

Central Appalachian Mine Closures

https://github.com/hgs13/EDA_Final_Project_2020

Hannah Smith

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1 Rationale and Research Questions

This project seeks to analyze the migration patterns of residents of coal counties in central Appalachia from the years 2000 to 2017. Two “coal counties” serve as a case study for migration in central Appalachia: Harlan County, Kentucky and Dickenson County, Virginia. Harlan County serves as a “Boom-Bust” county, meaning the county experienced a coal production boom in 2000 and a coal production bust in 2010. Dickenson, on the other hand, is a “Bust-Bust” county, where the county experienced a coal production bust in 2000 and did not recover by 2010.

An important portion of understanding migration in Appalachia is investigating the mine operations within the coal counties. As such, this project creates and analyzes a visualization of mine production and employee in Harlan and Dickenson counties between the years 2000 and 2011. The data analysis of the coal production and the number of employees in coal mines in each county could be indicative of migration patterns within the central Appalachian region.

2 Dataset Information

The data in this repository is coal mine data compiled by the Coal and America Bass Connections team at Duke University from the Energy Information Administration (EIA) online database throughout the fall of 2019. The data in this repository is coal mine data compiled by the Coal and America Bass Connections team at Duke University from the Energy Information Administration (EIA) online database throughout the fall of 2019.

"This report is mandatory under the Federal Energy Administration Act of 1974 (Public Law 93-275). Failure to comply may result in criminal fines, civil penalties, and other sanctions as provided by law. Title 18 USC 1001 makes it a criminal offense for any person knowingly and willingly to make to any Agency or Department of the United States any false, fictitious, or fraudulent statements as to any matter within its jurisdiction.

All coal mining companies that owned a mining operation which produced 25,000 or more short tons of coal during the reporting year must submit form EIA-7A, except for anthracite mines. All anthracite mines that produced 10,000 or more short tons during the reporting year must submit form EIA-7A. Standalone facilities (e.g., preparation plant/tipple/loading dock/train loadout) that worked 5,000 or more hours must submit the EIA-7A. Submit a separate form EIA-7A for each mining operation and standalone facility that meets the reporting criteria.

The U.S. Energy Information Administration's (EIA) Form EIA-7A, Annual Survey of Coal Production and Preparation, collects coal production data from U.S. coal mining companies. This includes information on the type and status of coal operations, characteristics of coalbeds mined, recoverable reserves, productive capacity and the disposition of coal mined which provides Congress with basic statistics concerning coal supply. These data appear in the Annual Coal Report, the Quarterly Coal Report, the Monthly Energy Review, and the Annual Energy Review. In addition, the EIA uses the data for coal supply analyses and in short-term modeling efforts, which produce forecasts of coal supply and prices requested by Congress. The forecast data also appear in the Short-Term Energy Outlook and the Annual Energy Outlook."

Therefore, the data used in this project should be timely and accurate. Furthermore, coal production during the decade this project explores was extremely variable. As such, there should be no exclusion of outliers in this report.

