Opioid Distributional Analysis

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20 March, 2018

### Data Structure

* Opioid deaths
* Medical costs
* Opioid addiction
* Criminal justice costs
* Productivity (income)

### County list

data(county.regions)  
data(state.regions)

### Opioid Deaths by County

opioid\_deaths <- read\_tsv("../data/Opioid Deaths 2016 - MCD.txt") %>%  
 select(-Notes) %>%  
 filter(!is.na(County)) %>%  
 mutate(region = `County Code` %>% as.numeric,  
 opioid\_deaths = Deaths) %>%  
 select(region, opioid\_deaths)

## Parsed with column specification:  
## cols(  
## Notes = col\_character(),  
## County = col\_character(),  
## `County Code` = col\_character(),  
## Deaths = col\_integer(),  
## Population = col\_integer(),  
## `Crude Rate` = col\_character()  
## )

## Warning in rbind(names(probs), probs\_f): number of columns of result is not  
## a multiple of vector length (arg 1)

## Warning: 89 parsing failures.  
## row # A tibble: 5 x 5 col row col expected actual file expected <int> <chr> <chr> <chr> <chr> actual 1 730 <NA> 6 columns 1 columns '../data/Opioid Deaths 2016 - MCD.txt' file 2 731 <NA> 6 columns 1 columns '../data/Opioid Deaths 2016 - MCD.txt' row 3 732 <NA> 6 columns 1 columns '../data/Opioid Deaths 2016 - MCD.txt' col 4 733 <NA> 6 columns 1 columns '../data/Opioid Deaths 2016 - MCD.txt' expected 5 734 <NA> 6 columns 1 columns '../data/Opioid Deaths 2016 - MCD.txt'  
## ... ................. ... ........................................................................ ........ ........................................................................ ...... ........................................................................ .... ........................................................................ ... ........................................................................ ... ........................................................................ ........ ........................................................................  
## See problems(...) for more details.

### GPCI by County

GPCI Index 2018 (Downloaded from CMS)

gpci\_xwalk <- read\_excel("../data/gpci\_county\_xwalk.xlsx", skip = 1) %>%  
 filter(!is.na(`Carrier Number`)) %>%  
 filter(!row\_number() == n()) %>%  
 fill(State) %>%  
 mutate(`MAC LOCALITY` = str\_c(`Carrier Number`, `Locality Number`) %>% as.numeric)  
  
gpci\_level <- read\_csv("../data/gpci\_2018.csv") %>%  
 select(`MAC LOCALITY`, `GPCI WORK`, `GPCI PE`, `GPCI MP`) %>%  
 mutate(GPCI = 4.5 \* `GPCI WORK` + 1.42 \* `GPCI PE` + 0.38 \* `GPCI MP`) %>%  
 right\_join(gpci\_xwalk) %>%  
 mutate(State = ifelse(State == "HAWAII/GUAM", "HAWAII", State)) %>%  
 unique

## Warning: Duplicated column names deduplicated: 'PROC STAT' => 'PROC  
## STAT\_1' [14], 'PCTC' => 'PCTC\_1' [37], 'CONV FACT' => 'CONV FACT\_1' [49],  
## 'NOT USED FOR MEDICARE' => 'NOT USED FOR MEDICARE\_1' [50]

## Parsed with column specification:  
## cols(  
## .default = col\_character(),  
## `MAC LOCALITY` = col\_integer(),  
## `GPCI WORK` = col\_double(),  
## `GPCI PE` = col\_double(),  
## `GPCI MP` = col\_double()  
## )

## See spec(...) for full column specifications.

## Joining, by = "MAC LOCALITY"

# Code 99291: RVU WORK = 4.5, RVU PE = 1.42. RVU MP = 0.38 FROM CMS  
  
find\_gpci = function(county, state) {  
 out <- gpci\_level %>% filter(str\_detect(State %>% tolower, state),  
 str\_detect(Counties %>% tolower, county))  
 if (nrow(out) == 1) {  
 return(out %>% pull(GPCI))  
 } else {  
 return(gpci\_level %>% filter(State %>% tolower == state,  
 str\_detect(Counties, "ALL COUNTIES|ALL OTHER COUNTIES")) %>%  
 pull(GPCI))  
 }  
}  
  
medical\_cost\_index <- county.regions %>%  
 select(region, county.name, state.name) %>%  
 rowwise() %>%   
 mutate(medical\_cost = find\_gpci(county.name, state.name)) %>%  
 ungroup %>%  
 select(region, medical\_cost)

### Opioid Addiction Rates

From SAMHSA

addiction\_xwalk1 <- read.sas7bdat("../data/substate\_county121314.sas7bdat") %>% tbl\_df %>%  
 select(sbst14n, state, county) %>%  
 mutate(county\_fips = state \* 1000 + county)  
  
  
# if > 1 tract in a county using the tract that is most representative  
addiction\_xwalk2 <- read.sas7bdat("../data/substate\_tract121314.sas7bdat") %>% tbl\_df %>%  
 select(sbst14n, state, county) %>%   
 group\_by(sbst14n, state, county) %>%  
 summarise(n\_tracts = n()) %>%  
 arrange(state, county, -n\_tracts) %>%  
 group\_by(state, county) %>%  
 filter(row\_number() == 1) %>%  
 ungroup %>%  
 select(-n\_tracts) %>%  
 mutate(county\_fips = state \* 1000 + county)  
  
addiction\_xwalk <- addiction\_xwalk1 %>% bind\_rows(addiction\_xwalk2) %>% unique

## Warning in bind\_rows\_(x, .id): Unequal factor levels: coercing to character

## Warning in bind\_rows\_(x, .id): binding character and factor vector,  
## coercing into character vector  
  
## Warning in bind\_rows\_(x, .id): binding character and factor vector,  
## coercing into character vector

nonmedical\_use <- read\_excel("../data/NonMed Use of Opioid.xlsx") %>%  
 mutate(state\_name = State %>% tolower,  
 nonmedical\_use\_pct = `Small \r\nArea Estimate`,  
 sbst14n = `Substate Region`) %>%  
 select(state\_name, nonmedical\_use\_pct, sbst14n) %>%  
 left\_join(state.regions %>% rename(state\_name = region, state\_fips = fips.numeric) %>%  
 select(state\_name, state\_fips)) %>%  
 filter(!is.na(state\_fips))

## Joining, by = "state\_name"

# correcting error in crosswalk  
nonmedical\_use <- addiction\_xwalk %>% rename(state\_fips = state) %>%   
 mutate(sbst14n = case\_when(sbst14n == "Trillium Health Resources 1" ~ "Trillium Healthcare Resources 1",  
 sbst14n == "Trillium Health Resources 2" ~ "Trillium Healthcare Resources 2",  
 TRUE ~ sbst14n)) %>%   
 left\_join(nonmedical\_use) %>%  
 select(county\_fips, nonmedical\_use\_pct) %>%  
 rename(region = county\_fips) %>%  
 filter(!is.na(region))

## Joining, by = c("sbst14n", "state\_fips")

nonmedical\_use <- county.regions %>% select(region, state.fips.character) %>% left\_join(nonmedical\_use)

## Joining, by = "region"

knitr:::knit\_code$get()

