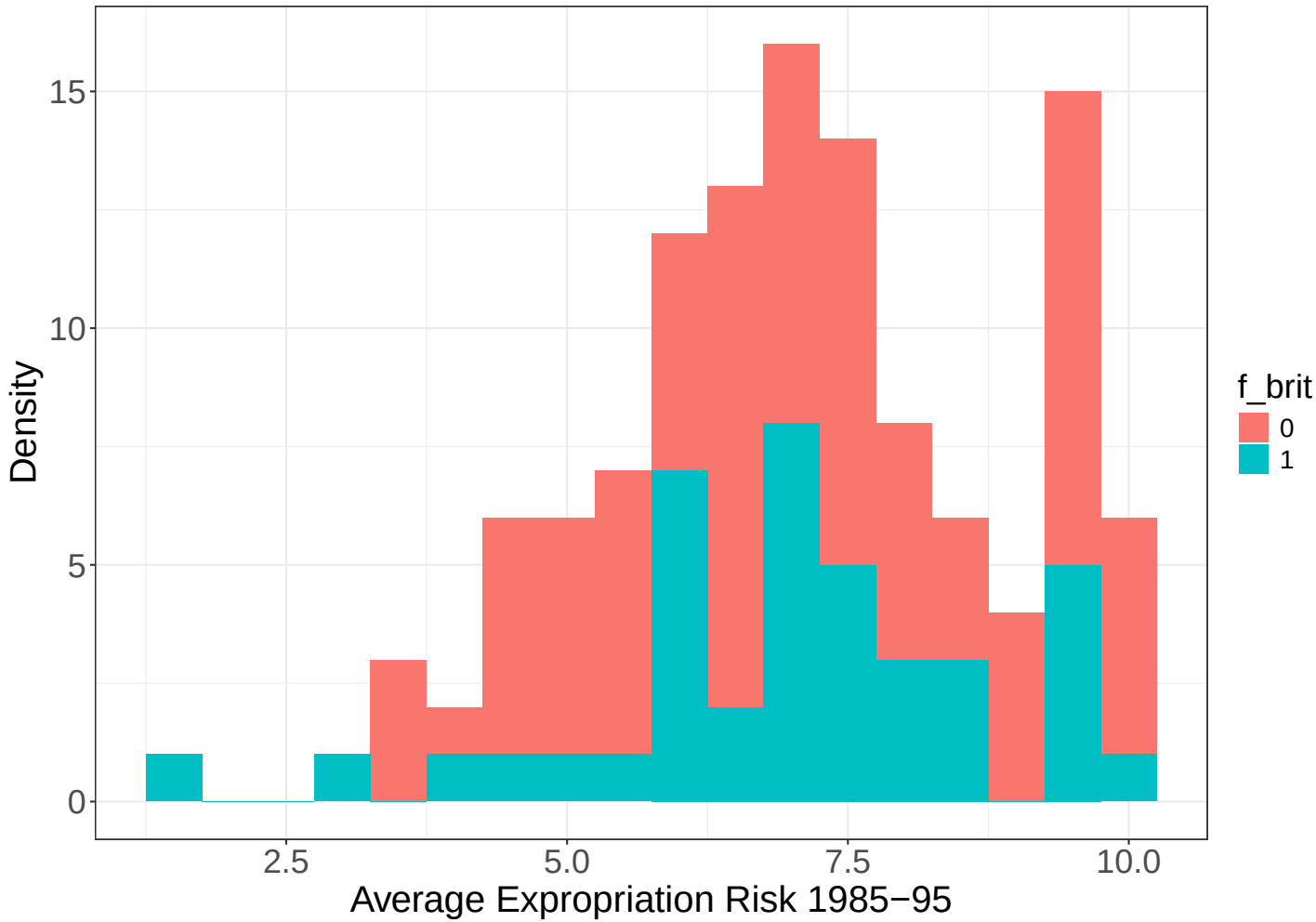
Histogram

Color by group

```
ggplot(data = df %>% filter(is.na(f_brit) == F),
       aes(x = avexpr, fill = f_brit)) +
  geom_histogram(binwidth = 0.5) +
  labs(x = "Average Expropriation Risk 1985-95", y = "Density") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Histogram

Color by group



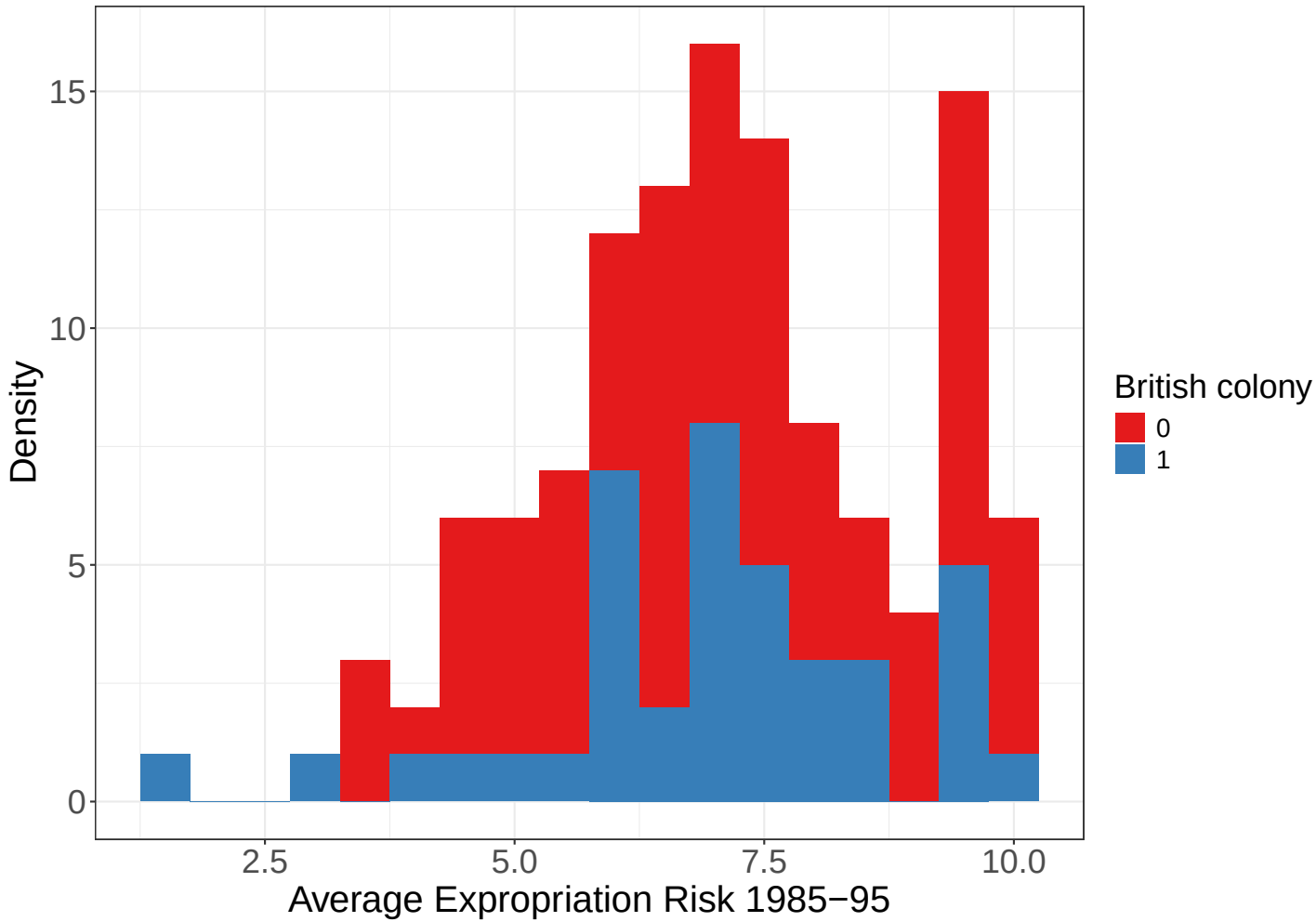
Histogram

Color by group

```
ggplot(data = df %>% filter(is.na(f_brit) == F),
       aes(x = avexpr, fill = f_brit)) +
  geom_histogram(binwidth = 0.5) +
  scale_fill_brewer(name = "British colony",
                    palette = "Set1") +
  labs(x = "Average Expropriation Risk 1985-95", y = "Density") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Histogram

