Opioid Policy Impact

Analyzing the impact of state-wide opioid policy on drug transactions and overdose death rates.

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Executive Summary

Over the past two decades, the United States has faced an alarming surge in the utilization and misuse of prescription opioids, leading to a profound escalation in opioid addiction. The consequential opioid overdose epidemic has prompted numerous states to respond with the adoption of policies aimed at controlling the supply of opioids and introducing harm-reduction measures. This research project critically examines the effectiveness of these policy interventions designed to mitigate the over-prescription of opioids.

The study's primary objectives are to assess the impact of these policy changes on two crucial fronts: (a) the prevalence of opioid drug prescriptions and (b) mortality rates associated with drug overdoses. Employing a robust methodology encompassing pre-post analysis and a difference-in-differences approach, the study meticulously investigates the outcomes of three specific policy changes – a Florida regulation enacted in 2010, a Washington regulation effective from January 2012, and a Texas regulation initiated in January 2007. In Florida, the implementation of a policy focusing on mandatory pain clinic registration and restrictions on drug dispensing revealed research findings that underscored a notable impact on opioid-related outcomes. Similarly, in Washington, the adoption of policies centered on prescription reassessment and preventative treatment presented research findings, suggesting a distinct influence on the opioid landscape. Texas, operating under its specific policy, did not exhibit significant changes, but there may be underlying reasons contributing to this observation. These nuanced findings not only establish a clear association between state policies and a reduction in prescription opioids but also illuminate the intricate complexities involved, providing valuable insights for policymakers navigating the multifaceted landscape of opioid control strategies.

Introduction

The opioid epidemic in the United States has its origins deeply embedded in the 1990s, a period marked by intensified efforts to address undertreated chronic pain. Unfortunately, this well-intentioned initiative resulted in aggressive marketing by pharmaceutical companies and a surge in opioid prescriptions by healthcare providers. The widespread use of opioid analgesics, both as prescription medications and through illicit channels, became a key contributor to the ongoing crisis. This epidemic, marked by a rise in opioid abuse and drug-related overdose deaths, has prompted reflexive legislative responses at various levels.

The legislative approach often focused on restricting the distribution of opioids, driven by the concern of preventing new patients from developing addiction. Despite the good-natured intent behind these policies, the effectiveness in reducing opioid abuse is far from straightforward. The potential consequence of restricting opioid distribution is the emergence of an increased demand for illegal opioids with unregulated dosages, thereby exacerbating the crisis. This report aims to investigate the causal impact of state-level opioid distribution policy on the prescription of opioids and drug related overdose deaths in the policy holding state. Three states are in question: Texas, Florida, and Washington.

Policies

The following opioid restricting policies were implemented in each of the respective states.

Florida (Effective February 2010):
In 2010, pain clinics were required to register with the state, and Operation Pill Nation was launched to target these clinics. Regulations on pain clinics were further tightened in the same year. In 2011, following a public health emergency, physicians were prohibited from dispensing Schedule II or III drugs from their offices, and mandatory dispenser reporting to a prescription drug monitoring program began. In 2012, the state expanded regulation of drug distributors and established a task force on prescription drug abuse and newborns. These measures aimed to curb the rampant misuse of prescription medications in Florida.

Washington (Effective January 2012):
In 2012, the Washington Department of Health implemented a new policy that targeted both prescription re-evaluation and preventative treatment as a measure to combat opioid drug overdoses. The law stipulates that patients who are on a stable, non-escalating dose of 40 mg Morphine Equivalent Dose (MED) per day or less should have their cases reviewed annually. Additionally, a mandatory consultation with a pain management specialist is required for adult patients when the prescribed dose reaches or exceeds 120 mg MED per day. Furthermore, the rule recommends that practitioners should avoid prescribing more than an average of 120 mg MED per day unless there is demonstrable improvement in the patient's function or a consultation with a pain management expert is obtained.

Texas (Effective January 2007):
Texas implemented a law that establishes a detailed protocol for physicians treating chronic pain, specifically designed to mitigate opioid abuse. It mandates comprehensive patient evaluations, including detailed medical histories and assessments of pain intensity and potential for substance abuse. The treatment plan must be clearly documented, specifying medications, dosages, and treatment goals. Informed consent is essential, with discussions about the risks of becoming addicted to controlled substances. Regular patient reviews are needed to assess treatment effectiveness and make necessary adjustments. The law also requires referrals for patients at risk of abuse or addiction. All aspects of treatment, consultations, and medication details must be meticulously documented in medical records. The framework of this law was designed to ensure responsible opioid prescribing.

In addressing the opioid crisis, each of these states has adopted a unique strategy that reflects their specific priorities and challenges. Florida's approach is more regulatory in nature, focusing on oversight and control of the entities involved in prescribing opioids, such as pain clinics and physicians. This strategy is indicative of a broader strategy to control the sources of opioid distribution within the state. On the other hand, Washington's policy puts a strong emphasis on the prescribing process itself, setting guidelines for periodic consultations at certain dosage thresholds. Washington's approach aims to directly influence how opioids are prescribed and managed on a case-by-case basis. This method suggests an emphasis on individual patient care and a focus on preventing the initial onset of opioid dependency. Texas's strategy is even more patient centric and highlights the importance of a detailed understanding of each patient's situation. This approach seems to reflect a balance between controlling opioid prescriptions and ensuring that patients with legitimate needs for pain management receive appropriate care. In the remaining sections, we will evaluate these three states in their different strategic approaches to combatting opioid abuse.

Data

Data Sources

Our research is based on three comprehensive datasets: shipping information, mortality statistics, and population data.

1. Opioid Shipment Data:

- Dataset Name: Prescription Opioid Shipment Data
- Source: The Washington Post
- Coverage: 2006 to 2015
- Details: The dataset, sourced from the Drug Enforcement Administration's Automation of Reports and Consolidated Orders System (ARCOS), as presented by The Washington Post, delves into the profound impact of legal opioid distribution in the United States spanning from 2006 to 2019. Focusing on the distribution of oxycodone and hydrocodone pills, which collectively constitute three-quarters of all opioid dosages shipped, the dataset is meticulously

organized at the county and state levels, and it holds opioid shipments data including specifics like drug types, quantities, and distribution locations.

