Does Recreational Marijuana Legalization Affect Hard-Drug Use? – Evidence from Cocaine Prevalence and Treatment Admissions

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1 Introduction

In this essay I will answer: "Does Recreational Marijuana Legalization Affect Hard-Drug Use? – Evidence from Cocaine Prevalence and Treatment Admissions." I strongly believe answering this question is essential for policy makers to be able to make decisions regarding marijuana legalization expansion and possibly legalizing other drugs. Discussions around implementing these policies should consider possible spillovers. Answering this also allows us as a society to reflect on the possible consequences of having a low-risk drug legalized. Furthermore, an important claim that this paper aims to evaluate is whether or not marijuana plays the role of a gateway drug. The idea that the consumption of marijuana inherently leads people to the consumption of hard drugs has been present in the political discourse for decades and is often brought up as one of the dangers in legalizing weed. If marijuana is truly a gateway drug, then legalizing recreational use should increase the consumption of hard drugs. That is because legalization ultimately facilitates access to the drug. So, if I find that these new laws have no effect or a negative effect on hard-drug use, then it would be reasonable to say that, according to the data I have access to, marijuana plays less of a gateway role then one would believe. If I do observe a positive effect, then maybe it truly is the case that weed serves as a gateway drug. These are a few of the interesting impacts that can arise from this analysis. This why I plan to use the fact that, starting in 2012 with Colorado state, several states in the United States have put into practice marijuana laws that allow for the recreational use of the substance to evaluate whether there has been a significant change in the consumption of hard drugs, more precisely cocaine.

About this topic there exists two main papers that dive into similar questions. The first one, from Chu, (2015)[1], focuses on the impact of the legalization of medical marijuana in the use of hard drugs. He uses data on criminal arrests and on treatment admissions related to heroin and cocaine to develop his analysis. These are respectively from the Uniform Crime Reporting (UCR) Program and the Treatment Episode Data Set: Admissions (TEDS-A) made available by the Substance Abuse and Mental Health Data Archive (SAMHSA). He finds that these laws either decreased or had no effect on hard-drug use. He does recognize however that "[o]ne obvious limitation of this study is that it relies largely on indirect measures of drug use." This can create all types of bias which he enumerates in his discussion portion of the paper. Therefore, finding

[1] Chu, "Do Medical Marijuana Laws Increase Hard-Drug Use?"

data that directly measures drug-use can truly make this analysis more reliable. That is what Wen et al., (2015)[2], do in their paper. They try to understand the impact of the legalization of medical marijuana in the consumption of marijuana, alcohol, and other drugs. They use data from the National Survey on Drug Use and Health (NSDUH), also made available by SAMHSA, which estimates the prevalence of different drugs in every state over several years. Their analysis avoids the indirect measure of use issue, but they also focus on the impact of medical marijuana and not recreational marijuana. That is probably due to the timing of their study. Colorado, the first state to fully legalize recreational marijuana, only started implementing its law in 2012, only two years before this study was published. Therefore, there was most likely not enough time after the event to see any true trends.

What I intend to do is to use both the data from the NSDUH that goes from 1999 to 2020 and the data from the TEDS-A that goes from 1992 to 2019 to calculate the effect of recreational marijuana laws (Rec legalization) on the use of cocaine. I chose not to use the UCR data since it only contains data on drug-related arrests and not on more specific outcomes such as cocaine-related arrests. Cocaine in my study will serve as the example for a hard drug because in the NSDUH dataset the prevalence of cocaine is the only outcome that appears in all the years of the dataset. My intention is to first analyze this dataset and use a dummy variable describing whether recreational weed is legalized in a given state and year to conduct a panel data analysis. This way I will be using a direct measure of drug use, a more precise measure than Chu, (2015) had access to, and adding on to Wen et al., (2015) analysis focusing on the effect of recreational marijuana legalization. Later I will also run a similar analysis on the TEDS-A dataset to understand if any effects found in the NSDUH data also show up in it. That is because if a significant increase or decrease in use is observed some effect should be seen in people being admitted for treatment as Chu, (2015) defends. This should also allow me to come up with an initial answer to the gateway drug question as only recreational use allowed for all individuals to consume the drug, making it an event that truly affected the whole population.

In the paper I start by further investigating the literature on this topic and going in depth into what previous research has achieved. As mentioned before, most interestingly there has been no research evaluating the impact of recreational marijuana legalization in different outcomes. I

[2] Wen, Hockenberry, and Cummings, "The Effect of Medical Marijuana Laws on Adolescent and Adult Use of Marijuana, Alcohol, and Other Substances."

then carefully explain the methodology I use to evaluate this question. By using a dummy variable that evaluates whether recreational use of marijuana is legal in a given state and year, I am able to conduct a panel data analysis to evaluate the effect recreational marijuana legalization has on the prevalence of cocaine, the prevalence of marijuana and the prevalence of alcohol for different age groups. In the analysis I control for both time fixed effects and state fixed effects. I also include population as a control variable. After that I also conduct use an event study design to understand whether or not the effect observed in the panel data analysis is due to previous trends or if there is truly a discontinuity once weed is fully legalized. I do this for marijuana, cocaine and alcohol. By doing them together, I am able to make clear if there is an increase in marijuana use due to the legalization that is in itself increasing the use of cocaine. I also include alcohol because to understand if there are any effects on drugs in general even if they are legal or if there is only an effect on illegal drugs such as cocaine. If I observe an increase in the use of cocaine and no increase in the use of alcohol, this will contribute to the reasoning that marijuana acts by itself as a gateway drug to hard drugs. Once I have these results I run a similar analysis on the TEDS-A data to observe if there is any increase associated with recreational marijuana legalization that corroborate the results found in the previous analysis. I then run robustness checks using the Chaisemartin et al[3] regression method to create the same event study graphs which is more appropriate given the fact that there is heterogeneity between when each state is treated (when marijuana is legalized for recreational use).

After running the panel data regression, I find that there are statistically significant effects of recreational marijuana legalization on both the prevalence of cocaine and marijuana, but no effects on the prevalence of alcohol. This does however depend on the age group analyzed. After running the event study for cocaine, I realize that most coefficients, no matter how close to the time of legalization, are not statistically significant and that the effect the panel data analysis is picking up could be mostly due to a general trend in the prevalence of cocaine and not necessarily a true effect from the legalization. Marijuana on the other end, there is a clear uptick in the trend and the effect seems to be greater the further away one is from the date of legalization. This is in accordance with the fact that most states structure distribution of marijuana slowly after legalizing. When running a panel data analysis and an event study with the TEDS-A data I observe no statistically significant effect of the recreational legalization on treatment admissions associated

[3] de Chaisemartin and D'Haultfoeuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects."

with cocaine, marijuana or alcohol. As the use of marijuana rarely leads to admissions, that result is expected. However, because no effect is observed in the case of cocaine that leads me to believe that the previous results are truly just picking up a general trend in the use of cocaine. Robustness checks confirm these outcomes with slight variations.

This paper adds on to previous academic research by using the same data previously used to evaluate the impact of more recent recreational laws. At first sight it leads to the idea that marijuana does act as a gateway drug, but at the end that is proven to most likely not be the case. By doing so it raises awareness to the fact that a simple panel data analysis is not enough to evaluate this outcome and that one will be mistaken to take big conclusions out of the publicly available data by the National Survey on Drug Use and Health. Access to more micro level data and evaluation of local implementation of the recreational laws is necessary to gradually answer this question.

2 Literature Review

Recreational marijuana laws were first passed in 2012 in both Colorado and Washington. This means that there has only been a little less than 10 years since the first laws came into effect. Because of this most studies have evaluated the effects of medical marijuana legalization in different outcomes due to the longer time since those laws were implemented. That is the case in Chu (2015)[4] and Wen et al. (2015)[5], reference papers in this subject.

Chu attempts to answer the question *Do Medical Marijuana Laws Increase Hard-Drug Use?*. His idea is that if medical marijuana laws increase the use of marijuana and hard drugs are a complement to marijuana, then one should see an increase in the use of hard drugs after these laws are approved. To evaluate this, he uses data on drug arrests and treatment admissions. These serve to him as indirect measures of hard drug use. The idea is that if arrests or treatment admissions related to a specific drug increase then it must mean that the actual use of those drugs increase. He finds that, in the case of marijuana, there is an increase around 10-15 percent in these outcomes after medical marijuana laws are approved. On the other hand, he does not find an increase in these outcomes for either cocaine or heroin. In fact, he observes a decrease between 0

[4] Chu, "Do Medical Marijuana Laws Increase Hard-Drug Use?"
[5] Wen, Hockenberry, and Cummings, "The Effect of Medical Marijuana Laws on Adolescent and Adult Use of Marijuana, Alcohol, and Other Substances."

and 15 percent in criminal arrests associated with heroin and cocaine combined. In the case of treatment admissions, he finds a decrease of 20 percent in heroin-related admissions and no effect in cocaine-related admissions. This indicates that most likely marijuana is not a complement to these drugs and therefore marijuana does not play a role of a gateway drug. This study is limited, however. That is due to the fact that he uses indirect measures for the use of hard drugs. Something he recognizes at the end of his paper. I believe treatment admissions is better used as a measure of extreme use of drugs as people only need medical assistance in those cases. That is why in this paper I use that data to understand if the impact on use is of a significant size. Together with prevalence data, treatment admissions data can carry a significant meaning.

Wen et al. attempt to answer a broader question. Their focus is on "The effect of medical marijuana laws on adolescent and adult use of marijuana, alcohol, and other substances". They use detailed version of the data from the National Survey on Drug Use and Health (NSDUH) from 2004 to 2012 and "estimated two-way fixed effects models with state-specific linear time trends and a rich set of individual- and state-level covariates." This survey creates estimates of the prevalence of different drugs and outcomes in all states plus the District of Columbia for every year in the dataset. With this they are able to directly observe the impact of medical marijuana laws on the prevalence of the outcomes they are interested in. They find an increase in most outcomes related to marijuana in those aged 21 or older. Those are the probability of current marijuana use, regular marijuana use and marijuana abuse or dependence. They also find an increase in people aged 12 to 20 trying marijuana. When it comes to hard drugs use, they observe no effect of these laws in the prevalence of cocaine or heroin, similar to what Chu finds in his study. It is important to note that they only have access to data from 2004 to 2012 making it impossible the analysis of recreational marijuana laws since those were first approved in 2012. It was only in 2022 that the NSDUH made publicly available data up to 2020 enabling analysis on the impacts of recreational marijuana laws.

3 Methodology

To investigate "Does Recreational Marijuana Legalization Affect Hard-Drug Use? – Evidence from Cocaine Prevalence and Treatment Admissions", I will use two main methods of analysis using two different datasets. The first one will be a panel data analysis and the second will be an event study design. The goal here is to understand what the impact of recreational marijuana

laws on hard-drug use is. In other words, whether the legalization of recreational use of cannabis leads to a change in how much people use hard drugs. To evaluate that I will use first the prevalence of cocaine and second treatment admissions related to cocaine use as a measure for hard drug use. Prevalence tells us what portion of the population uses a certain drug, which means it is a direct measure of the use of that drug. Therefore, we have a direct measure for the use of cocaine. I will be using cocaine as opposed to other drugs because the NSDUH only contains data for the prevalence of cocaine for all the years in their data. Treatment admissions are not a direct measure of use, but instead a measure of extreme use. Only people who use a drug intensively will need medical assistance. Still, if there is a big increase in the prevalence of cocaine, we should expect some increase in treatment admissions. That is why I also conduct the analysis on the TEDS-A data to further verify the analysis I run on the NSDUH data.

The panel data models will be the following:

$$Cocaine\_use\_prev_{it} = \beta_0 + \beta_1\, Rec\_legalization_{it} + \beta_2\, Pop_{it} + Z_i + W_t + \varepsilon_{it}$$

- $Cocaine\_use\_prev_{it}$ is the prevalence of cocaine use in a given year and state.
- $Rec\_legalization_{it}$ is a dummy that takes the value of 1 if marijuana is legalized for recreational use in a given year and state. In transition years it takes a value between 0 and 1 depending on the amount of months legalization applies.
- Pop_{it} is the population for a given year and state.
- Z_i is controlling for state fixed effects
- W_t is controlling for time fixed effects.
- ε_{it} is the error term

$$Cocaine\_use\_treat_{it} = \beta_0 + \beta_1\, Rec\_legalization_{it} + Z_i + W_t + \varepsilon_{it}$$

- $Cocaine\_use\_treat_{it}$ is the overall number of treatment admissions related to cocaine use in a given year and state.
- $Rec\_legalization_{it}$ is a dummy variable that takes the value of 1 if marijuana is legalized for recreational use in a given year and state. In transition years it takes a value between 0 and 1 depending on the amount of months legalization applies.
- Z_i is controlling for state fixed effects
- W_t is controlling for time fixed effects.
- ε_{it} is the error term

Here β_1 will be the coefficient of interest. It will indicate to us the effect of recreational marijuana legalization ($Rec\_legalization$) on either the prevalence of cocaine or the treatment admissions related to cocaine. It is also important to note that $Rec\_legalization$ takes values between 0 and 1 in transition years. In most cases in the year recreational marijuana is legalized only part of the year is impacted making it necessary a fractional value correspondent to the partial treatment. I dive into the specifics about this matter when I review the data I will be using. One variation of the regression above I run is using the log of the overall number of treatment admissions instead of the number itself. The range of the data is very large and varies a lot between states and years. Therefore, using log allows me to better interpret my results as it tells the percentage change in treatment admissions related to recreational legalization.