## $setup  
## [1] "require(mosaic) # Load additional packages here "   
## [2] "require(dplyr)"   
## [3] "require(readr)"   
## [4] "require(readxl)"   
## [5] "require(tidyr)"   
## [6] "require(stringr)"   
## [7] "require(choroplethr)"   
## [8] "require(choroplethrMaps)"   
## [9] "require(sas7bdat)"   
## [10] "require(tidycensus)"   
## [11] "require(lme4)"   
## [12] "require(glmmTMB)"   
## [13] "library(RColorBrewer)"   
## [14] ""   
## [15] "census\_api\_key('69d9f9e5add214b53a97d01d26fbec5051720528')"   
## [16] "source('process\_hospitalizations.R')"   
## [17] "# Some customization. You can alter or delete as desired (if you know what you are doing)."  
## [18] "# trellis.par.set(theme=theme.mosaic()) # change default color scheme for lattice"   
## [19] "knitr::opts\_chunk$set("   
## [20] " tidy=FALSE, # display code as typed"   
## [21] " size=\"small\") # slightly smaller font for code"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "setup"  
##   
## attr(,"chunk\_opts")$include  
## [1] FALSE  
##   
##   
## $county.list  
## [1] "data(county.regions)" "data(state.regions)"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "county.list"  
##   
##   
## $opioid.deaths  
## [1] "opioid\_deaths <- read\_tsv(\"../data/Opioid Deaths 2016 - MCD.txt\") %>%"  
## [2] " select(-Notes) %>%"   
## [3] " filter(!is.na(County)) %>%"   
## [4] " mutate(region = `County Code` %>% as.numeric,"   
## [5] " opioid\_deaths = Deaths) %>%"   
## [6] " select(region, opioid\_deaths) "   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "opioid.deaths"  
##   
##   
## $gpci  
## [1] ""   
## [2] "gpci\_xwalk <- read\_excel(\"../data/gpci\_county\_xwalk.xlsx\", skip = 1) %>%"   
## [3] " filter(!is.na(`Carrier Number`)) %>%"   
## [4] " filter(!row\_number() == n()) %>%"   
## [5] " fill(State) %>%"   
## [6] " mutate(`MAC LOCALITY` = str\_c(`Carrier Number`, `Locality Number`) %>% as.numeric)"   
## [7] ""   
## [8] "gpci\_level <- read\_csv(\"../data/gpci\_2018.csv\") %>%"   
## [9] " select(`MAC LOCALITY`, `GPCI WORK`, `GPCI PE`, `GPCI MP`) %>%"   
## [10] " mutate(GPCI = 4.5 \* `GPCI WORK` + 1.42 \* `GPCI PE` + 0.38 \* `GPCI MP`) %>%"   
## [11] " right\_join(gpci\_xwalk) %>%"   
## [12] " mutate(State = ifelse(State == \"HAWAII/GUAM\", \"HAWAII\", State)) %>%"   
## [13] " unique"   
## [14] ""   
## [15] ""   
## [16] "# Code 99291: RVU WORK = 4.5, RVU PE = 1.42. RVU MP = 0.38 FROM CMS"   
## [17] ""   
## [18] "find\_gpci = function(county, state) {"   
## [19] " out <- gpci\_level %>% filter(str\_detect(State %>% tolower, state),"   
## [20] " str\_detect(Counties %>% tolower, county))"   
## [21] " if (nrow(out) == 1) {"   
## [22] " return(out %>% pull(GPCI))"   
## [23] " } else {"   
## [24] " return(gpci\_level %>% filter(State %>% tolower == state,"   
## [25] " str\_detect(Counties, \"ALL COUNTIES|ALL OTHER COUNTIES\")) %>%"  
## [26] " pull(GPCI))"   
## [27] " }"   
## [28] "}"   
## [29] ""   
## [30] "medical\_cost\_index <- county.regions %>%"   
## [31] " select(region, county.name, state.name) %>%"   
## [32] " rowwise() %>% "   
## [33] " mutate(medical\_cost = find\_gpci(county.name, state.name)) %>%"   
## [34] " ungroup %>%"   
## [35] " select(region, medical\_cost)"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "gpci"  
##   
##   
## $opioid.addiction  
## [1] "addiction\_xwalk1 <- read.sas7bdat(\"../data/substate\_county121314.sas7bdat\") %>% tbl\_df %>%"   
## [2] " select(sbst14n, state, county) %>%"   
## [3] " mutate(county\_fips = state \* 1000 + county)"   
## [4] ""   
## [5] ""   
## [6] "# if > 1 tract in a county using the tract that is most representative"   
## [7] "addiction\_xwalk2 <- read.sas7bdat(\"../data/substate\_tract121314.sas7bdat\") %>% tbl\_df %>%"   
## [8] " select(sbst14n, state, county) %>% "   
## [9] " group\_by(sbst14n, state, county) %>%"   
## [10] " summarise(n\_tracts = n()) %>%"   
## [11] " arrange(state, county, -n\_tracts) %>%"   
## [12] " group\_by(state, county) %>%"   
## [13] " filter(row\_number() == 1) %>%"   
## [14] " ungroup %>%"   
## [15] " select(-n\_tracts) %>%"   
## [16] " mutate(county\_fips = state \* 1000 + county)"   
## [17] ""   
## [18] "addiction\_xwalk <- addiction\_xwalk1 %>% bind\_rows(addiction\_xwalk2) %>% unique"   
## [19] ""   
## [20] ""   
## [21] "nonmedical\_use <- read\_excel(\"../data/NonMed Use of Opioid.xlsx\") %>%"   
## [22] " mutate(state\_name = State %>% tolower,"   
## [23] " nonmedical\_use\_pct = `Small \\r\\nArea Estimate`,"   
## [24] " sbst14n = `Substate Region`) %>%"   
## [25] " select(state\_name, nonmedical\_use\_pct, sbst14n) %>%"   
## [26] " left\_join(state.regions %>% rename(state\_name = region, state\_fips = fips.numeric) %>%"   
## [27] " select(state\_name, state\_fips)) %>%"   
## [28] " filter(!is.na(state\_fips))"   
## [29] ""   
## [30] ""   
## [31] "# correcting error in crosswalk"   
## [32] "nonmedical\_use <- addiction\_xwalk %>% rename(state\_fips = state) %>% "   
## [33] " mutate(sbst14n = case\_when(sbst14n == \"Trillium Health Resources 1\" ~ \"Trillium Healthcare Resources 1\","  
## [34] " sbst14n == \"Trillium Health Resources 2\" ~ \"Trillium Healthcare Resources 2\","   
## [35] " TRUE ~ sbst14n)) %>% "   
## [36] " left\_join(nonmedical\_use) %>%"   
## [37] " select(county\_fips, nonmedical\_use\_pct) %>%"   
## [38] " rename(region = county\_fips) %>%"   
## [39] " filter(!is.na(region))"   
## [40] ""   
## [41] "nonmedical\_use <- county.regions %>% select(region, state.fips.character) %>% left\_join(nonmedical\_use)"   
## [42] "knitr:::knit\_code$get()"   
## [43] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "opioid.addiction"  
##   
##   
## $criminal.justice  
## [1] "criminal\_costs <- read\_csv(\"../data/criminal\_justice\_expenditures.csv\","   
## [2] " skip = 25, col\_names = F) %>%"   
## [3] " na.omit %>%"   
## [4] " filter(X2 != \"-\") %>%"   
## [5] " select(X1, X2, X4) %>%"   
## [6] " mutate(state = X1, criminal\_cost\_per\_capita = X4/(X2 %>% as.numeric \* 1000)) %>%"  
## [7] " select(state, criminal\_cost\_per\_capita)"   
## [8] ""   
## [9] "criminal\_costs <- county.regions %>%"   
## [10] " select(region, state.name) %>%"   
## [11] " left\_join(criminal\_costs %>% mutate(state.name = state %>% tolower) %>%"   
## [12] " select(state.name, criminal\_cost\_per\_capita)) %>%"   
## [13] " select(region, criminal\_cost\_per\_capita)"   
## [14] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "criminal.justice"  
##   
##   
## $overall.drug.deaths  
## [1] ""   
## [2] "drug\_deaths\_ucd <- read\_tsv(\"../data/Drug Deaths 2016 - UCD.txt\") %>%"  
## [3] " filter(!is.na(`County Code`)) %>%"   
## [4] " mutate(region = `County Code` %>% as.numeric,"   
## [5] " drug\_deaths\_ucd = Deaths) %>%"   
## [6] " select(region, drug\_deaths\_ucd)"   
## [7] ""   
## [8] "drug\_deaths\_mcd <- read\_tsv(\"../data/Drug Deaths 2016 - MCD.txt\") %>%"  
## [9] " filter(!is.na(`County Code`)) %>%"   
## [10] " mutate(region = `County Code` %>% as.numeric,"   
## [11] " drug\_deaths\_mcd = Deaths) %>%"   
## [12] " select(region, drug\_deaths\_mcd)"   
## [13] ""   
## [14] "drug\_deaths <- county.regions %>% select(region) %>%"   
## [15] " left\_join(drug\_deaths\_ucd) %>%"   
## [16] " left\_join(drug\_deaths\_mcd)"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "overall.drug.deaths"  
##   
##   
## $hospitalization.costs  
## [1] ""   
## [2] "hospitalization\_costs <- read\_rds(\"../data/hospitalization\_costs.rds\")"   
## [3] ""   
## [4] "county\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name != \"State Total\") %>%"  
## [5] " mutate(county.name = region\_name %>% tolower %>% str\_trim,"   
## [6] " state.name = state\_name %>% tolower %>% str\_trim) %>%"   
## [7] " inner\_join(county.regions) %>%"   
## [8] " select(region, discharges, mean\_costs, per\_capita\_costs, total\_costs)"   
## [9] ""   
## [10] "state\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name == \"State Total\") %>%"   
## [11] " mutate(region = state\_name %>% tolower %>% str\_trim,"   
## [12] " state\_total\_costs = total\_costs,"   
## [13] " state\_discharges = discharges,"   
## [14] " state\_mean\_costs = mean\_costs) %>%"   
## [15] " select(region, state\_total\_costs, state\_discharges, state\_mean\_costs)"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "hospitalization.costs"  
##   
##   
## $county.demographics  
## [1] "population <- get\_acs(geography = \"county\","   
## [2] " variables = c(population = \"B01003\_001\"),"   
## [3] " survey = \"acs5\","   
## [4] " year = 2016) %>%"   
## [5] " mutate(region = GEOID %>% as.numeric,"   
## [6] " total\_population = estimate) %>%"   
## [7] " select(region, total\_population)"   
## [8] ""   
## [9] "workers <- get\_acs(geography = \"county\","   
## [10] " variables = c(m2534 = \"B15001\_011\","   
## [11] " m3544 = \"B15001\_019\","   
## [12] " m4564 = \"B15001\_027\","   
## [13] " f2534 = \"B15001\_052\","   
## [14] " f3544 = \"B15001\_060\","   
## [15] " f4564 = \"B15001\_068\"),"   
## [16] " survey = \"acs5\","   
## [17] " year = 2016) %>%"   
## [18] " group\_by(GEOID) %>%"   
## [19] " summarise(working\_population = sum(estimate, na.rm = T)) %>%"   
## [20] " mutate(region = GEOID %>% as.numeric) %>% "   
## [21] " select(region, working\_population) %>% ungroup"   
## [22] ""   
## [23] "educational\_attainment <- get\_acs(\"county\","   
## [24] " variables = c(\"B06009\_001\", \"B06009\_002\", \"B06009\_003\"), year = 2016, survey = \"acs5\") %>%"  
## [25] " group\_by(GEOID) %>%"   
## [26] " summarise(pct\_no\_hs = estimate[2]/estimate[1],"   
## [27] " pct\_hs = estimate[3]/estimate[1],"   
## [28] " pct\_college = 1 - pct\_no\_hs - pct\_hs) %>%"   
## [29] " rename(region = GEOID) %>%"   
## [30] " mutate(region = region %>% as.numeric)"   
## [31] ""   
## [32] "urban\_rural <- read\_excel(\"../data/percent\_rural.xlsx\") %>%"   
## [33] " mutate(region = GEOID %>% as.numeric,"   
## [34] " percent\_rural = `2010 Census \\r\\nPercent Rural`) %>%"   
## [35] " select(region, percent\_rural)"   
## [36] ""   
## [37] ""   
## [38] "race <- get\_acs(geography = \"county\","   
## [39] " variables = c(total\_population = \"B03002\_001\","   
## [40] " black\_alone\_not\_hispanic = \"B03002\_004\","   
## [41] " hispanic\_all\_races = \"B03002\_012\"),"   
## [42] " survey = \"acs5\", year = 2016) %>%"   
## [43] " group\_by(GEOID) %>%"   
## [44] " summarise(percent\_black = estimate[2]/estimate[1] \* 100,"   
## [45] " percent\_hispanic = estimate[3]/estimate[1] \* 100) %>%"   
## [46] " mutate(region = GEOID %>% as.numeric) %>%"   
## [47] " select(region, percent\_black, percent\_hispanic)"   
## [48] " "   
## [49] "# med\_income <- get\_acs(geography = \"county\","   
## [50] "# variables = c(med\_income\_per\_capita = \"B06011\_001\"),"   
## [51] "# survey = \"acs5\", year = 2016) %>%"   
## [52] "# mutate(region = GEOID %>% as.numeric,"   
## [53] "# med\_income\_per\_capita = estimate) %>%"   
## [54] "# select(region, med\_income\_per\_capita)"   
## [55] ""   
## [56] "# mean\_income <- get\_acs(geography = \"county\","   
## [57] "# variables = c(income\_per\_capita = \"B19301\_001\"),"   
## [58] "# survey = \"acs5\", year = 2016) %>%"   
## [59] "# mutate(region = GEOID %>% as.numeric,"   
## [60] "# mean\_income\_per\_capita = estimate) %>%"   
## [61] "# select(region, mean\_income\_per\_capita)"   
## [62] ""   
