Estimate the Impact of Opioid Control Policies

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Motivation

For more than 30 years, the United States has suffered a widespread crisis of opioid addiction and overdose deaths. As a result, there have been significant policy efforts to address the opioid crisis. Led by the White House's Office of National Drug Control Policy [1], federal agencies such as the Drug Enforcement Agency (DEA), the Centers for Disease Control and Prevention (CDC), the Department of Health and Social Services (DHSS), and the National Institutes of Health (NIH) have taken several initiatives to combat it [2].

In addition to these efforts at the federal level, there has been enforcement of state-level opioid control policies in various parts of the US. For instance, the Texas Medical Board adopted regulations concerning treating pain with controlled substances in 2007. The Florida legislature also began to require that pain clinics treating pain with controlled substances register with the state in 2010, and the Washington Department of Health adopted a rule regulating prescribing opioids for pain treatment in 2012.

Evaluating the impact of these state-level policies on public health outcomes matters in health policy. It is because their geographic and temporal variation in policy adoption can offer an insight into a better understanding of the policy effects. In this project, the effects of opioid drug prescription regulations enforced in three states (Texas, Florida, and Washington) will be examined by focusing on their effects on 1) the volume of opioid shipments and 2) drug overdose deaths.

Furthermore, two approaches will be mainly used in the analysis. The first approach is a pre-post comparison focusing on the difference between pre-policy and post-policy outcomes. The other is a difference-in-difference method which compares the changes in outcomes over time between a state with a policy change and other states without the policy change.

Overview of the Data

In this analysis, three kinds of datasets will be used to examine the effectiveness of opioid control policies implemented in Texas, Florida, and Washington.

1) Opioid Drug Shipment Data: Provided by the Washington Post, this dataset offers county-level information about drug transactions from 2006 to 2014 that are sourced by the Drug Enforcement Administration's database, which tracks the path of every single pain pill sold in the United States. The dataset has records mainly about oxycodone and hydrocodone pills, which are known to consist of three-quarters of the total opioid shipments to pharmacies in the country.

2) Vital Statistics Mortality Data: This dataset, provided by the US Vital Statistics, contains data on every drug overdose death in the US from 2003 to 2015, and it also includes county-level information.

3) US Population Data: This dataset has population estimates for each county in the US from 2000 to 2020.

Analysis

The expectation is that the trend in opioid shipments and overdose deaths is lower in the states where regulations were implemented compared to the period before implementation and against jurisdictions where no policies were implemented. To analyze the effectiveness of the policy, it is expected that the trend for each of these quantities should be substantially less after the policies were implemented than before and that the trend should be substantially less for the treated states when compared to the control states.

Effect of regulation policy on opioid shipments
Florida

Below is the plot comparing the trend of the average annual per capita opioid shipments in Florida before and after policy implementation. Before the policy went into effect in January 2010, the trend of average per capita opioid shipments in Florida was positive, but after 2010, the trend turned negative. This substantial change in trend supports that the policy reduced the amount of opioids shipped to Florida.
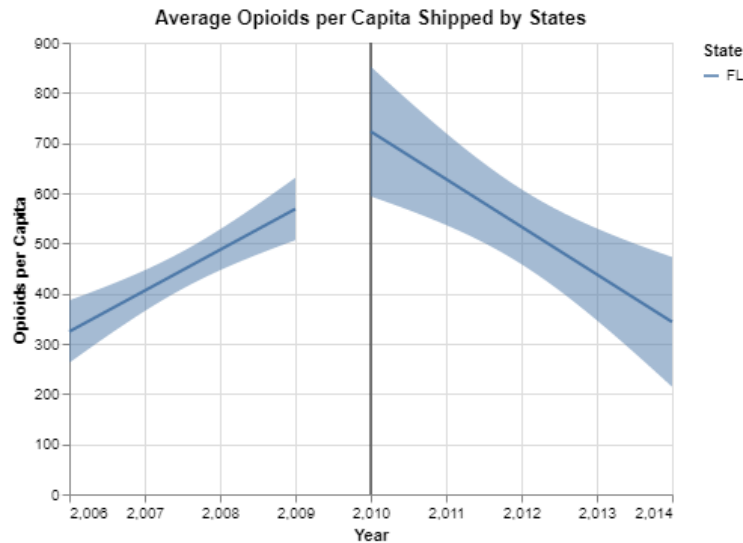
Fig 1: Opioids per capita for the intervention state Florida