I will also be estimating the effect the legalization has on marijuana use and alcohol use using both the NSDUH data and the TEDS-A data. Other than changing the outcomes evaluated, the regressions will be identical to the ones above. In the case of marijuana use, this analysis should allow me to more clearly evaluate whether marijuana is a gateway drug or not. If marijuana use and cocaine use move together, it would be a strong argument for the gateway drug hypotheses and the idea that cocaine and marijuana could be indeed complements. Running these regressions on alcohol use adds on to this by showing me whether increased marijuana use has an impact on the use of all drugs or if it truly only acts as a gateway drug increasing the use of harder drugs.

After these regressions are run, I run an event study design for cocaine use and marijuana use and alcohol use. I first do so using the NSDUH data and later the TEDS-A data. This should allow me to not only observe whether there is an effect of recreational marijuana laws on those outcomes, but also how the effect evolves over time and if there are any trends on the effect. To do that I will evaluate the following models:

NSDUH data:

$$Outcome_{it} = \beta_0 + \beta_2\, Pop_{it} + \sum_{k=-4}^{-2} \beta_k\ D\_leg_{it}^{k} + \sum_{k=0}^{4} \beta_k\ D\_leg_{it}^{k} + Z_i + W_t + \varepsilon_{it}$$

TEDS-A data:

$$Outcome_{it} = \beta_0 + \sum_{k=-4}^{-2} \beta_k\ D\_leg_{it}^{k} + \sum_{k=0}^{4} \beta_k\ D\_leg_{it}^{k} + Z_i + W_t + \varepsilon_{it}$$

This event study tells me the effect from 4 years before to 4 years after the legalization. I report these as traditional event study graphs.

Lastly, I will also conduct robustness checks using Chaisemartin et al.[6] regression method for the event study analysis. Sates legalized marijuana at different points in time. This introduces an issue of heterogeneity in the treatment. According to their paper, the coefficients we find in normal panel data and event study methods, in case there is heterogeneity, are in fact a weighted average of the effect of the treatment in different points in time. Therefore, to be sure of the preciseness of my analysis I decided to use their method of regression method to control for this issue.

4 Data Overview

To conduct this analysis, I will be using data from the National Survey on Drug Use and Health (NSDUH) and the Treatment Episode Data Set: Admissions (TEDS-A), which are both available for public access on the Substance Abuse & Mental Health Data Archive's website[7].

The NSDUH data contains state-level data from 1999 to 2020. For each year, state, and certain age groups, they provide estimates for the prevalence of several different outcomes such as alcohol use disorder in the past year, illicit drug use other than marijuana in the past month, along with several others (22 in total). The dataset also contains information about the size of the population and the response rate for all states, years, and age groups. In total there are 131584 observations in this dataset when in long form. Some of these outcomes only started being estimated and described more recently. Others were estimated in the past but removed from the dataset more recently. This does not impact this research as prevalence of cocaine, prevalence of marijuana, and prevalence of alcohol, which are the focus of this research, have estimates for all years in the data.

There are some important things I must note about this data. The prevalence estimates for each state and age group are constructed by combining two years of survey results. That means each estimate is related to a two-year period. Because of this, from now on when referring to time matters in this dataset, I will refer to two-year periods. For instance, if I say that the average cocaine prevalence estimates for people 12 years old or older in 1999-2000 was 1.66%, I am referring to the average cocaine prevalence estimate for people 12 years old or older for the two-year period from Jan-1999 to Dec-2000. This will also impact how I construct my dummy for recreational

[6] de Chaisemartin and D'Haultfoeuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects."
[7] "National Survey on Drug Use and Health 2020 (NSDUH-2020-DS0001) | SAMHDA."

marijuana legalization, something I elaborate on later. Another important aspect of this data is the fact that the period 2001-2002 is not present in it. According to the NSDUH codebook document, the reason for this is that there were changes established in 2002 survey that made it not comparable to the prior years in the data.[8] They say estimates from after 2002-2003 are more accurate, but also higher than prior years. Therefore, constructing estimates for the 2001-2002 period is not possible. Due to this, I will be excluding the data corresponding to the periods 1999-2000 and 2000-2001 from my analysis and only use the data from 2002-2003 and beyond. This should not have a huge impact in my results whatsoever, as the first recreational legalization happened in 2012, years after 2002-2003.

When using this data I focus on analyzing the impact of recreational marijuana legalization on the prevalence of cocaine use, prevalence of marijuana use and prevalence of alcohol use. Below is a table showing the mean and standard deviation (in parentheses) of the average prevalence of these outcomes in the United States over all the years in the data:

TABLE 1—AVERAGE PREVALENCE IN THE U.S. BY AGE GROUP

	(0) Persons aged 12 or older	(1) Persons aged 12 to 17	(2) Persons aged 18 to 25	(3) Persons aged 26 or older	(4) Persons aged 18 or older
Cocaine	0.0200	0.00991	0.0564	0.0151	0.0211
	(0.00602)	(0.00558)	(0.0180)	(0.00524)	(0.00632)
Marijuana	0.129	0.137	0.317	0.0958	0.128
	(0.0402)	(0.0260)	(0.0674)	(0.0415)	(0.0429)
Alcohol	0.518	0.134	0.605	0.550	0.558
	(0.0724)	(0.0374)	(0.0787)	(0.0785)	(0.0768)
Observations	918	918	918	918	918

Notes: The five columns present the mean and standard deviation (in parentheses) of the prevalence of cocaine, marijuana, and alcohol use over all of the years in the data and all 50 states plus District of Columbia.

An important thing to note about this table is the magnitude and meaning of these estimates. Prevalence is a measure of what percentage of a population is estimated to have experienced a given treatment. This is normally reported either as a decimal or a percentage. In the case of this

[8] Center for Behavioral Health Statistics and Quality, "1999 to 2019 National Surveys on Drug Use and Health (NSDUHs) Small Area Estimation Dataset: State Small Area Estimates, by Survey Year, Outcome, State, and Age Group, NSDUH Methodological Report."

analysis, we are concerned with the prevalence of cocaine, marijuana, and alcohol. Because using these drugs is not an extremely widespread behavior, the magnitude of these outcomes is relatively small. This should aid you in understanding later regressions and the magnitude of the outcomes we will observe. For instance, if the prevalence of cocaine in a given year and state for persons aged 12 or older was 0.0192 or 1.92% and we find a statistically significant impact of 0.00330 or 0.33% as a consequence of weed legalization, that would indicate a change of 17.18% in the prevalence of cocaine. In other words, what can seem as a very small change in prevalence can indicate huge differences when compared to the actual mean outcomes.

The TEDS-A data I use is a combination of the single year data from 1992 to 2019. Each yearly dataset contains every single treatment admission reported in that year and its details. For several different drugs and drug types there is a flag variable which is a dummy that accounts for whether or not a treatment admission had a given drug as the primary, secondary, or tertiary reason for admission. The datasets also contain STFIPS state codes to determine where each treatment admission was reported. This allowed me to collapse each yearly dataset's flag variables' sum by state and year. At the end I get a dataset containing total amount of treatment admission associated with each flag outcome for all states from 1992 to 2019. In total I arrive at 1388 observations in the final dataset I use for my analysis. The data is complete, meaning that there are no missing values due to how the data was constructed. Furthermore, as I do in the NSDUH data, I will be observing the effect of recreational marijuana legalization in the treatment admissions related to cocaine, marijuana, and alcohol. Below is a table showing the mean and standard deviation (in parentheses) of the average total treatment admissions and log of total treatment admissions related to these outcomes in the United States over all the years in the data:

TABLE 2—AVERAGE TREATMENT ADMISSIONS AND LOG TREATMENT ADMISSIONS IN THE U.S.

	(0) Number of Treatment Admissions	(1) Log of Number of Treatment Admissions
Cocaine	10001.3	8.251
	(18398.7)	(1.476)
Marijuana	12611.5	8.881
	(16241.8)	(1.093)
Alcohol	22160.7	9.434
	(30480.9)	(1.078)
Observations	1388	1388

Notes: The two columns present the mean and standard deviation (in parentheses) of the total number of treatment admissions and the log of the total number of treatment admissions related to cocaine, marijuana, and alcohol use over all of the years in the data and all 50 states plus District of Columbia.

An important aspect of this data, as you can see above, is that the number of treatment admissions vary enormously. Because of that using the log of this number seems to be the most appropriate approach. It makes the numbers more easily interpreted and can give us a better sense of the impact of recreational legalization. To do that I verified that for all the outcomes I am interested in there is not a single year and state that experienced zero treatment admissions related to these outcomes which could create issues when taking the log.

Other than these datasets, I had to construct a dataset determining which states have active recreational marijuana laws and when they legalized. To do that I used a website called Weedmaps that contains summaries of the marijuana legalization status for all 50 US states plus the District of Columbia[9] and supplemented that with detailed laws' descriptions gathered in several other websites. I found that Alaska, Arizona, California, Colorado, Connecticut, District of Columbia, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, New Mexico, New York, Oregon, Vermont, Virginia, and Washington have recreational marijuana laws in place. However, only a subset of these legalized recreational use before December 2020 which is up until where our data goes. Those states are: Alaska, California, Colorado, District of Columbia, Illinois,

[9] "Laws Archive."

Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, and Washington. Below you see a summary table with the dates associated with these recreational marijuana laws.

TABLE 3—RECREATIONAL MARIJUANA LAWS BY STATE

State	Date Recreational Marijuana Law Passed	Date Recreational Marijuana Law was Implemented
Alaska	4-Nov-2014	24-Feb-2015
California	8-Nov-2016	9-Nov-2016
Colorado	6-Nov-2012	10-Dec-2012
District of Columbia	1-Nov-2014	26-Feb-2015
Illinois	25-Jun-2019	1-Jan-2020
Maine	8-Nov-2016	30-Jan-2017
Massachusetts	1-Nov-2016	15-Dec-2016
Michigan	6-Nov-2018	6-Dec-2018
Nevada	8-Nov-2016	1-Jul-2017
Oregon	4-Nov-2014	1-Jul-2015
Vermont	22-Jan-2018	1-Jul-2018
Washington	6-Nov-2012	6-Dec-2012

Notes: These are the states with recreational marijuana laws implemented before December 2020.

Here you see both the date these laws were passed and the date they were implemented. In some cases, implementation happens the next day after the law is approved and in other cases months after. For my analysis what is the most important is the implementation date as that is truly when the recreational marijuana is made legal, and the population can start using it. All of these laws establish that consumption of marijuana for recreational use after that point in time is legal. Most of them also automatically legalize cultivation for personal use. The exception to this is Washington state that legalized consumption in 2012 but only legalized the planting of cannabis later. Anyway, this means that after these dates any citizen 21 or older can consume cannabis. Therefore, I consider that from that point in time onwards cannabis is accessible to everyone. Distribution, however, usually lags in time and is only regulated later. I recognize that some might only have true access later if they don't have the means to plant what they consume. I will be disregarding that in this paper and simply considering the date of implementation, but future papers could also evaluate the impact of distribution in the different outcomes I look at.

The information in the table above is essential so I can construct the dummy variables for the recreational legalization in both the NSDUH and the TEDS-A data for both the panel data

analysis and the event study analysis. Notice that except for Illinois, none of the implementation dates are on January 1st. This means that my dummies for the panel data analysis will have to carry fractional values between 0 and 1 for the years the law is implemented. I call these years *transition years*.

In the case of the TEDS-A data, calculating the value the dummy variable for the panel data should take for each transition year is very straightforward. I count the months recreational marijuana was legalized and divide by the total amount of moths in a year, twelfth. If legalization happens on or before the 15th of a given month, I count that month as legalized and otherwise I start counting from the month following. The table below describes what values the dummy takes for each state's transition year.

TABLE 4—DUMMY VALUES CORRESPONDING TO TRANSITION YEARS TEDS-A DATA

State	Date Recreational Marijuana Law Passed	Date Recreational Marijuana Law was Implemented	Transition Year	Months Legalized	Dummy Value
Alaska	4-Nov-2014	24-Feb-2015	2015	10	10/12
California	8-Nov-2016	9-Nov-2016	2016	2	2/12
Colorado	6-Nov-2012	10-Dec-2012	2012	1	1/12
District of Columbia	1-Nov-2014	26-Feb-2015	2015	10	10/12
Maine	8-Nov-2016	30-Jan-2017	2017	11	11/12
Massachusetts	1-Nov-2016	15-Dec-2016	2016	1	1/12
Michigan	6-Nov-2018	6-Dec-2018	2018	1	1/12
Nevada	8-Nov-2016	1-Jul-2017	2017	6	6/12
Oregon	4-Nov-2014	1-Jul-2015	2015	6	6/12
Vermont	22-Jan-2018	1-Jul-2018	2018	6	6/12
Washington	6-Nov-2012	6-Dec-2012	2012	1	1/12

Notes: These are the states with recreational marijuana laws implemented before December 2019. The TEDS-A dataset does not contain data for 2020 so Illinois that implemented its law in 2020 is removed from this table.

When it comes to the event study design, as a specific year of legalization is required to construct the study, I consider the year of implementation as the initial year with recreational marijuana legalized if the dummy value from the panel data design is higher or equal to 0.5. If lower, I consider the following year as the initial year.