## [63] "st\_population <- get\_acs(geography = \"state\","   
## [64] " variables = c(population = \"B01003\_001\"),"   
## [65] " survey = \"acs5\","   
## [66] " year = 2016) %>%"   
## [67] " mutate(region = NAME %>% tolower,"   
## [68] " total\_population = estimate) %>%"   
## [69] " select(region, total\_population)"   
## [70] ""   
## [71] "st\_workers <- get\_acs(geography = \"state\","   
## [72] " variables = c(m2534 = \"B15001\_011\","   
## [73] " m3544 = \"B15001\_019\","   
## [74] " m4564 = \"B15001\_027\","   
## [75] " f2534 = \"B15001\_052\","   
## [76] " f3544 = \"B15001\_060\","   
## [77] " f4564 = \"B15001\_068\"),"   
## [78] " survey = \"acs5\","   
## [79] " year = 2016) %>%"   
## [80] " group\_by(GEOID) %>%"   
## [81] " summarise(working\_population = sum(estimate, na.rm = T)) %>%"   
## [82] " rename(region = GEOID) %>% ungroup"   
## [83] ""   
## [84] "# st\_income <- get\_acs(geography = \"state\","   
## [85] "# variables = c(income\_per\_capita = \"B06011\_001\"),"   
## [86] "# survey = \"acs5\", year = 2016) %>%"   
## [87] "# mutate(region = NAME %>% tolower,"   
## [88] "# income\_per\_capita = estimate) %>%"   
## [89] "# select(region, income\_per\_capita)"   
## [90] ""   
## [91] "income <- read\_excel(\"../data/est16all.xls\", skip = 3) %>% select(`State FIPS Code`, `County FIPS Code`, `Median Household Income`)"  
## [92] ""   
## [93] "med\_income <- income %>% mutate(med\_income = `Median Household Income` %>% as.numeric,"   
## [94] " region = str\_c(`State FIPS Code`, `County FIPS Code`) %>% as.numeric) %>%"   
## [95] " right\_join(county.regions) %>% select(region, med\_income)"   
## [96] ""   
## [97] "st\_income <- income %>% filter(`County FIPS Code` == \"000\") %>%"   
## [98] " mutate(st\_med\_income = `Median Household Income` %>% as.numeric,"   
## [99] " fips.character = `State FIPS Code`) %>%"   
## [100] " right\_join(state.regions) %>%"   
## [101] " select(region, st\_med\_income)"   
## [102] ""   
## [103] "demographics <- county.regions %>% "   
## [104] " select(region) %>% "   
## [105] " left\_join(population) %>%"   
## [106] " left\_join(workers) %>%"   
## [107] " left\_join(race) %>% "   
## [108] " left\_join(med\_income) %>%"   
## [109] " left\_join(urban\_rural) %>%"   
## [110] " left\_join(educational\_attainment) %>% tbl\_df"   
## [111] ""   
## [112] "st\_demographics <- state.regions %>%"   
## [113] " select(region, fips.character) %>%"   
## [114] " left\_join(st\_income) %>%"   
## [115] " left\_join(st\_population) %>%"   
## [116] " left\_join(st\_workers)"   
## [117] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "county.demographics"  
##   
##   
## $health.costs  
## [1] "county\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name != \"State Total\") %>%"   
## [2] " mutate(county.name = region\_name %>% tolower %>% str\_trim,"   
## [3] " state.name = state\_name %>% tolower %>% str\_trim) %>%"   
## [4] " right\_join(county.regions)"   
## [5] ""   
## [6] "state\_hosp\_costs <- state\_hosp\_costs %>% right\_join(state.regions) %>% rename(state.name = region)"   
## [7] ""   
## [8] "hosp\_costs <- county\_hosp\_costs %>% left\_join(state\_hosp\_costs) %>% left\_join(demographics) %>%"   
## [9] " left\_join(st\_demographics %>% rename(state.name = region, total\_st\_population = total\_population))"   
## [10] " "   
## [11] "hosp\_costs\_model <- county\_hosp\_costs %>% "   
## [12] " left\_join(medical\_cost\_index) %>%"   
## [13] " left\_join(nonmedical\_use) %>%"   
## [14] " left\_join(demographics) %>%"   
## [15] " left\_join(opioid\_deaths) %>%"   
## [16] " left\_join(drug\_deaths) %>%"   
## [17] " mutate(log\_total\_hosp\_costs = log(total\_costs),"   
## [18] " log\_population = log(total\_population),"   
## [19] " log\_nonmedical\_use\_count = log(total\_population/1000 \* nonmedical\_use\_pct),"   
## [20] " log\_opioid\_deaths = log(opioid\_deaths),"   
## [21] " log\_drug\_deaths\_mcd = log(drug\_deaths\_mcd))"   
## [22] ""   
## [23] "h1 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_opioid\_deaths + log\_drug\_deaths\_mcd + (1|state.fips.character), data = hosp\_costs\_model)"  
## [24] ""   
## [25] "h1\_adj = sum(exp(resid(h1)))/(length(resid(h1)) - 7)"   
## [26] ""   
## [27] "h2 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_drug\_deaths\_mcd + (1|state.fips.character), data = hosp\_costs\_model)"   
## [28] ""   
## [29] "h2\_adj = sum(exp(resid(h2)))/(length(resid(h2)) - 6)"   
## [30] ""   
## [31] "h3 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + (1|state.fips.character), data = hosp\_costs\_model)"   
## [32] ""   
## [33] "h3\_adj = sum(exp(resid(h3)))/(length(resid(h3)) - 5)"   
## [34] ""   
## [35] "state\_opioid\_deaths <- read\_tsv(\"../data/State Opioid Deaths 2016 - MCD.txt\") %>%"   
## [36] " select(-Notes) %>%"   
## [37] " filter(!is.na(State)) %>%"   
## [38] " mutate(state.fips.character = `State Code`,"   
## [39] " state\_opioid\_deaths = Deaths) %>%"   
## [40] " select(state.fips.character, state\_opioid\_deaths)"   
## [41] ""   
## [42] "state\_medical\_costs <- medical\_cost\_index %>% left\_join(demographics) %>%"   
## [43] " left\_join(county.regions %>% select(region, state.fips.character)) %>%"   
## [44] " group\_by(state.fips.character) %>% "   
## [45] " summarise(medical\_cost = sum(total\_population/sum(total\_population, na.rm = T) \* medical\_cost, na.rm = T))"   
## [46] ""   
## [47] "state\_hosp\_costs\_model <- state\_hosp\_costs %>%"   
## [48] " left\_join(st\_demographics) %>%"   
## [49] " left\_join(state\_opioid\_deaths %>% rename(fips.character = state.fips.character)) %>%"   
## [50] " left\_join(state\_medical\_costs %>% rename(fips.character = state.fips.character)) %>%"   
## [51] " mutate(log\_hospital\_costs = log(state\_total\_costs),"   
## [52] " log\_total\_population = log(total\_population),"   
## [53] " log\_mean\_cost = log(state\_mean\_costs),"   
## [54] " log\_opioid\_deaths = log(state\_opioid\_deaths),"   
## [55] " log\_income = log(st\_med\_income))"   
## [56] ""   
## [57] "sh1 <- lm(log\_hospital\_costs ~ log\_total\_population +"   
## [58] " log\_opioid\_deaths + medical\_cost + log\_income, data = state\_hosp\_costs\_model)"   
## [59] ""   
## [60] "sh1\_adj <- sum(exp(resid(sh1)))/26"   
## [61] ""   
## [62] "state\_hosp\_costs <- state\_hosp\_costs\_model %>%"   
## [63] " mutate(state\_est\_hosp\_costs = ifelse(is.na(state\_total\_costs), exp(predict(sh1, state\_hosp\_costs\_model)) \* sh1\_adj, state\_total\_costs),"   
## [64] " state\_costs\_per\_capita = state\_est\_hosp\_costs/total\_population) %>%"   
## [65] " select(fips.character, state\_est\_hosp\_costs, state\_costs\_per\_capita)"   
## [66] ""   
## [67] "d1\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_opioid\_deaths + log\_drug\_deaths\_mcd))"   
## [68] ""   
## [69] "d1\_hosp <- d1\_hosp %>% mutate(predicted\_hospitalization\_costs1 = exp(predict(h1, d1\_hosp, allow.new.levels=TRUE)) \* h1\_adj)"   
## [70] ""   
## [71] "d2\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_drug\_deaths\_mcd))"   
## [72] ""   
## [73] "d2\_hosp <- d2\_hosp %>% mutate(predicted\_hospitalization\_costs2 = exp(predict(h2, d2\_hosp, allow.new.levels=TRUE)) \* h2\_adj)"   
## [74] ""   
## [75] "d3\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population))"   
## [76] ""   
## [77] "d3\_hosp <- d3\_hosp %>% mutate(predicted\_hospitalization\_costs3 = exp(predict(h3, d3\_hosp, allow.new.levels=TRUE)) \* h3\_adj)"   
## [78] ""   
## [79] "proj\_hospital\_costs <- hosp\_costs\_model %>% select(region, state.fips.character, total\_costs) %>%"   
## [80] " left\_join(state\_hosp\_costs %>% rename(state.fips.character = fips.character)) %>%"   
## [81] " left\_join(d1\_hosp %>% select(region, predicted\_hospitalization\_costs1)) %>% "   
## [82] " left\_join(d2\_hosp %>% select(region, predicted\_hospitalization\_costs2)) %>% "   
## [83] " left\_join(d3\_hosp %>% select(region, predicted\_hospitalization\_costs3)) %>%"   
## [84] " mutate(est\_total\_hosp\_costs = case\_when("   
## [85] " !is.na(total\_costs) ~ total\_costs,"   
## [86] " !is.na(predicted\_hospitalization\_costs1) ~ predicted\_hospitalization\_costs1,"   
## [87] " !is.na(predicted\_hospitalization\_costs2) ~ predicted\_hospitalization\_costs2,"   
## [88] " !is.na(predicted\_hospitalization\_costs3) ~ predicted\_hospitalization\_costs3)) %>%"   
## [89] " group\_by(state.fips.character) %>%"   
## [90] " mutate(total\_est\_costs = sum(est\_total\_hosp\_costs, na.rm = T)) %>%"   
## [91] " mutate(infl\_factor = state\_est\_hosp\_costs/total\_est\_costs,"   
## [92] " est\_total\_hosp\_costs = est\_total\_hosp\_costs \* infl\_factor) %>% ungroup"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "health.costs"  
##   
##   
## $opioid\_deaths  
## [1] "d <- county.regions %>% tbl\_df %>% dplyr::select(region, state.fips.character) %>%"   
## [2] " left\_join(opioid\_deaths) %>%"   
## [3] " left\_join(drug\_deaths) %>%"   
## [4] " left\_join(nonmedical\_use) %>%"   
## [5] " left\_join(demographics) %>%"   
## [6] " left\_join(medical\_cost\_index) %>%"   
## [7] " left\_join(county\_hosp\_costs) %>%"   
## [8] " mutate(nonmedical\_use\_count = nonmedical\_use\_pct \* total\_population/1000,"   
## [9] " drug\_deaths\_mcd = drug\_deaths\_mcd,"   
## [10] " opioid\_deaths = opioid\_deaths %>% as.numeric) %>%"   
## [11] " mutate(log\_drug\_deaths\_mcd = log(drug\_deaths\_mcd),"   
## [12] " log\_nonmedical\_use\_count = log(nonmedical\_use\_count),"   
## [13] " log\_population = log(total\_population),"   
## [14] " log\_income = log(med\_income),"   
## [15] " log\_med\_income = log(med\_income),"   
## [16] " log\_opioid\_deaths = log(opioid\_deaths))"   
## [17] ""   
## [18] "m1 <- glmmTMB(opioid\_deaths ~ log\_drug\_deaths\_mcd + log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black + "   
## [19] " percent\_hispanic + pct\_no\_hs +"   
## [20] " (1|state.fips.character), data = d, family = nbinom2(link = \"log\"), verbose = F)"   
## [21] ""   
## [22] "m2 <- glmmTMB(opioid\_deaths ~ log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black + "   
## [23] " percent\_hispanic + pct\_no\_hs +"   
## [24] " (1|state.fips.character), data = d, family = nbinom2(link = \"log\"), verbose = F)"   
## [25] ""   
## [26] "d1\_deaths <- d %>% filter(!is.na(log\_drug\_deaths\_mcd + log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black + "  
## [27] " percent\_hispanic + pct\_no\_hs))"   
## [28] ""   
## [29] "d1\_deaths <- d1\_deaths %>% mutate(predicted\_opioid\_deaths1 = predict(m1, d1\_deaths, allow.new.levels=TRUE))"   
## [30] ""   
## [31] "d2\_deaths <- d %>% filter(!is.na(log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black + "   
## [32] " percent\_hispanic + pct\_no\_hs))"   
## [33] ""   
## [34] "d2\_deaths <- d2\_deaths %>% mutate(predicted\_opioid\_deaths2 = predict(m2, d2\_deaths, allow.new.levels=TRUE))"   
## [35] ""   
## [36] "proj\_opioid\_deaths <- d %>% select(region, opioid\_deaths, total\_population) %>% "   
## [37] " left\_join(d1\_deaths %>% select(region, predicted\_opioid\_deaths1)) %>% "   
## [38] " left\_join(d2\_deaths %>% select(region, predicted\_opioid\_deaths2)) %>% "   
## [39] " select(region, total\_population, opioid\_deaths, predicted\_opioid\_deaths1, predicted\_opioid\_deaths2)"   
## [40] ""   
## [41] "proj\_opioid\_deaths <- county.regions %>% select(region, state.fips.character, state.abb) %>% "   
