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First Movers in Marijuana: Tourism Boom or Bust?

A Thesis Presented

by

Henry Minervini

To the Keck Science Department

Of Claremont Mckenna, Pitzer, and Scripps Colleges

In partial fulfillment of

The degree of Bachelor of Arts

Senior Thesis in Physics

April 29, 2019

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Abstract

In 2014, Colorado and Washington legalized the cultivation, sale, and consumption of recreational marijuana for anyone over the age of 21. In doing so, the two states presented the first opportunities for marijuana-specific tourism in the United States. Direct benefits of legalization to these first movers, namely tax revenues generated through the sale of marijuana, have been quantified, but the indirect benefits in the tourism sector are as of yet unquantified. Although there is a large body of informal literature and popular media on marijuana tourism, academic study of the subject is scant. Working with a panel composed of 47 of the contiguous United States over the years 2005-2016, this study utilizes a synthetic control methodology to construct hypothetical time series for various tourism indicators for the cases of non-legalization in Colorado and Washington. Comparison of these hypothetical time series to the actual time series reveals the effects of legalization. A similar methodology is applied to all states to find the "placebo effects" and to establish significance. In traveler expenditures, traveler-generated taxes, tourism industry employment, and tourism industry payroll, Washington shows effects of legalization of greater magnitude and significance than those in Colorado. Only 8% of other states show an effect on tourism revenues as large as that of Washington. Additionally this study finds that each state can be approximated with a weighted average of a small group of peers and that weather, price, and an interacted migration and political orientation variable have low predictive power on tourism indicators. Lastly, this study suggests possible causes and policy implications of the discrepancy between the states.

Acknowledgements

I would first like to thank my parents for support in generating the idea for this thesis and for pushing me to pursue it to a fully realized project. A thank you must be given to my mother for her support for a thesis almost exclusively about Marijuana.[1] My friends have been a daily support system for me during the process of producing this research. Jared, Alex, Bach, Tyler, Alex, Edgar, Eric, Mei, Sasha, David, Jason, Ella, and Carolina, each of you has helped in some way to make this thesis possible, and I am grateful.

My academic advisor, Scot Gould, was invaluable in navigating the registration of this thesis in the Keck Science Department, and in helping me navigate the requirements of a physics major. I might not have a diploma without him. Professor Janet Smith made sure this thesis is readable. It's easy to become lost in the jargon, and her insistence that I explain clearly and simply improved my understanding greatly (and hopefully the reader's too). She has done more to critique and clarify my writing than anyone else. My CMC reader, Professor Ben Gillen, was my source for all technical questions. His ability to explain the difficult methodologies in this paper and his patience with my inability to grasp them is commendable. I must thank him for his help in developing a robust and meaningful analysis. Thanks go to F.D.C Willard for his valuable contribution to the discussion. A number of teachers and professors certainly deserve explicit mention here for their help in developing my knowledge and this thesis, but space does not allow. To these myriad influences, thank you very much.

[1] "Sorry Mom"

Introduction and Motivation

In 2017, Colorado broke all-time tourism records for the eighth consecutive year. The state saw record levels of growth in visitors, traveler spending, and traveler generated tax revenues. The levels of growth in Colorado's tourism metrics are well above national averages (Colorado Tourism Office, 2018). While such increases may be explained by factors such as improving economic conditions, advertising, consolidation in the ski resort space, or weather patterns, a significant informal literature points towards the impact of marijuana legalization. Colorado and Washington are both first movers into the realm of legal marijuana and are reaping benefits in the form of taxes on marijuana (Light, Orens, Lewandowski, & Pickton, 2014). Additional tourism activity as a result of legalization would represent an as-of-yet unquantified tax benefit. I hypothesize that marijuana legalization has had a positive marginal impact on tourism activity in both states.

Being a Colorado resident and having worked in the Colorado tourism sector, my home state is of particular interest. As a result, I focus more on Colorado than on Washington in this paper. The hospitality industry is Colorado's second largest employer (COEDIT, 2019), and the state is known as a top tourist destination. My curiosity on the relationship of marijuana and tourism in my home state is the impetus for this research. Ultimately the results of this paper indicate that Colorado may have lessons to learn from Washington regarding marijuana tourism.