In the case of the NSDUH data there is one more aspect we must consider. Because I have data relative to two-year periods, there will be two transition years. For instance, in the case of

Colorado, that implemented its marijuana law on December 10th, 2012, both 2011-2012 and 2012-2013 two-year periods experience partial legalization treatment. In other words, marijuana was legalized in only 1 month of the 24 months in 2011 and 2012 and in only 13 months of the 24 months in 2012 and 2013. Therefore, the dummy will take fractional values twice for each state with recreational marijuana laws. For each of those two-year periods I count the months recreational marijuana was legalized and divide by the total amount of moths in the two-year period, twenty-four. If legalization happens on or before the 15^{th} of a given month, I count that month as legalized and otherwise I start counting from the month following. The table below describes what values the dummy takes for each state's transition two-year periods.

TABLE 5—DUMMY VALUES CORRESPONDING TO TRANSITION YEARS NSDUH DATA

State	Date Recreational Marijuana Law Passed	Date Recreational Marijuana Law was Implemented	Two-Year Transition Period #1	Months Legalized	Dummy Value	Two-Year Transition Period #2	Months Legalized	Dummy Value
Alaska	4-Nov-2014	24-Feb-2015	2014-2015	10	10/24	2015-2016	22	22/24
California	8-Nov-2016	9-Nov-2016	2015-2016	2	2/24	2016-2017	14	24/24
Colorado	6-Nov-2012	10-Dec-2012	2011-2012	1	1/24	2012-2013	13	13/24
District of Columbia	1-Nov-2014	26-Feb-2015	2014-2015	10	10/24	2015-2016	22	22/24
Illinois	25-Jun-2019	1-Jan-2020	2019-2020	12	12/24	-	-	-
Maine	8-Nov-2016	30-Jan-2017	2016-2017	11	11/24	2017-2018	23	23/24
Massachusetts	1-Nov-2016	15-Dec-2016	2015-2016	1	1/24	2016-2017	13	13/24
Michigan	6-Nov-2018	6-Dec-2018	2017-2018	1	1/24	2018-2019	13	13/24
Nevada	8-Nov-2016	1-Jul-2017	2016-2017	6	6/24	2017-2018	18	18/24
Oregon	4-Nov-2014	1-Jul-2015	2014-2015	6	6/24	2015-2016	18	18/24
Vermont	22-Jan-2018	1-Jul-2018	2017-2018	6	6/24	2018-2019	18	18/24
Washington	6-Nov-2012	6-Dec-2012	2011-2012	1	1/24	2012-2013	13	13/24

Notes: These are the states with recreational marijuana laws implemented before December 2019. The TEDS-A dataset does not contain data for 2020 so Illinois that implemented its law in 2020 is removed from this table.

For the NSDUH data event study, I consider the initial two-year period with recreational marijuana legalized the period where the dummy value from the panel data design is higher or equal to 0.5. This means that for all states, except for Illinois that has a dummy value of 0.5 for the first two-year transition period, the second two-year transition period is the initial two-year period.

With the NSDUH data and the Marijuana Laws Data combined I am able to generate three graphs below. They show the evolution of the average prevalence of marijuana use, cocaine use, and alcohol use over time for three different groups. The green line shows the value for the state of Colorado that fully legalized recreational marijuana in 2012 (red line). The purple line shows the average for all other states in the United States that did not legalize recreational use at any point between 2002 and 2020. The blue line shows the average between Alaska, California, District of Columbia, Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, and Washington which are the states that fully legalized recreational use after 2012 and before 2020 when our data ends. Note, that Washington legalized recreational use in 2012, but not growing. That came a bit later which is why I do not combine it with Colorado.

FIGURE 1:

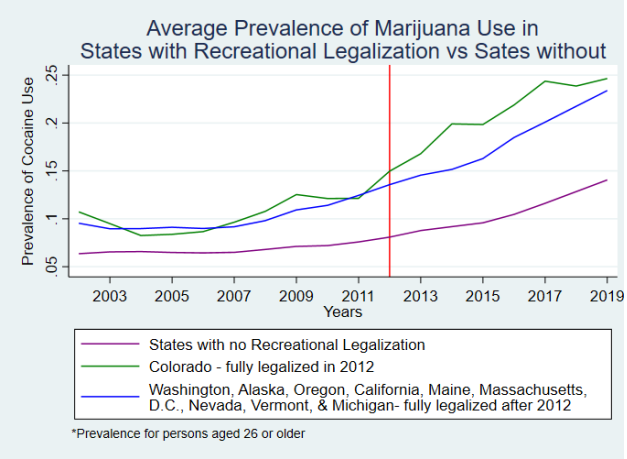


FIGURE 2:

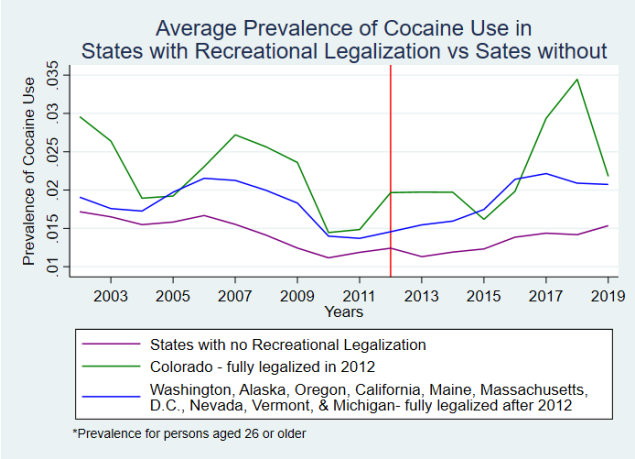
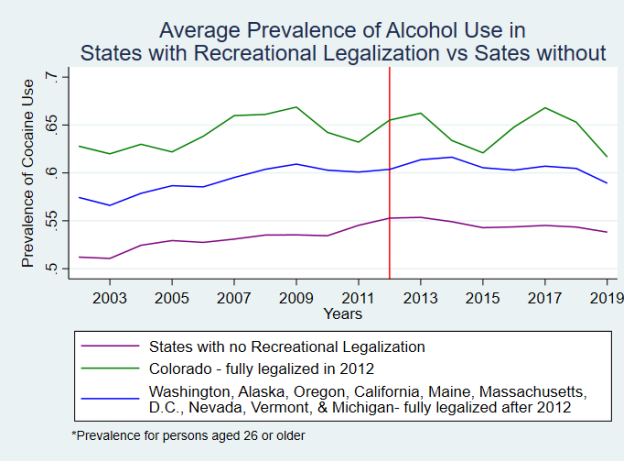


FIGURE 3:



As you can see above in figure 1, the data for Colorado and for non-legalized states track each other relatively well until 2012 when they start deviating. The data for Colorado is quite noisy, but I believe the trend is very clear. Colorado, after fully legalizing recreational use of marijuana observes a steady increase in marijuana after legalization (red line). This contributes to the idea that the widespread availability of weed most likely contributed to the increase in marijuana use. In figures 2 and 3, the data for Colorado does not show a similar trend. It does not seem to be the case at first glance that after legalization there is an uptick in the prevalence of cocaine use or alcohol use.

Using the TEDS-A data and the Marijuana Laws Data, we can create similar evolution graphs. Below you see the evolution of the average log of treatment admissions related to marijuana use cocaine use, and alcohol use over time for the same three different groups above. I also include a figure with the evolution of the average log of total treatment admissions related to drug use to see if there are any general trends we can observe.

FIGURE 4:

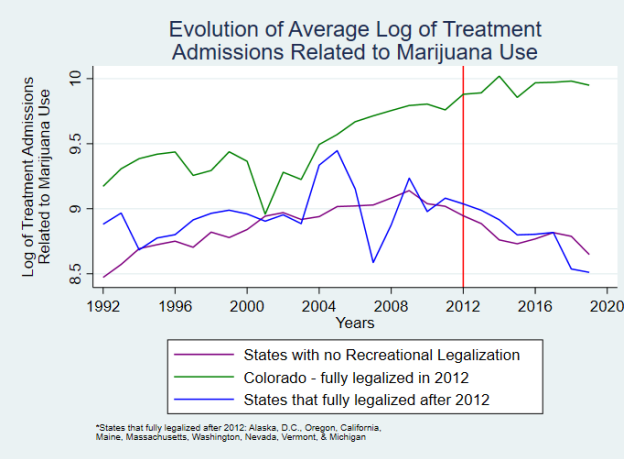


FIGURE 5:

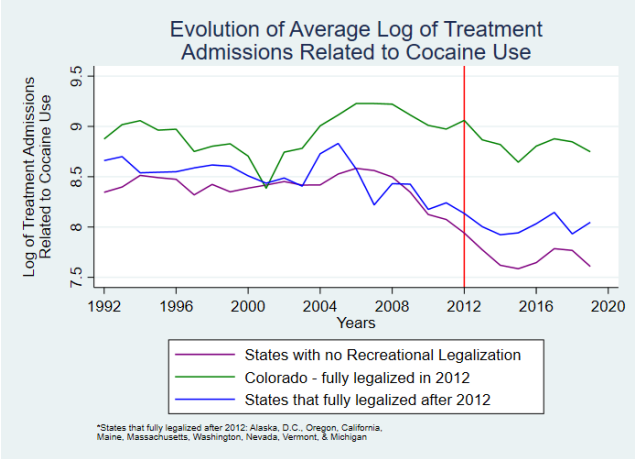


FIGURE 6:

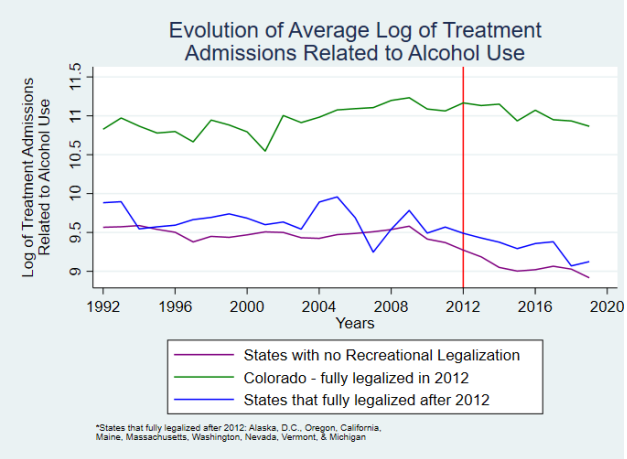
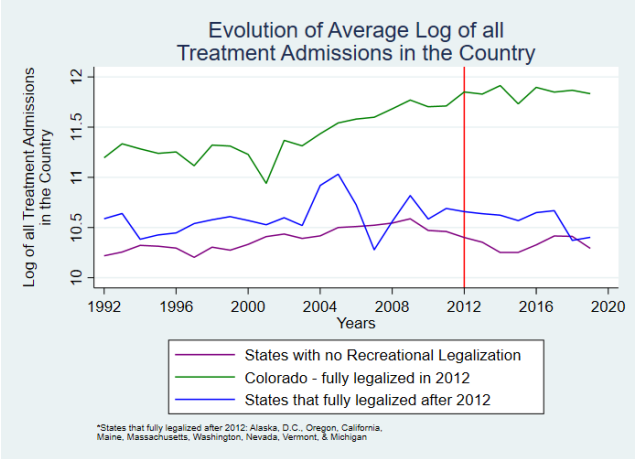


FIGURE 7:



In figures 4, 5, 6, and 7, the data for Colorado shows that it also does not seem to be the case that after legalization there is an uptick in the average of the log of the treatment admissions associated with these outcomes. In fact, Colorado seems not to follow the trends of the other states and the data for it is even more noisy than the one from NSDUH. We will now evaluate all of these trends more formally.

6 Results

Using the data from the National Survey on Drug Use and Health (NSDUH) containing the prevalence of cocaine use, marijuana use and alcohol use for all states and the District of Columbia from 2002 to 2020 together with the recreational marijuana laws dates and dummy value we have previously determined, I am able to run a panel data regression with two-way fixed effects. I start

by running the regression for marijuana use prevalence to establish whether there is an increase in marijuana consumption after recreational use is legalized. The data is divided into different age groups: persons aged 12 or older, persons aged 12 to 17, persons aged 18 to 25, persons aged 26 or older, and persons aged 18 or older. Throughout my whole analysis I run different regressions and report the results for every single of these age groups. This way I can observe any possible variations between these groups.

TABLE 6—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON MARIJUANA USE PREVALENCE

	Panel Data Regression				
	(A) Persons aged 12 or older	(B) Persons aged 12 to 17	(C) Persons aged 18 to 25	(D) Persons aged 26 or older	(E) Persons aged 18 or older
Rec legalization	0.05293***	0.01384***	0.05303***	0.05721***	0.05594***
	(0.00546)	(0.00211)	(0.01050)	(0.00545)	(0.00580)
pop	-0.00000**	-0.00000	0.00000*	-0.00000***	-0.00000**
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	918	918	918	918	918
Adj R-squared	0.935	0.827	0.914	0.931	0.937

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Above you can see the panel data regression results evaluating the effect of marijuana recreational laws (Rec legalization) on the prevalence of marijuana use. This initial coefficient results lead us to believe that there is a positive effect of recreational laws on the use of marijuana. In other words, those laws increase the use of marijuana for all age groups since the coefficients are statistically significant to the 1% level for all the age groups. It also seems to be the case that for all age groups, except persons aged 12 to 17 years old (B), the magnitude of the effect is similar. Generally, this confirms the initial hypotheses that when a state legalizes cannabis use consumption of the drug increases. Therefore, if we observe a positive effect of marijuana laws on cocaine use it would contribute to the idea that marijuana and cocaine are complements. To put it in another way, it would lead me to believe that marijuana possibly does act as a gateway drug.