Color by group



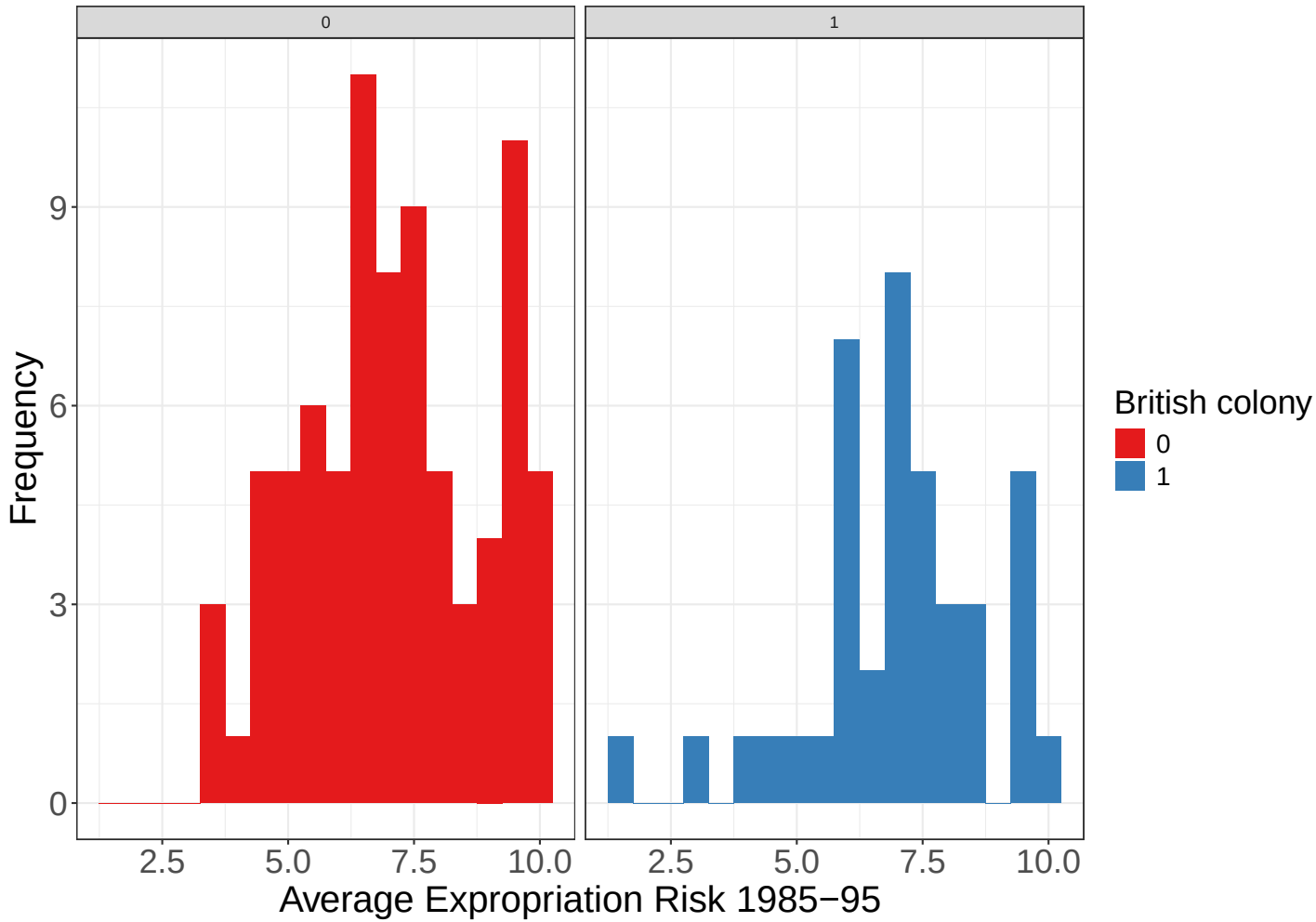
Histogram

Faceting

```
ggplot(data = df %>% filter(is.na(f_brit) == F),
       aes(x = avexpr, fill = f_brit)) +
  geom_histogram(binwidth = 0.5) +
  scale_fill_brewer(name = "British colony",
                    palette = "Set1") +
  labs(x = "Average Expropriation Risk 1985-95", y = "Frequency") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14)) +
  facet_wrap(~f_brit)
```