- Link to Original Source: The Washington Post - Prescription Opioid Shipment Data

2. Overdose Mortality Data:

- Dataset Name: Vital Statistics Mortality Data
- Source: Pleis JR, Ward BW, Lucas JW. Summary health statistics for U.S. adults: National Health Interview Survey, 2009. National Center for Health Statistics. Vital Health Stat 10(249). 2010.
- Coverage: 2003 to 2015
- Details: The US Vital Statistics records contain comprehensive information on every registered death in the United States. From the dataset, we acquired summarized mortality statistics for both drug and non-drug-related causes in every county across the nation. This dataset offers insights into mortality patterns at the county level, encompassing both drug and non-drug causes. Through annual aggregation, it becomes a valuable tool for examining trends in overdose mortality over the same timeframe as the opioid shipment data, providing a robust resource for analysis and research.

3. U.S. Population Data:

- Dataset Name: SEER*Stat Database - Populations
- Source: Surveillance, Epidemiology, and End Results (SEER) Program, National Cancer Institute
- Coverage: 1969 to 2020
- Details: To control potential confounding variables, population data is essential. The SEER*Stat Database provides total U.S. population data from 1969 to 2020, adjusted for events like Katrina and Rita. This dataset, linked to county attributes, serves as a foundation for normalizing the overdose mortality and opioid shipment data, allowing for per capita analyses and ensuring that the observed trends are not solely due to changes in population size.
- Link to Original Source: SEER Program - SEER*Stat Database

Data Manipulation

Standardizing Opioid Shipments:

The dataset comprehensively covers the distribution data for both oxycodone and hydrocodone pills, accompanied by a set of diverse variables that offer detailed insights into the entities engaged in opioid transactions. To facilitate a standardized assessment, a normalization process is implemented, focusing on the potency of the drugs. This involves the calculation of drug potency as the product of three essential factors: "Dosage Strength (dos_str)," representing the strength of the dose in milligrams; "Dosage Units," indicating the quantity of pills, patches, or lozenges shipped; and "MME_Conversion_Factor" (Morphine Milligram Equivalent Conversion Factor), denoting the opioid dosage's equivalency to morphine. Specifically, the normalization involves multiplying the calculated base weight in grams (CALC_BASE_WT_IN_GM) by the MME_Conversion_Factor (in milligrams) and then scaling it by a factor of 1000. This meticulous process ensures a standardized and uniform basis for evaluating and comparing various opioids present in the dataset.

Standardizing Opioid Overdose Death:

We employed ICD-10 codes to identify instances of overdose mortality and distinguish specific causes of death. Our primary focus was on identifying deaths with drug overdose as the underlying cause, using codes X40-X44 (unintentional), X60-X64 (suicide), X85 (homicide), Y10-Y14 (undetermined intent), and all other drug-induced causes. The data is consistently recorded annually for each county. To conduct a comprehensive analysis of death rates related to opioids, we aggregated all these categories together by county and normalized over population, resulting in metrics specifically for opioid overdose deaths.

Handling Missing Data:

The missing data in the drug death statistics is primarily attributed to privacy regulations enforced by the US Vital Statistics Agency. The agency censors data when the number of people in a specific category (e.g., one county/year/cause of death category) is less than 10. This privacy measure aims to protect individuals' identities by withholding information in cases of low counts, both for privacy reasons and to prevent potential identification of individuals in small communities. However, in addition to the anonymity reasons for missing data, there are counties which have missing data for every year referenced. There were 47 counties across all states which contain no death data at all. This makes it very difficult to identify why the data is missing. It could still be due to anonymity, however it could be due to the county's failure to report drug overdose data. We attempt to account for any reason for missing data with stochastic regression imputation.

Stochastic regression imputation uses the same methodology as a simple linear regression. This imputation method is optimal for our case because it will add randomness which is typically unaccounted for in traditional imputation methods. We use the different factors of interest to the county: state, population, opioid amounts, and year. These factors are then used to predict the number of drug related deaths which occur in counties that did not previously have deaths. The model was trained and tested using "true" data, data which already has the death counts. The model was 90% accurate in predicting the deaths in a county. This number was calculated and compared on data which already reported the deaths to ensure an accurate model.

Following the training and testing of the model, it was used to impute or fill in the missing death data for all states.[1] The imputed data resulted in an accurate representation based off population and opioid imports. As death counts cannot be decimals, they were rounded to the nearest whole number post processing for a more realistic death count. Please see the distribution of state/year combinations for before and after data imputation in appendix [1] and [2].

We can reasonably trust this data imputation method as the error was low and the accuracy was high.

[1] Texas before year 2006 did not have opioid data, therefore, those two years prior used a new model training and testing in the same fashion described. The model which predicted just 2 years for Texas missing data had 84% accuracy.

Methodology

Pre/Post Analysis:

This study conducts a pre-post analysis to examine the opioid-related death rates in connection with the implementation of policy changes in three states: Florida, Washington, and Texas. The focus is on discerning patterns in opioid overdose rates before and after the policy changes to gain preliminary insights into the impact of the policies. The dataset is segmented into two periods for the analysis: the pre-policy change period (three years prior) and the post-policy change period (three years from the year of implementation). The shaded areas surrounding the lines on the graphs indicate standard errors, providing a measure of uncertainty around the displayed data points. This helps account for potential variability and enhances the robustness of the analysis. It is crucial to acknowledge that while pre-post analyses offer valuable insights, they may not consider potentially confounding factors that could affect the observed trends.