History of Marijuana Laws in the United States

Marijuana is illegal at the federal level and has been since the early 1900s. In November 2000, the state of Colorado legalized medical marijuana. Patients required a prescription from a doctor and were granted the ability to grow up to six marijuana plants. The first marijuana dispensaries emerged when the Colorado Department of Public Health and Environment

informally determined that a caregiver may cultivate and provide marijuana for no more than 5 patients (30 plants). In 2007, a Denver district court ruled that this limit was arbitrary, allowing for the first marijuana storefronts. In the following years, attitudes on marijuana softened at both the state and federal level: The Ogden Memorandum from the Obama administration directed that federal resources were not to be used against individuals in compliance with state laws, and three separate laws from the state of Colorado explicitly authorized and regulated medical marijuana dispensaries. In 2012, voters in Colorado approved Amendment 64, allowing for the consumption and sale of marijuana for anyone over the age of 21 (Sensible Colorado, 2013). In January 2014, Colorado became the first state with retail outlets for recreational marijuana.

In 1998 Washington passed an initiative allowing for the possession of a 60 day supply of marijuana for personal medicinal use with valid documentation from a physician. In 2007 and in 2010 the state strictly defined a 60 day supply and expanded the lists of applicable conditions and prescribing medical professionals. In 2011, the first grow operations were licensed through a voluntary registry of patients and caregivers, which registry allowed for home grow operations and shared gardens. Soon after, in 2012, voters approved a bill to allow storefronts for recreational marijuana. In 2014, just a few months after Colorado's first dispensaries appeared, Washington followed suit. (NCSL, 2015). In the same year, Alaska and Oregon both legalized recreational marijuana, but without systems for sale.

An important distinction must be made between legalization and decriminalization. Legalization allows cultivation, sale (or in some cases only gifting), possession, and consumption of marijuana, while decriminalization allows only for possession and consumption, but still imposes penalties for cultivation or sale. Vermont, Maryland, Missouri, Delaware, and Illinois decriminalized cannabis prior to 2016. As it pertains to tourism,

decriminalization should not encourage marijuana tourism, since sale of marijuana to tourists is strictly illegal.

As of the time of writing, 10 states allow recreational marijuana use, 23 allow medical marijuana use, and 17 still prohibit all use.[2] (Hanson & Garcia, 2019). Within Colorado and Washington, towns and counties have the ability to reverse the decision of the state partially: they may disallow all sale of marijuana in their jurisdictions. As of 2016 in Colorado, 53 municipalities had chosen to allow recreational marijuana sales, 165 had not chosen to allow retail marijuana sales, and 15 had ineffective moratoria on legalized marijuana. In 2016, just 23 of 64 Colorado counties had allowed for any sale of marijuana (Aguilar & Murray, 2016). Similar county and municipal data is not available for Washington, although some counties and municipalities have opted to restrict sales like those in Colorado.

What is Marijuana?

Marijuana is a flowering plant, differentiated on the properties of its cannabinoids and terpenes. Marijuana contains Tetrahydrocannabinol (THC), a psychoactive cannabinoid and the main psychoactive chemical in the plant, as well as Cannabidiol (CBD), a non-psychoactive cannabinoid and the major therapeutic chemical in the plant. These are the two most discussed of over 100 cannabinoids contained in the plant. Additionally, varieties can be distinguished by their terpene content. Terpenes are organic compounds that add odor and flavor to marijuana.

Marijuana can be consumed in several primary ways. For psychoactive effects, it can be smoked, vaporized, or taken orally. Products that can be smoked and vaped include flower (the dried flowers of the marijuana plant), and concentrates (processed marijuana products that contain high levels of desired compounds, typically THC). Marijuana can be infused into fats

[2] These numbers refer to high-THC marijuana only. When all marijuana varieties are included, these numbers change to 36 and 4 respectively.