The plot below compares the trend of the per capita opioid shipments for Florida against Florida's control states before and after policy implementation. When comparing these two trends, Florida's trend after the policy was implemented was substantially less than their control states' and had a much more significant reduction than the control states when comparing the periods before and after policy implementation. This substantial reduction compared to the control states further supports that the policy reduced the quantity of opioids shipped to Florida. Therefore, with respect to the reduction of opioids distributed to Florida, this suggests that Florida's policy has been effective.
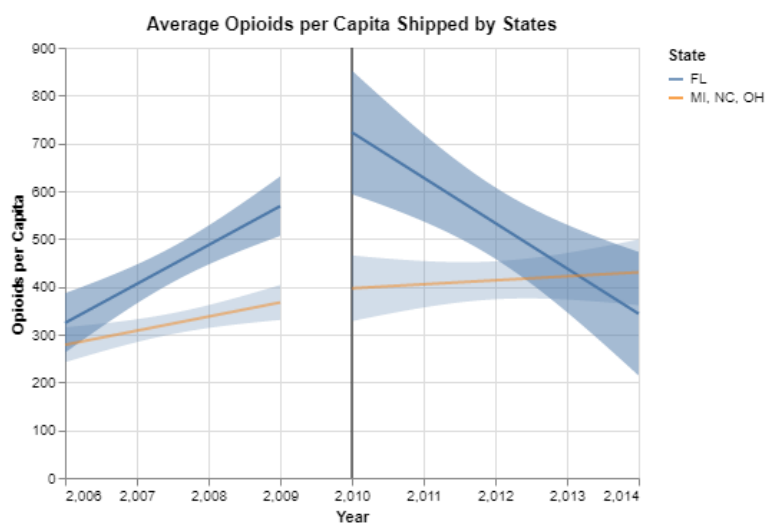

Fig 2. Average opioids per capita for Florida and its control states

Washington

Below is the plot comparing the trend of opioid shipments before and after policy implementation in Washington. Before the policy went into effect in January 2012, the trend of per capita opioid shipments in Washington was positive, but after 2012, the trend appeared flat. While the trend has reduced when comparing the period before and after policy implementation, this reduction seems moderate and insignificant. This slight reduction in trend warrants further analysis before supporting the hypothesis that the policy reduced the amount of opioids shipped to Washington.
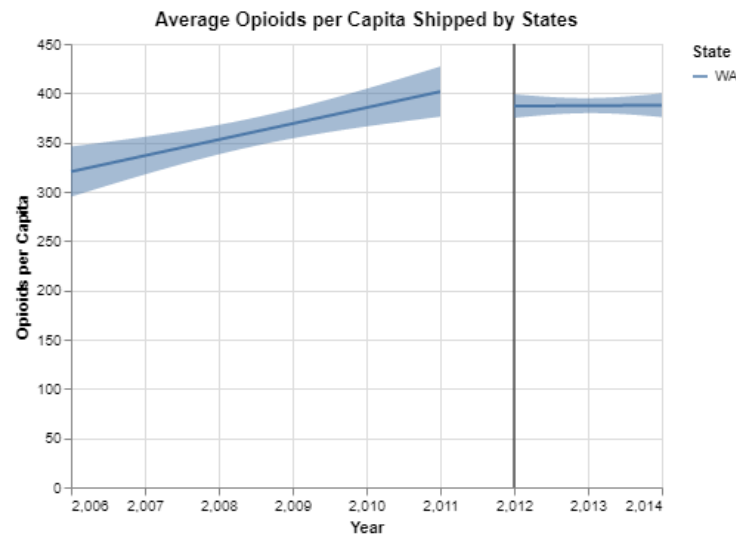

