Backwards Design

November 2, 2025

Topic:

Evaluating the effectiveness of opioid prescription regulations on prescribing behavior and overdose deaths.

Project Question

Florida (Policy starts February 2010)

Q1. How did Florida's 2010 opioid prescription regulation affect the volume of opioids prescribed in Florida counties?

Q2. How did Florida's 2010 opioid prescription regulation affect drug overdose deaths in Florida counties?

Washington (Policy starts January 2012)

Q3. How did Washington's 2012 opioid prescription regulation affect the volume of opioids prescribed in Washington counties?

Q4. How did Washington's 2012 opioid prescription regulation affect drug overdose deaths in Washington counties?

Project Hypothesis

Florida (2010 Policy)

Hypothesis 1 (H1-FL): Florida's 2010 opioid prescription regulation caused a decrease in the volume of opioids prescribed per county.

Hypothesis 2 (H2-FL): Florida's 2010 opioid prescription regulation led to a decrease in opioid overdose mortality rates per county.

Washington (2012 Policy)

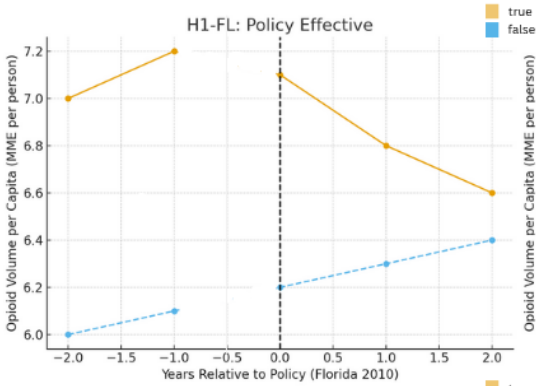
Hypothesis 3 (H1-WA): Washington's 2012 opioid prescription regulation caused a decrease in the volume of opioids prescribed per county.

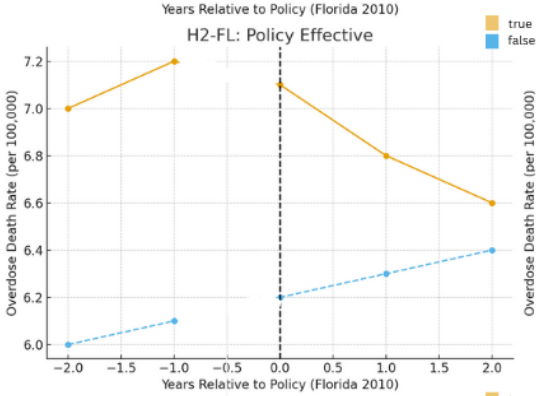
Hypothesis 4 (H2-WA): Washington's 2012 opioid prescription regulation led to a decrease in opioid overdose mortality rates per county.

