

# DATA 512 Project Part 2 – Extension Plan

Debbie Davis

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## Motivation/Problem Statement

Wildfire smoke has a range of potential impacts on different aspects of society, including economic activity, health, and labor markets. Due to time constraints and the availability of specific data sources, this project aims to focus narrowly on the labor market outcomes in Memphis, Tennessee. Specifically, the analysis seeks to determine the extent to which wildfire smoke affects labor market outcomes in Memphis, such as unemployment and hours worked. Based on the most recent U.S. Bureau of Labor Statistics, the Trade, Transportation, and Utilities sector employs the most people in the Memphis area. By concentrating on this sector as well as overall labor market trends, this project aims to provide insights into:

1. **Impact on Unemployment and Hours Worked:** Analyzing the relationship between the annual smoke estimate (developed in Part 1) and labor market outcomes, including unemployment rates and total hours worked, will help determine if increased smoke exposure correlates with adverse labor market conditions, which may indicate disruptions in workforce availability and productivity.
2. **Influence of Seasonal Factors:** In addition to the smoke estimate, seasonal weather variables—such as average temperature and precipitation—will be included to understand the broader environmental influences on employment metrics.

The historical analysis will cover data from 2007 to the present, with projections for 2025 through 2050 based on identified trends. This analysis aims to equip local policymakers with insights into potential economic risks posed by wildfire smoke, supporting the development of strategies to mitigate future impacts.

## Impact Focus

The primary focus of this extension plan is the economic impact of smoke events on Memphis, specifically analyzing workforce productivity and unemployment rates. The goal is to understand how seasonal smoke affects the trade and transportation sector and overall employment. If time allows, the analysis will be extended to include other sectors in the CES dataset, providing a broader view of smoke impacts across different segments of Memphis's economy. This aligns with the project's overall goal of exploring the potential impacts of smoke on

various aspects of the labor market while maintaining a narrow focus due to the available data and time constraints. This will support informed decision-making for mitigating economic disruptions.

## Datasets

### 1. *Local Area Unemployment Statistics (LAUS):*

- This dataset provides monthly employment, unemployment, and labor force participation data for Memphis. It helps understand workforce participation changes that could be linked to smoke events.
- Maintained by the U.S. Bureau of Labor Statistics (BLS)
- Available data from 1990 - Current
- Link: [BLS LAUS - Memphis, TN](#)

### 2. *Current Employment Statistics (CES) – State and Area Employment, Hours, and Earnings:*

- This survey provides monthly data on employment, hours worked, and earnings by industry sector. For Memphis, we will focus initially on data from the trade and transportation sectors to measure changes in productivity. If time permits, the analysis will be expanded to include other sectors in the CES dataset to provide a more comprehensive view of labor market impacts.
- Maintained by the U.S. Bureau of Labor Statistics (BLS)
- Available data from 2007 - Current
- Link: [BLS CES - State and Area](#)

### 3. *NOAA Global Summary of the Month (GSOM) Dataset:*

- The NOAA GSOM dataset provides monthly summaries of temperature (average, maximum, and minimum) and total precipitation from weather stations worldwide, including Memphis. This dataset will help capture seasonal weather variations that may influence employment and productivity.
- Variables to Use:
  - Average Monthly Temperature (TAVG)
  - Monthly Maximum Temperature (TMAX)
  - Monthly Minimum Temperature (TMIN)
  - Total Monthly Precipitation (PRCP)
- Available data from 1940 – Current

- Link: [NOAA GSOM](#)
  - Please reference the screenshot below for information on ordering data via the NOAA Data Online website

Product	GSOM (CSV)	
Order Details	Hide Details ^	
	Processing Completed	2024-11-06
	Stations	GHCND:USW00013893
	Begin Date	2009-09-01 00:00
	End Date	2019-09-01 23:59
	Data Types	DX32, DX90, DP01, DP10, EMXP, PRCP, SNOW, TAVG, CDSO, EMXT, EMNT, HDSD, TMAX, TMIN, AWND, WDF2, WDF5, WSF2, WSF5
	Units	Standard
	Custom Flag(s)	Station Name, Geographic Location
	Eligible for Certification	No

### Model Approach Overview:

This project will use a linear regression model to analyze how wildfire smoke exposure affects labor market outcomes, specifically unemployment rates and hours worked in Memphis. The analysis will consist of two parts: a historical analysis and future projections.