3 Exploratory Analysis

3.1 Data Exploration

Data exploration of the Harlan and Dickenson County raw data files.

```
dim(harlan.raw)
```

```
## [1] 509 15
```

```
dim(dickenson.raw)
```

```
## [1] 194 15
```

```
str(harlan.raw)
```

```
## 'data.frame':    509 obs. of  15 variables:
## $ year           : int  2011 2011 2011 2011 2011 2011 2011 2011 2011 2011 2011
## $ mine.name      : Factor w/ 126 levels "# 1","# 2","# 3",...: 34 104 122 4
## $ mine.state     : Factor w/ 1 level "Kentucky (East)": 1 1 1 1 1 1 1 1 1
## $ countystr      : Factor w/ 1 level "Harlan": 1 1 1 1 1 1 1 1 1 1 ...
## $ mine.basin     : Factor w/ 1 level "Appalachia Central": 1 1 1 1 1 1 1 1
## $ mine.status    : Factor w/ 6 levels "Active","Active, men not working, n
## $ mine.type      : Factor w/ 1 level "Underground": 1 1 1 1 1 1 1 1 1 ..
## $ company.type   : Factor w/ 3 levels "Contractor","Indepedent Producer Op
## $ operation.type : Factor w/ 2 levels "Mine only","Preparation Plant": 1 2
## $ operating.company : Factor w/ 102 levels "A & M Coal Co Inc",...: 54 64 37 3
## $ operating.company.address: Factor w/ 92 levels "1160 Jackson Dr, Paris, TN 38242",
## $ production.stons : Factor w/ 400 levels "0","1,013,140",...: 248 1 1 1 1 1
## $ average.employees : int  110 25 22 20 2 9 127 2 35 4 ...
## $ labor.hours     : Factor w/ 468 levels "", "1,211", "1,692",...: 174 243 365
## $ ARC            : int   1 1 1 1 1 1 1 1 1 1 ...
```

```
str(dickenson.raw)
```

```
## 'data.frame':    194 obs. of  15 variables:
## $ year           : int  2011 2011 2011 2011 2011 2011 2011 2011 2011 2011 2011
## $ mine.name      : Factor w/ 56 levels "#1","#2","#44",...: 37 16 36 32 11
## $ mine.state     : Factor w/ 1 level "Virginia": 1 1 1 1 1 1 1 1 1 1 ...
## $ countystr      : Factor w/ 1 level "Dickenson": 1 1 1 1 1 1 1 1 1 1 ...
## $ mine.basin     : Factor w/ 1 level "Appalachia Central": 1 1 1 1 1 1 1 1
## $ mine.status    : Factor w/ 5 levels "Active","Active, men working, not p
## $ mine.type      : Factor w/ 1 level "Underground": 1 1 1 1 1 1 1 1 1 ..
## $ company.type   : Factor w/ 3 levels "Contractor","Indepedent Producer Op
## $ operation.type : Factor w/ 2 levels "Mine only","Preparation Plant": 1 1
## $ operating.company : Factor w/ 57 levels "Apple Jacks Coal Company Inc",...:
## $ operating.company.address: Factor w/ 61 levels "1229 Homecreek Rd., Big Rock, VA 2
## $ production.stons : Factor w/ 163 levels "0","1,719","103,817",...: 87 118 7
```

```
## $ average.employees      : int   16 17 13 14 94 48 37 101 36 7 ...
## $ labor.hours            : Factor w/ 168 levels "","1,689","101,738",...: 97 127 84
## $ ARC                    : int    1 1 1 1 1 1 1 1 1 1 ...
```

```
colnames(harlan.raw)
```

```
## [1] "year"                "mine.name"
## [3] "mine.state"          "countyst"
## [5] "mine.basin"          "mine.status"
## [7] "mine.type"           "company.type"
## [9] "operation.type"       "operating.company"
## [11] "operating.company.address" "production.stons"
## [13] "average.employees"    "labor.hours"
## [15] "ARC"
```

```
colnames(dickenson.raw)
```

```
## [1] "year"                "mine.name"
## [3] "mine.state"          "countyst"
## [5] "mine.basin"          "mine.status"
## [7] "mine.type"           "company.type"
## [9] "operation.type"       "operating.company"
## [11] "operating.company.address" "production.stons"
## [13] "average.employees"    "labor.hours"
## [15] "ARC"
```

```
summary(harlan.raw)
```

```
##      year      mine.name      mine.state      countyst
## Min.   :2000   Mine #1      : 24   Kentucky (East):509   Harlan:509
## 1st Qu.:2003   Prep Plant   : 21
## Median :2006   Mine No 1    : 19
## Mean   :2006   Mine No. 1    : 11
## 3rd Qu.:2008   No 1 Plant    : 11
## Max.   :2011   Darby Fork No 1: 10
##                (Other)      :413
##                mine.basin      mine.status
## Appalachia Central:509   Active      :420
##                Active, men not working, not producing: 1
##                Active, men working, not producing   : 34
##                Mine closed by MSHA                   : 21
##                Permanently abandoned                 : 27
##                Temporarily closed                    : 6
##
##      mine.type      company.type      operation.type
## Underground:509   Contractor      : 92   Mine only      :399
##                Independent Producer Operator:324   Preparation Plant:110
```



```

##           Operating Subsidiary           : 93
##
##
##
##
##           operating.company
## Harlan Cumberland Coal Company: 46
## Lone Mountain Processing Inc  : 31
## Manalapan Mining Co., Inc.    : 29
## Manalapan Mining Company Inc  : 28
## Liggett Mining Llc           : 23
## Rex Coal Company, Inc.        : 14
## (Other)                       :338
##           operating.company.address  production.stons
## P.O. Box 269, Grays Knob, KY 40829   : 42      0      :110
## P.O. Box 527, Benham, KY 40807       : 35      1,013,140: 1
## 8174 E Hwy 72, Pathfork, KY 40863    : 31      1,046,339: 1
## P.O. Box 838, Middlesboro, KY 40965  : 28      1,047,698: 1
## P.O. Box 1226, Norton, VA 24273      : 25      1,122,057: 1
## General Delivery, Grays Knob, KY 40829: 22      1,186,166: 1
## (Other)                             :326      (Other)  :394
## average.employees  labor.hours      ARC
## Min.   : 1.00      : 40   Min.   :1
## 1st Qu.: 15.00     23,520 : 3   1st Qu.:1
## Median : 25.00     1,211  : 1   Median :1
## Mean   : 34.83     1,692  : 1   Mean   :1
## 3rd Qu.: 40.00     1,702  : 1   3rd Qu.:1
## Max.   :166.00     1,705  : 1   Max.   :1
## NA's   :40        (Other):462