## [42] " left\_join(proj\_opioid\_deaths) %>% "   
## [43] " left\_join(state\_opioid\_deaths) %>%"   
## [44] " filter(!is.na(total\_population))"   
## [45] ""   
## [46] "proj\_opioid\_deaths <- proj\_opioid\_deaths %>%"   
## [47] " mutate(est\_opioid\_deaths = case\_when("   
## [48] " !is.na(opioid\_deaths) ~ opioid\_deaths,"   
## [49] " !is.na(predicted\_opioid\_deaths1) ~ predicted\_opioid\_deaths1,"   
## [50] " !is.na(predicted\_opioid\_deaths2) ~ predicted\_opioid\_deaths2)"   
## [51] " ) %>%"   
## [52] " group\_by(state.fips.character) %>%"   
## [53] " mutate(est\_state\_opioid\_deaths = sum(est\_opioid\_deaths, na.rm = T),"   
## [54] " infl\_factor = state\_opioid\_deaths/est\_state\_opioid\_deaths,"   
## [55] " est\_opioid\_deaths = est\_opioid\_deaths \* infl\_factor) %>% ungroup"   
## [56] ""   
## [57] "projection\_summary1 <- proj\_opioid\_deaths %>%"   
## [58] " select(est\_opioid\_deaths, opioid\_deaths, total\_population, state.fips.character) %>%"   
## [59] " mutate(modeled = ifelse(is.na(opioid\_deaths), 1, 0)) %>%"   
## [60] " group\_by(state.fips.character) %>%"   
## [61] " summarise(opioid\_deaths = 100 \* sum(est\_opioid\_deaths, na.rm = T)/sum(total\_population, na.rm = T),"   
## [62] " modeled\_pct = sum(total\_population \* modeled, na.rm = T)/sum(total\_population, na.rm = T))"   
## [63] ""   
## [64] "projection\_summary2 <- proj\_hospital\_costs %>% left\_join(demographics) %>%"   
## [65] " select(total\_costs, est\_total\_hosp\_costs, total\_population, state.fips.character) %>%"   
## [66] " mutate(modeled = ifelse(is.na(total\_costs), 1, 0)) %>%"   
## [67] " group\_by(state.fips.character) %>% "   
## [68] " summarise(per\_capita\_costs = sum(est\_total\_hosp\_costs, na.rm = T)/sum(total\_population, na.rm = T),"   
## [69] " modeled\_pct = sum(total\_population \* modeled, na.rm = T)/sum(total\_population, na.rm = T))"   
## [70] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "opioid\_deaths"  
##   
##   
## $build.model  
## [1] "fatal\_costs <- 431.7"   
## [2] "total\_nonfatal\_costs <- 72.3"   
## [3] "nonfatal\_health\_costs <- total\_nonfatal\_costs \* 0.5068966"   
## [4] "total\_criminal\_justice\_costs <- total\_nonfatal\_costs \* 0.1344828"   
## [5] "total\_productivity\_costs <- total\_nonfatal\_costs \* 0.3586207 "   
## [6] ""   
## [7] ""   
## [8] "d <- county.regions %>% tbl\_df %>% "   
## [9] " left\_join(proj\_opioid\_deaths %>% select(region, est\_opioid\_deaths)) %>%"   
## [10] " left\_join(proj\_hospital\_costs %>% select(region, est\_total\_hosp\_costs)) %>%"   
## [11] " left\_join(nonmedical\_use) %>%"   
## [12] " left\_join(medical\_cost\_index) %>%"   
## [13] " left\_join(criminal\_costs) %>%"   
## [14] " left\_join(demographics)"   
## [15] ""   
## [16] "d <- d %>% filter(!is.na(total\_population), !is.na(med\_income)) %>% "   
## [17] " mutate(death\_wt = est\_opioid\_deaths/sum(est\_opioid\_deaths, na.rm = T),"   
## [18] " death\_cost = death\_wt \* fatal\_costs \* 10^9,"   
## [19] " death\_cost\_pc = death\_cost/total\_population) %>%"   
## [20] " mutate(health\_wt = est\_total\_hosp\_costs/sum(est\_total\_hosp\_costs),"   
## [21] " health\_cost = health\_wt \* nonfatal\_health\_costs \* 10^9,"   
## [22] " health\_cost\_pc = health\_cost/total\_population) %>%"   
## [23] " mutate(criminal\_wt = (nonmedical\_use\_pct \* total\_population \* criminal\_cost\_per\_capita)/sum(nonmedical\_use\_pct \* total\_population \* criminal\_cost\_per\_capita),"  
## [24] " criminal\_cost = criminal\_wt \* total\_criminal\_justice\_costs \* 10^9,"   
## [25] " criminal\_cost\_pc = criminal\_cost/total\_population) %>%"   
## [26] " mutate(productivity\_wt = (med\_income \* 0.175 \* nonmedical\_use\_pct \* working\_population)/sum(med\_income \* 0.175 \* nonmedical\_use\_pct \* working\_population),"   
## [27] " productivity\_cost = productivity\_wt \* total\_productivity\_costs \* 10^9,"   
## [28] " productivity\_cost\_pc = productivity\_cost/total\_population)"   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "build.model"  
##   
##   
## $make.county.maps  
## [1] ""   
## [2] "o <- d %>% "   
## [3] " filter(total\_population > 2500, !(state.name %in% c(\"alaska\", \"hawaii\"))) %>%"   
## [4] " mutate(per\_capita\_nf\_cost = (criminal\_cost + health\_cost + productivity\_cost)/total\_population,"   
## [5] " per\_capita\_total\_cost = (criminal\_cost + health\_cost + productivity\_cost + death\_cost)/total\_population)"  
## [6] ""   
## [7] "write\_csv(o, \"../out/county\_data.csv\")"   
## [8] ""   
## [9] "### NON-FATAL COSTS"   
## [10] ""   
## [11] "map1 <- o %>% select(region, per\_capita\_nf\_cost) %>%"   
## [12] " mutate(value = per\_capita\_nf\_cost) %>%"   
## [13] " select(region, value)"   
## [14] ""   
## [15] "q <- c(56, 129, 153, 183, 231, 727)"   
## [16] ""   
## [17] "c = CountyChoropleth$new(map1)"   
## [18] "c$title = \"Non-Fatal Opioid Costs Per Capita by County in 2015\""   
## [19] "c$set\_num\_colors(5)"   
## [20] "c$set\_zoom(state.regions$region[-c(1, 12)])"   
## [21] "c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, \"Oranges\"),"   
## [22] " name = \"Per Capita Cost\","   
## [23] " labels = c(str\_c(\"$\", q[1] %>% round, \" to $\", q[2] %>% round),"   
## [24] " str\_c(\"$\", q[2] %>% round, \" to $\", q[3] %>% round),"   
## [25] " str\_c(\"$\", q[3] %>% round, \" to $\", q[4] %>% round),"   
## [26] " str\_c(\"$\", q[4] %>% round, \" to $\", q[5] %>% round),"   
## [27] " str\_c(\"$\", q[5] %>% round, \" to $\", q[6] %>% round)),"   
## [28] " na.value = \"black\","   
## [29] " drop = F)"   
## [30] ""   
## [31] "c$render() + "   
## [32] " theme(text=element\_text(size=14, family=\"Times\")) +"   
## [33] " theme(plot.title = element\_text(hjust = 0.5),"   
## [34] " plot.caption = element\_text(size = 8),"   
## [35] " legend.title = element\_text(size = 12),"   
## [36] " legend.text = element\_text(size = 10))"   
## [37] ""   
## [38] "### TOTAL COSTS"   
## [39] ""   
## [40] "map2 <- o %>% select(region, per\_capita\_total\_cost) %>%"   
## [41] " mutate(value = per\_capita\_total\_cost) %>%"   
## [42] " select(region, value)"   
## [43] ""   
## [44] "q <- c(160, 824, 1153, 1585, 2232, 8734)"   
## [45] ""   
## [46] "c = CountyChoropleth$new(map2)"   
## [47] "c$title = \"Total Opioid Costs Per Capita by County in 2015\""   
## [48] "c$set\_num\_colors(5)"   
## [49] "c$set\_zoom(state.regions$region[-c(1, 12)])"   
## [50] "c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, \"Oranges\"),"   
## [51] " name = \"Per Capita Cost\","   
## [52] " na.value = \"black\","   
## [53] " labels = c(str\_c(\"$\", q[1] %>% round, \" to $\", q[2] %>% round),"   
## [54] " str\_c(\"$\", q[2] %>% round, \" to $\", q[3] %>% round),"   
## [55] " str\_c(\"$\", q[3] %>% round, \" to $\", q[4] %>% round),"   
## [56] " str\_c(\"$\", q[4] %>% round, \" to $\", q[5] %>% round),"   
## [57] " str\_c(\"$\", q[5] %>% round, \" to $\", q[6] %>% round)),"   
## [58] " drop = F)"   
## [59] ""   
## [60] "c$render() + "   
## [61] " theme(text=element\_text(size=14, family=\"Times\")) +"   
## [62] " theme(plot.title = element\_text(hjust = 0.5),"   
## [63] " plot.caption = element\_text(size = 8),"   
## [64] " legend.title = element\_text(size = 12),"   
## [65] " legend.text = element\_text(size = 10))"   
## [66] ""   
## [67] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "make.county.maps"  
##   
##   
## $make.state.maps  
## [1] ""   
## [2] "o2 <- d %>% group\_by(state.name) %>%"   
## [3] " summarise(criminal\_cost = sum(criminal\_cost),"   
## [4] " health\_cost = sum(health\_cost),"   
## [5] " productivity\_cost = sum(productivity\_cost),"   
## [6] " death\_cost = sum(death\_cost),"   
## [7] " total\_cost = sum(criminal\_cost + health\_cost + productivity\_cost),"   
## [8] " total\_population = sum(total\_population),"   
## [9] " health\_cost\_pc = sum(health\_cost)/sum(total\_population),"   
## [10] " productivity\_cost\_pc = sum(productivity\_cost)/sum(total\_population),"   
## [11] " death\_cost\_pc = sum(death\_cost)/sum(total\_population)) %>%"   
## [12] " ungroup %>%"   
## [13] " mutate(per\_capita\_nf\_cost = (criminal\_cost + health\_cost + productivity\_cost)/total\_population,"   
## [14] " per\_capita\_total\_cost = (criminal\_cost + health\_cost + productivity\_cost + death\_cost)/total\_population,"  
## [15] " region = state.name)"   
## [16] ""   
## [17] "write\_csv(o2, \"../out/state\_data.csv\")"   
## [18] ""   
## [19] "### NON-FATAL COSTS"   
## [20] ""   
## [21] "map3 <- o2 %>% select(region, per\_capita\_nf\_cost) %>%"   
## [22] " mutate(value = per\_capita\_nf\_cost) %>%"   
## [23] " select(region, value)"   
## [24] ""   
## [25] "q <- c(118, 160, 195, 226, 289, 493)"   
## [26] ""   
## [27] "c = StateChoropleth$new(map3)"   
## [28] "c$title = \"Non-Fatal Opioid Costs Per Capita by State in 2015\""   
## [29] "c$set\_num\_colors(5)"   
## [30] "c$set\_zoom(state.regions$region[-c(1, 12)])"   
## [31] "c$show\_labels = FALSE"   
## [32] "c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, \"Oranges\"),"   
## [33] " name = \"Per Capita Cost\","   
## [34] " na.value = \"black\","   
## [35] " labels = c(str\_c(\"$\", q[1] %>% round, \" to $\", q[2] %>% round),"   
## [36] " str\_c(\"$\", q[2] %>% round, \" to $\", q[3] %>% round),"   
## [37] " str\_c(\"$\", q[3] %>% round, \" to $\", q[4] %>% round),"   
## [38] " str\_c(\"$\", q[4] %>% round, \" to $\", q[5] %>% round),"   
## [39] " str\_c(\"$\", q[5] %>% round, \" to $\", q[6] %>% round)),"   
## [40] " drop = F)"   
## [41] ""   
## [42] "c$render() + "   
## [43] " theme(text=element\_text(size=14, family=\"Times\")) +"   
## [44] " theme(plot.title = element\_text(hjust = 0.5),"   
## [45] " plot.caption = element\_text(size = 8),"   
## [46] " legend.title = element\_text(size = 12),"   
## [47] " legend.text = element\_text(size = 10))"   
## [48] ""   
## [49] "### TOTAL COSTS"   
## [50] ""   
## [51] "map4 <- o2 %>% select(region, per\_capita\_total\_cost) %>%"   
## [52] " mutate(value = per\_capita\_total\_cost) %>%"   
## [53] " select(region, value)"   
## [54] ""   
## [55] "q <- c(394, 907, 1385, 1827, 2530, 4378)"   
## [56] ""   
## [57] "c = StateChoropleth$new(map4)"   
## [58] "c$title = \"Total Opioid Costs Per Capita by State in 2015\""   
## [59] "c$set\_num\_colors(5)"   
## [60] "c$set\_zoom(state.regions$region[-c(1, 12)])"   
## [61] "c$show\_labels = FALSE"   
## [62] "c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, \"Oranges\"),"   
## [63] " name = \"Per Capita Cost\","   
## [64] " labels = c(str\_c(\"$\", q[1] %>% round, \" to $\", q[2] %>% round),"   
## [65] " str\_c(\"$\", q[2] %>% round, \" to $\", q[3] %>% round),"   
## [66] " str\_c(\"$\", q[3] %>% round, \" to $\", q[4] %>% round),"   
## [67] " str\_c(\"$\", q[4] %>% round, \" to $\", q[5] %>% round),"   
## [68] " str\_c(\"$\", q[5] %>% round, \" to $\", q[6] %>% round)),"   
## [69] " na.value = \"black\","   
## [70] " drop = F)"   
## [71] ""   
## [72] "c$render() + "   
## [73] " theme(text=element\_text(size=14, family=\"Times\")) +"   
## [74] " theme(plot.title = element\_text(hjust = 0.5),"   
## [75] " plot.caption = element\_text(size = 8),"   
## [76] " legend.title = element\_text(size = 12),"   
## [77] " legend.text = element\_text(size = 10))"   
## [78] ""   
## attr(,"chunk\_opts")  
## attr(,"chunk\_opts")$label  
## [1] "make.state.maps"

