Regression

Henry Siegler

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```
library(tidyverse)
library(here)
library(tinytex)
library(estimatr)
library(texreg)
library(stargazer)
library(sandwich)


df <- read_csv(here("Cleaned_Data", "DATA.csv"))


df_nwerq <- read_csv(here("Cleaned_Data", "DATA3.csv"))
df %>%
  filter(state != "District of Columbia") %>%
  pull(total) %>%
  mean()
```

```
## [1] 9.402272
```

```
df_nwerq %>%
  filter(state != "District of Columbia") %>%
  pull(total) %>%
  mean()
```

```
## [1] 9.402272
```

```r
options(scipen = 99)

mod_total <- lm_robust(total ~ PDMP + avg_age + bachelors_pct + median_income
                       + unemp_rate + white_pct + personal_health_care + factor(year) + factor(state), data = df, se_type = "HC1")
```

```r
mod2_total <- lm(total ~ PDMP + avg_age + bachelors_pct + median_income
                       + unemp_rate + white_pct + personal_health_care +
            factor(year) + factor(state), data = df)

cov2_total <- vcovHC(mod2_total, type = "HC1")
robust_se2_total <- sqrt(diag(cov2_total))


mod1_total <- lm(total ~ PDMP + factor(year) + factor(state), data = df)
cov1_total <- vcovHC(mod1_total, type = "HC1")
robust_se1_total <- sqrt(diag(cov1_total))
```

```r
fe_vector <- c("Fixed Effects", "Yes", "Yes")
covariate_vector <- c("Covariates", "No", "Yes")


stargazer(mod1_total, mod2_total, type = "latex",
          se = list(robust_se1_total, robust_se2_total), omit = c("factor"),
          add.lines = list(fe_vector, covariate_vector),
          dep.var.caption = "Dependent Variable: Total Opioid Overdose Death Rate per 100,000",
          dep.var.labels.include = FALSE,
          covariate.labels = c("PDMP in Operation",
                               "Average Age",
                               "Percentage with Bachelor's Degree",
                               "Median Income",
                               "Unemployment Rate",
                               "Percentage that is White",
                               "Personal Healthcare Spending per Capita"))
```

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Table 1:

	Dependent Variable: Total Opioid Overdose Death Rate per 100,000	
	(1)	(2)
PDMP in Operation	−0.526	−0.795*
	(0.471)	(0.443)
Average Age		1.372***
		(0.424)
Percentage with Bachelor's Degree		1.196***
		(0.275)
Median Income		−0.049
		(0.045)
Unemployment Rate		−0.090
		(0.160)
Percentage that is White		0.190**
		(0.097)
Personal Healthcare Spending per Capita		2.997***
		(0.503)
Constant	−1.289*	−86.595***
	(0.683)	(16.531)
Fixed Effects	Yes	Yes
Covariates	No	Yes
Observations	1,071	1,071
R^2	0.721	0.764
Adjusted R^2	0.701	0.746
Residual Std. Error	4.240 (df = 999)	3.912 (df = 993)
F Statistic	36.363*** (df = 71; 999)	41.724*** (df = 77; 993)
Note:		*p<0.1; **p<0.05; ***p<0.01

HEROIN SYNTHETIC

```
mod <- lm_robust(heroin_synthetic ~ PDMP + avg_age + bachelors_pct + median_income
                        + unemp_rate + white_pct + personal_health_care +
                          factor(year) + factor(state), data = df, se_type = "HC1")
```

```
mod2_heroin <- lm(heroin_synthetic ~ PDMP + avg_age + bachelors_pct + median_income
                        + unemp_rate + white_pct + personal_health_care +
                      factor(year) + factor(state), data = df)

cov2_heroin <- vcovHC(mod2_heroin, type = "HC1")
robust_se2_heroin <- sqrt(diag(cov2_heroin))


mod1_heroin <- lm(heroin_synthetic ~ PDMP + factor(year) + factor(state), data = df)

cov1_heroin <- vcovHC(mod1_heroin, type = "HC1")
robust_se1_heroin <- sqrt(diag(cov1_heroin))
```