(butter, oil, etc) and consumed in a variety of food products known as edibles. Effects of edibles tend to last longer than smoking or vaping. For non-psychoactive effects, low-THC marijuana strains can be consumed via the methods above. Additionally a large selection of topical marijuana products (tinctures, lotions, body oils, etc) exists. These topical products have supposed therapeutic effects and little to no psychoactive effect. Visitors to the states of Colorado and Washington are permitted to buy and use all of the products listed above.

In all the states where marijuana is legal, it must be consumed in a private space. All applicable laws against smoking and/or vaping apply to marijuana products. No state allows sale and consumption of marijuana in the same location. Similar to relevant alcohol policy, a maximum blood concentration of THC is defined as a legal limit for driving.

Marijuana Tourism: A Hot Topic with Limited Study

Colorado's and Washington's legalizations in 2014 presented the first opportunities in the United States for marijuana-specific tourism. In October 2015, Travel and Leisure Magazine ran an article titled "A Pot-Smoker's Guide to Elite Marijuana Tourism" (Peterson, 2015). In the article, there are recommendations for dispensaries, tours, and other marijuana friendly attractions. A plethora of other popular sources contain similar recommendations and language: "Tourists flock to Colorado to smoke legal weed" – CNNMoney (Smith, 2014), "Colorado welcomes cannabis-curious tourists" – CBS (Laguerre-Wilkinson, 2015) , "The Next Big Thing in Cannabis: Tourism" – Forbes (Kovacevich, 2018), "The Brave New World of Cannabis Tourism" - Travel Channel (Horn, 2018). In addition, a Colorado company developed a "World Cannabis Week" in 2018, centered around the 4/20 holiday (an unofficial holiday for marijuana), and the event recently occurred again in 2019 (worldcannabisweek.com). One can visit websites specifically for marijuana tourism such as Kushtourism.com, Coloradopotguide.com, Coloradocannabistours.com, My420tours.com, and Cannabistours.com.

Suffice it to say that popular press and media is buzzing with mentions of marijuana tourism. These sources informally define the new marijuana tourism market segment.

Despite the large body of informal literature, academic study of marijuana tourism is scant. This can be partially explained by the limited amount of data available for study. As of the time of writing, for most variables of interest, three years of data are available post-legalization (2014-2016). In addition, the general body of literature on marijuana is growing quickly with studies of the effect of legalization on many different public policy variables. Researchers are interested in a wide array of effects. Expectedly, some secondary effects like those on tourism have not yet been studied

This study seeks to be a forerunner in the understanding of the relationship of the markets for tourism and for marijuana. As first movers in the marijuana market, Colorado and Washington have the potential to establish themselves as US marijuana destinations, potentially capitalizing on the desire of tourists to consume marijuana while on vacation.[3] My study tests the hypothesis that marijuana legalization has a significant positive marginal effect on tourism activity in Colorado and Washington.

Literature Review

As is the case with many new bodies of literature, clear taxonomies are still emerging. The body of literature immediately relevant to Marijuana tourism is rather small, and this study seeks to add significantly to the understanding of marijuana tourism. Kang, O'Leary, & Miller (2016) give a summary of existing literature and outline a research agenda for understanding marijuana tourism with Colorado as a focal point. This review captures many of the newer