Difference-in-Difference Analysis:

To enhance our analysis, we employed a Difference-in-Difference (DiD) approach to evaluate whether observed changes in states implementing policy alterations significantly differ from changes in states without policy adjustments during the same timeframe. This methodology helps mitigate the risk of attributing observed changes solely to the implemented policy, considering potential confounding factors. The DiD analysis utilizes a linear regression model to estimate the impact of the policy change by comparing the difference between the treated state (Florida, Washington, or Texas) and untreated states (three selected reference states) before and after the policy change. Visualization of the DiD model results is facilitated through plotting functions utilizing the Altair and Seaborn libraries, with error bands to depict standard errors. The key insight derived from DiD focuses on whether there is a noteworthy difference in the changes observed in opioid overdose rates between the policy-change state (Florida) and non-policy-change states. A statistically significant DiD estimate implies that the policy change had an effect beyond any national trends affecting all states.

Reference State Selection

The reliability of our Difference-in-Difference (DiD) analysis heavily depends on the assumption of parallel trends between the treated and untreated groups before the policy change. Essentially, this means that, if there were no policy changes, both groups would have followed similar trends over time. To ensure the utmost accuracy, we took a deep dive into the background of each state, considering various factors that might influence the opioid scenario. We meticulously analyzed shipment data for both the opioid states and our carefully selected reference states, making sure the trends aligned even before any policy tweaks. Beyond opioid data, we took into consideration economic and geographic factors that directly contribute to the opioid landscape. We restricted our analysis to data from states up to the years preceding policy changes, minimizing potential biases. Furthermore, we diligently confirmed that there were no significant policy alterations related to opioids in the chosen reference states during the same period, thus affirming the validity of our reference state choices.

Florida:

Florida had a policy change in 2010, which was centered around limiting pill mills or opioid prescription clinics. The priority selection of control states revolved around this crucial policy change in the opioid epidemic. There were three states which also stood out with pill mill problems: Tennessee, West Virginia, and Ohio[1][2]. These states had either a later policy change or a severely less restrictive policy change than Florida enacted. The states also actively had similar opioid death and transaction rates to that of Florida[3].

In the figure below, we see that Tennessee and West Virginia had very similar opioid transaction rates prior to the policy change. Ohio has a somewhat smaller rate of opioids but still follows the same slope.

Figure 1: Florida Opioid Transaction Rates with Policy Change

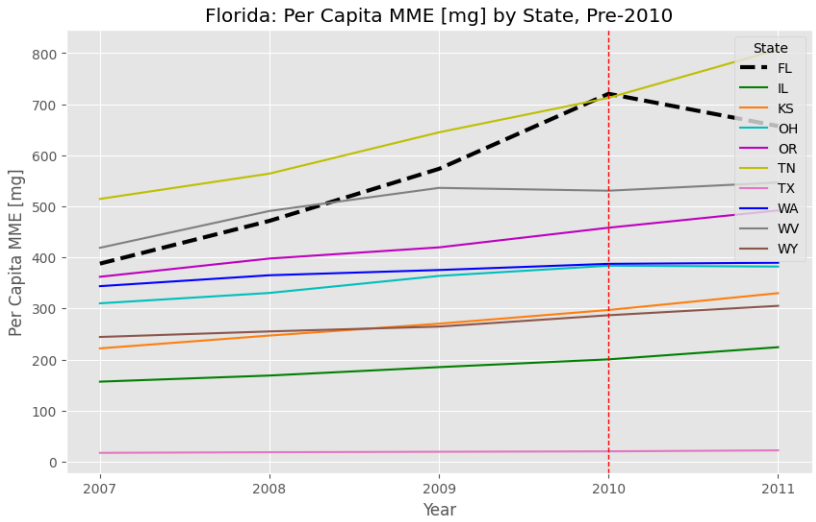

Figure 1: Opioid transaction rates of potential control states to identify which follow similar trends to Florida's opioid crisis prior to "Operation Pill Mill" in 2010.

In figure 2, we see that Florida's death line slope moderately follows a similar trend to that of Ohio and Tennessee. West Virginia has a significantly higher death rate; however, West Virginia was one of the most similar policy-wise to that of Florida. West Virginia also has a severe pill mill problem, and they in acted a less restrictive policy [1]. Therefore, West Virginia remains a reasonable control state to analyze.

Figure 2: Florida Overdose Death Rates with Policy Change

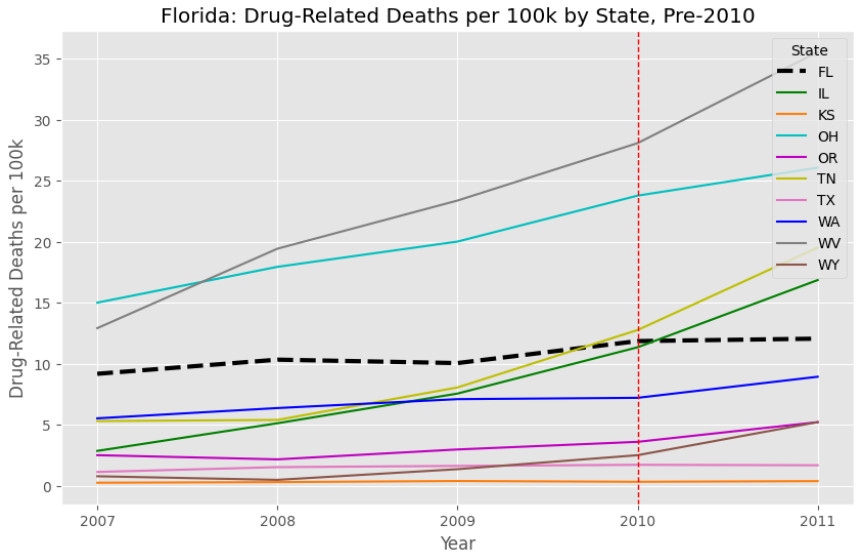

Figure 2: Opioid overdose rates of potential control states to identify which follow similar trends to Florida's opioid crisis prior to "Operation Pill Mill" in 2010.

Washington:

Figure 3 below show the average annual per capita morphine equivalent in mg for the state of Washington three years prior to the implementation of new opioid restricting policy. The per capita MME remained fairly constant during the years leading up to the new policy. This trend was a top priority in deciding Washington's reference states because much of the policy implemented in 2012 focused on the contingencies of prescribing higher dosages of opioids. If this intent was effective we should see the per capita distribution of opioids receive the brunt of the policy regulation.