Now that we have established the effect on marijuana use, we must run a regression for the prevalence of cocaine use. Bellow you can see the panel data regression results evaluating the effect of marijuana recreational laws (Rec legalization) on the prevalence of cocaine use.

TABLE 7—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON COCAINE USE PREVALENCE

	Panel Data Regression				
	(A) Persons aged 12 or older	(B) Persons aged 12 to 17	(C) Persons aged 18 to 25	(D) Persons aged 26 or older	(E) Persons aged 18 or older
Rec legalization	0.00333***	0.00043	0.00696**	0.00297***	0.00342***
	(0.00094)	(0.00072)	(0.00336)	(0.00079)	(0.00098)
pop	-0.00000	-0.00000***	0.00000	-0.00000	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	918	918	918	918	918
Adj R-squared	0.795	0.914	0.817	0.761	0.782

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Here the coefficients are also positive and statistically significant for all age groups except for persons aged 12 to 17 (B). What this initial result tells me is that there seems to be a positive effect of recreational marijuana legalization on the prevalence of cocaine use for all age groups except young adolescents. Furthermore, the magnitude of this effect seems to be similar for persons aged 12 or older, 26 or older, and 18 or older. People aged 18 to 25 seem to observe a larger effect than the others. This point to slight heterogeneities between the age groups something that could be further explored in future studies. The outcomes above are very surprising. Previous research evaluating the impact of medical marijuana legalization has found no effect or negative effects of those policies on the prevalence of cocaine even though the research makes clear that medical laws increase marijuana use. Therefore, I was initially expecting similar results. No effect or negative effects. It could be the case that when marijuana is made available to all through a recreational marijuana law, the complement nature of both drugs becomes evident for some reason while before that was not the case. But to determine if this effect is truly happening more analysis is needed.

Next, I run the same style panel data regression to evaluate the effect of recreational marijuana laws (Rec legalization) on the prevalence of alcohol use.

TABLE 6—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON ALCOHOL USE PREVALENCE

	Panel Data Regression				
	(A) Persons aged 12 or older	(B) Persons aged 12 to 17	(C) Persons aged 18 to 25	(D) Persons aged 26 or older	(E) Persons aged 18 or older
Rec legalization	0.00275	0.00158	0.00765	-0.00187	-0.00039
	(0.00852)	(0.00346)	(0.00710)	(0.00950)	(0.00857)
pop	-0.00000	0.00000	0.00000*	-0.00000*	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	918	918	918	918	918
Adj R-squared	0.945	0.901	0.930	0.938	0.944

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Contrary to what the results for the prevalence of cocaine use and marijuana use show, these initial results show no effect on the prevalence of alcohol use due to the recreational legalization of cannabis. This means that if marijuana use is truly increasing, that seems to have no effect on the use of alcohol. In other words, marijuana does not seem to be either a complement or a substitute for alcohol. Furthermore, the fact that alcohol is not usually considered to be a hard drug together with the fact that its use seems to not be increasing while cocaine use is, serves as a strong argument for marijuana being a gateway drug. In other words, these initial results tell the story that more people seem to be using hard drugs after weed is legalized and that indeed weed is acting as a gateway drug.

To further understand these results, I run an event study below for the prevalence of marijuana use, cocaine use, and alcohol use. It measures the effect recreational marijuana laws have from 4 years prior to 4 years after these laws are implemented. This should give us a better understanding on how these results are taking place overtime and if truly there is a discontinuity once recreational marijuana is legalized. The year before the law is implemented is omitted in the regression to serve as a comparison basis to all other years, which is why it takes the value of zero with no confidence interval. There is one event study for each age group and outcome.

FIGURE 8:

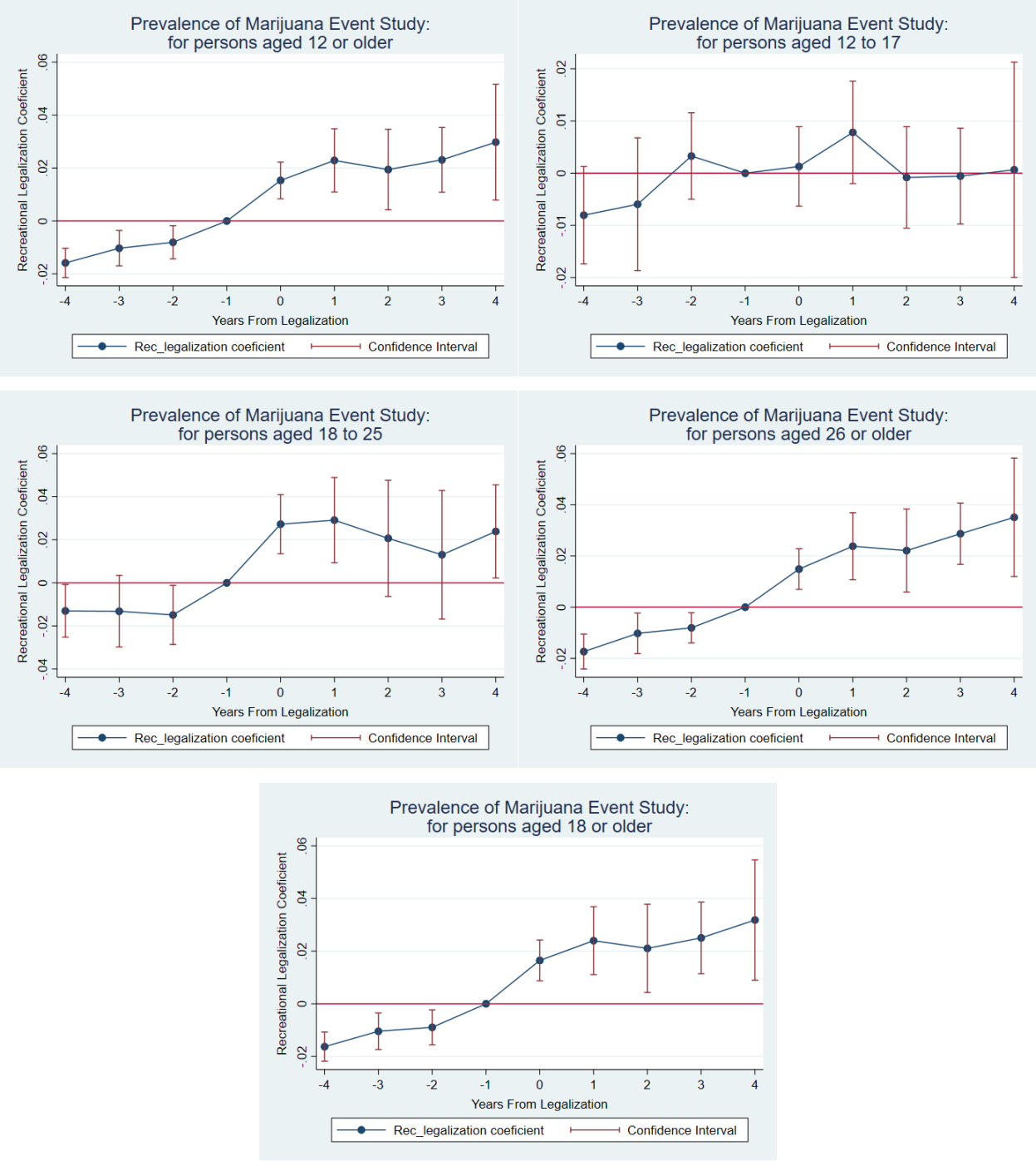
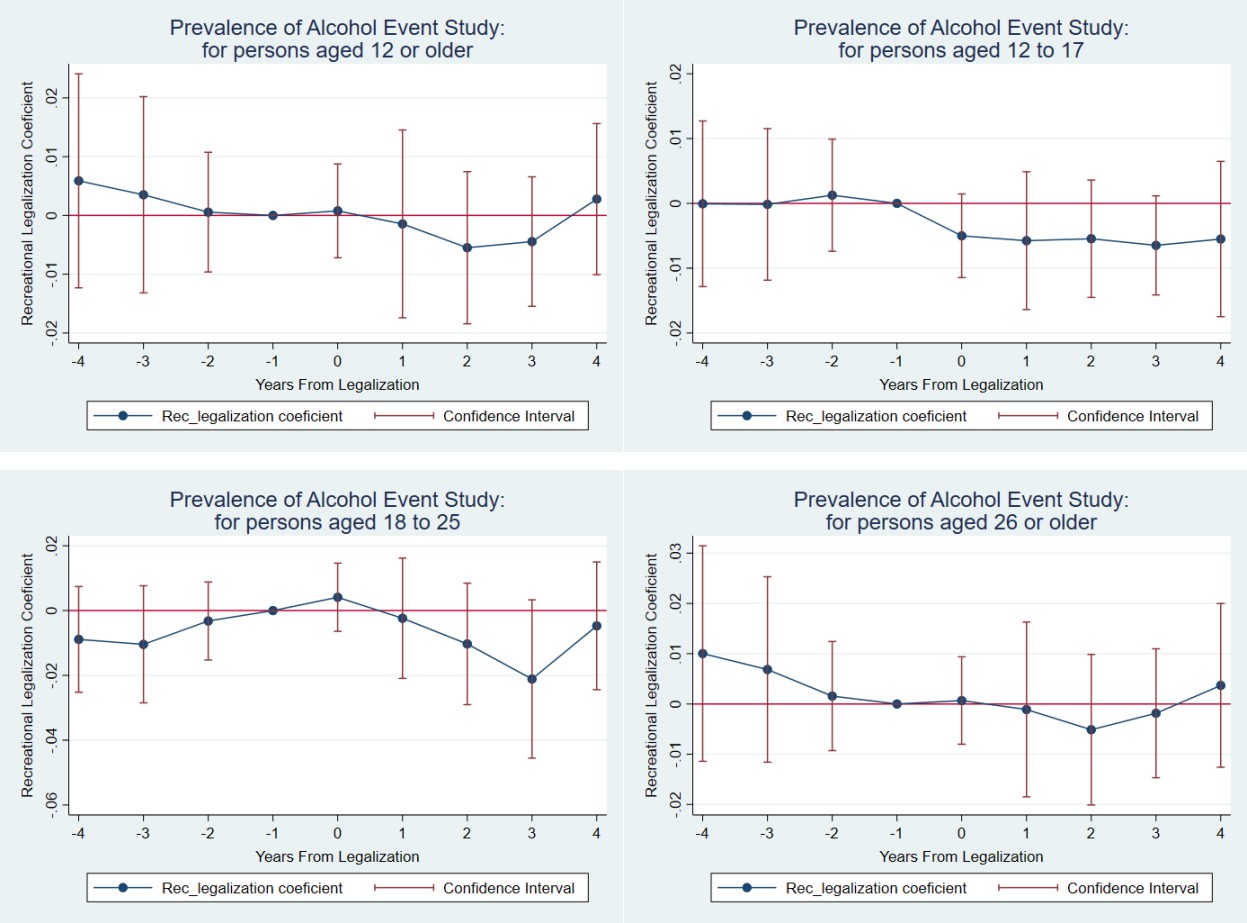


Figure 8 contains the event studies' results that evaluate the effect of legalization on the prevalence of marijuana use over time. Except for persons aged 12 to 17, there is a clear uptick in the effect of recreational marijuana laws after they are implemented. There seems to be a pre trend in those graphs, however, there is an acceleration on the prevalence after marijuana is legalized

for recreational use. This tells us that the effects we pick up in the panel data analysis seem to hold in the event study design for all age groups except persons aged 12 to 17. For that age group, the evolution seems to be more complex, and the effect over time is not statistically significant. Further research into why the panel data analysis picks up an effect is needed. Overall, as expected, it seems to be the case that when marijuana is fully legalized its us increases in the general population. Therefore, if the results for the prevalence of cocaine hold, the argument for gateway drug will be gaining even more evidence.