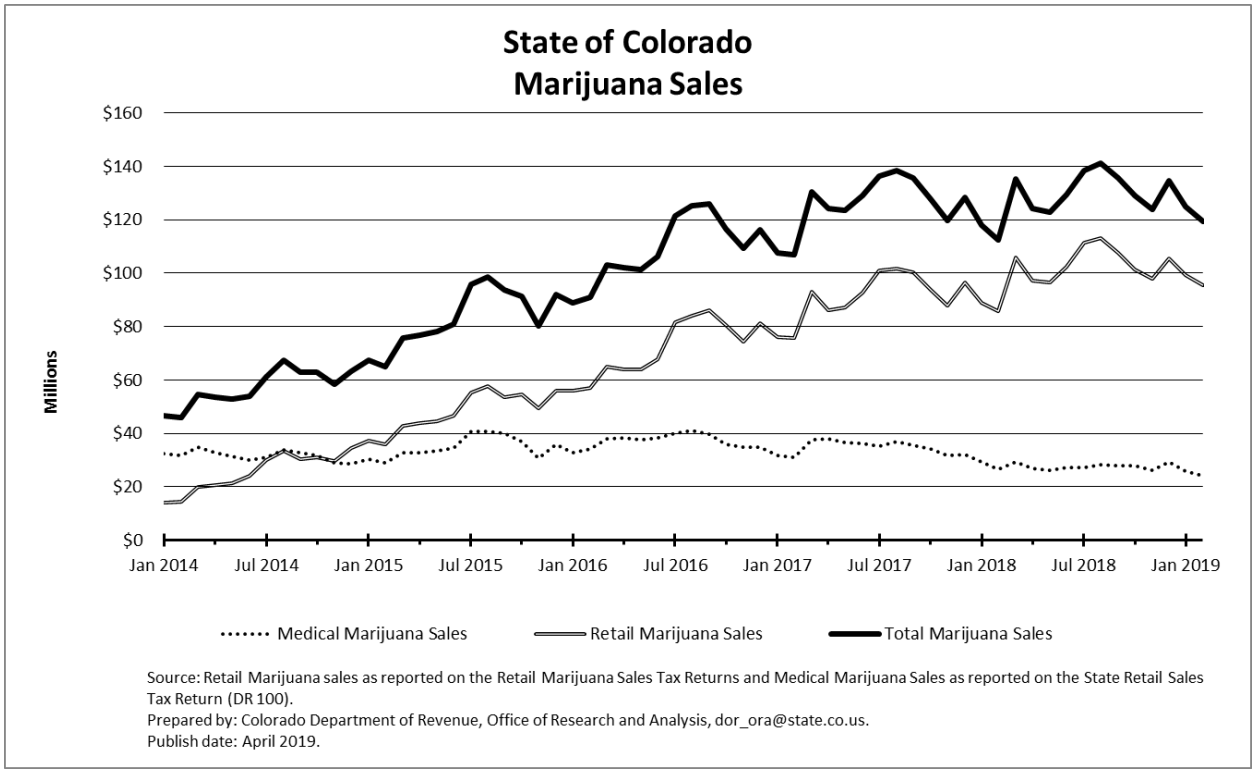
[3] See Belhassen, Santos, & Uriely (2007) for marijuana tourist motivations, each of which are potentially applicable to the cases Colorado and Washington

sources from Kang, O'Leary, and Miller's paper, and expands on its research agenda for "Economic and social impact."

Colorado Tourists are Buying Marijuana

Several studies have established that visitors to the state of Colorado are purchasing and consuming marijuana. In the first year after legalization, marijuana-related emergency room visits by visitors to the state doubled, compared to the year prior (Kim et al, 2016). Hao & Cowan (2017) suggest that retail marijuana laws are associated with increased marijuana possession arrests in the bordering counties of neighboring states. Finally, the Colorado Department of Revenue, in their commissioned 2014 Market Size and Demand study, found that tourists represent a large share of the market for recreational marijuana. In counties designated as "tourist counties" total marijuana sales increased by 100% or more upon legalization of recreational marijuana. When compared to increases of 20% or less in metro counties, the sharp increases in tourist heavy counties indicate that tourists are purchasing from recreational marijuana stores. The study estimates that tourists may constitute 44% of recreational marijuana demand in metro counties and up to 90% in tourist counties (Light, Orens, Lewandowski, & Pickton, 2018). In Figure 1, is a graph from the Colorado Department of Revenue which plots marijuana sales in the state. Per the 2014 Market Size and Demand study, one can assume a large percentage of retail sales to be to visitors.