Figure 3: Washington vs Other States Opioid Transaction Rates

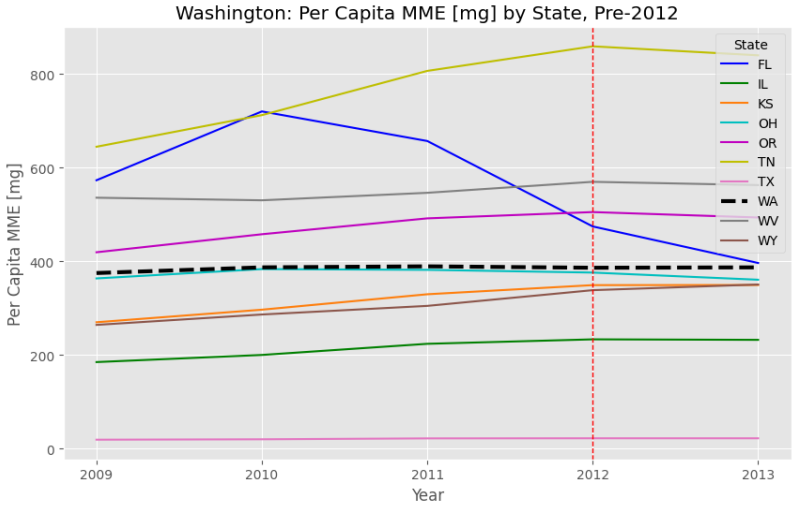

Figure 3: Washington has a very limited difference in trends. We will pick states which are the closest to this trend.

The other consideration made when selecting the reference states for Washington was the state's balance between urban and rural counties. Washington is a state where most of the population lives in dense urban cities (Seattle Metropolitan: 51.9% [4]), but the majority of the counties are rural. This imbalance is important for policies targeting opioid prescriptions because of the discrepancy of healthcare treatment for rural vs. urban communities. A measure of a county's rurality is provided by the CDC [5]. The average rurality score for each state was calculated by averaging the 2006 and 2013 rurality score across all counties in the state. 2006 and 2013 were the closest years to policy implementation where the score was calculated. The rurality score is measured on a scale from 1 (urban) to 6 (rural). The rurality score of Washington is 4.41 indicating more rural counties exist in Washington despite having a large population concentration in one city. This pattern was also a primary consideration when determining reference states.

Based on the criteria above, three states were selected: Oregon (higher), Ohio (equal), and Illinois (lower). From figure __, each of these states shows a stable per capita morphine equivalent prior to policy implementation in 2012.Additionally, these three states strike a balance between higher (Oregon), equal (Ohio), and lower (Illinois) per capita morphine equivalent compared to Washington. Finally, these three states each have large metropolitan cities that house over 50% of the states population (Portland Oregon, Chicago Illinois, Columbus/Cincinatti Ohio) yet each of them cumulatively have more rural counties than non-rural counties. Table 1 below shows the rurality scores for each of the three states. For this causal analysis Oregon, Illinois, and Ohio will serve as the control states before and after policy implementation in Washington.

Table 1: Rurality Scores for Washington and similar states.

	Washington	Oregon	Illinois	Ohio
Rurality Score (1 Rural) - (6 Urban)	4.41	4.57	4.55	4.14

Texas

Due to constraints arising from the limited availability of shipment data for certain years, we made the decision to exclude Texas shipment data from our analysis. In our examination of opioid morbidity data of Texas, Wyoming, Kansas, and Illinois were chosen as reference states. It is noteworthy that Texas demonstrates an exceptionally low drug-related mortality rate, ranking 4th lowest among states in the year 2021, after Nebraska, South Dakota, and Iowa. When selecting a reference group for Texas, our aim was to identify states with similarly low mortality rates and comparable fluctuations over time. In contrast to states with higher morbidity rates and greater fluctuations three years before 2007, such as Ohio and West Virginia, we opted for Wyoming, Kansas, and Illinois as they align more closely with Texas in terms of both low mortality rates and comparable variability patterns.

Figure 4: Texas vs Other States Opioid Death Rates

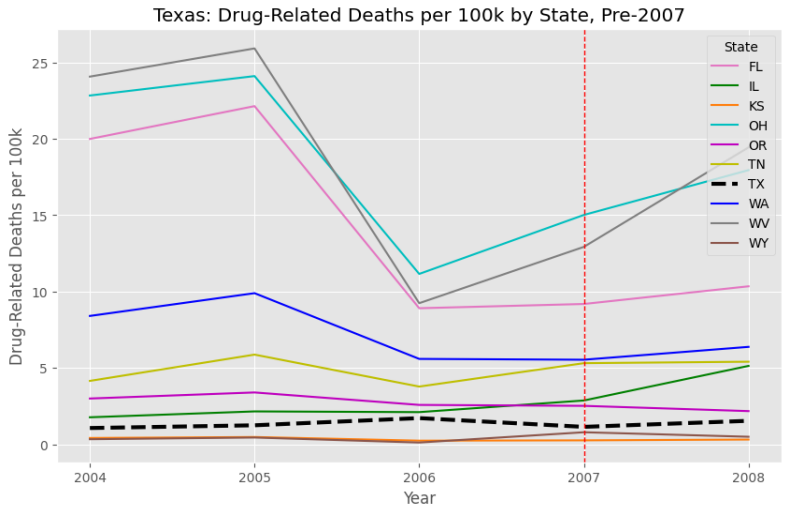

Figure 4: Texas maintains a low number of deaths and has no change in slope for all years. We will pick states which follow this similar trend.

Opioid Death Rate

Pre-Post Analysis

The first analysis we want to look at is a pre-post analysis of the opioid death rates relative to the implementation of policy. Pre-post analyses do not allow us to account for potentially confounding factors, but it does offer a glimpse of the overall opioid overdose trends before and after the policy implementation. Below are three pre-post plots for each of the three states in question. A timeframe of 3 years is allotted on either side of the policy implementation to allow enough time to identify trends.