```

```
summary(dickenson.raw)
```

```

##           year           mine.name           mine.state           countyst
## Min.   :2000   Cherokee Mine           : 12   Virginia:194   Dickenson:194
## 1st Qu.:2001   Mc Clure River Plant: 10
## Median :2004   Nme                       : 8
## Mean   :2005   No 8                       : 7
## 3rd Qu.:2007   No. 3 Mine                 : 7
## Max.   :2011   No. 4                       : 7
##           (Other)                       :143
##           mine.basin           mine.status
## Appalachia Central:194   Active           :151
##           Active, men working, not producing: 14
##           Mine closed by MSHA           : 4
##           Permanently abandoned         : 21

```

```

##              Temporarily closed              : 4
##
##
##      mine.type              company.type              operation.type
## Underground:194 Contractor :50 Mine only :162
##      Indepedent Producer Operator:66 Preparation Plant: 32
##      Operating Subsidiary :78
##
##
##
##      operating.company
## DickensonRussell Coal Company : 19
## Clinchfield Coal Company : 12
## DickensonRussell Coal Co Llc : 9
## L & J Equipment Company : 9
## Apple Jacks Coal Company, Inc.: 7
## DickensonRussell Coal Co., Ll : 7
## (Other) :131
##      operating.company.address production.stons
## P.O. Box 1426, Grundy, VA 24614 : 15 0 : 32
## 5703 Crutchfield Dr, Norton, VA 24273: 11 1,719 : 1
## P.O. Box 1025, Grundy, VA 24614 : 9 103,817: 1
## P.O. Box 148, Vansant, VA 24656 : 8 104,108: 1
## P.O. Box 458, Big Rock, VA 24603 : 8 104,515: 1
## Rt 2, Box 73, Cleveland, VA 24225 : 8 109,076: 1
## (Other) :135 (Other):157
## average.employees labor.hours ARC
## Min. : 1.00 : 26 Min. :1
## 1st Qu.: 12.00 79,091 : 2 1st Qu.:1
## Median : 16.00 1,689 : 1 Median :1
## Mean : 30.11 101,738: 1 Mean :1
## 3rd Qu.: 40.00 104,181: 1 3rd Qu.:1
## Max. :117.00 107,901: 1 Max. :1
## NA's :26 (Other):162
sum(as.numeric(harlan.raw$average.employees), na.rm = TRUE)

## [1] 16336
sum(as.numeric(dickenson.raw$average.employees), na.rm = TRUE)

## [1] 5058
sum(as.numeric(harlan.raw$production.stons), na.rm = TRUE)

## [1] 80309

```

```
sum(as.numeric(dickenson.raw$production.stons), na.rm = TRUE)
```

```
## [1] 13397
```