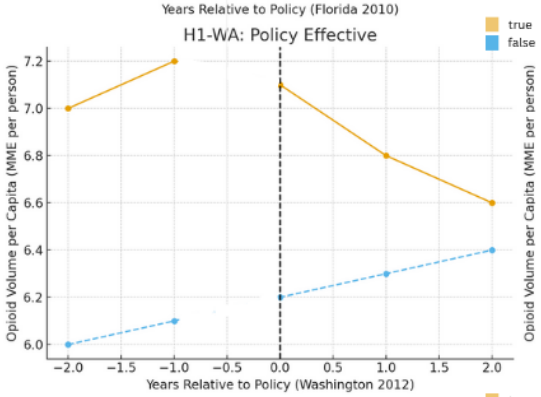
Model Results

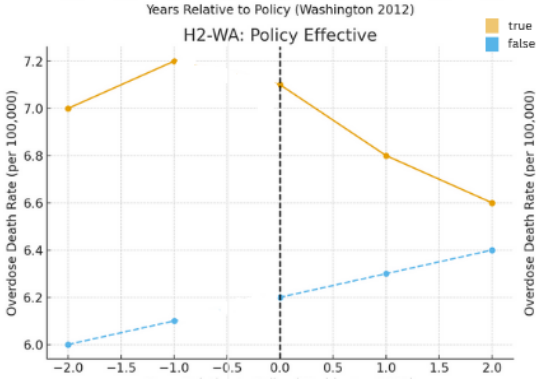
Question	If Hypothesis is True (H_1 Supported)	If Hypothesis is False (H_0 Not Rejected)
Q1 – Florida (2010): Effect on Opioid Prescribing	• Opioid prescribing per capita decreases after 2010 in Florida. • Clear drop or flattening relative to control states. • DiD $\beta < 0$ and statistically significant.	• No change in prescribing trend after 2010. • Prescribing continues as before or matches control states. • DiD $\beta \approx 0$ or not significant.
Q2 – Florida (2010): Effect on Overdose Deaths	• Short-term (0–1 years): deaths may rise or remain steady due to substitution to heroin/fentanyl. • Long-term: overdose mortality declines relative to expected trend. • DiD $\beta < 0$ (after initial period).	• No reduction in overdose deaths. • Deaths remain stable or continue increasing post-2010. • DiD $\beta \approx 0$ or $\beta > 0$.
Q3 – Washington (2012): Effect on Opioid Prescribing	• Opioid prescribing declines after 2012 in Washington compared to control states. • Treated trend bends downward post-policy. • DiD $\beta < 0$ and significant.	• No visible change in prescribing trend after 2012. • Treated and control trends remain parallel. • DiD $\beta \approx 0$ or not significant.
Q4 – Washington (2012): Effect on Overdose Deaths	• Short-term: overdose deaths may slightly increase or plateau. • Long-term: overdose mortality declines relative to control states. • DiD $\beta < 0$ (after 1–2 years).	• No decline in overdose deaths. • Deaths stay flat or continue rising after policy. • DiD $\beta \approx 0$ or $\beta > 0$.

Diff-in-Diff, Non-Parallel Trends (Hypothetical Visuals for Different Possible DiD Test Results)









Final Variables Required

Component	What Information Is Needed (General Description)	Why It's Needed
Outcome Variable, Prescribing (for H1 & H3)	Total opioid volume consumed/prescribed per county per year (e.g., in Morphine Milligram Equivalents (MME) per capita).	This is the dependent variable (Y) when analyzing prescription behavior.
Outcome Variable, Overdose Deaths (for H2 & H4)	Number of opioid-related overdose deaths per county per year (or per 100,000 residents).	This is the dependent variable (Y) when analyzing mortality effects.
Population	County-level population per year.	Needed to calculate per capita prescribing or death rates for fair comparison across counties.
Policy Implementation Timing (Time Indicator)	Whether an observation is before or after the policy year (e.g., 0/1 indicator where 1 = post-policy).	Used to separate pre-policy and post-policy periods in DiD.
Geographic Unit (Grouping)	County identifier and state identifier for each observation.	Allows aggregation and comparison between treated and control regions.
Treatment Group Indicator	Indicator showing whether a county belongs to a state that implemented the policy (e.g., Florida or Washington) or to a control state.	Distinguishes between treatment and control groups.
Time	Year of observation for each county	Needed to observe trends over time and align policy year.
Cause of Death Classification (for H2 & H4)	Specific drug overdose classifications (e.g., opioid-related causes, using ICD-10 categories).	Ensures only opioid-related deaths are counted in mortality analysis.

Data Sources

1. **ARCOS (Automation of Reports and Consolidated Orders System) Shipment Data**
    - **Source:** DEA ARCOS database obtained by *The Washington Post* (via FOIA)
    - **Contains:** Detailed records of opioid pill shipments, including:
        - Reporter and buyer details (names, DEA IDs, business type, state, county, ZIP).
        - Drug information (drug name, NDC, strength, dosage form, MME_Conversion_Factor).
        - Shipment volume and strength (CALC_BASE_WT_IN_GM, DOSAGE_UNIT, QUANTITY).
        - Transaction date.
    - Key Variables Needed
        - **Drug flow measure:** CALC_BASE_WT_IN_GM or MME_Conversion_Factor × DOSAGE_UNIT (proxy for prescribing volume).
        - **Geography:** COUNTY, STATE → allows aggregation to **county-year** level.