Fig 3: Opioids per capita for the intervention state Washington

The following plot below compares the trend of the per capita opioid shipments for Washington against Washington's control states before and after policy implementation. When comparing these two trends, Washington's trend after the policy was implemented was substantially less negative than its control states' and had a much smaller reduction in trend than its control states when comparing against before the policy implementation. Compared to the control states, this limited reduction in trend does not support the expectation that the policy reduced the quantity of opioids shipped to Washington. Therefore, with respect to the reduction of opioids distributed to Washington, this suggests that Washington's policy has been ineffective.
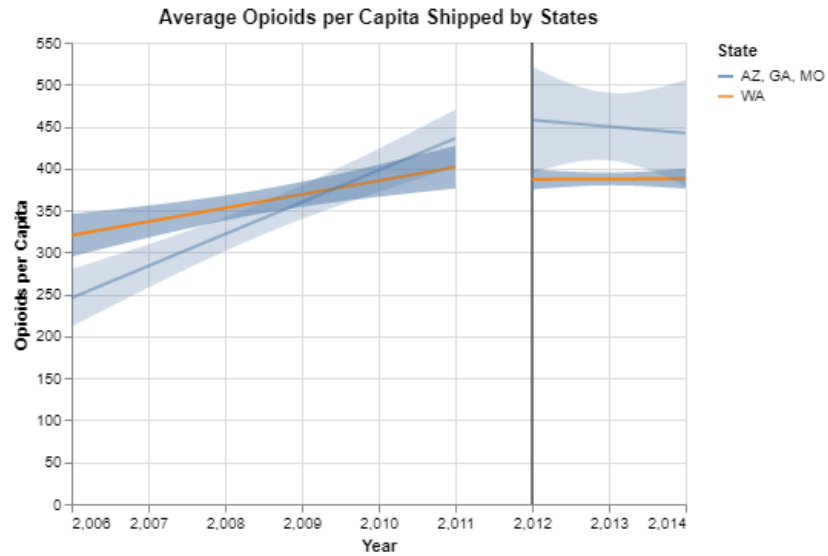
Fig 4. Average opioids per capita for Washington and its control states

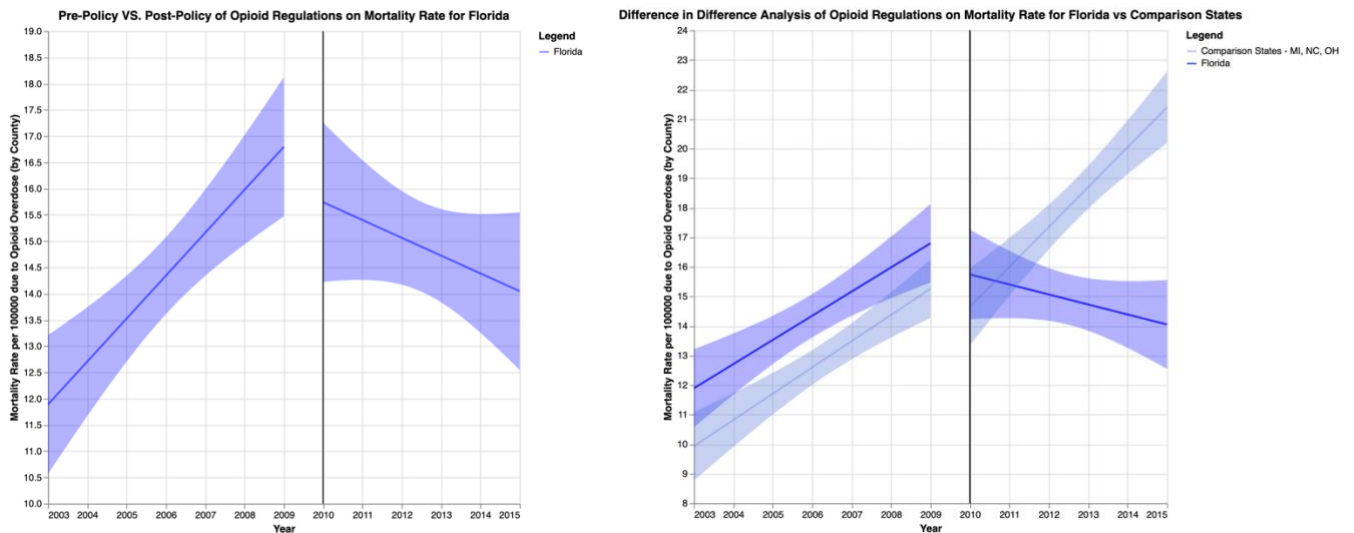# Effect of regulation policy on the mortality rate of opioid overdose Florida

Figure 5: Chart of the mortality rate of opioid-drug overdose between the pre-policy and post-policy periods; the regulation policy was effective in Florida in February 2010.