FIGURE 9:



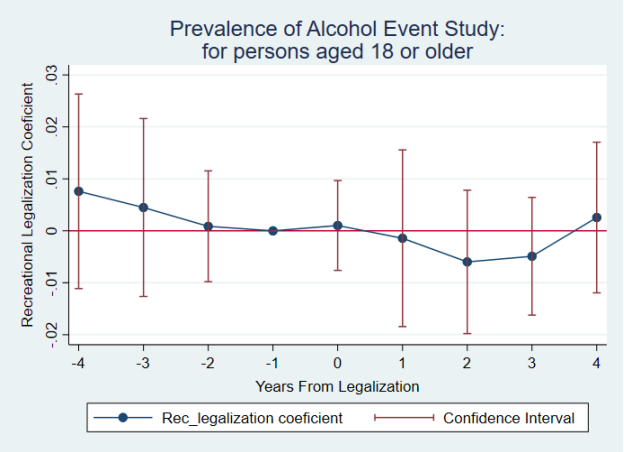
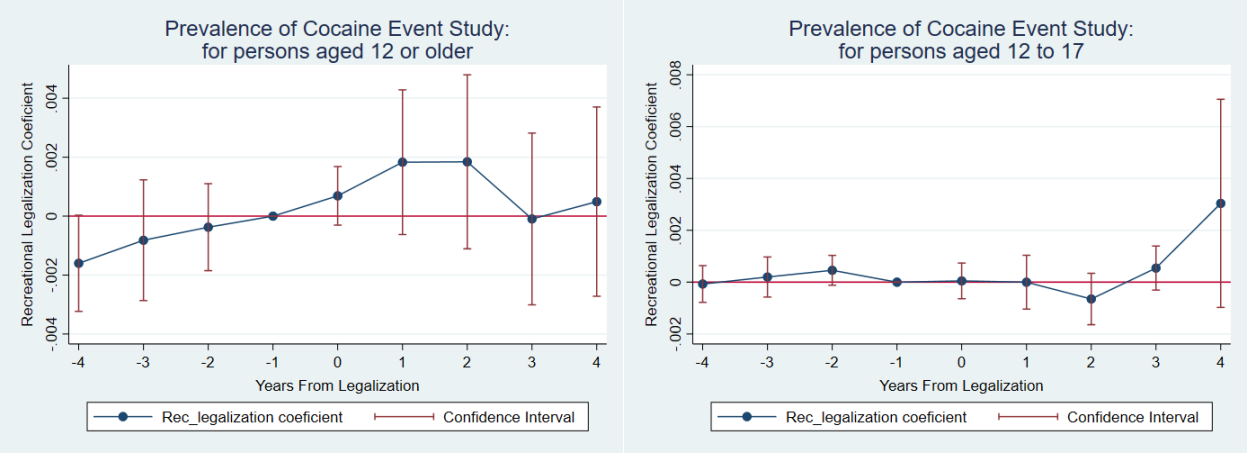
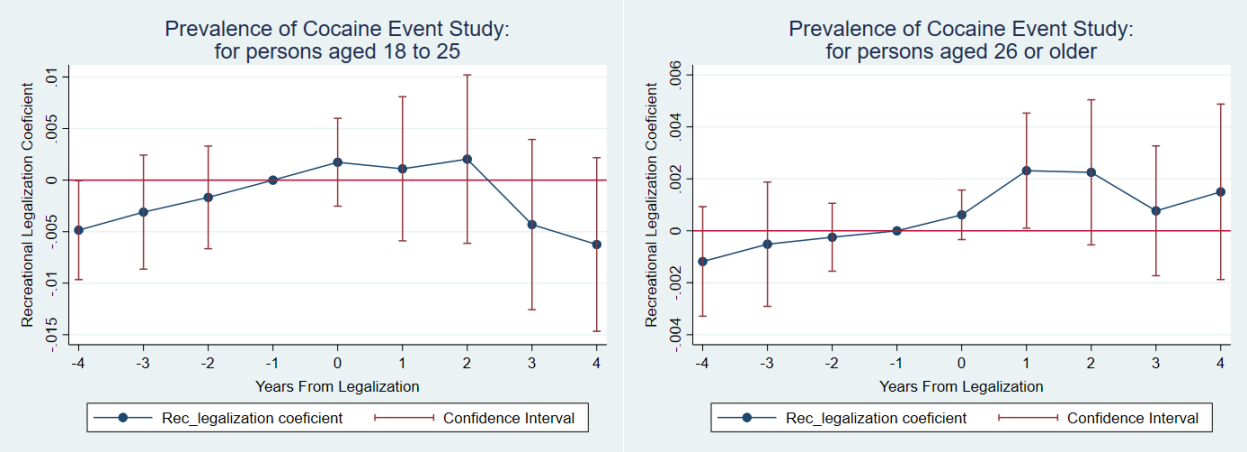


Figure 9 confirms our initial results that recreational marijuana legalization has no effect on the prevalence of alcohol use. All the event study graphs above are flat and show no statistically significant effect of the legalization overtime. At this point this seems to be a very compelling and hard to question result. Therefore, for the reasons previously mentioned, if cocaine prevalence is truly increasing the gateway nature of weed seem to be concentrated on increasing the use of hard drugs having no effect on other socially accepted drugs.

FIGURE 10:





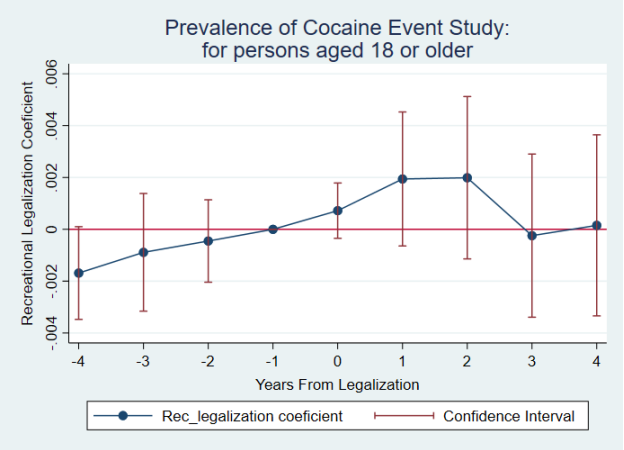


Figure 10 contains the event study results for the prevalence of cocaine use. The interesting thing here is that the effect basically disappears. There seems to be no statistically significant effects over time in all age groups. For persons aged 12 to 17 the result confirms what we previously saw in the panel data analysis. There is no change once weed is legalized and overall the graph stays flat. For all other age groups there is a general upward pre trend in the coefficients that continues after marijuana legalization. This is most likely what the panel data analysis is picking up on leading it to find an effect that is not truly existent. Therefore, even though the previous results were corroborating with the idea that marijuana was a gateway drug, with these findings we cannot say that is the case. In fact, together with the initial evolution graph of cocaine prevalence of cocaine use for Colorado (Figure 2), we now seem to be able to say that cocaine use is not impacted by recreational marijuana laws.

To further understand if what we saw above is truly what is happening, I will now analyze the TEDS-A data with the aid of the Marijuana Laws data and the dummy values previously described. To start, I will also run panel data analysis but in this case for the treatment admissions

related to marijuana use, cocaine use and alcohol use. I run these regressions with the number of treatment admissions related to these outcomes and the log of those numbers. I do so to be able to better understand and evaluate the results since the range of the number of treatment admissions is very high.

TABLE 9—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON TREATMENT ADMISSIONS RELATED TO MARIJUANA USE

	Panel Data Regression	
	(A) Linear Regression	(B) Log Regression
Rec legalization	46.38733	0.16952
	(2,172.69929)	(0.17775)
Year fixed effect	Yes	Yes
State fixed effect	Yes	Yes
Observations	1,388	1,388
Adj R-squared	0.918	0.878

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 10—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON TREATMENT ADMISSIONS RELATED TO ALCOHOL USE

	Panel Data Regression	
	(A) Linear Regression	(B) Log Regression
Rec legalization	1,999.47098	0.28421*
	(3,210.94796)	(0.15409)
Year fixed effect	Yes	Yes
State fixed effect	Yes	Yes
Observations	1,388	1,388
Adj R-squared	0.945	0.901

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 11—THE EFFECT OF RECREATIONAL MARIJUANA LAWS ON TREATMENT ADMISSIONS RELATED TO COCAINE USE

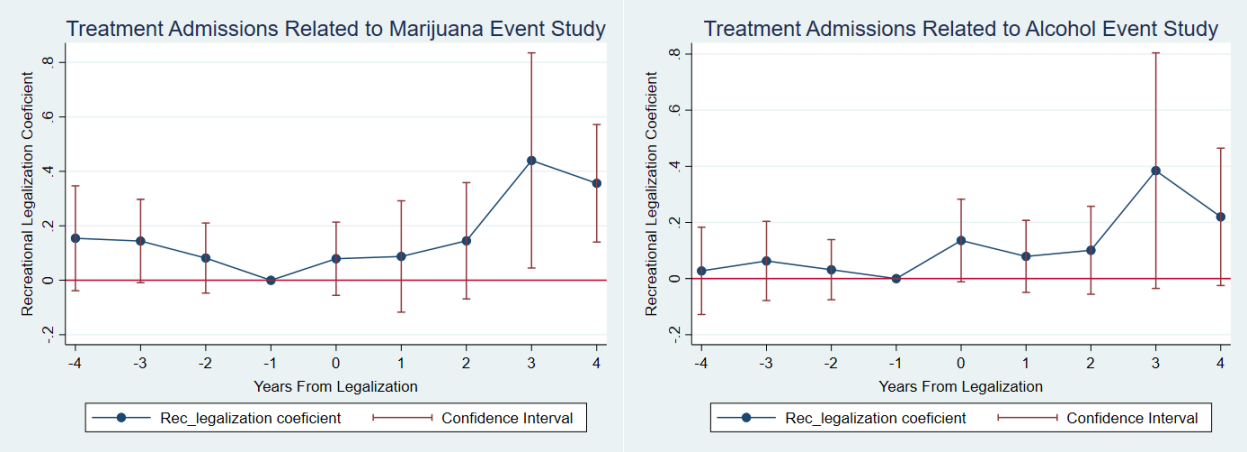
	Panel Data Regression	
	(A) Linear Regression	(B) Log Regression
Rec legalization	-873.12193	0.17383
	(2,622.48278)	(0.21678)
Year fixed effect	Yes	Yes
State fixed effect	Yes	Yes
Observations	1,388	1,388
Adj R-squared	0.937	0.919

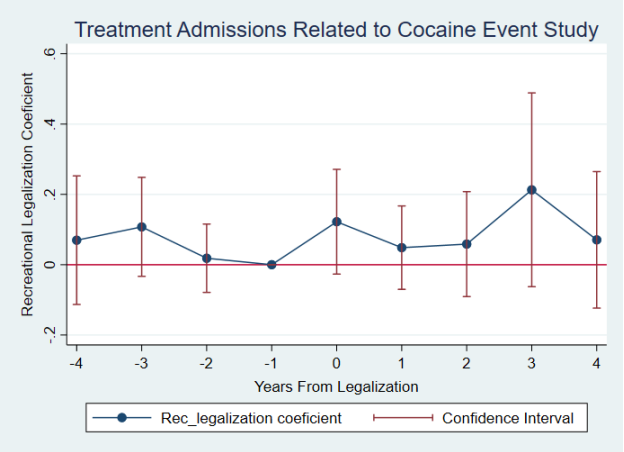
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

These three different regression tables show similar things. There seems to be no highly statistically significant effects of recreational marijuana legalization on treatment admissions related to all three of these outcomes. In the case of marijuana that is expected as intuitively marijuana is not a drug that normally causes people to have to be admitted for treatment. In fact, according to the Center for Disease Control and Prevention (CDC) "overdose caused solely by marijuana is unlikely."[10] Furthermore, when you look at the original dataset, most of the time marijuana shows up in a treatment report it is as a secondary or tertiary reason for admission and not the main one. There are other drugs that are leading people to be admitted not weed. Therefore, even with marijuana legalization, no increase in treatment admissions is understandable. In the case of alcohol, these results further confirm what we found in the prevalence data results. No increase seems to take place. And finally, in this analysis we see no effect on treatment admissions related to cocaine. This is initially surprising because there could be an upward trend in the data as we saw in the study with the NSDUH data, but that does not seem to translate to this study. Now that we know no result is found the case for marijuana being a gateway drug is even less likely.

Next, I run an event study using the log of treatment admissions related to cocaine use, marijuana use, and alcohol use to understand if there is a discontinuity in the data that the panel data is falling to absorb and to also understand how these outcomes evolve over time.

[10] "Frequently Asked Questions."





Interestingly what we see here is an impact of recreational legalization on treatment admissions related to marijuana use three to four years after legalization is established. That could indicate that overtime as prevalence of marijuana increases people use more and more marijuana which ends up leading to some increase in treatment admissions in the long run. How and why, this happens is beyond the scope of this study, but might be an interesting subject of future research. What is important is the fact that there is a slight upward trend in marijuana treatment admissions after legalization which further verifies an increase in the use of the drug. When it comes to treatment admissions related to alcohol and cocaine, the graph is flat and there are no coefficients statistically significantly different from zero. In other words, there is nothing in these results that change my previous analysis. These results just reiterate the fact that there is no apparent effect of the recreational marijuana laws on the use of cocaine and alcohol. It is also interesting to note that the upward trend in the prevalence of cocaine we saw in figure 10 does not translate to an upward trend in treatment admissions. That is surprising as those should normally be correlated with each other. The fact that they are not could also be subject of future research.

Overall, what the above analysis tells us is that recreational marijuana laws seem to have no effect on either the prevalence of alcohol or treatment admissions related to alcohol. Furthermore, these policies seem to have a clear positive effect on the prevalence of marijuana use and some effect in the long run on treatment admissions related to marijuana. This adds on and confirms previous research that reaches similar conclusions when it comes to medical marijuana laws. It is not the case, however, that these laws have a positive effect on the prevalence of cocaine. Initial panel data analysis using NSDUH data suggests that there could be an effect, but an event study design show no effect over time and indicate that the initial regressions is most likely picking up an effect from a more general upward trend in cocaine prevalence. Treatment admissions related to cocaine do not seems to go up which corroborates with the idea that there is no impact from recreational marijuana laws on the use of cocaine. Therefore, previous research on the topic appears to be correct when it says that increases in marijuana use have no effect on increases in cocaine use. I find no evidence, however, that this might decrease the use of cocaine as Chu (2015)[11] observed.