Formatting Relevant Columns in Harlan and Dickenson County Raw Datasets

```
harlan.raw$year <- as.numeric(harlan.raw$year)
harlan.raw$ARC <- as.logical(harlan.raw$ARC)
harlan.raw$mine.status <- as.character(harlan.raw$mine.status)
harlan.raw$operation.type <- as.character(harlan.raw$operation.type)
harlan.raw$production.stons <- as.numeric(harlan.raw$production.stons)
harlan.raw$average.employees <- as.integer(harlan.raw$average.employees)
harlan.raw$labor.hours <- as.integer(harlan.raw$labor.hours)

dickenson.raw$year <- as.numeric(dickenson.raw$year)
dickenson.raw$ARC <- as.logical(dickenson.raw$ARC)
dickenson.raw$mine.status <- as.character(dickenson.raw$mine.status)
dickenson.raw$operation.type <- as.character(dickenson.raw$operation.type)
dickenson.raw$production.stons <- as.numeric(dickenson.raw$production.stons)
dickenson.raw$average.employees <- as.numeric(dickenson.raw$average.employees)
dickenson.raw$labor.hours <- as.numeric(dickenson.raw$labor.hours)
```

Visual Data Exploration of Harlan and Dickenson raw data

##Data Wrangling Joining Harlan and Dickenson raw data together

```
minedata <- full_join(harlan.raw, dickenson.raw)
```

```
## Joining, by = c("year", "mine.name", "mine.state", "countyst",
## "mine.basin", "mine.status", "mine.type", "company.type", "operation.type",
## "operating.company", "operating.company.address", "production.stons",
## "average.employees", "labor.hours", "ARC")

## Warning: Column `mine.name` joining factors with different levels, coercing to
## character vector

## Warning: Column `mine.state` joining factors with different levels, coercing to
## character vector

## Warning: Column `countyst` joining factors with different levels, coercing to
## character vector

## Warning: Column `operating.company` joining factors with different levels,
## coercing to character vector

## Warning: Column `operating.company.address` joining factors with different
## levels, coercing to character vector
```

Filtering for data relevant to research questions

```

harlan.clean <- harlan.raw %>%
  select(year:countystr, mine.status, operation.type, operating.company,
         production.stons:labor.hours) %>%
  filter(mine.status == "Active", operation.type == "Mine only") %>%
  group_by(year, countystr) %>%
  mutate(total.production = sum(production.stons), total.employee = sum(average.employees),
         mean.employee = mean(average.employees), na.rm = TRUE)

dickenson.clean <- dickenson.raw %>%
  select(year:countystr, mine.status, operation.type, operating.company,
         production.stons:labor.hours) %>%
  filter(mine.status == "Active", operation.type == "Mine only") %>%
  group_by(year, countystr) %>%
  mutate(total.production = sum(production.stons), total.employee = sum(average.employees),
         mean.employee = mean(average.employees), na.rm = TRUE)

minedata.clean <- minedata %>%
  select(year:countystr, mine.status, operation.type, operating.company,
         production.stons:labor.hours) %>%
  filter(mine.status == "Active", operation.type == "Mine only") %>%
  group_by(year, countystr) %>%
  mutate(total.production = sum(production.stons), total.employee = sum(average.employees),
         mean.employee = mean(average.employees), na.rm = TRUE)

```

Save the data in the processed folder

```

write.csv(harlan.clean, "./Data/Processed/EIA_MineData_Harlan_Processed.csv")
write.csv(dickenson.clean, "./Data/Processed/EIA_MineData_Dickenson_Processed.csv")
write.csv(minedata.clean, "./Data/Processed/EIA_MineData_Combined_Processed.csv")

```

4 Analysis

4.1 Question 1: Is the total number of employees for all mines in a boom-bust or a bust-bust county in the years 2000 to 2011 a significant predictor of annual coal production for all mines?

```
## Scale for 'x' is already present. Adding another scale for 'x', which will  
## replace the existing scale.
```