Above are the plots comparing the trends of the average annual per 100000 drug-induced deaths in Florida and its control states (MI, OH, NC) before and after policy implementation in Florida. Before the policy was enacted in February 2010, the trend of drug-induced deaths in Florida was increasing. After 2010, the trend became decreasing. This substantial change in trend supports the

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hypothesis that the policy reduced the quantity of drug-induced deaths in Florida. When comparing Florida's trend against its control states, the variation of trends between Florida and its control states on pre-policy periods (before 2009) was relatively small, while the variation of trends between Florida and its control states on post-policy (after 2010) periods became very large because these states did not publish a regulation policy for opioid drugs thus continued to have rising tendencies of drug-induced deaths. In general, after Florida implemented policy for opioid drugs in 2010, the mortality rate per 100000 of opioid-drug overdose in FL dropped immediately and maintained a downward tendency from 2010. This might not happen if the regulation policy was not implemented. Therefore, we conclude that the policy of opioid regulations had a positive impact on decreasing the mortality rate of opioid-drug overdose in Florida.
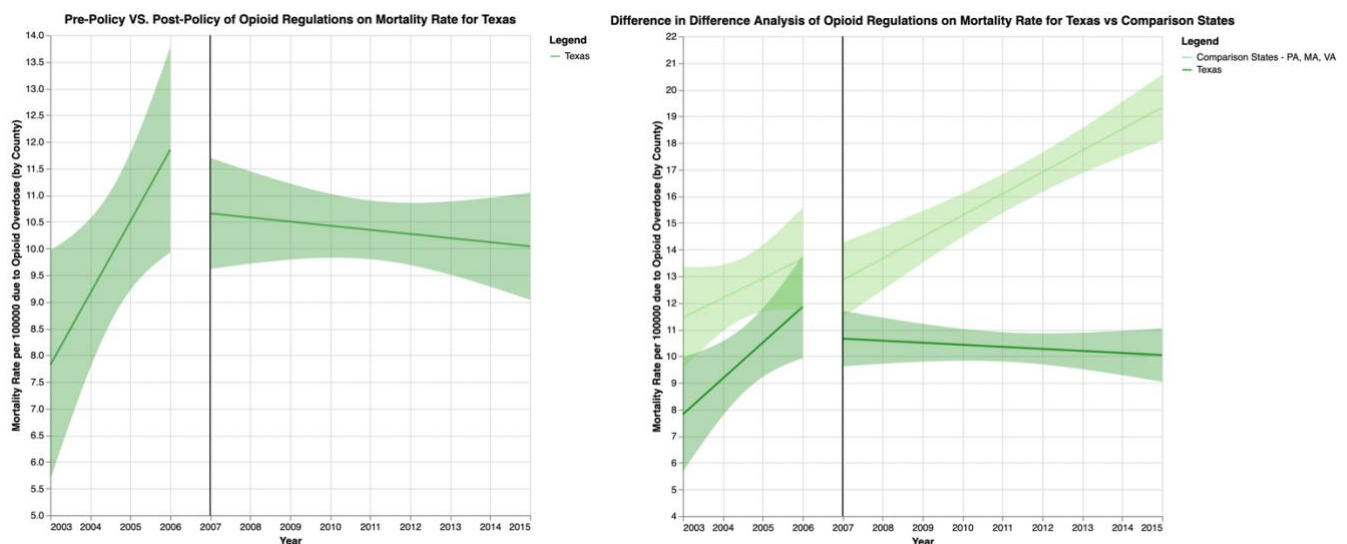
Texas

Figure 6: Chart of the mortality rate of opioid-drug overdose between the pre-policy and post-policy periods; the regulation policy was effective in Texas in January 2007.