### Criminal Justice Costs

criminal\_costs <- read\_csv("../data/criminal\_justice\_expenditures.csv",  
 skip = 25, col\_names = F) %>%  
 na.omit %>%  
 filter(X2 != "-") %>%  
 select(X1, X2, X4) %>%  
 mutate(state = X1, criminal\_cost\_per\_capita = X4/(X2 %>% as.numeric \* 1000)) %>%  
 select(state, criminal\_cost\_per\_capita)

## Parsed with column specification:  
## cols(  
## X1 = col\_character(),  
## X2 = col\_character(),  
## X3 = col\_integer(),  
## X4 = col\_integer(),  
## X5 = col\_double(),  
## X6 = col\_integer(),  
## X7 = col\_double(),  
## X8 = col\_integer(),  
## X9 = col\_double(),  
## X10 = col\_integer(),  
## X11 = col\_double()  
## )

criminal\_costs <- county.regions %>%  
 select(region, state.name) %>%  
 left\_join(criminal\_costs %>% mutate(state.name = state %>% tolower) %>%  
 select(state.name, criminal\_cost\_per\_capita)) %>%  
 select(region, criminal\_cost\_per\_capita)

## Joining, by = "state.name"

### Overall Drug-related Deaths

drug\_deaths\_ucd <- read\_tsv("../data/Drug Deaths 2016 - UCD.txt") %>%  
 filter(!is.na(`County Code`)) %>%  
 mutate(region = `County Code` %>% as.numeric,  
 drug\_deaths\_ucd = Deaths) %>%  
 select(region, drug\_deaths\_ucd)

## Parsed with column specification:  
## cols(  
## Notes = col\_character(),  
## County = col\_character(),  
## `County Code` = col\_character(),  
## Deaths = col\_integer(),  
## Population = col\_integer(),  
## `Crude Rate` = col\_character()  
## )

## Warning in rbind(names(probs), probs\_f): number of columns of result is not  
## a multiple of vector length (arg 1)

## Warning: 80 parsing failures.  
## row # A tibble: 5 x 5 col row col expected actual file expected <int> <chr> <chr> <chr> <chr> actual 1 962 <NA> 6 columns 1 columns '../data/Drug Deaths 2016 - UCD.txt' file 2 963 <NA> 6 columns 1 columns '../data/Drug Deaths 2016 - UCD.txt' row 3 964 <NA> 6 columns 1 columns '../data/Drug Deaths 2016 - UCD.txt' col 4 965 <NA> 6 columns 1 columns '../data/Drug Deaths 2016 - UCD.txt' expected 5 966 <NA> 6 columns 1 columns '../data/Drug Deaths 2016 - UCD.txt'  
## ... ................. ... ...................................................................... ........ ...................................................................... ...... ...................................................................... .... ...................................................................... ... ...................................................................... ... ...................................................................... ........ ......................................................................  
## See problems(...) for more details.

drug\_deaths\_mcd <- read\_tsv("../data/Drug Deaths 2016 - MCD.txt") %>%  
 filter(!is.na(`County Code`)) %>%  
 mutate(region = `County Code` %>% as.numeric,  
 drug\_deaths\_mcd = Deaths) %>%  
 select(region, drug\_deaths\_mcd)

## Parsed with column specification:  
## cols(  
## Notes = col\_character(),  
## County = col\_character(),  
## `County Code` = col\_character(),  
## Deaths = col\_integer(),  
## Population = col\_integer(),  
## `Crude Rate` = col\_character()  
## )

## Warning in rbind(names(probs), probs\_f): number of columns of result is not  
## a multiple of vector length (arg 1)

## Warning: 126 parsing failures.  
## row # A tibble: 5 x 5 col row col expected actual expected <int> <chr> <chr> <chr> actual 1 2616 Population an integer 5435746389 file 2 2617 <NA> 6 columns 1 columns row 3 2618 <NA> 6 columns 1 columns col 4 2619 <NA> 6 columns 1 columns expected 5 2620 <NA> 6 columns 1 columns actual # ... with 1 more variables: file <chr>  
## ... ................. ... ........................................ ........ ........................................ ...... ........................................ .... ........................................ ... ........................................ ... ........................................ ........ ........................................ ...... .......................................  
## See problems(...) for more details.

drug\_deaths <- county.regions %>% select(region) %>%  
 left\_join(drug\_deaths\_ucd) %>%  
 left\_join(drug\_deaths\_mcd)

## Joining, by = "region"

## Joining, by = "region"

### HOSPITALIZATION COSTS

hospitalization\_costs <- read\_rds("../data/hospitalization\_costs.rds")  
  
county\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name != "State Total") %>%  
 mutate(county.name = region\_name %>% tolower %>% str\_trim,  
 state.name = state\_name %>% tolower %>% str\_trim) %>%  
 inner\_join(county.regions) %>%  
 select(region, discharges, mean\_costs, per\_capita\_costs, total\_costs)

## Joining, by = c("county.name", "state.name")

state\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name == "State Total") %>%  
 mutate(region = state\_name %>% tolower %>% str\_trim,  
 state\_total\_costs = total\_costs,  
 state\_discharges = discharges,  
 state\_mean\_costs = mean\_costs) %>%  
 select(region, state\_total\_costs, state\_discharges, state\_mean\_costs)

### COUNTY/STATE COVARIATES

population <- get\_acs(geography = "county",  
 variables = c(population = "B01003\_001"),  
 survey = "acs5",  
 year = 2016) %>%  
 mutate(region = GEOID %>% as.numeric,  
 total\_population = estimate) %>%  
 select(region, total\_population)

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

workers <- get\_acs(geography = "county",  
 variables = c(m2534 = "B15001\_011",  
 m3544 = "B15001\_019",  
 m4564 = "B15001\_027",  
 f2534 = "B15001\_052",  
 f3544 = "B15001\_060",  
 f4564 = "B15001\_068"),  
 survey = "acs5",  
 year = 2016) %>%  
 group\_by(GEOID) %>%  
 summarise(working\_population = sum(estimate, na.rm = T)) %>%  
 mutate(region = GEOID %>% as.numeric) %>%   
 select(region, working\_population) %>% ungroup

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

educational\_attainment <- get\_acs("county",  
 variables = c("B06009\_001", "B06009\_002", "B06009\_003"), year = 2016, survey = "acs5") %>%  
 group\_by(GEOID) %>%  
 summarise(pct\_no\_hs = estimate[2]/estimate[1],  
 pct\_hs = estimate[3]/estimate[1],  
 pct\_college = 1 - pct\_no\_hs - pct\_hs) %>%  
 rename(region = GEOID) %>%  
 mutate(region = region %>% as.numeric)

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

urban\_rural <- read\_excel("../data/percent\_rural.xlsx") %>%  
 mutate(region = GEOID %>% as.numeric,  
 percent\_rural = `2010 Census \r\nPercent Rural`) %>%  
 select(region, percent\_rural)

## Warning in function\_list[[k]](value): NAs introduced by coercion

race <- get\_acs(geography = "county",  
 variables = c(total\_population = "B03002\_001",  
 black\_alone\_not\_hispanic = "B03002\_004",  
 hispanic\_all\_races = "B03002\_012"),  
 survey = "acs5", year = 2016) %>%  
 group\_by(GEOID) %>%  
 summarise(percent\_black = estimate[2]/estimate[1] \* 100,  
 percent\_hispanic = estimate[3]/estimate[1] \* 100) %>%  
 mutate(region = GEOID %>% as.numeric) %>%  
 select(region, percent\_black, percent\_hispanic)