        - **Date:** TRANSACTION_DATE → used to derive **year** variable.
    - **Period covered:** 2006–2014 approximately
    - **Purpose:** To estimate **opioid shipments/prescribing intensity per capita** by county and year, and test **policy impacts in Florida (2010)** and **Washington (2012)** relative to control states.
2. **U.S. Vital Statistics Mortality Data (2003–2015)**
    - **Source:** U.S. Vital Statistics Mortality Records (pre-downloaded county-level summary)
    - **Contains:** Annual death counts by **county**, **year**, and **cause of death** (drug/alcohol induced vs. non-drug causes).
    - **Key variables**
        - **Outcome measure:** Deaths due to overdose (drug/alcohol induced).
        - **Geography:** County name and **FIPS code** (standardized unique identifier).
        - **Time:** Year (2003–2015).
    - **Purpose in your analysis:**

      To measure **opioid overdose mortality rates** at the county-year level before and after policy changes.
3. **County-Level Crosswalk / Population Data (Auxiliary Dataset)**
    - **Source: [External]** Publicly available FIPS code crosswalk or U.S. Census county population estimates.
    - **Purpose:**
        - To link counties between ARCOS data and Vital Statistics using **County FIPS**.
        - To calculate **per capita prescribing and death rates**.
        - May also help normalize any differences in county naming conventions or missing geographic identifiers in ARCOS data.
    - **Key variables:** State, County, FIPS_Code, Population.

4. Dataset Relation and Merging Workflows

1. **Aggregate ARCOS data** to county-year level:
    - Sum opioid shipments by county-year (e.g., grams, MME-adjusted units).
2. **Clean and match county identifiers:**
    - Normalize county names, remove “County/Parish/Borough” suffixes.
    - Use FIPS codes (2-digit state + 3-digit county) to enable merging PDS_ProjectSummary.pdf.
3. **Merge with Vital Statistics data** by **County FIPS** and **Year** to obtain overdose fatalities.
4. **Add population data** to compute per-capita measures:

- Prescribing per capita = Total opioid grams / county population.
- Mortality rate = Overdose deaths / county population × 100,000.

5. **Subset the dataset** to:
    - Florida and Washington for treatment.
    - ≥3 demographically and regionally similar control states for comparison.

Division of Labor

Project Phase	**Main Task**	**Lead (Responsible)**	**Support (Review / Assist)**
Week 1: Data Setup & Cleaning	Create GitHub repository and folder structure	Bruce (A)	Sejal (B), Farnoosh (C)
	Download ARCOS (opioid shipment) dataset	Bruce (A)	Sejal (B)
	Clean and process ARCOS dataset (columns, units, aggregation to county-year)	Sejal (B)	Bruce (A), Farnoosh (C)
	Download and clean CDC mortality dataset (overdose deaths, population, ICD-10)	Farnoosh (C)	Bruce (A), Sejal (B)
Week 2: EDA & Pre-Post Analysis	Merge documentation of datasets and code comments in GitHub	Bruce (A)	Sejal (B), Farnoosh (C)
	Visualize opioid prescribing trends (MME per capita)	Bruce (A)	Sejal (B), Farnoosh (C)
	Visualize overdose mortality trends	Sejal (B)	Bruce (A), Farnoosh (C)
	Conduct and plot simple pre-post comparison (before/after policy)	Farnoosh (C)	Bruce (A), Sejal (B)
	Present findings in team sync, adjust based on feedback	All	All
Week 3: Difference-in-Differences Analysis	Run DiD model for Florida (2010) opioid prescribing & deaths	Bruce (A)	Sejal (B), Farnoosh (C)
	Run DiD model for Washington (2012) opioid prescribing & deaths	Sejal (B)	Bruce (A), Farnoosh (C)
	Check DiD assumptions (parallel trends, event-study)	Bruce (A)	Sejal (B), Farnoosh (C)
	Compare effect sizes between states and outcomes	Sejal (B)	Bruce (A), Farnoosh (C)
Final Output & Reporting	Write final report (methods, results, discussion)	Farnoosh (C)	Bruce (A), Sejal (B)
	Organize GitHub (final scripts, cleaned data, plots, README)	Farnoosh (C)	Bruce (A), Sejal (B)
	Proofread, ensure reproducibility, final presentation	All	All