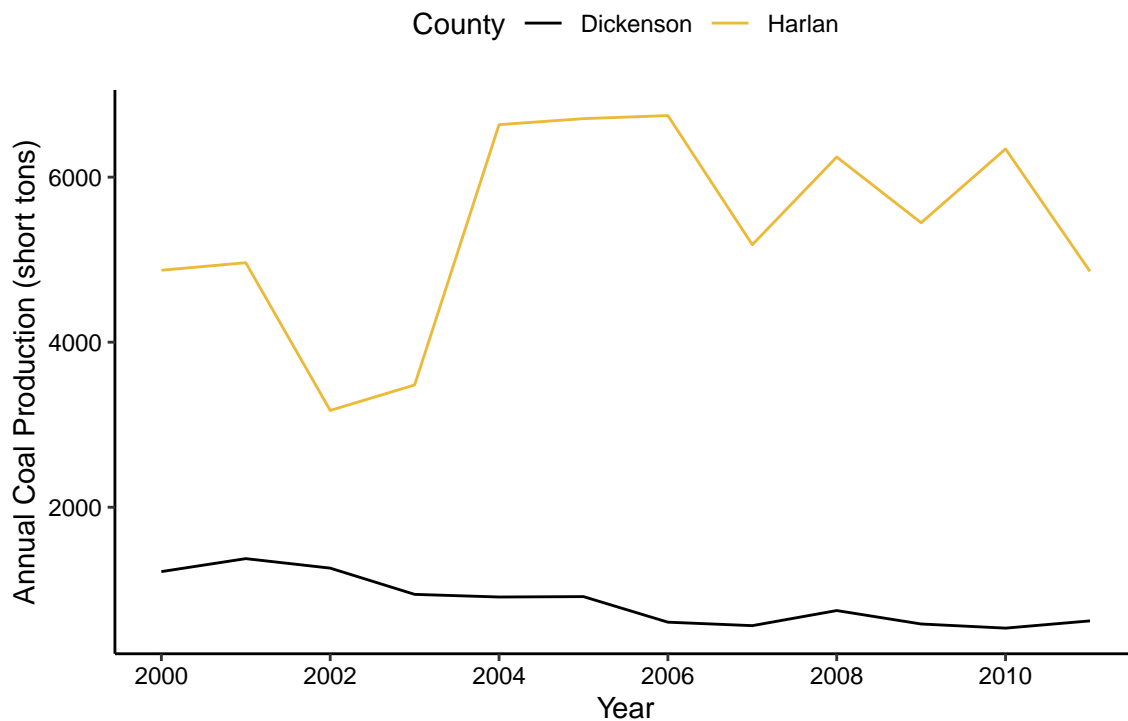


Figure 1: Total Annual Coal Production in Harlan and Dickenson Counties

```
## Scale for 'x' is already present. Adding another scale for 'x', which will  
## replace the existing scale.
```

```
## Warning: Removed 43 rows containing missing values (geom_path).
```

```
## Warning: Removed 43 rows containing missing values (geom_path).
```