Histogram

Faceting



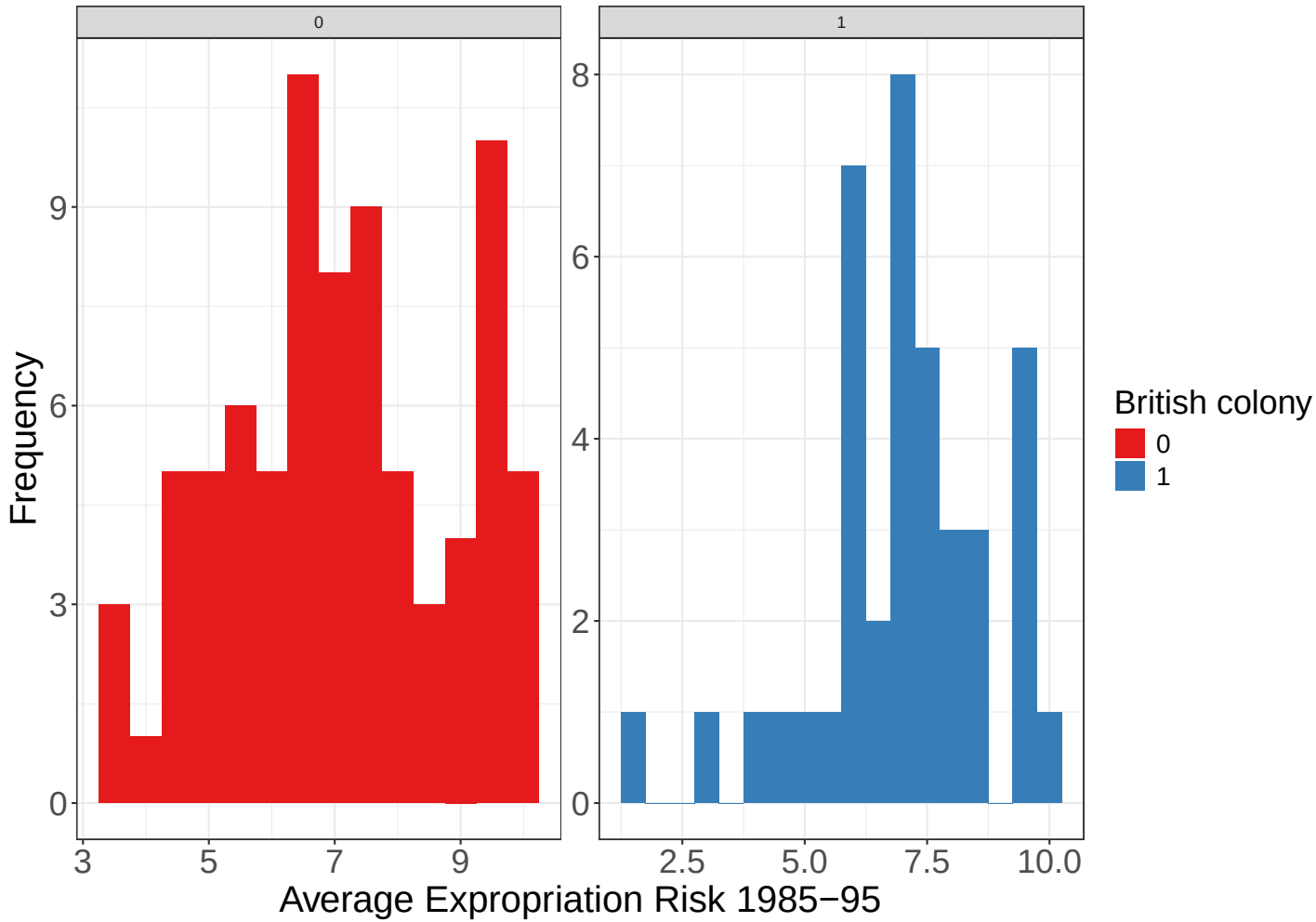
Histogram

Controlling scales

```
ggplot(data = df %>% filter(is.na(f_brit) == F),
       aes(x = avexpr, fill = factor(f_brit))) +
  geom_histogram(binwidth = 0.5) +
  scale_fill_brewer(name = "British colony",
                    palette = "Set1") +
  labs(x = "Average Expropriation Risk 1985-95", y = "Frequency") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14)) +
  facet_wrap(~f_brit, scales = "free")
```