The historical analysis will cover the period from 2007 to 2024, with 2007 as the starting point due to data availability limitations in the Bureau of Labor Statistics' Current Employment Statistics (CES) dataset. This dataset provides state and area employment, hours, and earnings data, allowing for quarterly comparisons to assess the impact of smoke exposure over time. In this model, the dependent variable (change\_in\_outcome) will represent changes in labor market outcomes for each quarter, calculated as the difference from the same quarter in the previous year.

Building on these historical trends, projections will be made for the years 2025 to 2050 to estimate the potential future impact of smoke exposure. The model's independent variables will include the annual smoke estimate (smoke\_estimate), average temperature (avg\_temperature), and total precipitation (precipitation), which collectively capture smoke exposure and seasonal weather influences.

The model equation is as follows:

$$\text{change\_in\_outcome} = \text{smoke\_estimate} * \text{beta} + \text{avg\_temperature} + \text{precipitation} + \text{error\_term}$$

- **smoke\_estimate:** Annual smoke exposure based on data from Part 1.
- **avg\_temperature and precipitation:** Seasonal weather variables were included to understand the broader environmental influences on employment metrics.
- Beta and error\_term will be estimated through regression analysis. Beta indicates the strength of the relationship between each predictor and the outcome, and error\_term captures residual unexplained variability.

### Notes on Smoke Estimate from Part 1

The smoke estimates from Part 1 are calculated annually. In Part 2, since additional data sources are available monthly and quarterly, we will apply a consistent smoke estimate for each quarter within the calendar year. AQI data is available for Memphis, TN, and given that Part 1 results showed discrepancies between smoke estimates and AQI values, I will incorporate AQI data alongside smoke estimates if time permits.

### Related Research and Model Inspiration:

Several studies inspired the approach for this project:

1. Borgschulte et al. (2022): The article "Air Pollution and the Labor Market: Evidence from Wildfire Smoke" provided the idea of using changes in labor market outcomes as the dependent variable. This approach focuses on comparing quarterly changes to better capture impacts over time.
  - Link: [Air Pollution and the Labor Market](#)
2. Nielsen-Pincus et al. (2013): The study "The Effects of Large Wildfires on Employment and Wage Growth and Volatility in the Western United States" used a GARCH model to analyze wage volatility. While the GARCH model seemed like an interesting approach, it was not feasible given the time constraints for this project. However, it inspired the inclusion of weather data, recognizing the need to account for environmental factors in labor market analysis.
  - Link: [The Effects of Large Wildfires on Employment and Wage Growth](#)
3. Meier et al. (2023): The study "The regional economic impact of wildfires: Evidence from Southern Europe" also informed the overall direction of exploring economic impacts but did not directly influence the modeling approach used here.
  - Link: [The regional economic impact of wildfires](#)

## Unknowns and Dependencies

While downloading NOAA data was straightforward, retrieving the full historical data from the BLS site may present challenges due to its complex interface. This could introduce delays in obtaining all the data required for the analysis. Additionally, some metrics may lack sector-specific breakdowns, potentially requiring aggregations or assumptions that could introduce uncertainty. Data exploration on the new datasets is also still needed to assess their reliability, which will be essential for ensuring accurate results in the analysis.

## Timeline to Completion

Week 1 (Nov 4 – 10)

- Data Acquisition
- Proof of Concept (small subset of data)

Week 2 (Nov 11 – 17)

- Full-scale implementation (all data)

Week 3 (Nov 18 – 24)

- Initial draft of Repo Documentation and Project Report
- Presentation slide development

Week 4 (Nov 25 – Dec 1)

- **Milestone: Slides due on Nov 27**
- Presentation Rehearsals

Week 5 (Dec 2 – Dec 6)

- **Milestone: Presentation on Dec 2**
- **Milestone: Repo & Project Report due on Dec 4**
- Code Revision
- Final draft of Repo Documentation and Project Report

## References

- Borgschulte, M., Molitor, D., & Zou, E. Y. (2022). Air Pollution and the Labor Market: Evidence from Wildfire Smoke. *The Review of Economics and Statistics*, 1–46. [https://doi.org/10.1162/rest\\_a\\_01243](https://doi.org/10.1162/rest_a_01243)
- Meier, S., Elliott, R. J. R., & Strobl, E. (2023). The regional economic impact of wildfires: Evidence from Southern Europe. *Journal of Environmental Economics and Management*, 118, 102787-. <https://doi.org/10.1016/j.jeem.2023.102787>
- Nielsen-Pincus, M., Moseley, C., & Gebert, K. (2013). The Effects of Large Wildfires on Employment and Wage Growth and Volatility in the Western United States. *Journal of Forestry*, 111(6), 404–411. <https://doi.org/10.5849/jof.13-012>