Figure 1: CDOR Reported Marijuana Sales



Marijuana Informs Travel Decisions

Another vein of literature seeks to study the motivations and attitudes of marijuana tourists. This literature is essential to an understanding of marijuana tourism as a whole. Belhassen, Santos, & Uriely (2007) group marijuana tourists into four major motivations: curiosity, recreation, authenticity, and drug smuggling. Taylor (2018) seeks to define marijuana tourism, a difficult task based on varying and mixed motivations for travel. She settles on "*purchasing with the intent to consume marijuana products while temporarily traveling away from one's normal place of work or residence*," a definition important to this study. In 2015, the Colorado Tourism Office published the results of a survey on tourist attitudes towards Marijuana. The survey shows that potential summer visitors reported that marijuana laws influenced their decisions 49% of the time, although only 8% reported visiting a dispensary. In the prior year, the survey asked more specific questions with regard to positive and negative

influence of marijuana laws on travel decisions: 20% of potential visitors reported a positive influence, 15% a negative influence, and 65% no influence (Blevins, 2015). As it stands, this vein of literature does not present a unified picture of how, why, and to what extent tourists are engaging in marijuana tourism.

Broader Bodies of Literature on Marijuana and Travel

It is worth mentioning, but not reviewing, two bodies of literature into which this study falls, but is not immediately related. First, there is wide array of study on various effects of legalization including but not limited to public health (opioid overdose, suicide, pediatric exposures, etc), consumption of various drugs (alcohol, marijuana, tobacco, illegal drugs, etc), law enforcement (crime rates, traffic accidents, etc), and other effects (sickness absences, housing prices, marijuana THC potency, etc). My study will add to this broad and growing category of literature on effects of marijuana legalization. Second, this study also falls into the category of tourism impact studies. This body of literature seeks to find determinants for tourism metrics (visitor numbers, expenditures, etc). These determinants include but are not limited to weather events, ecological disasters, advertising, and macroeconomic indicators. My study will also add to the broad body of literature regarding determinants of tourism.

Empirical Approach

Synthetic Control Methodology Explained

In any study seeking to analyze causality, an adequate counterfactual is necessary to show that, without the treatment of interest, the hypothesized effect is or is not present. In the case of Colorado's tourism revenues and marijuana legalization, a perfect counterfactual would be a Colorado in which marijuana was not legalized. Obviously, this hypothetical Colorado does not exist, and no other state is a perfect comparable. It is for these reasons that this study

employs the synthetic control methodology (SCM) as developed by Abadie & Gardeazabal (2003).

To explain this methodology it is easiest to address a specific case from this study. I use the case of tourism expenditures in Colorado. SCM uses a donor pool of other states to construct hypothetical tourism revenues for a Colorado in which marijuana was not legalized. The largest possible donor pool is that of all other states without the treatment of interest (see Data section for a definition of treatment), but it may be restricted on other criteria. The hypothetical tourism revenues are calculated from a weighted average of actual tourism revenues from the donor pool in the treatment period (2014-2016). Weights are determined by the similarity of the dependent variable and other matching variables between the donors and Colorado in the pre-treatment period. To demonstrate the validity of the synthetic control for the treatment group, the same methodology is applied to the other non-treated states, and (ideally) the constructed revenues of the donors are seen to match closely the actual revenues in the treatment period.

SCM is similar to a difference in difference (DID) methodology, with the key distinction that the synthetic control group is constructed from an unequally-weighted average of donors with SCM, as opposed to an equally-weighted average of donors with DID. Presumably, allowing weights to vary among the donor pool increases the accuracy of the synthetic control, since it is constructed from those states most similar in factors other than the treatment of interest.

History of Synthetic Control Methodology

SCM was formally developed by Abadie & Gardeazabal (2003) to study the economic costs of conflict. In their paper, the authors examine the effect of the terrorist conflict in Basque Country in the 1960's, finding that it caused a decrease of about 10 percentage points in per capita GDP relative to a synthetic control without terrorism. Abadie & Gardeazabal's paper

builds on the work of Card (1989) and Card & Kreuger (1994) each of whom used less formalized versions of SCM. These authors studied the effect of Cuban migration to Miami on the labor market and the effect of minimum wage increases on employment in New Jersey, respectively. Abadie, Diamond, & Hainsmueller (2010) build upon the 2003 paper, addressing some of the methodological shortcomings and analyzing the effect of California's 1988 tobacco control program. They find that 12 years after the inception of the program, per-capita annual cigarette consumption was 26 packs lower than a synthetic control without the program.