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

# med\_income <- get\_acs(geography = "county",  
# variables = c(med\_income\_per\_capita = "B06011\_001"),  
# survey = "acs5", year = 2016) %>%  
# mutate(region = GEOID %>% as.numeric,  
# med\_income\_per\_capita = estimate) %>%  
# select(region, med\_income\_per\_capita)  
  
# mean\_income <- get\_acs(geography = "county",  
# variables = c(income\_per\_capita = "B19301\_001"),  
# survey = "acs5", year = 2016) %>%  
# mutate(region = GEOID %>% as.numeric,  
# mean\_income\_per\_capita = estimate) %>%  
# select(region, mean\_income\_per\_capita)  
  
st\_population <- get\_acs(geography = "state",  
 variables = c(population = "B01003\_001"),  
 survey = "acs5",  
 year = 2016) %>%  
 mutate(region = NAME %>% tolower,  
 total\_population = estimate) %>%  
 select(region, total\_population)

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

st\_workers <- get\_acs(geography = "state",  
 variables = c(m2534 = "B15001\_011",  
 m3544 = "B15001\_019",  
 m4564 = "B15001\_027",  
 f2534 = "B15001\_052",  
 f3544 = "B15001\_060",  
 f4564 = "B15001\_068"),  
 survey = "acs5",  
 year = 2016) %>%  
 group\_by(GEOID) %>%  
 summarise(working\_population = sum(estimate, na.rm = T)) %>%  
 rename(region = GEOID) %>% ungroup

## Please note: `get\_acs()` now defaults to a year or endyear of 2016.

# st\_income <- get\_acs(geography = "state",  
# variables = c(income\_per\_capita = "B06011\_001"),  
# survey = "acs5", year = 2016) %>%  
# mutate(region = NAME %>% tolower,  
# income\_per\_capita = estimate) %>%  
# select(region, income\_per\_capita)  
  
income <- read\_excel("../data/est16all.xls", skip = 3) %>% select(`State FIPS Code`, `County FIPS Code`, `Median Household Income`)  
  
med\_income <- income %>% mutate(med\_income = `Median Household Income` %>% as.numeric,  
 region = str\_c(`State FIPS Code`, `County FIPS Code`) %>% as.numeric) %>%  
 right\_join(county.regions) %>% select(region, med\_income)

## Warning in function\_list[[k]](value): NAs introduced by coercion

## Joining, by = "region"

st\_income <- income %>% filter(`County FIPS Code` == "000") %>%  
 mutate(st\_med\_income = `Median Household Income` %>% as.numeric,  
 fips.character = `State FIPS Code`) %>%  
 right\_join(state.regions) %>%  
 select(region, st\_med\_income)

## Joining, by = "fips.character"

demographics <- county.regions %>%   
 select(region) %>%   
 left\_join(population) %>%  
 left\_join(workers) %>%  
 left\_join(race) %>%   
 left\_join(med\_income) %>%  
 left\_join(urban\_rural) %>%  
 left\_join(educational\_attainment) %>% tbl\_df

## Joining, by = "region"

## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"

st\_demographics <- state.regions %>%  
 select(region, fips.character) %>%  
 left\_join(st\_income) %>%  
 left\_join(st\_population) %>%  
 left\_join(st\_workers)

## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"

### BUILD HEALTH COSTS MODEL

county\_hosp\_costs <- hospitalization\_costs %>% filter(region\_name != "State Total") %>%  
 mutate(county.name = region\_name %>% tolower %>% str\_trim,  
 state.name = state\_name %>% tolower %>% str\_trim) %>%  
 right\_join(county.regions)

## Joining, by = c("county.name", "state.name")

state\_hosp\_costs <- state\_hosp\_costs %>% right\_join(state.regions) %>% rename(state.name = region)

## Joining, by = "region"

hosp\_costs <- county\_hosp\_costs %>% left\_join(state\_hosp\_costs) %>% left\_join(demographics) %>%  
 left\_join(st\_demographics %>% rename(state.name = region, total\_st\_population = total\_population))

## Joining, by = "state.name"

## Joining, by = "region"

## Joining, by = c("state.name", "fips.character", "working\_population")

hosp\_costs\_model <- county\_hosp\_costs %>%   
 left\_join(medical\_cost\_index) %>%  
 left\_join(nonmedical\_use) %>%  
 left\_join(demographics) %>%  
 left\_join(opioid\_deaths) %>%  
 left\_join(drug\_deaths) %>%  
 mutate(log\_total\_hosp\_costs = log(total\_costs),  
 log\_population = log(total\_population),  
 log\_nonmedical\_use\_count = log(total\_population/1000 \* nonmedical\_use\_pct),  
 log\_opioid\_deaths = log(opioid\_deaths),  
 log\_drug\_deaths\_mcd = log(drug\_deaths\_mcd))

## Joining, by = "region"

## Joining, by = c("region", "state.fips.character")

## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"

h1 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_opioid\_deaths + log\_drug\_deaths\_mcd + (1|state.fips.character), data = hosp\_costs\_model)  
  
h1\_adj = sum(exp(resid(h1)))/(length(resid(h1)) - 7)  
  
h2 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_drug\_deaths\_mcd + (1|state.fips.character), data = hosp\_costs\_model)  
  
h2\_adj = sum(exp(resid(h2)))/(length(resid(h2)) - 6)  
  
h3 <- lmer(log\_total\_hosp\_costs ~ medical\_cost + log\_nonmedical\_use\_count + log\_population + (1|state.fips.character), data = hosp\_costs\_model)  
  
h3\_adj = sum(exp(resid(h3)))/(length(resid(h3)) - 5)  
  
state\_opioid\_deaths <- read\_tsv("../data/State Opioid Deaths 2016 - MCD.txt") %>%  
 select(-Notes) %>%  
 filter(!is.na(State)) %>%  
 mutate(state.fips.character = `State Code`,  
 state\_opioid\_deaths = Deaths) %>%  
 select(state.fips.character, state\_opioid\_deaths)

## Parsed with column specification:  
## cols(  
## Notes = col\_character(),  
## State = col\_character(),  
## `State Code` = col\_character(),  
## Deaths = col\_integer(),  
## Population = col\_integer(),  
## `Crude Rate` = col\_double()  
## )

## Warning in rbind(names(probs), probs\_f): number of columns of result is not  
## a multiple of vector length (arg 1)

## Warning: 59 parsing failures.  
## row # A tibble: 5 x 5 col row col expected actual expected <int> <chr> <chr> <chr> actual 1 53 <NA> 6 columns 1 columns file 2 54 <NA> 6 columns 1 columns row 3 55 <NA> 6 columns 1 columns col 4 56 <NA> 6 columns 1 columns expected 5 57 <NA> 6 columns 1 columns actual # ... with 1 more variables: file <chr>  
## ... ................. ... ................................. ........ ................................. ...... ................................. .... ................................. ... ................................. ... ................................. ........ ................................. ...... .......................................  
## See problems(...) for more details.

state\_medical\_costs <- medical\_cost\_index %>% left\_join(demographics) %>%  
 left\_join(county.regions %>% select(region, state.fips.character)) %>%  
 group\_by(state.fips.character) %>%   
 summarise(medical\_cost = sum(total\_population/sum(total\_population, na.rm = T) \* medical\_cost, na.rm = T))

## Joining, by = "region"  
## Joining, by = "region"

state\_hosp\_costs\_model <- state\_hosp\_costs %>%  
 left\_join(st\_demographics) %>%  
 left\_join(state\_opioid\_deaths %>% rename(fips.character = state.fips.character)) %>%  
 left\_join(state\_medical\_costs %>% rename(fips.character = state.fips.character)) %>%  
 mutate(log\_hospital\_costs = log(state\_total\_costs),  
 log\_total\_population = log(total\_population),  
 log\_mean\_cost = log(state\_mean\_costs),  
 log\_opioid\_deaths = log(state\_opioid\_deaths),  
 log\_income = log(st\_med\_income))

## Joining, by = "fips.character"

## Joining, by = "fips.character"  
## Joining, by = "fips.character"

sh1 <- lm(log\_hospital\_costs ~ log\_total\_population +  
 log\_opioid\_deaths + medical\_cost + log\_income, data = state\_hosp\_costs\_model)  
  
sh1\_adj <- sum(exp(resid(sh1)))/26  
  
state\_hosp\_costs <- state\_hosp\_costs\_model %>%  
 mutate(state\_est\_hosp\_costs = ifelse(is.na(state\_total\_costs), exp(predict(sh1, state\_hosp\_costs\_model)) \* sh1\_adj, state\_total\_costs),  
 state\_costs\_per\_capita = state\_est\_hosp\_costs/total\_population) %>%  
 select(fips.character, state\_est\_hosp\_costs, state\_costs\_per\_capita)  
  
d1\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_opioid\_deaths + log\_drug\_deaths\_mcd))  
  
d1\_hosp <- d1\_hosp %>% mutate(predicted\_hospitalization\_costs1 = exp(predict(h1, d1\_hosp, allow.new.levels=TRUE)) \* h1\_adj)  
  
d2\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population + log\_drug\_deaths\_mcd))  
  
d2\_hosp <- d2\_hosp %>% mutate(predicted\_hospitalization\_costs2 = exp(predict(h2, d2\_hosp, allow.new.levels=TRUE)) \* h2\_adj)  
  
d3\_hosp <- hosp\_costs\_model %>% filter(!is.na(medical\_cost + log\_nonmedical\_use\_count + log\_population))  
  
d3\_hosp <- d3\_hosp %>% mutate(predicted\_hospitalization\_costs3 = exp(predict(h3, d3\_hosp, allow.new.levels=TRUE)) \* h3\_adj)  
  
proj\_hospital\_costs <- hosp\_costs\_model %>% select(region, state.fips.character, total\_costs) %>%  
 left\_join(state\_hosp\_costs %>% rename(state.fips.character = fips.character)) %>%  
 left\_join(d1\_hosp %>% select(region, predicted\_hospitalization\_costs1)) %>%   
 left\_join(d2\_hosp %>% select(region, predicted\_hospitalization\_costs2)) %>%   
 left\_join(d3\_hosp %>% select(region, predicted\_hospitalization\_costs3)) %>%  
 mutate(est\_total\_hosp\_costs = case\_when(  
 !is.na(total\_costs) ~ total\_costs,  
 !is.na(predicted\_hospitalization\_costs1) ~ predicted\_hospitalization\_costs1,  
 !is.na(predicted\_hospitalization\_costs2) ~ predicted\_hospitalization\_costs2,  
 !is.na(predicted\_hospitalization\_costs3) ~ predicted\_hospitalization\_costs3)) %>%  
 group\_by(state.fips.character) %>%  
 mutate(total\_est\_costs = sum(est\_total\_hosp\_costs, na.rm = T)) %>%  
 mutate(infl\_factor = state\_est\_hosp\_costs/total\_est\_costs,  
 est\_total\_hosp\_costs = est\_total\_hosp\_costs \* infl\_factor) %>% ungroup

## Joining, by = "state.fips.character"

## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"