Florida's "Operation Pill Mill" was enacted in 2010. We see prior to 2010 the death rate was climbing steadily. Following the policy restrictions the death rate is now decreasing, and hopefully will continue to decrease with more years under the policy restriction.

Figure 5: Florida Death Rate Pre and Post Policy Change

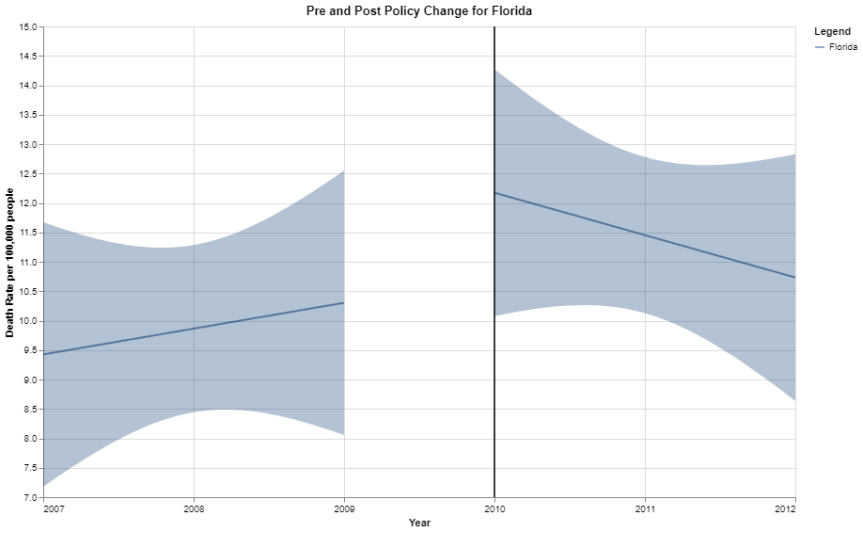

Figure 5: Florida following an opioid restriction policy change, sees a decline in deaths per 100,000 people across the entire state.

Washington has a very large opioid problem, as the most recent treatment state to receive a policy change. It has very limited data to see the true effect of its opioid restriction policy. That is seen in it's pre-post graph for opioid deaths. Although Washington included more consultation and patient help related opioid regulations, we have yet to see a decline in deaths. However, it can be a few more years until the death rates decrease from the policy changes.

Figure 6: Washington Death Rate Pre and Post Policy Change

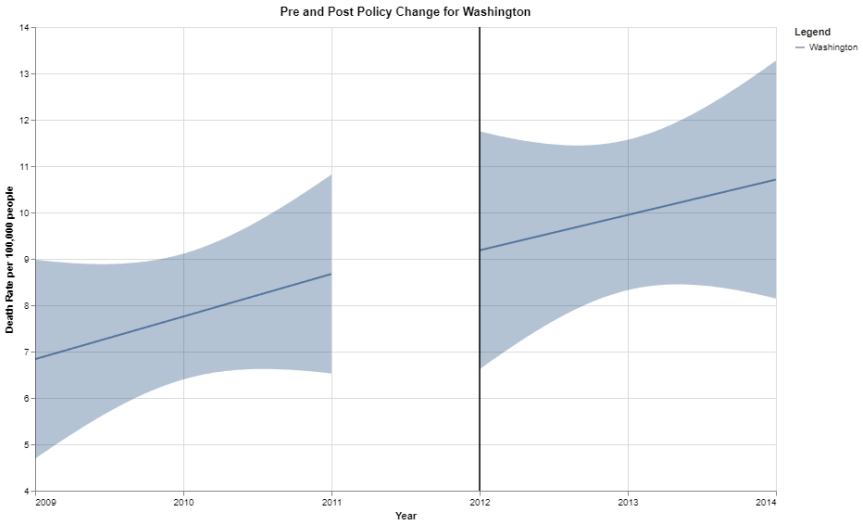

Figure 6: Washington state fails to see a change in opioid related deaths following their policy change.

Lastly, Texas had the earliest policy change in 2007. It's purpose was to limit the number of prescriptions by requiring more specific reasons for the patient's prescription. Texas had one of the lowest drug overdose rates compared to all the states looked at through analysis. Therefore it is of no surprise that the graph shows no decrease in deaths. The death rates have the same trend as they did prior to the policy change. This could be due to Texas's rurality or to their limited number of opioid deaths to begin with.

Figure 7: Texas Death Rate Pre and Post Policy Change

Figure 7: Texas fails to decrease their already limited opioid death rate following a policy change. They still have a very low death rate.

Difference-in-Difference Analysis

As mentioned previously we will now follow a more comparative analysis of treatment state(FL, WA, TX) contrasted to states with similar trends in opioid deaths and policy changes. The death counts were turned into death rates per 100,000 people so that they are better understood and more adaptable to counties of all population sizes.

Florida's regression line for before and after policy changes shows the same trend or a slight decrease following the policy change. However, the selected control states have a similar trend before 2010, and continue to rise at the same trend before 2010. This demonstrates Florida's policy may have impacted opioid policy death rates for the better.

Figure 8: Difference-in-Difference for Opioid Death Rates for Florda vs Control States

Figure 8: Florida slightly declines after policy change in 2010, while control states fail to decline due to lack of strict policy.

Washington prior to its 2012 policy change followed a very slow climbing death rate. It's control states had a slightly higher opioid related death trend, however, given their similar geographic factors they remain good control states. Following the 2012 policy, Washington sees no change. The state continues its steady and slow increase for opioid related death rates. However, the control states see a sharp increase in deaths following 2012. There is limited support to say this is due to Washington's policy change, however Washington did not see a severe increase in opioid related deaths while similar states did.