This analysis of marijuana and tourism utilizes the STATA package developed by Galiani & Quistorff (2016), which automates the processes described in Abadie et al. (2010) as well as builds upon its methodology to allow for multiple treated units and adds some graphing utilities. This package is one of several that have been developed for the purpose of implementing SCM. Other similar recent applications of SCM include Dickerson (2018), who analyzed the effect of marijuana legalization on opioid overdose rates in Washington, and Hanson, Miller, & Weber (2018), who analyzed the effect of marijuana legalization on traffic fatalities in Colorado.

Mathematics of the Estimation

The following is an explanation derived heavily from Galiani & Quistorff (2016). Their paper as well as Abadie et al. (2010) contain fuller explanations of these estimation techniques.

Estimation is performed with a group of J donors over T periods. D_{jt} is a binary indicator of treatment for unit j at time t. The observed outcome variable, Y_{jt}, is thought to be the sum of the treatment effect, $\alpha_{jt}D_{jt}$, and the synthetic counterfactual, Y_{jt}^N, where N indicates non-treatment. Y_{jt} is specified as follows:

$$Y_{jt} = \alpha_{jt}D_{jt} + Y_{jt}^N$$

$$Y_{jt} = \alpha_{jt} D_{jt} + (\delta_t + \boldsymbol{\theta_t Z_j} + \boldsymbol{\lambda_t \mu_j} + \xi_{jt})$$

δ_t – an unspecified time factor
$\boldsymbol{\theta_t}$ – (1 x r) vector of unknown parameters
$\mathbf{Z_j}$ – (r x 1) vector of observed covariates
$\boldsymbol{\lambda_t}$ – (1 x F) vector of unknown factors
$\boldsymbol{\mu_j}$ – (F x 1) vector of unknown factor loadings
ξ_{jt} – Error, independent across units and time with mean 0

Assuming unit 1 to be the treated unit, the estimated effect, $\widehat{\alpha_{1t}}$, is specified as follows:

$$\widehat{\alpha_{1t}} = Y_{1t} - \sum_{j \geq 2} w_j Y_{jt}$$

The (T x J) matrix $\mathbf{Y_0}$ contains all outcomes for the donors, that is all Y_{jt}. $\mathbf{W}$ is a (J x 1) vector of observation weights, w_j, where $\sum_j w_j = 1$ and $w_j \geq 0$. A (T x 1) vector of weighted outcomes can be be produced as $\mathbf{Y_0 W}$. Additionally, k matching variables are contained in the (k x J) Matrix, $\mathbf{X_0}$, including $\mathbf{Z_j}$ as specified above and M linear combinations of the pre-treatment outcome variable, such that k =r + M, where r is the dimension of $\mathbf{Z_j}$. Finally, $\mathbf{V}$ is a (k x k) matrix of matching variable weights, indicating relative significance.

Estimation consists of finding the optimal weight matrices $\mathbf{W}$ and $\mathbf{V}$. $\mathbf{V}$ is chosen so as to minimize the prediction error in the outcome variable in the pre-treatment period. Two distance measures are defined $\|\boldsymbol{A}\|_{\boldsymbol{B}} = \sqrt{\boldsymbol{A'BA}}$ and $\|\boldsymbol{A}\| = \sqrt{\boldsymbol{A'A}}$. Partitioning the outcome variable into pre and post-treatment vectors as $\boldsymbol{Y}_j = (\overleftarrow{\boldsymbol{Y_j}} \setminus \overrightarrow{\boldsymbol{Y_j}})$, the pre- treatment root mean squared prediction error (RMSPE) is defined as $\overleftarrow{s_1} = \left\| \overleftarrow{\boldsymbol{Y_1}} - \overleftarrow{\boldsymbol{Y_0}} \boldsymbol{W} \right\|$. Post-treatment RMSPE, $\overrightarrow{s_1}$, is defined similarly. $\mathbf{W}$ is picked to minimize the RMSPE of the matching variables, $\|\boldsymbol{X_1} - \boldsymbol{X_0 W}\|_{\boldsymbol{V}}$.