### BUILD OPIOID DEATH MODEL

d <- county.regions %>% tbl\_df %>% dplyr::select(region, state.fips.character) %>%  
 left\_join(opioid\_deaths) %>%  
 left\_join(drug\_deaths) %>%  
 left\_join(nonmedical\_use) %>%  
 left\_join(demographics) %>%  
 left\_join(medical\_cost\_index) %>%  
 left\_join(county\_hosp\_costs) %>%  
 mutate(nonmedical\_use\_count = nonmedical\_use\_pct \* total\_population/1000,  
 drug\_deaths\_mcd = drug\_deaths\_mcd,  
 opioid\_deaths = opioid\_deaths %>% as.numeric) %>%  
 mutate(log\_drug\_deaths\_mcd = log(drug\_deaths\_mcd),  
 log\_nonmedical\_use\_count = log(nonmedical\_use\_count),  
 log\_population = log(total\_population),  
 log\_income = log(med\_income),  
 log\_med\_income = log(med\_income),  
 log\_opioid\_deaths = log(opioid\_deaths))

## Joining, by = "region"  
## Joining, by = "region"

## Joining, by = c("region", "state.fips.character")

## Joining, by = "region"  
## Joining, by = "region"

## Joining, by = c("region", "state.fips.character")

m1 <- glmmTMB(opioid\_deaths ~ log\_drug\_deaths\_mcd + log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black +   
 percent\_hispanic + pct\_no\_hs +  
 (1|state.fips.character), data = d, family = nbinom2(link = "log"), verbose = F)  
  
m2 <- glmmTMB(opioid\_deaths ~ log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black +   
 percent\_hispanic + pct\_no\_hs +  
 (1|state.fips.character), data = d, family = nbinom2(link = "log"), verbose = F)  
  
d1\_deaths <- d %>% filter(!is.na(log\_drug\_deaths\_mcd + log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black +   
 percent\_hispanic + pct\_no\_hs))  
  
d1\_deaths <- d1\_deaths %>% mutate(predicted\_opioid\_deaths1 = predict(m1, d1\_deaths, allow.new.levels=TRUE))  
  
d2\_deaths <- d %>% filter(!is.na(log\_nonmedical\_use\_count + log\_population + log\_med\_income + percent\_rural + percent\_black +   
 percent\_hispanic + pct\_no\_hs))  
  
d2\_deaths <- d2\_deaths %>% mutate(predicted\_opioid\_deaths2 = predict(m2, d2\_deaths, allow.new.levels=TRUE))  
  
proj\_opioid\_deaths <- d %>% select(region, opioid\_deaths, total\_population) %>%   
 left\_join(d1\_deaths %>% select(region, predicted\_opioid\_deaths1)) %>%   
 left\_join(d2\_deaths %>% select(region, predicted\_opioid\_deaths2)) %>%   
 select(region, total\_population, opioid\_deaths, predicted\_opioid\_deaths1, predicted\_opioid\_deaths2)

## Joining, by = "region"

## Joining, by = "region"

proj\_opioid\_deaths <- county.regions %>% select(region, state.fips.character, state.abb) %>%   
 left\_join(proj\_opioid\_deaths) %>%   
 left\_join(state\_opioid\_deaths) %>%  
 filter(!is.na(total\_population))

## Joining, by = "region"

## Joining, by = "state.fips.character"

proj\_opioid\_deaths <- proj\_opioid\_deaths %>%  
 mutate(est\_opioid\_deaths = case\_when(  
 !is.na(opioid\_deaths) ~ opioid\_deaths,  
 !is.na(predicted\_opioid\_deaths1) ~ predicted\_opioid\_deaths1,  
 !is.na(predicted\_opioid\_deaths2) ~ predicted\_opioid\_deaths2)  
 ) %>%  
 group\_by(state.fips.character) %>%  
 mutate(est\_state\_opioid\_deaths = sum(est\_opioid\_deaths, na.rm = T),  
 infl\_factor = state\_opioid\_deaths/est\_state\_opioid\_deaths,  
 est\_opioid\_deaths = est\_opioid\_deaths \* infl\_factor) %>% ungroup  
  
projection\_summary1 <- proj\_opioid\_deaths %>%  
 select(est\_opioid\_deaths, opioid\_deaths, total\_population, state.fips.character) %>%  
 mutate(modeled = ifelse(is.na(opioid\_deaths), 1, 0)) %>%  
 group\_by(state.fips.character) %>%  
 summarise(opioid\_deaths = 100 \* sum(est\_opioid\_deaths, na.rm = T)/sum(total\_population, na.rm = T),  
 modeled\_pct = sum(total\_population \* modeled, na.rm = T)/sum(total\_population, na.rm = T))  
  
projection\_summary2 <- proj\_hospital\_costs %>% left\_join(demographics) %>%  
 select(total\_costs, est\_total\_hosp\_costs, total\_population, state.fips.character) %>%  
 mutate(modeled = ifelse(is.na(total\_costs), 1, 0)) %>%  
 group\_by(state.fips.character) %>%   
 summarise(per\_capita\_costs = sum(est\_total\_hosp\_costs, na.rm = T)/sum(total\_population, na.rm = T),  
 modeled\_pct = sum(total\_population \* modeled, na.rm = T)/sum(total\_population, na.rm = T))

## Joining, by = "region"

### DEVELOP COUNTY-LEVEL ESTIMATES

fatal\_costs <- 431.7  
total\_nonfatal\_costs <- 72.3  
nonfatal\_health\_costs <- total\_nonfatal\_costs \* 0.5068966  
total\_criminal\_justice\_costs <- total\_nonfatal\_costs \* 0.1344828  
total\_productivity\_costs <- total\_nonfatal\_costs \* 0.3586207   
  
  
d <- county.regions %>% tbl\_df %>%   
 left\_join(proj\_opioid\_deaths %>% select(region, est\_opioid\_deaths)) %>%  
 left\_join(proj\_hospital\_costs %>% select(region, est\_total\_hosp\_costs)) %>%  
 left\_join(nonmedical\_use) %>%  
 left\_join(medical\_cost\_index) %>%  
 left\_join(criminal\_costs) %>%  
 left\_join(demographics)

## Joining, by = "region"  
## Joining, by = "region"

## Joining, by = c("region", "state.fips.character")

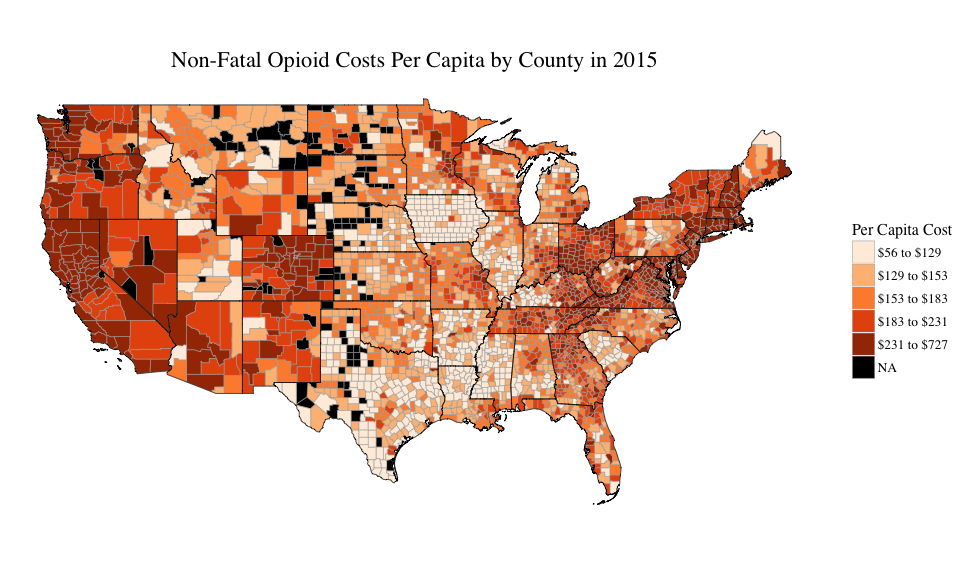
## Joining, by = "region"  
## Joining, by = "region"  
## Joining, by = "region"

d <- d %>% filter(!is.na(total\_population), !is.na(med\_income)) %>%   
 mutate(death\_wt = est\_opioid\_deaths/sum(est\_opioid\_deaths, na.rm = T),  
 death\_cost = death\_wt \* fatal\_costs \* 10^9,  
 death\_cost\_pc = death\_cost/total\_population) %>%  
 mutate(health\_wt = est\_total\_hosp\_costs/sum(est\_total\_hosp\_costs),  
 health\_cost = health\_wt \* nonfatal\_health\_costs \* 10^9,  
 health\_cost\_pc = health\_cost/total\_population) %>%  
 mutate(criminal\_wt = (nonmedical\_use\_pct \* total\_population \* criminal\_cost\_per\_capita)/sum(nonmedical\_use\_pct \* total\_population \* criminal\_cost\_per\_capita),  
 criminal\_cost = criminal\_wt \* total\_criminal\_justice\_costs \* 10^9,  
 criminal\_cost\_pc = criminal\_cost/total\_population) %>%  
 mutate(productivity\_wt = (med\_income \* 0.175 \* nonmedical\_use\_pct \* working\_population)/sum(med\_income \* 0.175 \* nonmedical\_use\_pct \* working\_population),  
 productivity\_cost = productivity\_wt \* total\_productivity\_costs \* 10^9,  
 productivity\_cost\_pc = productivity\_cost/total\_population)

### MAKE MAPS FOR COUNTIES

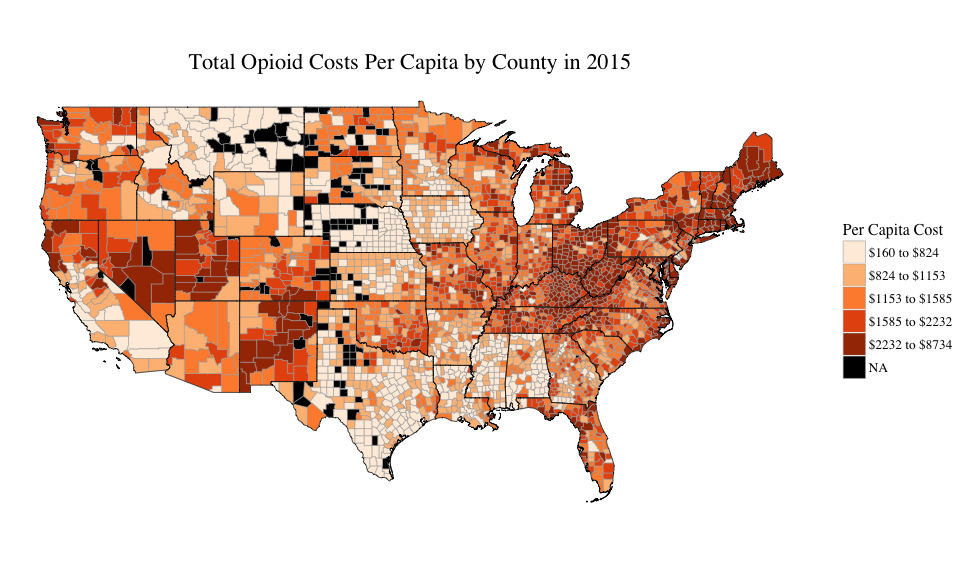
o <- d %>%   
 filter(total\_population > 2500, !(state.name %in% c("alaska", "hawaii"))) %>%  
 mutate(per\_capita\_nf\_cost = (criminal\_cost + health\_cost + productivity\_cost)/total\_population,  
 per\_capita\_total\_cost = (criminal\_cost + health\_cost + productivity\_cost + death\_cost)/total\_population)  
  
write\_csv(o, "../out/county\_data.csv")  
  