7 Robustness Checks

The event study we ran on both the NSDUH and the TEDS-A data has a fundamental limitation. As Chaisemartin et al. (2015)[12] defend in their study, two-way fixed effect event study analysis can create over or under estimations of the true coefficients when there is heterogeneity in the treatment. That is, when the different entities are treated at different times in the data. In their paper they defend that a traditional event study analysis generates a weighted average of different treatments done at different points in time leading to misestimations. This is the case in our analysis since different states legalized marijuana for recreational use at different points in time. Chaisemartin and D'Haultfoeuille have created a STATA library containing commands to control for this heterogeneity problem. In the appendix of this paper, I run those commands to evaluate the effect of recreational marijuana laws on the prevalence of marijuana use, alcohol use, and cocaine use and compare them to the traditional event study results. I also do the same for the log of treatment admissions related to cocaine use, marijuana use and alcohol use. Overall, the results are extremely similar, and all the interpretations done above continue to be valid, which is

[11] Chu, "Do Medical Marijuana Laws Increase Hard-Drug Use?"
[12] de Chaisemartin and D'Haultfoeuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects."

why those graphs are not included here. In other words, the analysis in *results* hold when using Chaisemartin et al. event study design.

8 Conclusion

This paper attempts to answer the question "Does Recreational Marijuana Legalization Affect Hard-Drug Use? – Evidence from Cocaine Prevalence and Treatment Admissions." Mostly due to the unavailability of data, previous research has only attempted to evaluate the impact of medical marijuana legalization on the use of hard drugs. This left space for one to investigate the impacts of more recent laws that have legalized marijuana for recreational use. Given that since 2012 several states have proposed and passed legislation on those lines and that by 2022 the Substance Abuse and Mental Health Data Archive (SAMHDA) has made available the results of the National Survey on Drug Use and Health (NSDUH) up until 2020 and the Treatment Episode Data Set: Admissions (TEDS-A) up until 2019, I am finally able to start attempting to understand the impacts recreational marijuana laws have on the prevalence of marijuana use, cocaine use, and alcohol use as well as the treatment admissions related to these drugs.

In this paper I have used both panel data regressions and an event studies to understand if marijuana recreational laws impact the outcomes I just mentioned. After running panel data regressions on the NSDUH data, initial results show that there seems to be an increase in the prevalence marijuana use after legalization happens. The event studies using both the NSDUH, and the TEDS-A data further confirm that recreational marijuana laws do increase the use of marijuana similar to what is found regarding the impact of medical marijuana laws. This also holds after controlling for heterogeneity in the treatment which can be seen in the appendix of this paper. When it comes to alcohol use, both the results of the panel data analysis and the event studies using both datasets we look point out that marijuana recreational laws have on effect on the prevalence of alcohol use and treatment admissions related to alcohol. Marijuana and alcohol do not seem to be complements leading me to believe that when it comes to alcohol marijuana does not act as a gateway drug. More broadly one could say that there generally this serves as evidence that marijuana does not act as a gateway drug to socially perceived non-hard drugs. More analysis into the impact of marijuana recreational laws on other non-hard drugs could be done to further evaluate if that is truly the case.

Knowing that marijuana use does increase after legalization, an increase in cocaine use prevalence or treatment admissions related to cocaine would contribute to the idea that both drugs are indeed complements. In other words, that marijuana is a gateway drug. The impact on cocaine use prevalence, however, is not clear at first. Our initial panel data analysis using the NSDUH data observes a clear increase in this outcome after recreational policies. Nevertheless, our event study design does not observe a discontinuity with legalization. Instead, it shows an upward trend in the coefficients but no statistically significant effects. It seems to be the case that the panel data two-way fixed effects method is generating statistically significant effects due to more general trends in the prevalence of cocaine. This does differ across age groups. Some age groups show that there is no clear effect from the start. Overall, it is hard to defend that the initial panel data results are true. After running both panel data regressions and event studies on the TEDS-A data, this is further confirmed. No effect of recreational legalization is observed on treatment admissions related to cocaine.

Given the results we observed there are a few ideas I must point out. The first one is the fact that in our analysis it is clear that the results vary across age groups. The reason why that happens, however, is not clear. My hypothesis is that there are a couple of things in play. First, all recreational marijuana laws only have a direct impact on only people aged 21 years or older. Anyone younger than that still must obtain cannabis through illegal means, either through falsification of identity or through a secondary market. Therefore, for those age groups there are still barriers that can dampen the effect of legalization. Second, young adolescents do not consume more cannabis nor more cocaine after legalization, which could imply that those age groups are simply less interested in such endeavors. This are very initial hypothesis, but more data and further analysis could be done to better understand this age differences.

Furthermore, the data from the both NSDUH and TEDS-A that is publicly available allowed me to construct the analysis I made which I believe has added on to this literature by pointing out clear upward trends in marijuana use, and the lack of trends in cocaine use and alcohol use. It is important to note that sue to our initial results analysis using the NSDUH data can be misleading. Future researchers should be careful when driving conclusions from simple panel data analyses using that data. Additionally, both these datasets contain only state level data. In the future if estimations were made up to the county level, one could explore differences in implementation by county and better investigate this question. For instance, different counties regulate the

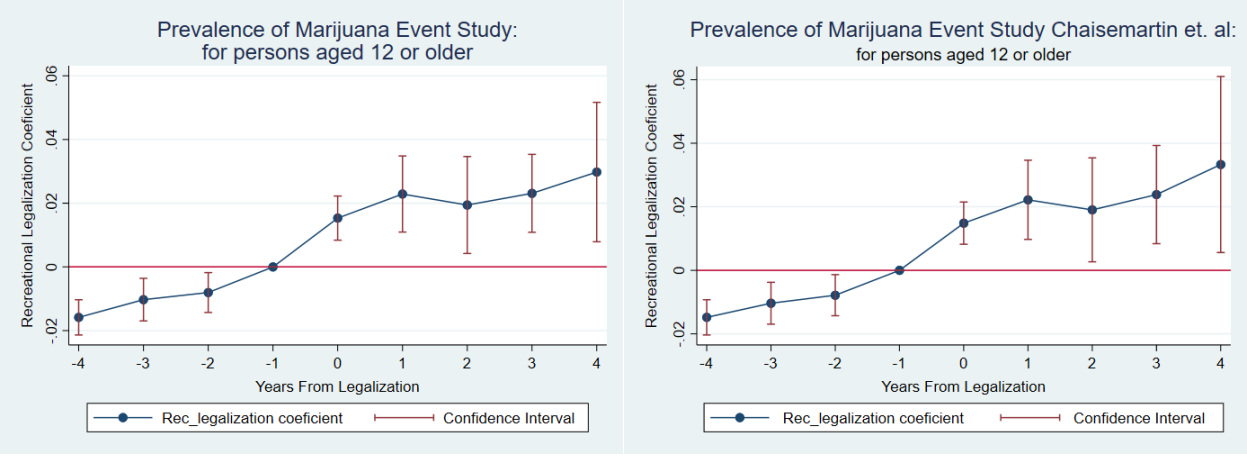
distribution of marijuana at different times. Sometimes these differences in regulation take years to converge. California is a prime example of that. Using this fact, one could run a difference in differences regression to see if there are differences in cocaine use, alcohol use and marijuana use between different counties with different implementations time frames. This also points to a bigger idea that recreational marijuana laws are implemented in very different ways across states. The variations there might also be interesting to better explore especially when it comes to the impacts legalized distribution of cannabis has.

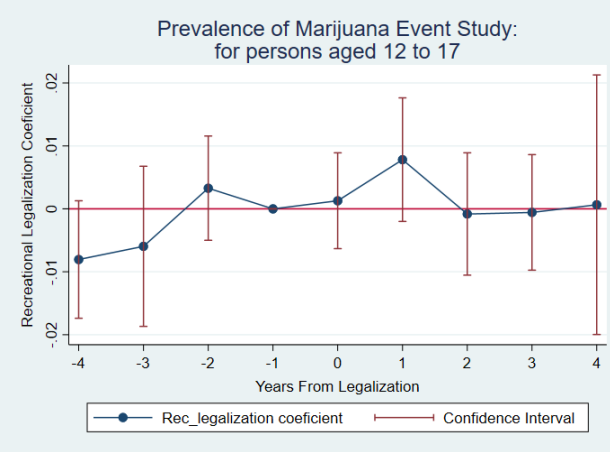
Overall legalizing recreational marijuana is a fairly recent phenomenon in the United States that will have an impact in generations to come. As more data becomes available, the more we will be able to understand these policies. For now, we know that recreational marijuana laws do increase marijuana consumption and seem to have no impacts on the use of other drugs.

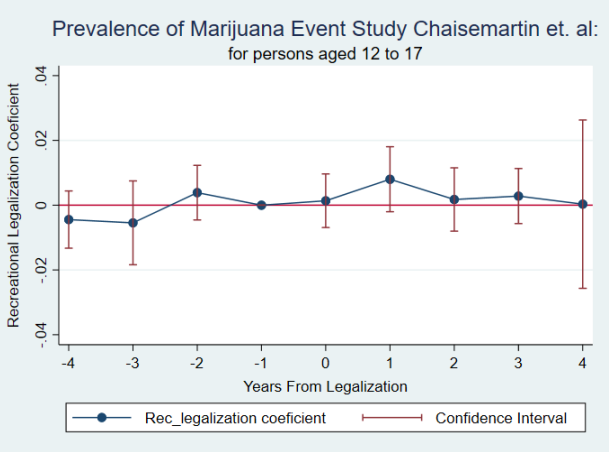
9 Appendix

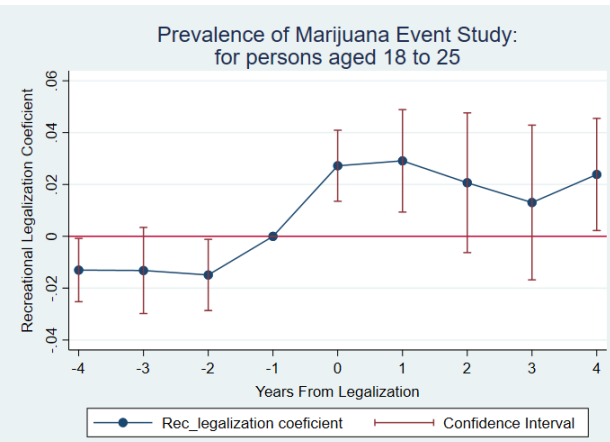
APPENDIX 1:

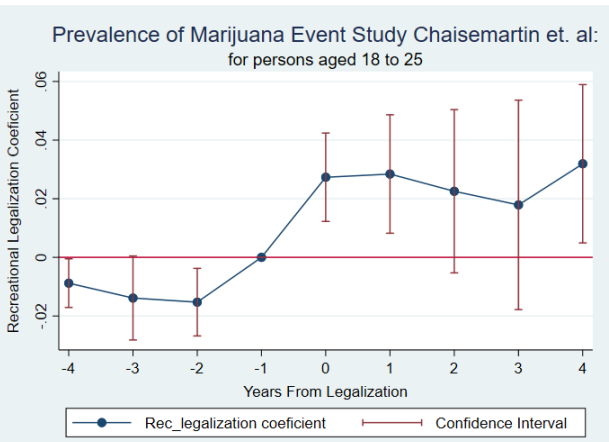
Below you see the comparison between the event study graphs regarding the prevalence of marijuana use using the traditional regression method and Chaisemartin et al regression method. Both use the NSDUH data.

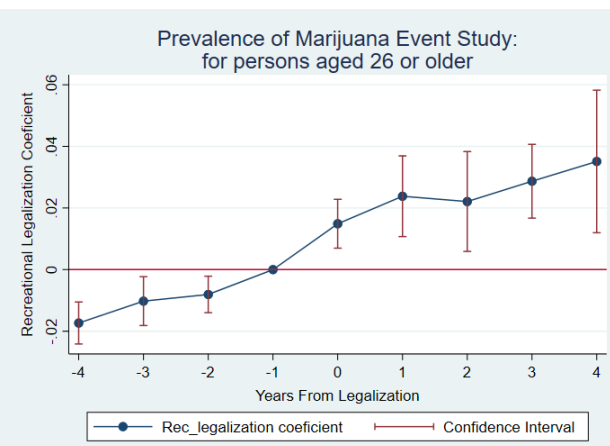


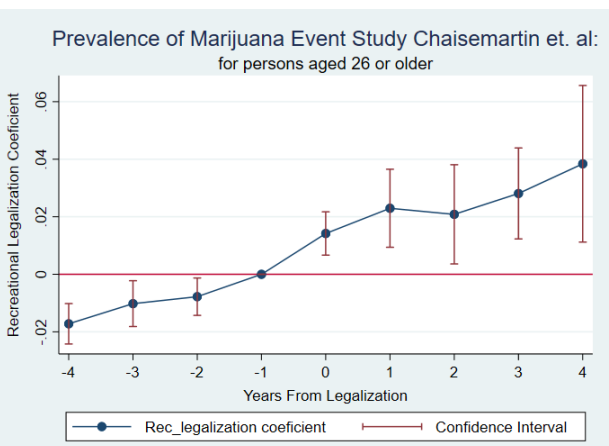

Prevalence of Marijuana Event Study:
for persons aged 12 to 17
Recreational Legalization Coeficient
-.02
-.01
0
.01
.02
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