Figure 9: Difference-in-Difference for Opioid Related Deaths for Washington vs Control States

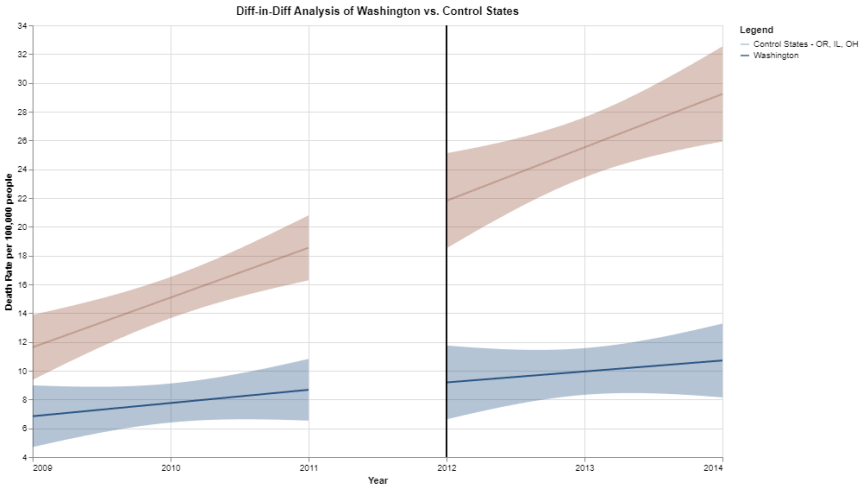

Figure 9: Washington shows no change in deaths after the policy change. However, similar states did continue to see a steeper increase in deaths following 2012.

Texas, as mentioned earlier, has a low number of opioid related deaths compared to most states addressed in this analysis. Before 2007, Texas had a slow increase in deaths for a couple years, until after the policy change it dropped, only to increase on a similar trend. Control states which had lower rates than Texas before 2007 exhibit a significant and steep increase in opioid-related fatalities. While we cannot definitively attribute this to the policy change, the fact that Texas did not observe a notable surge in deaths is an encouraging indicator.

Figure 10: Difference-in-Difference for Opioid Related Deaths for Texas vs Control States

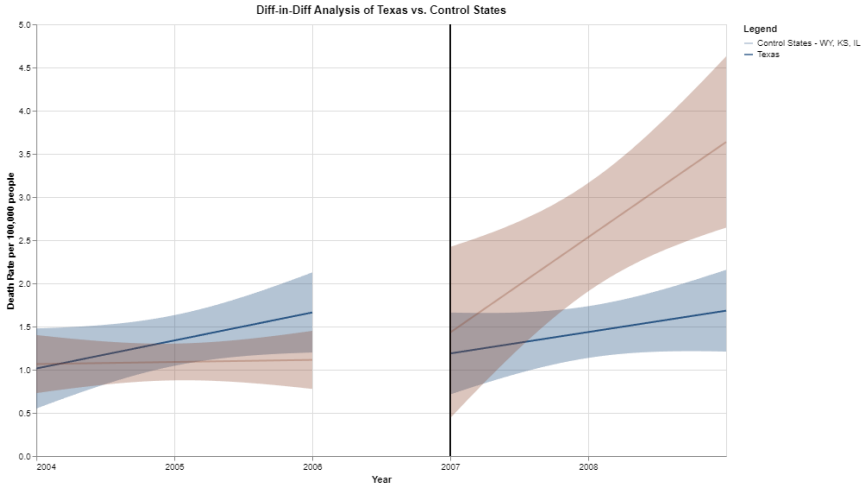

Figure 10: Texas continues to have a very low death rate both before and after policy change. Control states demonstrate the effect on opioid deaths when there is no policy change.

Opioid Transactions

Pre-Post Analysis:

The second part of our analysis will focus on the effect of policy on opioid transactions. Because legislative policy operates in the legal realm, it's important to analyze trends of the legal distribution of opioids to see if, independent of overdose deaths, there is a change in opioid distribution quantities after policy implementation. For this analysis, only Florida and Washington will be analyzed. Tracking of opioid transactions began in 2006 and the Texas policy being evaluated was implemented in 2007. Therefore, there is not enough data prior to policy implementation to make a judgement of whether the policy had an effect on legal transaction of opioids.

For the Pre-Post plots below, the y-axis is measured in milligram morphine equivalent per capita. For more information on this metric refer to the "Standardizing Opioid Shipments" section above. The x-axis is measured in years for a span of three years prior and three years after policy implementation.

The first state to analyze is Florida. The Pre-Post figure below shows the trend of opioid transactions before and after policy implementation in 2010. The plot shows a clear downward trend in opioid prescriptions per capita following the policy implementation. This suggests that the state's policies,

including the registration requirement for pain clinics, the initiation of Operation Pill Nation, and the establishment of a prescription drug monitoring program, may have been effective in reducing opioid prescriptions. However, we will reserve this conclusion until the Diff-in-diff plot proves that the references states did not also exhibit the same sharp decline in opioid transactions.

Figure 11: Pre-Post Analysis of Regulations on Opioid Shipments for Florida

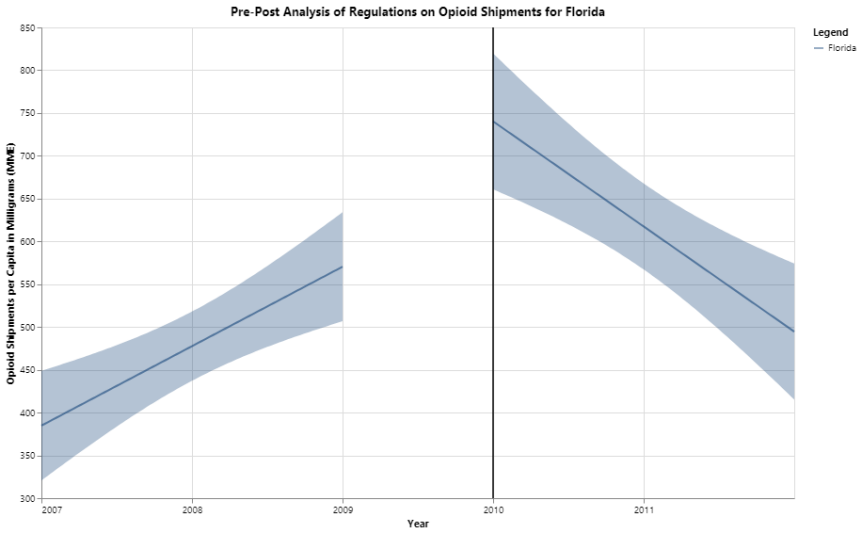

Figure 11: Florida changes from positive trend to negative trend in opioid transactions after policy implementation in 2010.