### NON-FATAL COSTS  
  
map1 <- o %>% select(region, per\_capita\_nf\_cost) %>%  
 mutate(value = per\_capita\_nf\_cost) %>%  
 select(region, value)  
  
q <- c(56, 129, 153, 183, 231, 727)  
  
c = CountyChoropleth$new(map1)  
c$title = "Non-Fatal Opioid Costs Per Capita by County in 2015"  
c$set\_num\_colors(5)  
c$set\_zoom(state.regions$region[-c(1, 12)])  
c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, "Oranges"),  
 name = "Per Capita Cost",  
 labels = c(str\_c("$", q[1] %>% round, " to $", q[2] %>% round),  
 str\_c("$", q[2] %>% round, " to $", q[3] %>% round),  
 str\_c("$", q[3] %>% round, " to $", q[4] %>% round),  
 str\_c("$", q[4] %>% round, " to $", q[5] %>% round),  
 str\_c("$", q[5] %>% round, " to $", q[6] %>% round)),  
 na.value = "black",  
 drop = F)  
  
c$render() +   
 theme(text=element\_text(size=14, family="Times")) +  
 theme(plot.title = element\_text(hjust = 0.5),  
 plot.caption = element\_text(size = 8),  
 legend.title = element\_text(size = 12),  
 legend.text = element\_text(size = 10))

## Warning in self$bind(): The following regions were missing and are being  
## set to NA: 13239, 31149, 40025, 48045, 30055, 38027, 38037, 38039, 38043,  
## 38047, 38065, 48431, 30109, 31007, 31057, 31071, 31075, 35021, 31115,  
## 41021, 48447, 49009, 48033, 46063, 46069, 46075, 46097, 46113, 30019,  
## 20187, 21201, 13265, 48301, 48327, 53023, 51091, 38013, 38087, 38095,  
## 49033, 20203, 8079, 46049, 46107, 46119, 32011, 35011, 30075, 31005, 31069,  
## 31077, 48173, 48269, 8033, 51515, 20025, 20033, 20101, 48101, 48109, 48125,  
## 48345, 56027, 48235, 48243, 8115, 28055, 38023, 38033, 31165, 30079, 30103,  
## 41055, 48443, 31015, 46089, 31049, 46021, 29227, 30011, 30033, 30045,  
## 31091, 31103, 38001, 26083, 48311, 48261, 48155, 31113, 46073, 38083,  
## 20199, 20071, 20083, 30037, 31171, 31183, 32009, 30051, 30059, 30069,  
## 30107, 31009, 31073, 31085, 31117, 38007, 38091, 46017, 46055, 46095,  
## 46111, 41069, 48359, 48393, 48433, 48011, 8053, 48137, 8057, 48263, 8111,  
## 49031, 6003, 8017, 8061, 16025, 16033



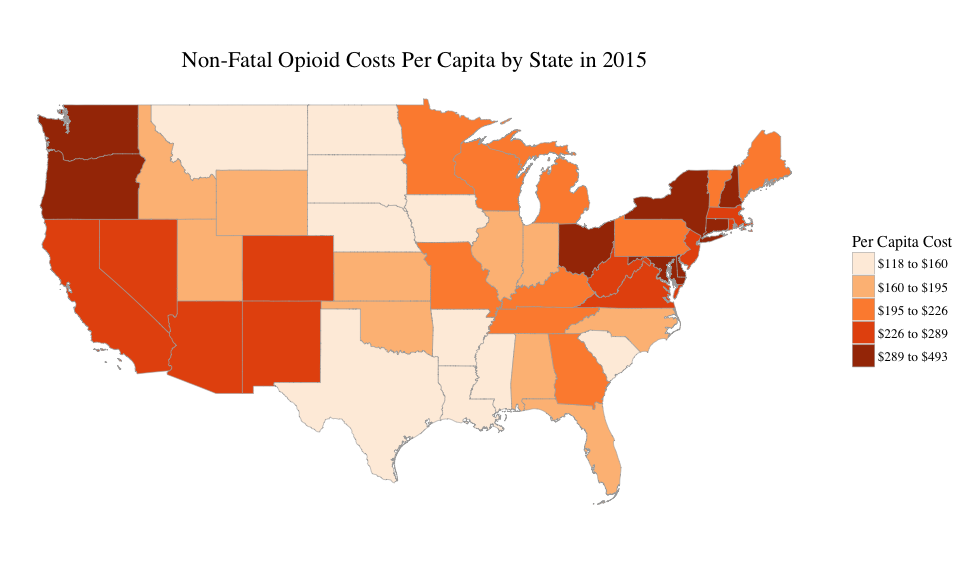
### TOTAL COSTS  
  
map2 <- o %>% select(region, per\_capita\_total\_cost) %>%  
 mutate(value = per\_capita\_total\_cost) %>%  
 select(region, value)  
  
q <- c(160, 824, 1153, 1585, 2232, 8734)  
  
c = CountyChoropleth$new(map2)  
c$title = "Total Opioid Costs Per Capita by County in 2015"  
c$set\_num\_colors(5)  
c$set\_zoom(state.regions$region[-c(1, 12)])  
c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, "Oranges"),  
 name = "Per Capita Cost",  
 na.value = "black",  
 labels = c(str\_c("$", q[1] %>% round, " to $", q[2] %>% round),  
 str\_c("$", q[2] %>% round, " to $", q[3] %>% round),  
 str\_c("$", q[3] %>% round, " to $", q[4] %>% round),  
 str\_c("$", q[4] %>% round, " to $", q[5] %>% round),  
 str\_c("$", q[5] %>% round, " to $", q[6] %>% round)),  
 drop = F)  
  
c$render() +   
 theme(text=element\_text(size=14, family="Times")) +  
 theme(plot.title = element\_text(hjust = 0.5),  
 plot.caption = element\_text(size = 8),  
 legend.title = element\_text(size = 12),  
 legend.text = element\_text(size = 10))

## Warning in self$bind(): The following regions were missing and are being  
## set to NA: 13239, 31149, 40025, 48045, 30055, 38027, 38037, 38039, 38043,  
## 38047, 38065, 48431, 30109, 31007, 31057, 31071, 31075, 35021, 31115,  
## 41021, 48447, 49009, 48033, 46063, 46069, 46075, 46097, 46113, 30019,  
## 20187, 21201, 13265, 48301, 48327, 53023, 51091, 38013, 38087, 38095,  
## 49033, 20203, 8079, 46049, 46107, 46119, 32011, 35011, 30075, 31005, 31069,  
## 31077, 48173, 48269, 8033, 51515, 20025, 20033, 20101, 48101, 48109, 48125,  
## 48345, 56027, 48235, 48243, 8115, 28055, 38023, 38033, 31165, 30079, 30103,  
## 41055, 48443, 31015, 46089, 31049, 46021, 29227, 30011, 30033, 30045,  
## 31091, 31103, 38001, 26083, 48311, 48261, 48155, 31113, 46073, 38083,  
## 20199, 20071, 20083, 30037, 31171, 31183, 32009, 30051, 30059, 30069,  
## 30107, 31009, 31073, 31085, 31117, 38007, 38091, 46017, 46055, 46095,  
## 46111, 41069, 48359, 48393, 48433, 48011, 8053, 48137, 8057, 48263, 8111,  
## 49031, 6003, 8017, 8061, 16025, 16033



### MAKE MAPS FOR STATES

o2 <- d %>% group\_by(state.name) %>%  
 summarise(criminal\_cost = sum(criminal\_cost),  
 health\_cost = sum(health\_cost),  
 productivity\_cost = sum(productivity\_cost),  
 death\_cost = sum(death\_cost),  
 total\_cost = sum(criminal\_cost + health\_cost + productivity\_cost),  
 total\_population = sum(total\_population),  
 health\_cost\_pc = sum(health\_cost)/sum(total\_population),  
 productivity\_cost\_pc = sum(productivity\_cost)/sum(total\_population),  
 death\_cost\_pc = sum(death\_cost)/sum(total\_population)) %>%  
 ungroup %>%  
 mutate(per\_capita\_nf\_cost = (criminal\_cost + health\_cost + productivity\_cost)/total\_population,  
 per\_capita\_total\_cost = (criminal\_cost + health\_cost + productivity\_cost + death\_cost)/total\_population,  
 region = state.name)  
  
write\_csv(o2, "../out/state\_data.csv")  
  
### NON-FATAL COSTS  
  
map3 <- o2 %>% select(region, per\_capita\_nf\_cost) %>%  
 mutate(value = per\_capita\_nf\_cost) %>%  
 select(region, value)  
  
q <- c(118, 160, 195, 226, 289, 493)  
  
c = StateChoropleth$new(map3)  
c$title = "Non-Fatal Opioid Costs Per Capita by State in 2015"  
c$set\_num\_colors(5)  
c$set\_zoom(state.regions$region[-c(1, 12)])  
c$show\_labels = FALSE  
c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, "Oranges"),  
 name = "Per Capita Cost",  
 na.value = "black",  
 labels = c(str\_c("$", q[1] %>% round, " to $", q[2] %>% round),  
 str\_c("$", q[2] %>% round, " to $", q[3] %>% round),  
 str\_c("$", q[3] %>% round, " to $", q[4] %>% round),  
 str\_c("$", q[4] %>% round, " to $", q[5] %>% round),  
 str\_c("$", q[5] %>% round, " to $", q[6] %>% round)),  
 drop = F)  
  
c$render() +   
 theme(text=element\_text(size=14, family="Times")) +  
 theme(plot.title = element\_text(hjust = 0.5),  
 plot.caption = element\_text(size = 8),  
 legend.title = element\_text(size = 12),  
 legend.text = element\_text(size = 10))



### TOTAL COSTS  
  
map4 <- o2 %>% select(region, per\_capita\_total\_cost) %>%  
 mutate(value = per\_capita\_total\_cost) %>%  
 select(region, value)  
  
q <- c(394, 907, 1385, 1827, 2530, 4378)  
  
c = StateChoropleth$new(map4)  
c$title = "Total Opioid Costs Per Capita by State in 2015"  
c$set\_num\_colors(5)  
c$set\_zoom(state.regions$region[-c(1, 12)])  
c$show\_labels = FALSE  
c$ggplot\_scale = scale\_fill\_manual(values = brewer.pal(5, "Oranges"),  
 name = "Per Capita Cost",  
 labels = c(str\_c("$", q[1] %>% round, " to $", q[2] %>% round),  
 str\_c("$", q[2] %>% round, " to $", q[3] %>% round),  
 str\_c("$", q[3] %>% round, " to $", q[4] %>% round),  
 str\_c("$", q[4] %>% round, " to $", q[5] %>% round),  
 str\_c("$", q[5] %>% round, " to $", q[6] %>% round)),  
 na.value = "black",  
 drop = F)  
  
c$render() +   
 theme(text=element\_text(size=14, family="Times")) +  
 theme(plot.title = element\_text(hjust = 0.5),  
 plot.caption = element\_text(size = 8),  
 legend.title = element\_text(size = 12),  
 legend.text = element\_text(size = 10))