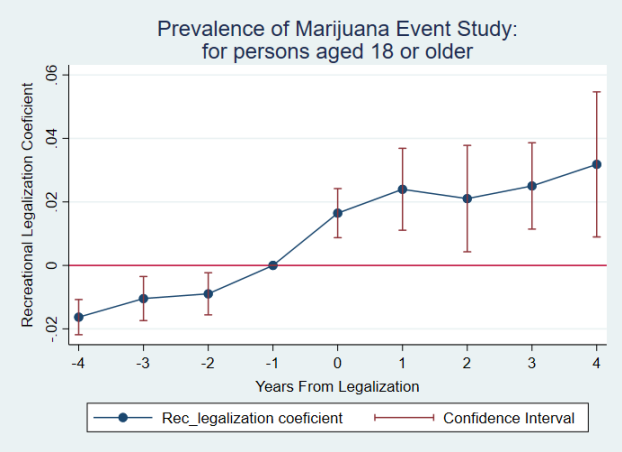

Prevalence of Marijuana Event Study Chaisemartin et. al:
for persons aged 12 to 17
Recreational Legalization Coeficient
-.04
-.02
0
.02
.04
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

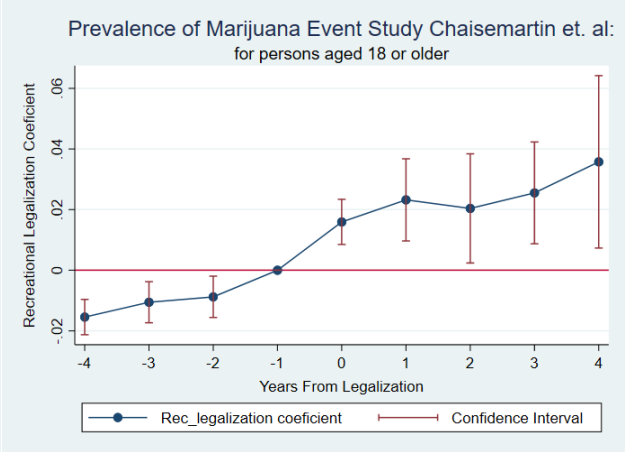

Prevalence of Marijuana Event Study:
for persons aged 18 to 25
Recreational Legalization Coeficient
-.04
-.02
0
.02
.04
.06
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval


Prevalence of Marijuana Event Study Chaisemartin et. al:
for persons aged 18 to 25
Recreational Legalization Coeficient
-.02
0
.02
.04
.06
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval


Prevalence of Marijuana Event Study:
for persons aged 26 or older
Recreational Legalization Coeficient
-.02
0
.02
.04
.06
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

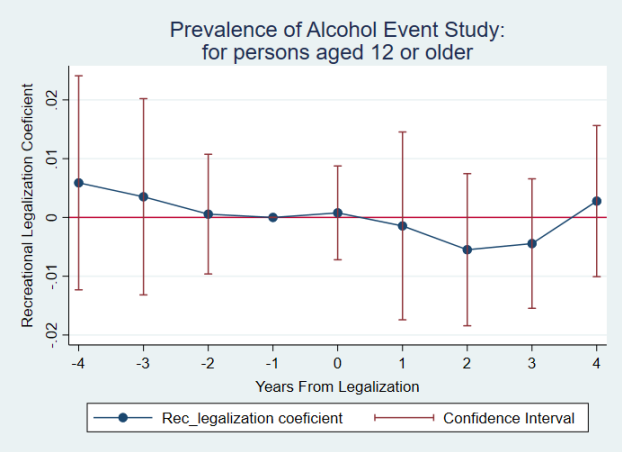

Prevalence of Marijuana Event Study Chaisemartin et. al:
for persons aged 26 or older
Recreational Legalization Coeficient
-.02
0
.02
.04
.06
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

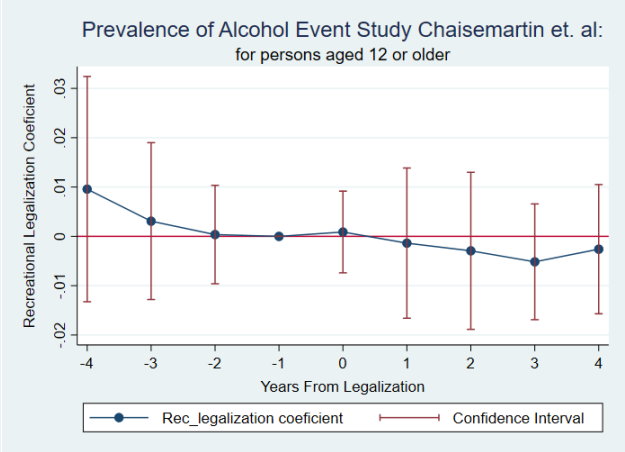


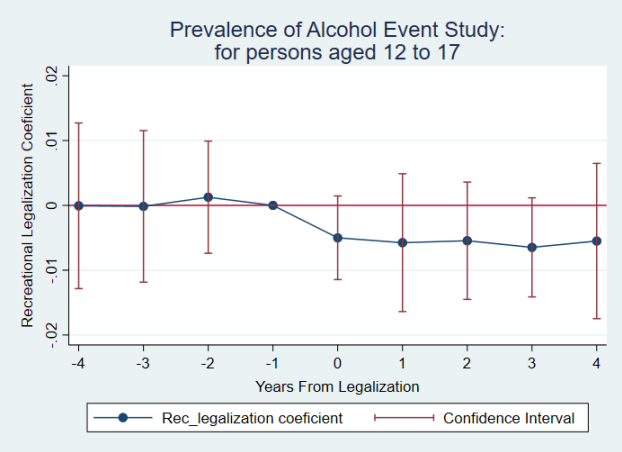


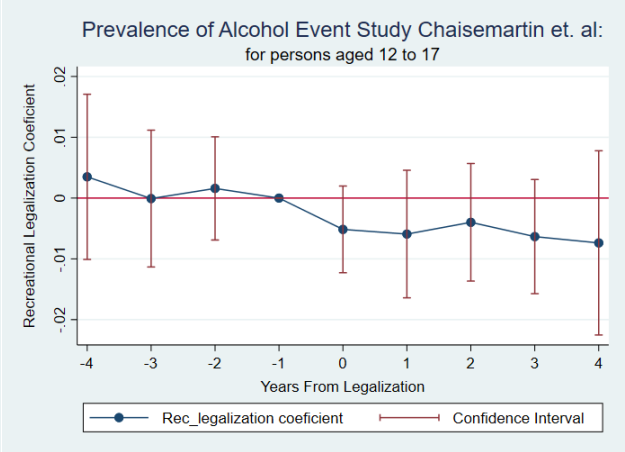
APPENDIX 2:

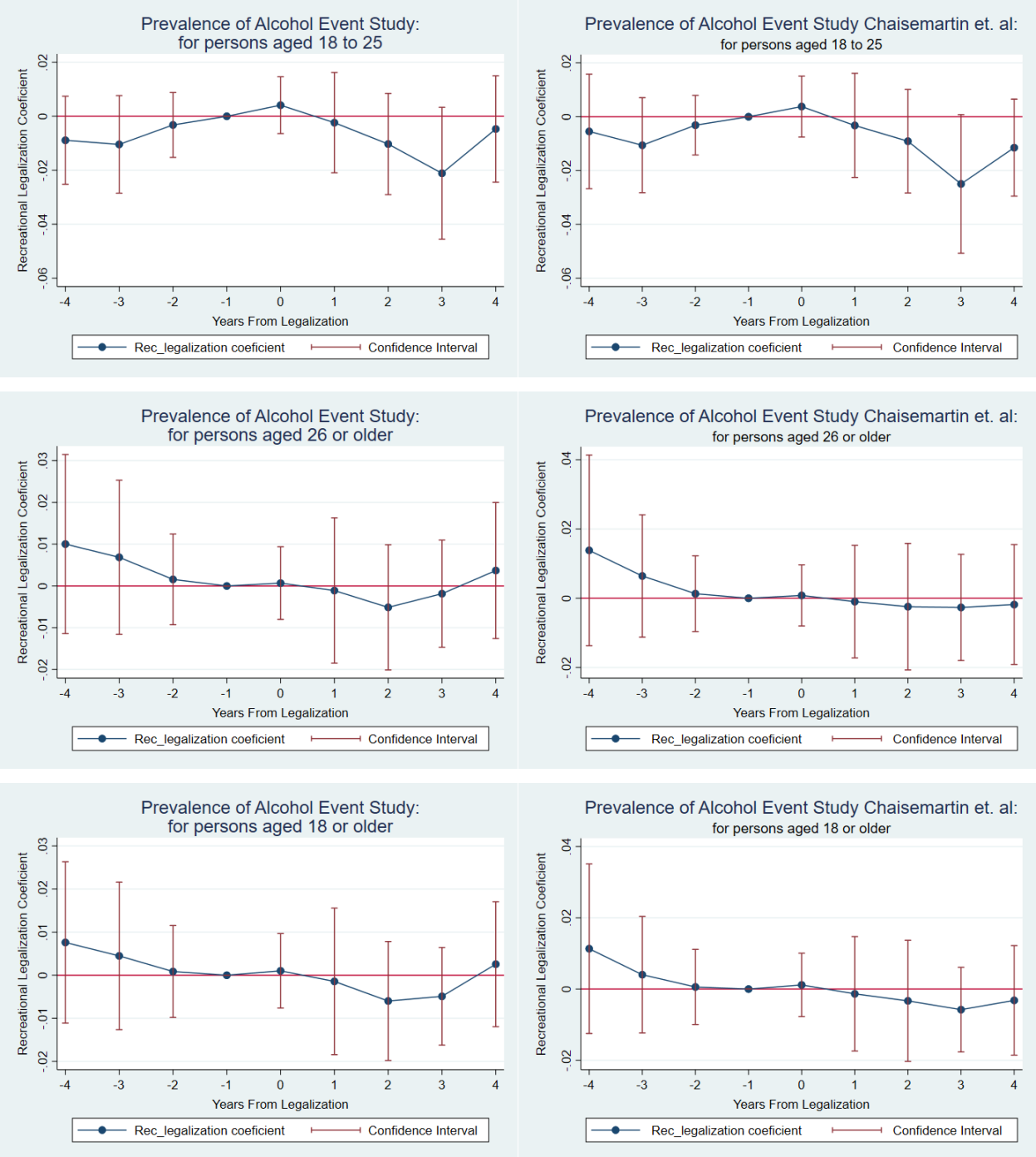
Below you see the comparison between the event study graphs regarding the prevalence of alcohol use using the traditional regression method and Chaisemartin et al regression method. Both use the NSDUH data.





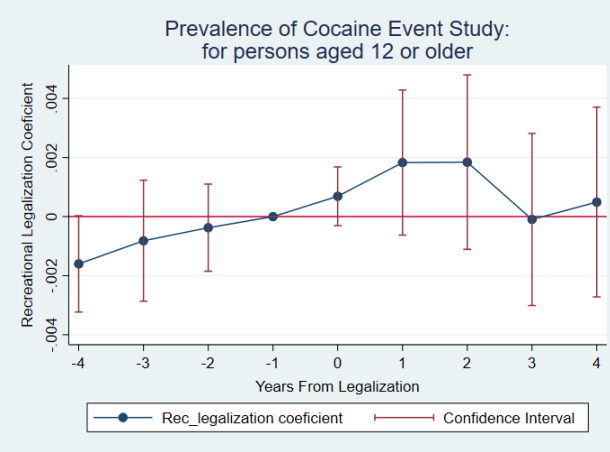


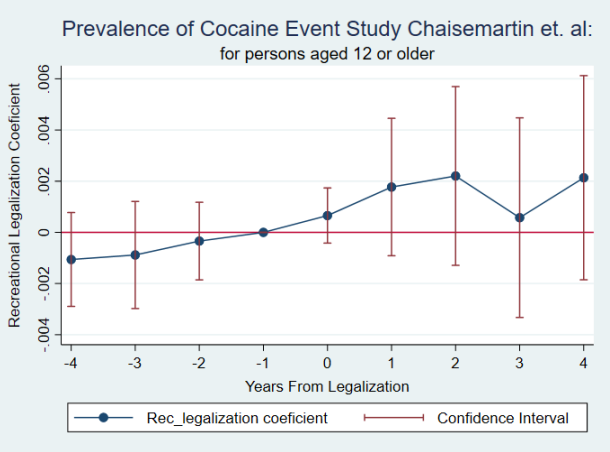


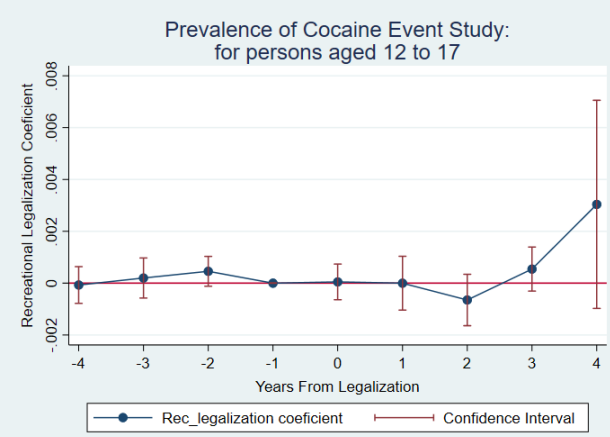


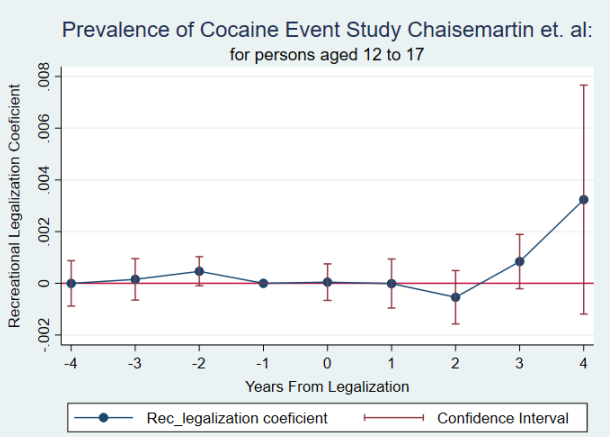
APPENDIX 3:

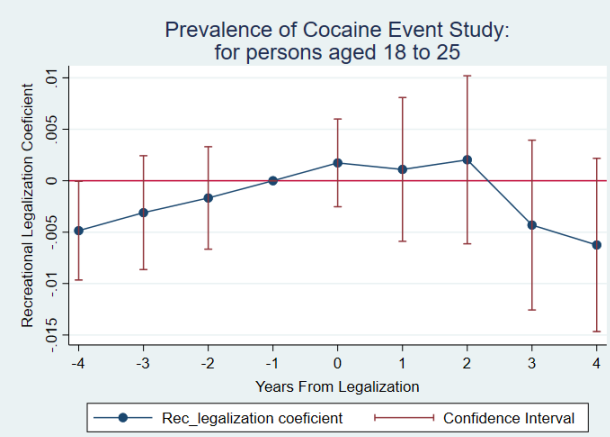
Below you see the comparison between the event study graphs regarding the prevalence of cocaine use using the traditional regression method and Chaisemartin et al regression method. Both use the NSDUH data.