In Washington (below), there is a consistent increase from 2009 up until the point of policy implementation in 2012. After the policy implementation, the trend appears to reverse slightly or stabilize. Something to note is the large error bars suggesting high variance in the data. This could be an indication that the morphine equivalent per capita for each county vary greatly – more significantly than what was observed in Florida. If this variance is captured in the varying degrees of county rurality within Washington, then we should see a similar variance in the control states when analyzing the diff-in-diff plots.

Figure 12: Pre-Post Analysis of Regulations on Opioid Shipments for Washington

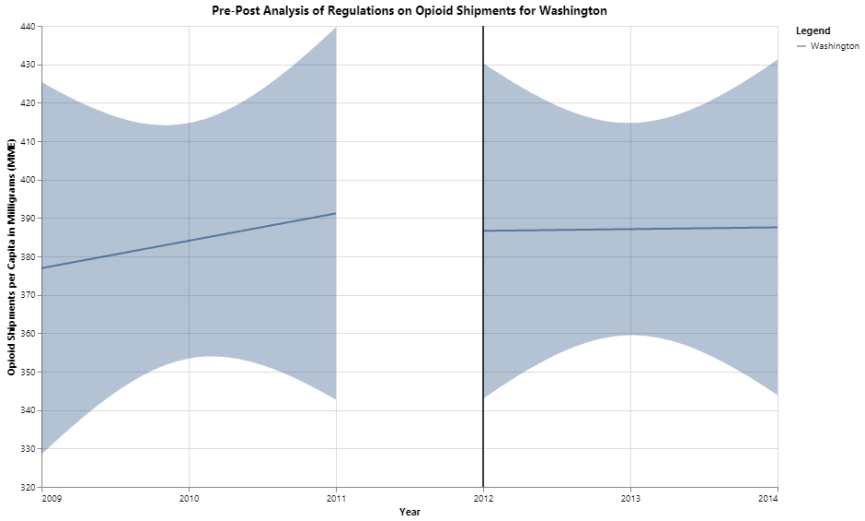

Figure 12: Washingtons opioid shipments per capita remained relatively unchanged after policy implementation.

From the Pre-Post plots alone, the policies, which focused on re-evaluating prescriptions and preventative treatment measures (Washington), may have been less effective than Florida policies which prohibited Schedule II and III drugs from being distributed by certain providers. However it is important to understand the trends of the control states to know if confounding factors may be hidden.

Difference-in-Difference Analysis:

Each Diff-in-diff plot below measures the y-axis in milligram morphine equivalent per capita, same as the pre-post plots. The x-axis is measured in years for a span of three years prior and three years after policy implementation. The blue lines represent the treatment state that received the policy change, and the brown line is the linear regression line for the three control states. The control states remained the same as they were in the overdose deaths analysis.

Continuing the pre-post analysis for Florida, we see the significant decrease in opioid shipments per capita following the policy implementation in Florida. However, the control states show the exact opposite trend. The control states continue the upward trend in MME per capita after 2012. In fact the trend looks relatively unchanged. Given this information, and with the assumption that the control states selected are an adequate representation of a Florida without policy, we can conclude that the Florida policy had a significant impact in reducing the legal distribution of opioids.

Figure 13: Diff-in-Diff Analysis of Regulations on Opioid Shipments for Florida

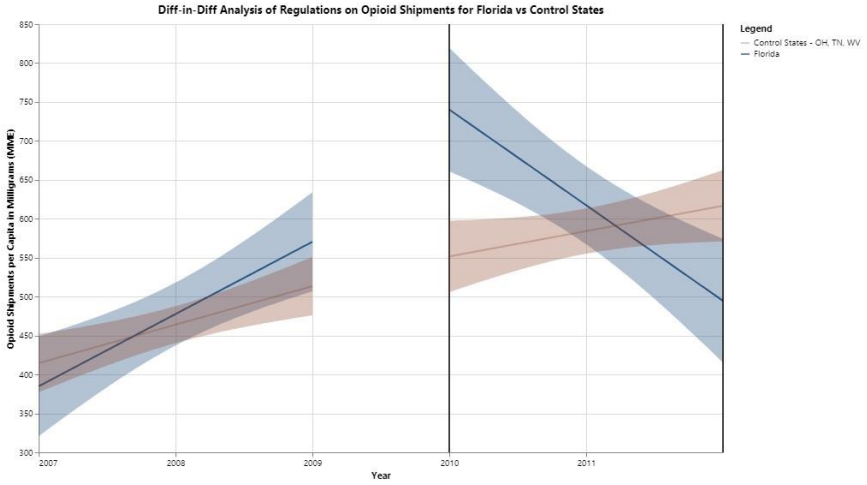

Figure 13: Florida saw a sharp decrease in MME per capita following their policy change, while control states continued to follow their trend after 2010.

The trend for Washington again shows a slight stabilization in opioid transactions per capita after policy implementation. However, the control states show the transaction rates start to decline after 2012. Because the control states show a more significant change than Washington, we cannot conclude that the change in Washington's MME per capita was due to the new regulations. In fact, the changes for Washington were so subtle that the policy may not have had any discernable impact at all.