Above are the plots comparing the trends of the average annual per 100000 drug-induced deaths in Texas and its control states ((MA, PA, VA) before and after policy implementation in Texas. Before the policy went into effect in January 2007, the trend of drug-induced deaths in Texas was increasing. After 2010, the trend became decreasing. While the decreasing degree was not apparent, this change in trend supports the hypothesis that the policy reduced the quantity of drug-induced deaths in Texas. When comparing Texas's trend against its control states, the variation of trends between Texas and its control states on pre-policy periods (before 2006) was relatively

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small, while the variation of trends between Florida and its control states on post-policy (after 2007) periods became very large because these states did not publish regulation policies for opioid drugs thus continued to have rising tendencies of drug-induced deaths. In general, after Texas implemented a policy for opioid drugs in 2007, the mortality rate per 100000 of opioid-drug overdose in TX dropped immediately and maintained a downward tendency from 2007. This might not happen if the regulation policy was not implemented. Hence, we conclude that the policy of opioid regulations had a positive impact on decreasing the mortality rate of opioid-drug overdose in Texas.
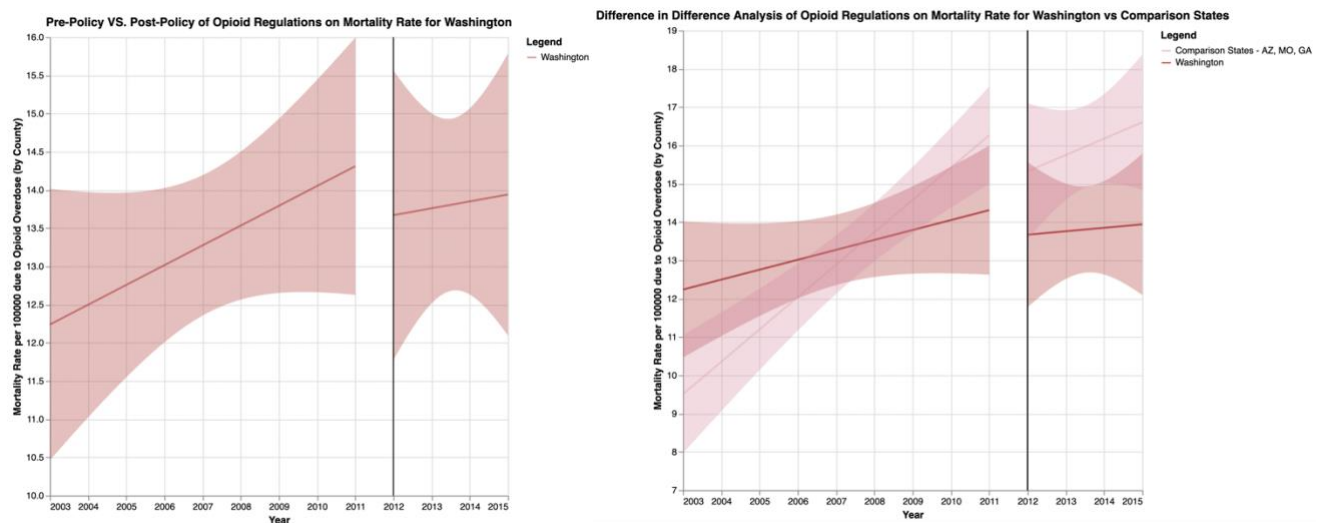
Washington

Figure 7: Chart of the mortality rate of opioid-drug overdose between the pre-policy and post-policy periods; the regulation policy was effective in Washington in January 2012.

Below are the plots comparing the trends of the average annual per 100000 drug-induced deaths in Washington and its control states (MO, GA, AZ) before and after policy implementation in Washington. Before the policy went into effect in January 2012, the trend of drug-induced deaths in Washington was increasing. However, after implementing the regulation policy for opioid drugs in 2012 at WA, the mortality rate of opioid-drug overdose in WA did not drop, it continued to keep an upward, but lesser degree tendency from 2012. Consequently, this change in trend does not support the hypothesis that the policy reduced the quantity of drug-induced deaths in Washington. When comparing Washington's trend against its control states, the variation of trends between Washington and its control states in pre-policy periods (before 2011) and the variation of trends

between Washington and its control states in post-policy (after 2012) periods was not different, so much because all states continued to have rising tendencies of drug-induced deaths. Therefore, although the mortality rates in Washington were lower than other control states on average after implementing the policy; because Washington still had a rising trend of mortality rates of opioid-drug overdose after 2012, we conclude that the policy of opioid regulations did not have a positive impact on decreasing the mortality rate of opioid-drug overdose in Washington.