Histogram

Controlling scales



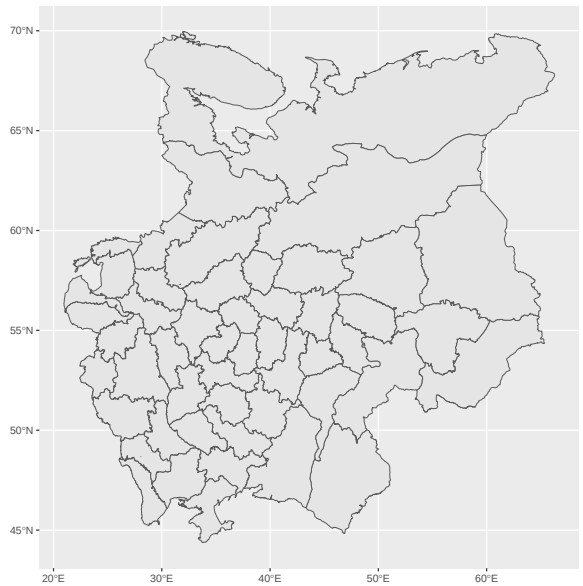
Intro to maps

- A lot of social processes have a spatial dimension
  - *Everything is related to everything else, but near things are more related than distant things*
  - Visualizing data in space might be really illuminating
- To plot a map, you need a file that contains the coordinates of objects you want to display (it is usually called a shapefile)
- Use `st_read()` from the `sf` package to load a shapefile in R
- In `ggplot2`, use `geom_sf()` to add a map layer