Figure 14: Diff-in-Diff Analysis of Regulations on Opioid Shipments for Florida

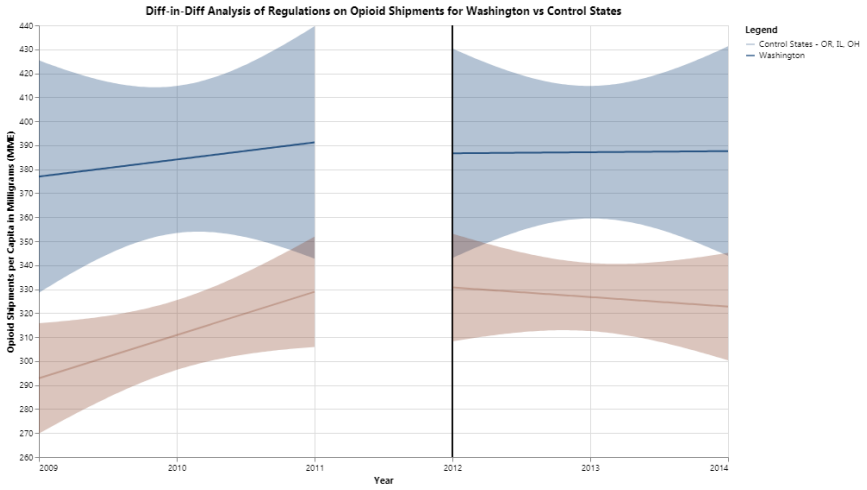

Figure 14: Washington had a slightly increasing trend for opioid shipments. However, after the policy change it leveled out and no longer has an increasing amount of opioids coming into the state.

Comparing these two plots together and their representative states, we conclude that policies targeting the legality of distributing opioids (Florida) were highly effective in reducing the transaction of opioids. The trend for Washington after 2012 suggests that Washington's policy measures, which included mandatory patient review and consultations for high-dose prescriptions, had nearly no effect on the legal distribution of opioids per capita.

Conclusion

Pulling both the mortality analysis and the opioid transactions analysis together, we can find patterns that indicate how effective the different policy strategies are. In Florida, the enactment of policies in 2010, such as mandatory registration for pain clinics and restrictions on the dispensing of Schedule II and III drugs, resulted in a substantial decline in opioid transactions per capita and decline in mobility rate. This indicates that the state's emphasis on regulating the legality of opioid distribution was highly successful in reducing legal opioid prescriptions. Conversely, Washington's 2012 policies, which focused on prescription reassessment and preventative treatment, led to a more modest impact, with a slight stabilization observed in opioid transactions per capita and mobility rate. This suggests a less pronounced effect on legal opioid distribution compared to the impactful measures implemented in Florida. Regarding Texas, the analysis indicates that the state's opioid-related death rate remained relatively stable post-implementation of its 2007 policy. Despite data limitations preventing a detailed assessment of the impact on legal opioid transactions, Texas's consistently low and stable opioid-related death rate implies that the state's policy may have played a role in maintaining control over the opioid crisis.

Future Work

However, several important limitations should be acknowledged. Firstly, the study focused on a select set of policies, potentially overlooking the broader policy landscape over the past two decades. A more comprehensive approach would provide a fuller understanding of the evolving opioid epidemic. Secondly, data limitations, including missing values, were addressed through imputation, introducing potential biases. Additionally, the study relied on opioid shipment and reported overdose data, excluding other critical metrics such as illegal opioid sources and the number of individuals addicted without resulting in overdose deaths.

In future research, our aim is to gather more detailed data, including geographical and economical information at the county level. This enhanced granularity will enable policymakers to pinpoint at-risk counties or those excluded from the current analysis. Furthermore, as new synthetic opioids emerge, we plan to investigate their impact on public health and work dynamics.

In conclusion, the opioid epidemic is a critical public health issue requiring continuous attention from policymakers. Leveraging data science, policymakers can gain insights and a nuanced understanding of the problem. Given the dynamic nature of the issue, we commit to refining our research methodology, expanding data sources, and broadening the scope to better address the evolving challenges posed by the opioid crisis.

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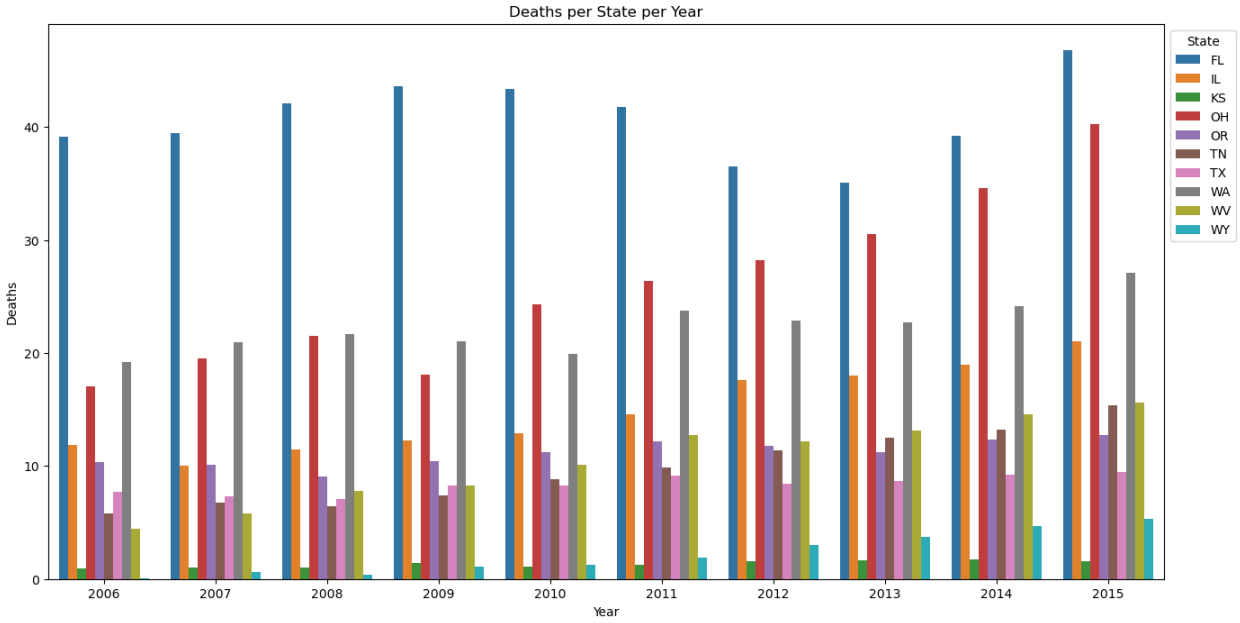
Appendix

[1] Before Missing Data Imputation



[2] After Missing Data Imputation