```
fe_vector <- c("Fixed Effects", "Yes", "Yes")
covariate_vector <- c("Covariates", "No", "Yes")


stargazer(mod1_heroin, mod2_heroin, type = "latex",
          se = list(robust_se1_heroin, robust_se2_heroin), omit = c("factor"),
          add.lines = list(fe_vector, covariate_vector),
          dep.var.caption = "Dependent Variable: Heroin and Synthetic Opioid Overdose Death Rate per 100,000",
          dep.var.labels.include = FALSE,
          covariate.labels = c("PDMP in Operation",
                               "Average Age",
                               "Percentage with Bachelor's Degree",
                               "Median Income",
                               "Unemployment Rate",
                               "Percentage that is White",
                               "Personal Healthcare Spending per Capita"))
```

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Table 2:

	Dependent Variable: Heroin and Synthetic Opioid Overdose Death Rate per 100,000	
	(1)	(2)
PDMP in Operation	−0.430	−0.728*
	(0.454)	(0.415)
Average Age		1.860***
		(0.399)
Percentage with Bachelor's Degree		1.624***
		(0.257)
Median Income		−0.021
		(0.045)
Unemployment Rate		0.005
		(0.143)
Percentage that is White		0.184*
		(0.096)
Personal Healthcare Spending per Capita		2.940***
		(0.542)
Constant	−1.400**	−111.298***
	(0.701)	(16.149)
Fixed Effects	Yes	Yes
Covariates	No	Yes
Observations	1,071	1,071
R^2	0.681	0.748
Adjusted R^2	0.658	0.729
Residual Std. Error	4.167 (df = 999)	3.710 (df = 993)
F Statistic	29.990*** (df = 71; 999)	38.359*** (df = 77; 993)
Note:		*p<0.1; **p<0.05; ***p<0.01

PRESCRIPTION

```
mod_prescription <- lm_robust(prescription ~ PDMP + avg_age + bachelors_pct + median_income
                        + unemp_rate + white_pct + personal_health_care +
                          factor(year) + factor(state), data = df, se_type = "HC1")
```

```
mod2_prescription <- lm(prescription ~ PDMP + avg_age + bachelors_pct + median_income
                          + unemp_rate + white_pct + personal_health_care +
                        factor(year) + factor(state), data = df)

cov2_prescription <- vcovHC(mod2_prescription, type = "HC1")
robust_se2_prescription <- sqrt(diag(cov2_prescription))


mod1_prescription <- lm(prescription ~ PDMP + factor(year) + factor(state), data = df)

cov1_prescription <- vcovHC(mod1_prescription, type = "HC1")
robust_se1_prescription <- sqrt(diag(cov1_prescription))
```

```
fe_vector <- c("Fixed Effects", "Yes", "Yes")
covariate_vector <- c("Covariates", "No", "Yes")


stargazer(mod1_prescription, mod2_prescription, type = "latex",
          se = list(robust_se1_prescription, robust_se2_prescription), omit = c("factor"),
          add.lines = list(fe_vector, covariate_vector),
          dep.var.caption = "Dependent Variable: Prescription Opioid Overdose Death Rate per 100,000",
          dep.var.labels.include = FALSE,
          covariate.labels = c("PDMP in Operation",
                               "Average Age",
                               "Percentage with Bachelor's Degree",
                               "Median Income",
                               "Unemployment Rate",
                               "Percentage that is White",
                               "Personal Healthcare Spending per Capita"))
```

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Table 3:

	Dependent Variable: Prescription Opioid Overdose Death Rate per 100,000	
	(1)	(2)
PDMP in Operation	-0.345^{**}	-0.329^{*}
	(0.168)	(0.170)
Average Age		-0.017
		(0.140)
Percentage with Bachelor's Degree		-0.273^{***}
		(0.085)
Median Income		-0.036^{**}
		(0.017)
Unemployment Rate		-0.146^{**}
		(0.068)
Percentage that is White		-0.001
		(0.030)
Personal Healthcare Spending per Capita		0.241
		(0.153)
Constant	-0.187	5.971
	(0.287)	(5.515)
Fixed Effects	Yes	Yes
Covariates	No	Yes
Observations	1,071	1,071
R^2	0.740	0.747
Adjusted R^2	0.721	0.727
Residual Std. Error	1.583 (df = 999)	1.567 (df = 993)
F Statistic	40.004^{***} (df = 71; 999)	38.039^{***} (df = 77; 993)
Note:		*p<0.1; **p<0.05; ***p<0.01

METHADONE

```
df2 <- read_csv(here("Cleaned_Data", "DATA_METHADONE.csv"))

mod_methadone <- lm_robust(methadone_rate ~ PDMP + avg_age + bachelors_pct + median_income
                       + unemp_rate + white_pct + personal_health_care + factor(year) + factor(state), data = df2, se_type = "HC1")
```

```
mod2_methadone <- lm(methadone_rate ~ PDMP + avg_age + bachelors_pct + median_income
                       + unemp_rate + white_pct + personal_health_care + factor(year) + factor(state), data = df2)

cov2_methadone <- vcovHC(mod2_methadone, type = "HC1")
robust_se2_methadone <- sqrt(diag(cov2_methadone))


mod1_methadone <- lm(methadone_rate ~ PDMP + factor(year) + factor(state), data = df2)

cov1_methadone <- vcovHC(mod1_methadone, type = "HC1")
robust_se1_methadone <- sqrt(diag(cov1_methadone))
```