Intro to maps

```
library(sf)
re = st_read("re/re.shp")
```

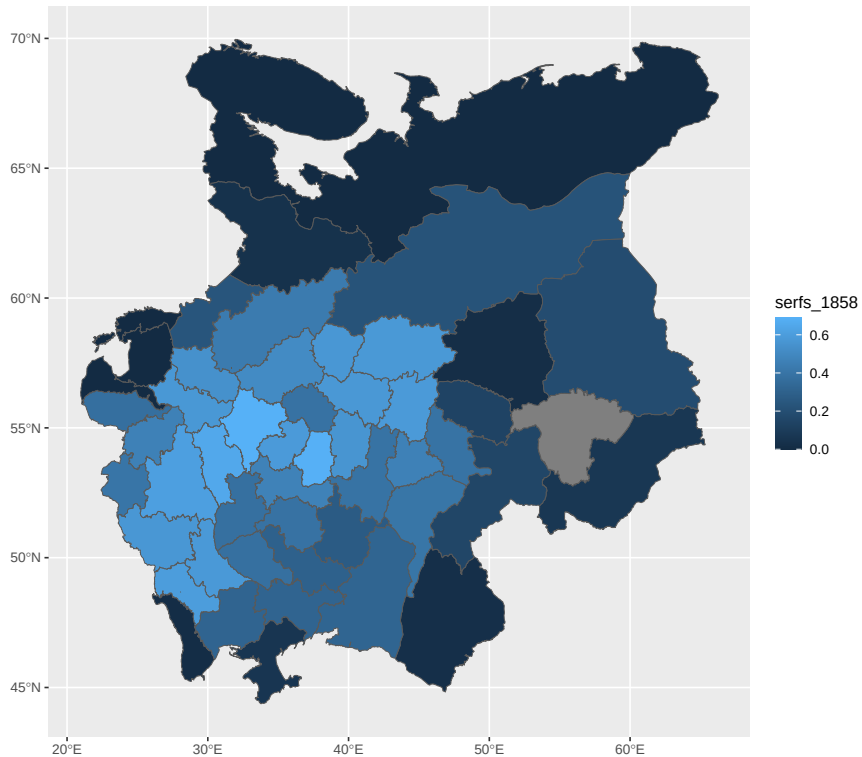
```
ggplot(data = re) +
  geom_sf()
```



Intro to maps

Coloring a map

```
ggplot(data = re, aes(fill = serfs_1858)) +
  geom_sf()
```



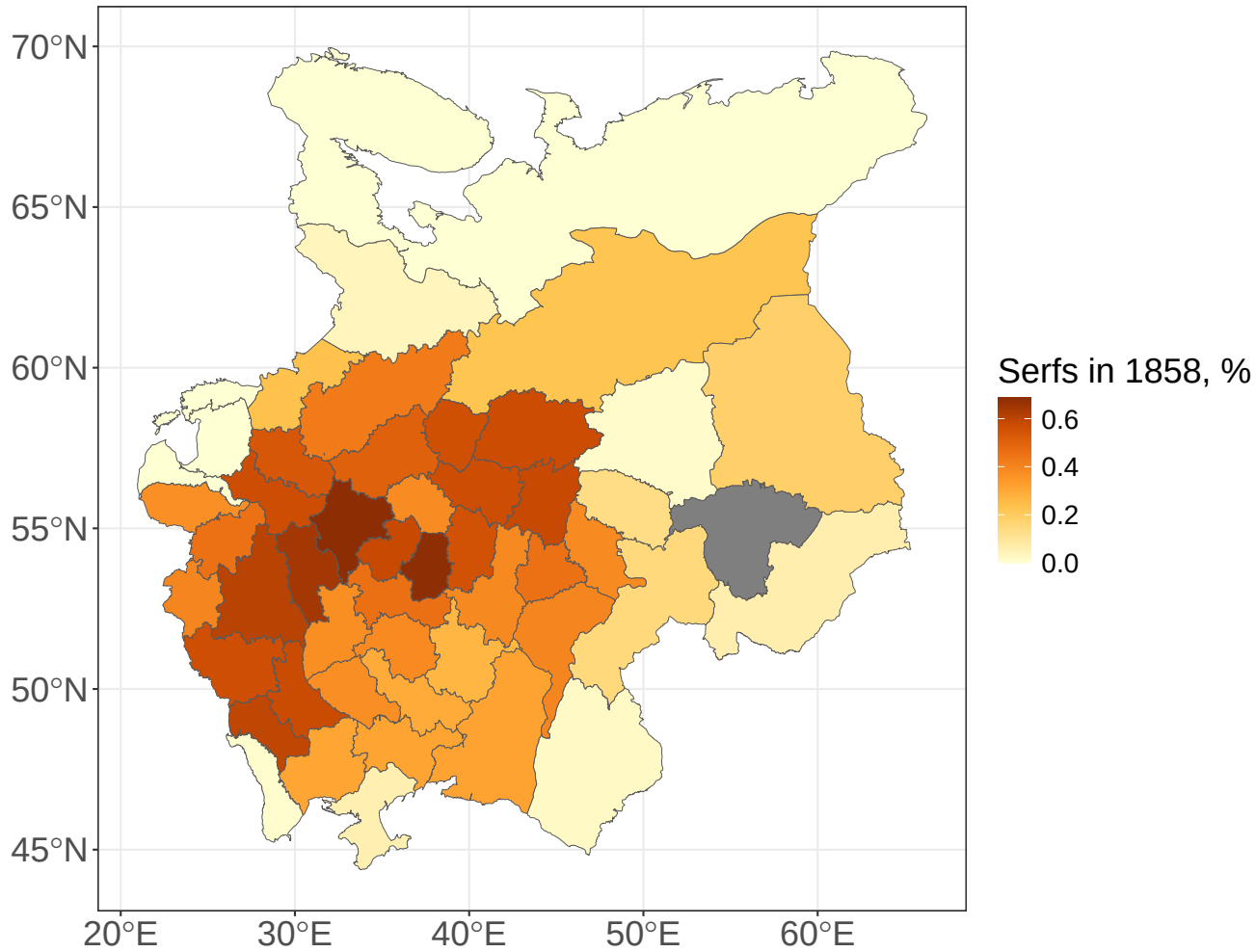
Intro to maps

Customizing a map

```
ggplot(data = re, aes(fill = serfs_1858)) +
  geom_sf() +
  scale_fill_distiller(palette = "YlOrBr",
                       direction = 1,
                       name = "Serfs in 1858, %") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 20),
        axis.title.y = element_text(size = 20),
        axis.text.x = element_text(size = 18),
        axis.text.y = element_text(size = 18),
        legend.title = element_text(size = 18),
        legend.text = element_text(size = 14))
```

Intro to maps

Customizing a map



Exporting a plot

```
ggplot(data = re, aes(fill = serfs_1858)) +
  geom_sf()
ggsave("my-first-map.pdf")
```

Activity

1. Plot a histogram of settler mortality rates (`logem4`). Set `binwidth` equal to 1. Label axes and customize colors. Examine the histograms of settler mortality rates across British and non-British colonies.
   - Here you can access the list of colors available in R
2. Plot a scatterplot of settler mortality rates and the logarithm of GDP per capita in 1995 (`logpgp95`). Label points and add a regression line.
3. Build a boxplot of settler mortality rates setting `aes(y = logem4)` and adding `geom_boxplot()`
   - Suppose you want to zoom in on countries for which log mortality rates lie between 3 and 7 Set the limits of the y scale. What do you notice?
   - Now use `coord_cartesian(ylim = c(3, 7))` instead of setting the scale. What changes now?
   - Throughout the problem, you can also plot the median adding a layer with a horizontal line using `geom_hline(yintercept = median(df$logem4, na.rm = T))` (don't forget to change a color)

Further reads & useful resources

- Textbooks
  - Winston Chang, R Graphics Cookbook
  - Hadley Wickham, ggplot2: Elegant Graphics for Data Analysis
- Colors
  - Colors in R
  - Color palettes generator
- Maps
  - David Rumsey Map Center workshops
  - Look up shapefiles at Stanford EarthWorks