Interpretation of the Analysis

The two main strengths of this analysis are that when evaluating the impacts of the regulation policy of opioid drugs in three states (FL, TX, WA), we use the pre-post comparison and the difference in difference analysis. First, to determine whether the regulation policies of opioid drugs had a positive impact on drug overdose deaths or opioid shipments, the pre-post comparison focuses on examining changes over time for each policy-implemented state. If the policies had no effect, after introducing the policies, the plots would depict an ongoing rise or relatively constant tendencies in opioid shipments and overdose deaths. If the policy had a positive influence, after implementing the policies, the plots would indicate a gradual decline trend in opioid shipments and drug overdose deaths. Second, a difference-in-difference analysis is used to explore whether there were more significant variations in opioid shipments or drug overdose deaths between pre- and post-policy periods in each state that had adopted the regulation policy of opioids than in other states that had not. Specifically, we compare the policy-implemented states with states without related policies by choosing three control states based on similar population sizes and opioid dispense rates for each treatment state. Finally, we evaluate the impacts of regulatory policy by recalling a pre-post analysis to compare the tendencies of average mortality rates with related control states.

Limitations

First, to protect personal privacy, if the number of people in a given category (i.e. one county/year/cause of death category) is less than 10, the US Vital Statistics agency will not record such data. Hence, the actual values of total deaths of opioid-drug overdose will be higher than the data we used in this case, so the actual average mortality rates of opioid-drug overdose per capita will also be higher than the mortality rates we calculated. Second, since the U.S. census is

conducted every ten years, the population data for all years except for 2010, which is determined, are estimated rather than statistical. In addition, there are numerous ways that the population from census inquiry goes wrong, including non-response, measurement, inaccurate statistical unit definitions, and even the investigators' prejudice [3]. Therefore, the actual population may differ from the data we used here, but we can't get the most realistic data, so these analyses may not fully reflect the real situation. Third, our control states were selected based on similar population sizes and opioid dispense rates. Still, we did not consider other similar factors, such as income and education levels, so our analysis may be somewhat one-sided. Last but not least, most states have generally enacted multiple opioid control policies as the opioid crisis has evolved for decades. For example, many states implemented some combination of naloxone laws, Good Samaritan laws, and medical marijuana laws during 2015-2017. In addition to pre-existing prescription drug monitoring program (PDMP) laws, by 2017, most states had implemented at least 3 of these four categories of policies [4]. Therefore, it will be unreasonable to put too much emphasis on specific time points, namely the years 2007 (Texas), 2010 (Florida), and 2012 (Washington). For the same reason, it is almost impossible to identify perfect comparison states which were not impacted by the policy of interest at all. These factors serve to complicate the accurate evaluation of opioid policy effectiveness. In general, despite key takeaways from this analysis, extracting causal information from drug policy analysis is still challenging. Many states have enacted multiple opioid control policies as the opioid crisis has evolved over the decades. For example, several states implemented a combination of naloxone laws, Good Samaritan laws, and medical marijuana laws during 2015-2017. Furthermore, in addition to pre-existing prescription drug monitoring program (PDMP) laws, by 2017, most states had implemented at least 3 of these four categories of policies [5]. Therefore, it is challenging to ascertain appropriate control groups and ensure all confounding variables are accounted for. These factors complicate valid inferences on the causal effects of opioid control policies.

Conclusion

Based on this analysis, Florida and Texas have been able to implement successful policies to combat the opioid epidemic. They should be used as a best practice case study for other states that struggle to reduce opioid deaths and over-prescription opioids. Conversely, Washington's policy

in 2012 is relatively ineffective at combating the opioid epidemic and should be updated to follow Florida's implementation, which has been substantially more successful.

References

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[3] "Demerits of a Census Investigation (2022)." [Online]. Available: https://www.toppr.com/guides/business-economics-cs/descriptive-statistics/census/#Demerits_of_a_Census_Investigation

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