```
fe_vector <- c("Fixed Effects", "Yes", "Yes")
covariate_vector <- c("Covariates", "No", "Yes")


stargazer(mod1_methadone, mod2_methadone, type = "latex",
          se = list(robust_se1_methadone, robust_se2_methadone), omit = c("factor"),
          add.lines = list(fe_vector, covariate_vector),
          dep.var.caption = "Dependent Variable: Methadone Overdose Death Rate per 100,000",
          dep.var.labels.include = FALSE,
          covariate.labels = c("PDMP in Operation",
                               "Average Age",
                               "Percentage with Bachelor's Degree",
                               "Median Income",
                               "Unemployment Rate",
                               "Percentage that is White",
                               "Personal Healthcare Spending per Capita"))
```

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Table 4:

	Dependent Variable: Methadone Overdose Death Rate per 100,000	
	(1)	(2)
PDMP in Operation	0.017	−0.009
	(0.070)	(0.068)
Average Age		0.074
		(0.073)
Percentage with Bachelor's Degree		0.092**
		(0.037)
Median Income		0.009
		(0.007)
Unemployment Rate		0.071**
		(0.028)
Percentage that is White		0.007
		(0.014)
Personal Healthcare Spending per Capita		0.163***
		(0.061)
Constant	0.282***	−5.506*
	(0.093)	(3.019)
Fixed Effects	Yes	Yes
Covariates	No	Yes
Observations	1,008	1,008
R^2	0.664	0.679
Adjusted R^2	0.640	0.653
Residual Std. Error	0.607 (df = 939)	0.596 (df = 933)
F Statistic	27.295*** (df = 68; 939)	26.625*** (df = 74; 933)
Note:		*p<0.1; **p<0.05; ***p<0.01

ALL RESULTS

```
fe_vector_final <- c("Fixed Effects", "Yes", "Yes", "Yes", "Yes")
covariate_vector_final <- c("Covariates", "Yes", "Yes", "Yes", "Yes")


stargazer(mod2_total, mod2_heroin, mod2_prescription, mod2_methadone,
          type = "latex",
          se = list(robust_se2_total, robust_se2_heroin, robust_se2_prescription, robust_se2_methadone),
          omit = c("factor"),
          add.lines = list(fe_vector_final, covariate_vector_final),
          dep.var.caption = "Dependent Variable: Overdose Death Rate per 100,000 for Four Categories of Opioids:",
          dep.var.labels.include = FALSE,
          column.labels = c("All", "Heroin and Synthetic", "Prescription", "Methadone"),
          covariate.labels = c("PDMP in Operation",
                               "Average Age",
                               "Percentage with Bachelor's Degree",
                               "Median Income",
                               "Unemployment Rate",
                               "Percentage that is White",
                               "Personal Healthcare Spending per Capita"))
```

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Table 5:

	Dependent Variable: Overdose Death Rate per 100,000 for Four Categories of Opioids:			
	All	Heroin and Synthetic	Prescription	Methadone
	(1)	(2)	(3)	(4)
PDMP in Operation	−0.795*	−0.728*	−0.329*	−0.009
	(0.443)	(0.415)	(0.170)	(0.068)
Average Age	1.372***	1.860***	−0.017	0.074
	(0.424)	(0.399)	(0.140)	(0.073)
Percentage with Bachelor's Degree	1.196***	1.624***	−0.273***	0.092**
	(0.275)	(0.257)	(0.085)	(0.037)
Median Income	−0.049	−0.021	−0.036**	0.009
	(0.045)	(0.045)	(0.017)	(0.007)
Unemployment Rate	−0.090	0.005	−0.146**	0.071**
	(0.160)	(0.143)	(0.068)	(0.028)
Percentage that is White	0.190**	0.184*	−0.001	0.007
	(0.097)	(0.096)	(0.030)	(0.014)
Personal Healthcare Spending per Capita	2.997***	2.940***	0.241	0.163***
	(0.503)	(0.542)	(0.153)	(0.061)
Constant	−86.595***	−111.298***	5.971	−5.506*
	(16.531)	(16.149)	(5.515)	(3.019)
Fixed Effects	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes
Observations	1,071	1,071	1,071	1,008
R^2	0.764	0.748	0.747	0.679
Adjusted R^2	0.746	0.729	0.727	0.653
Residual Std. Error	3.912 (df = 993)	3.710 (df = 993)	1.567 (df = 993)	0.596 (df = 933)
F Statistic	41.724*** (df = 77; 993)	38.359*** (df = 77; 993)	38.039*** (df = 77; 993)	26.625*** (df = 74; 933)

Note: *p<0.1; **p<0.05; ***p<0.01