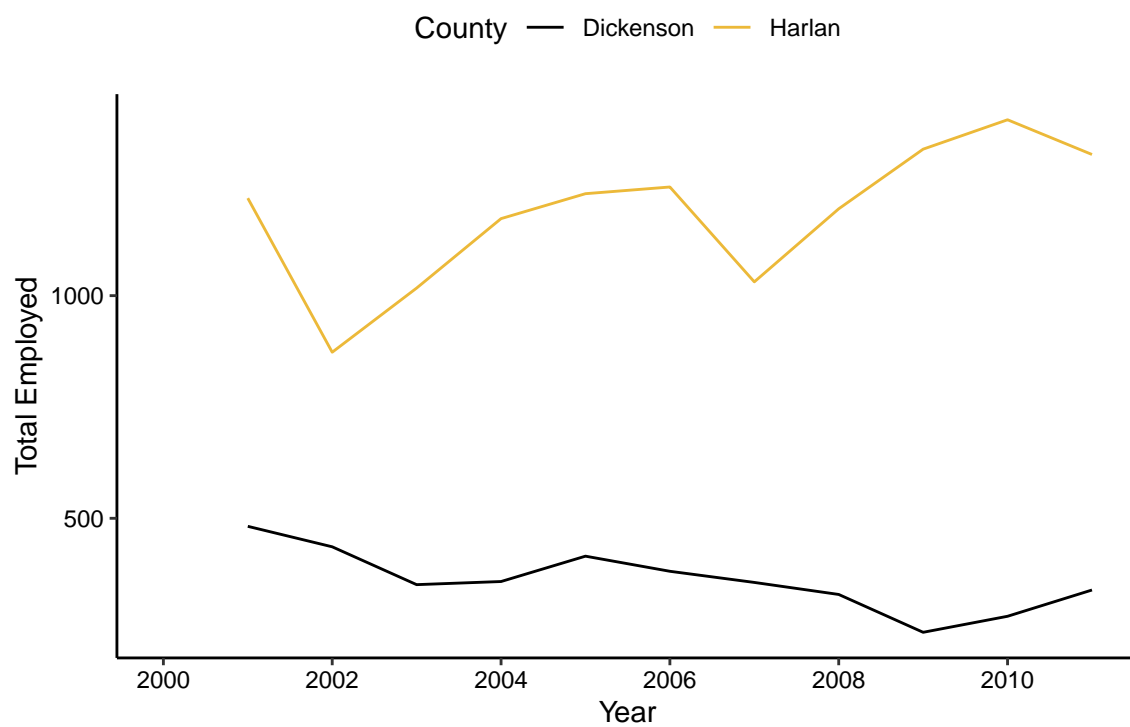


Figure 2: Total Number of Employees in Harlan and Dickenson Counties, 2000 to 2011

5 Summary and Conclusions

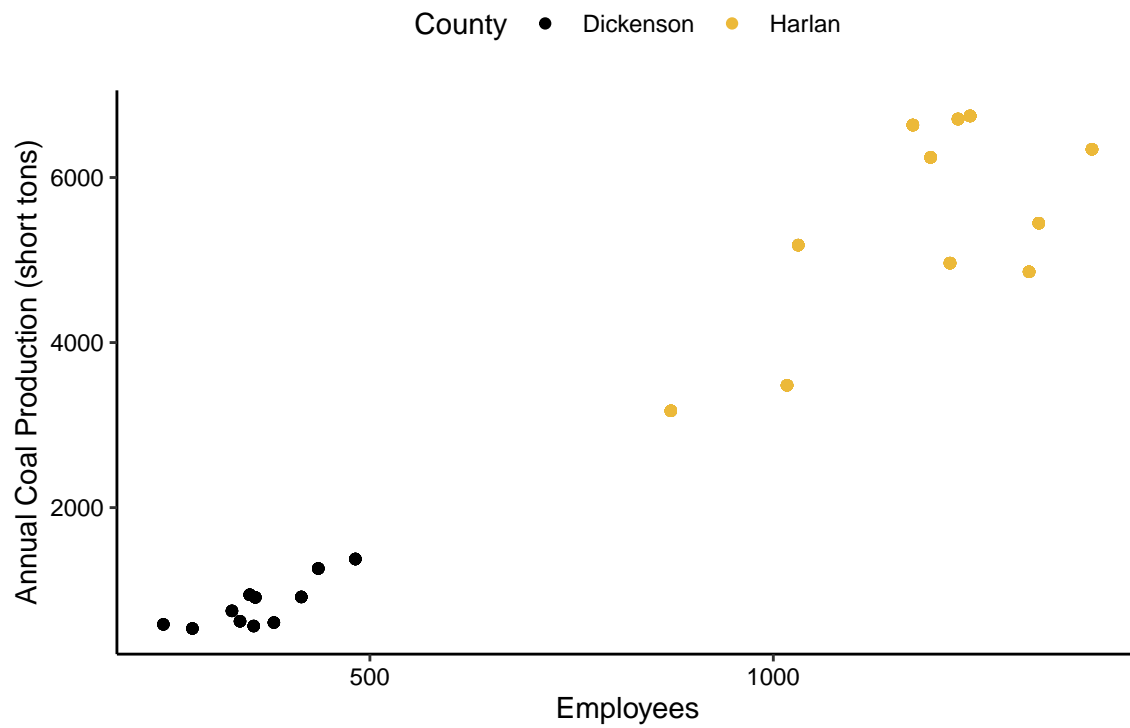


Figure 3: Annual Coal Production Compared to Total Employees in Harlan and Dickenson Counties, 2000 to 2011 (ANOVA; $df = 288$, $F = 276$, $p\text{-value} < 0.001$)

6 References

<add references here if relevant, otherwise delete this section>