MINIMUM WAGE AND PART-TIME EMPLOYMENT: A PYTHON-BASED PANEL DATA STUDY ACROSS 40 U.S. CITIES

1. Introduction

In recent years, several U.S. states and cities have implemented gradual increases in minimum wage laws to improve living standards. While the intention is positive, businesses often respond by altering workforce structures—especially increasing or decreasing reliance on part-time workers to manage labor costs.

To understand the empirical relationship between minimum wage increases and part-time employment patterns, we were commissioned by a policy research group to perform an econometric analysis using Python. The study used panel data across 40 U.S. cities over a 6-year period (2016–2022) to control for unobservable, city-specific factors and national time shocks.

2. Objective

- To estimate the effect of local minimum wage changes on the percentage of part-time employment in urban labor markets
- To apply fixed-effects panel regression using Python for consistent, policy-relevant inference
- To provide a report with interpretable tables, model diagnostics, and narrative framing useful for both academic and applied audiences

3. Data Used

The dataset was constructed from publicly available sources:

- **BLS (Bureau of Labor Statistics)**: Part-time employment rates by city
- **Department of Labor**: Historical minimum wage laws by city/state
- **ACS (American Community Survey)**: City-level controls (unemployment rate, median income, education levels)

Panel Dataset Details:

- **Units**: 40 U.S. cities
- **Timeframe**: 2016 to 2022 (annual)

- **Variables**:
    - PartTimeShare – % of employed persons working <35 hrs/week
    - MinWage – City/state-level minimum wage (USD/hour)
    - UnemploymentRate – Annual unemployment rate (%)
    - MedianIncome – Median household income (USD)
    - CollegeGradRate – % population with a bachelor's degree or higher

4. Methodology

4.1 Data Preparation

- Created a balanced panel (N = 40 cities, T = 7 years)
- Adjusted for inflation using CPI deflators (real MinWage and MedianIncome)
- Converted wide-format city-year data into long-format panel data using pandas.melt()
- Generated city and year dummy variables using patsy and statsmodels for fixed-effects modeling

4.2 Econometric Model

- Applied **Fixed Effects (Within) Estimator** to control for time-invariant city factors
- Equation:

$$PartTimeShare_{it} = \beta_0 + \beta 1 MinWage_{it} + \beta 2 UnemploymentRate_{it} + \beta 3 MedianIncome_{it} + \beta 4 CollegeGradRate_{it} + \alpha_i + \lambda_t + \epsilon_{it}$$

- Where:
    - α_i= City-specific effects
    - λ_t= Year-specific effects
    - ϵ_{it} = idiosyncratic error term

4.3 Model Diagnostics

- Checked for heteroskedasticity using Breusch-Pagan test
- Tested for serial correlation using Wooldridge test
- Clustered standard errors at the city level using cov_type='cluster' in statsmodels

- Cross-validated fixed vs random effects using Hausman Test (Python implementation)

5. Key Results

Variable	Coefficient	Std. Error	P-value
Real_MinWage	+0.276	0.091	0.004
UnemploymentRate	+0.121	0.034	0.001
MedianIncome	–0.00014	0.00006	0.020
CollegeGradRate	–0.089	0.037	0.018
Year Fixed Effects	Included	—	—
City Fixed Effects	Included	—	—

- R-squared (within): **0.48**
- Number of observations: **280**
- Number of entities (cities): **40**

6. Econometric Interpretation

- A **\$1 increase in minimum wage** is associated with a **0.28 percentage point increase** in the share of part-time employment, holding other factors constant
- Cities with higher **unemployment** tend to show higher part-time shares, reinforcing labor flexibility behavior
- **Higher income and education levels** are associated with a lower share of part-time employment
- Model diagnostics confirmed validity of fixed-effects specification; robust to clustering and heteroskedasticity

7. Report Output

- **PDF Report (APA style, 20 pages)**:
    - Abstract, introduction, model setup, detailed results, and interpretation
    - Fixed-effects vs random-effects justification with Hausman test appendix

- Visualizations: Line plots (MinWage trends), bar charts (top 5 cities with highest change), and residual vs fitted plots

- **Python Files**:
  - Clean, modular Jupyter notebook with all preprocessing, regression steps, and diagnostics
  - Exported summary_frame.csv for direct table inclusion in presentations
- **Executive Slide Deck**:
  - 6-slide summary of insights, visual highlights, and three policy recommendations

8. Strategic Recommendations

- HR and workforce planners should prepare for small increases in part-time ratios when adjusting wages, especially in price-sensitive retail/service sectors
- City governments can pair wage increases with incentives for full-time hiring in vulnerable sectors
- Further research can combine this with productivity or earnings data to measure quality-of-work effects