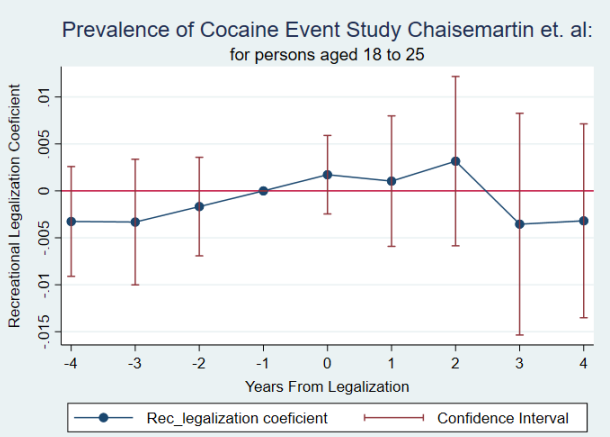

Prevalence of Cocaine Event Study:
for persons aged 12 or older
Recreational Legalization Coeficient
-.004
-.002
0
.002
.004
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

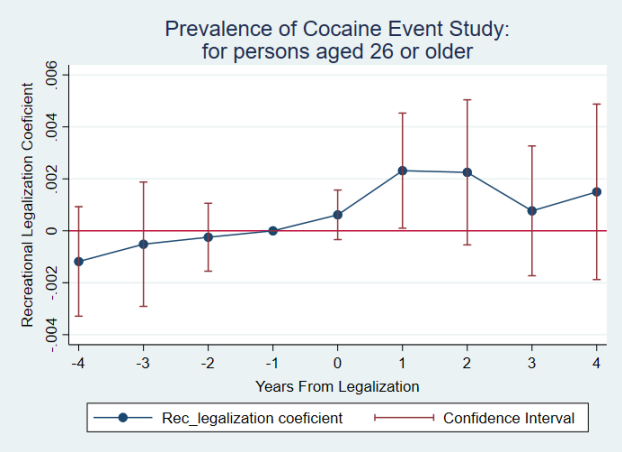

Prevalence of Cocaine Event Study Chaisemartin et. al:
for persons aged 12 or older
Recreational Legalization Coeficient
-.004
-.002
0
.002
.004
.006
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

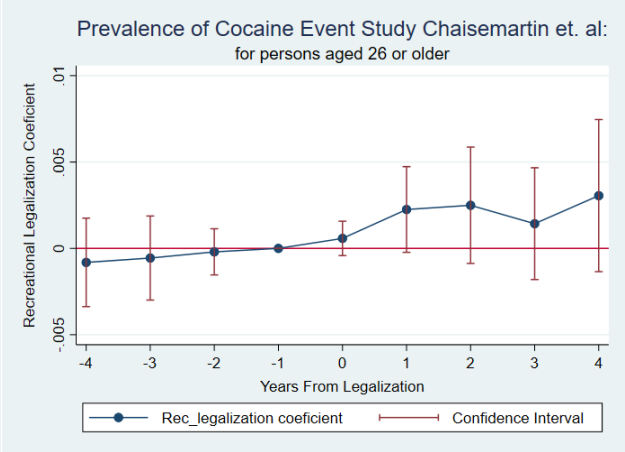

Prevalence of Cocaine Event Study:
for persons aged 12 to 17
Recreational Legalization Coeficient
-.002
0
.002
.004
.006
.008
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

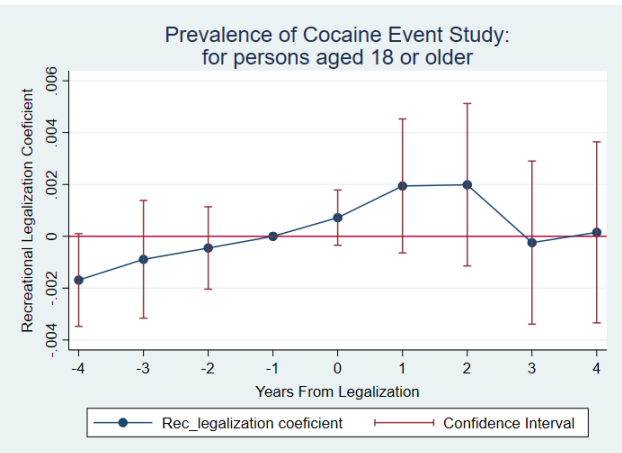

Prevalence of Cocaine Event Study Chaisemartin et. al:
for persons aged 12 to 17
Recreational Legalization Coeficient
-.002
0
.002
.004
.006
.008
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval

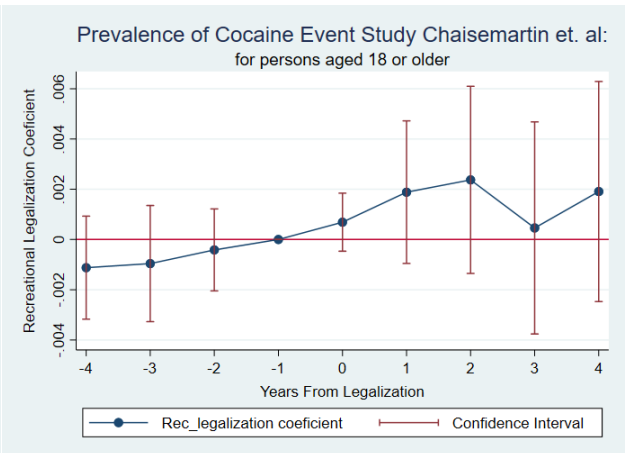

Prevalence of Cocaine Event Study:
for persons aged 18 to 25
Recreational Legalization Coeficient
-.015
-.01
-.005
0
.005
.01
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval


Prevalence of Cocaine Event Study Chaisemartin et. al:
for persons aged 18 to 25
Recreational Legalization Coeficient
-.015
-.01
-.005
0
.005
.01
-4
-3
-2
-1
0
1
2
3
4
Years From Legalization
Rec_legalization coeficient
Confidence Interval



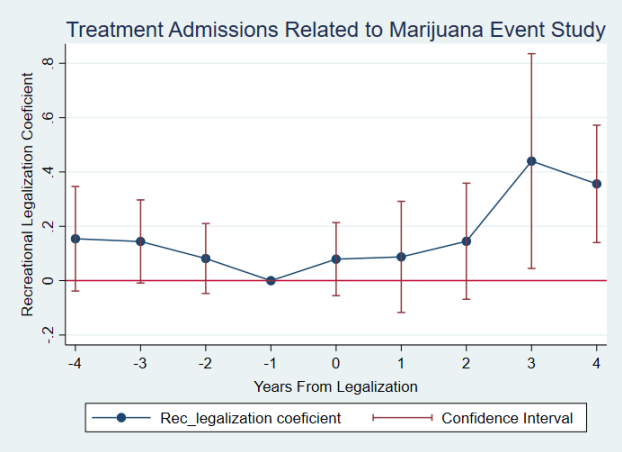


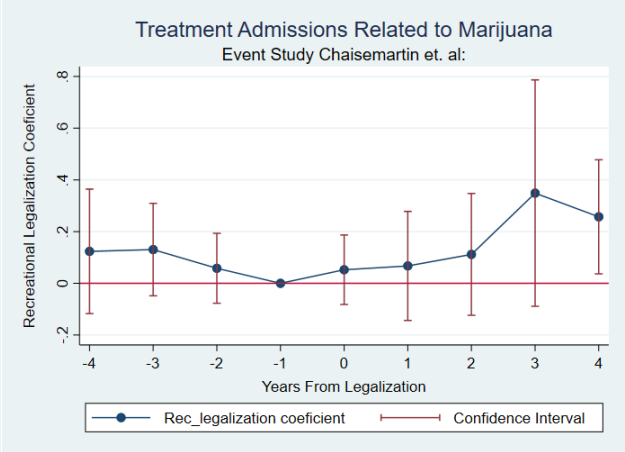




APPENDIX 4:

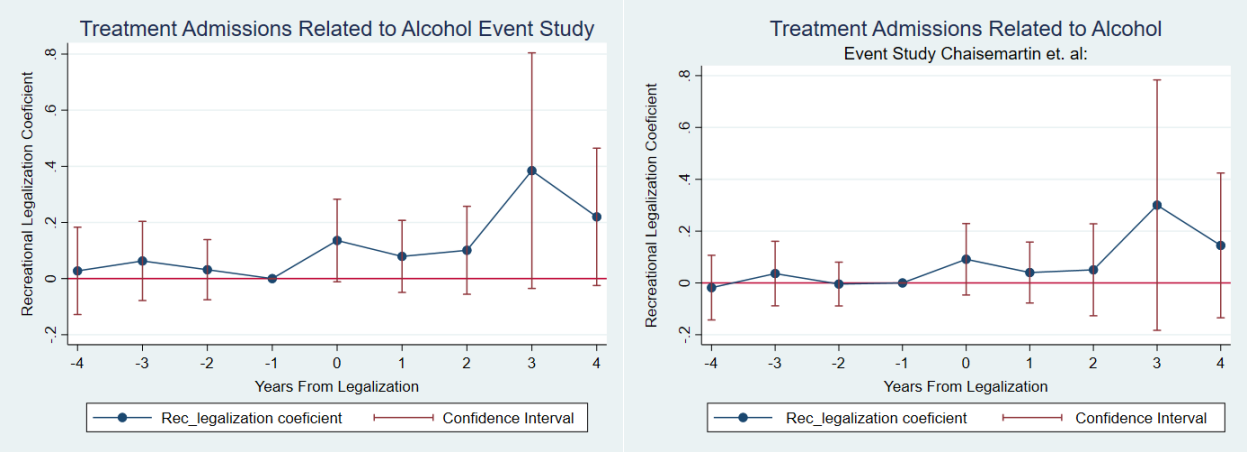
Below you see the comparison between the event study graphs regarding the treatment admissions related to marijuana use using the traditional regression method and Chaisemartin et al regression method. Both use the TEDS-A data.





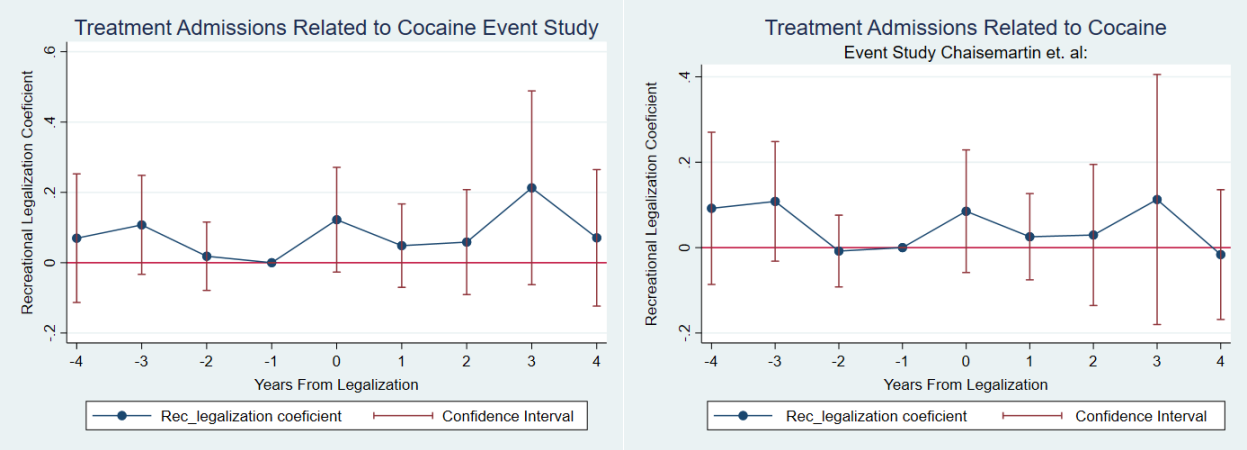
APPENDIX 5:

Below you see the comparison between the event study graphs regarding the treatment admissions related to alcohol use using the traditional regression method and Chaisemartin et al regression method. Both use the TEDS-A data.



APPENDIX 6:

Below you see the comparison between the event study graphs regarding the treatment admissions related to cocaine use using the traditional regression method and Chaisemartin et al regression method. Both use the TEDS-A data.



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