Finally, statistical significance is determined using a placebo test. The same procedure is run on each donor as if it had the treatment, excluding the actual treated unit from the donor pool. Defining the distribution of placebo effects in the donor pool as $\widehat{\alpha_{1t}^{PL}}$, a two sided p-value is defined as follows:

$$\text{p-value} = \Pr(\,|\widehat{\alpha_{1t}^{PL}}| \;\geq\; |\widehat{\alpha_{1t}}|\,) = \frac{\sum_{j\neq 1} 1(|\widehat{\alpha_{jt}}| \geq |\widehat{\alpha_{1t}}|\,)}{J}$$

Since treatment is not randomized, this p-value can be interpreted as the percentage of units with an estimated effect at least as large as the treated unit. This p-value can also standardized by dividing all effects by $\widehat{s_1}$.

Data

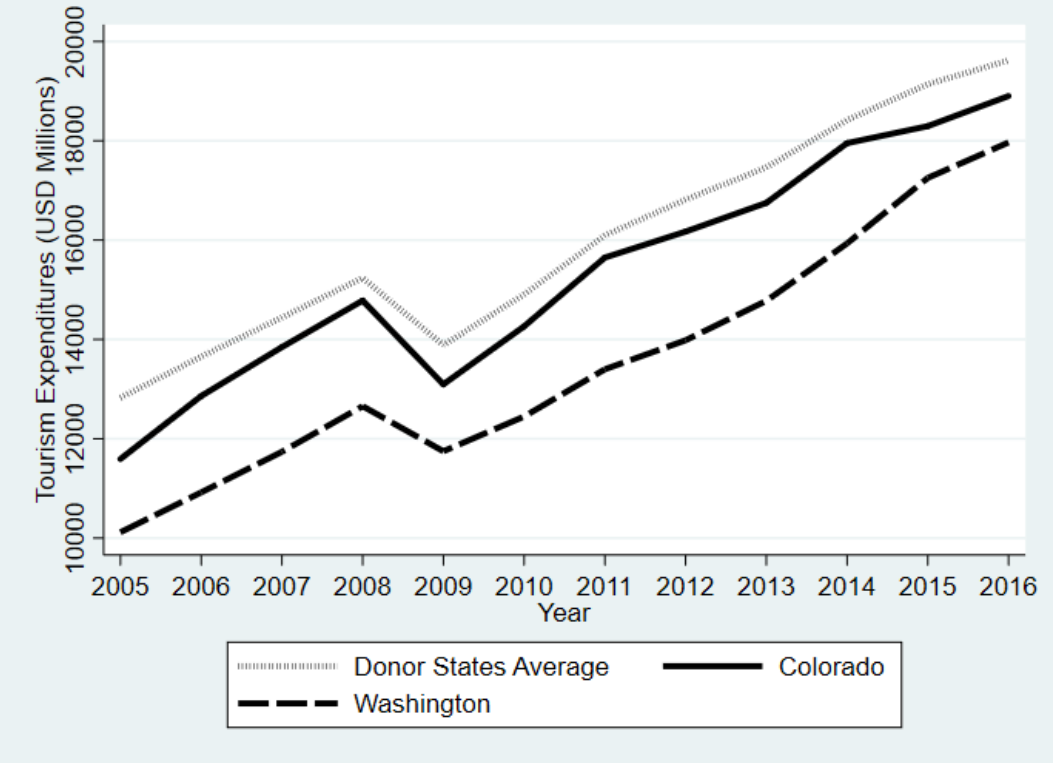
Tourism Indicators

Several indicators for tourism are published annually by the U.S. Travel Association (USTA). For each of the 50 states and for all years 2000-2016, the USTA publishes estimates for traveler expenditures; employment levels and payroll income in the tourism sector; and traveler-generated total, federal, state, and local taxes. All are presented in millions of USD except employment, which is presented in number of jobs. Summary statistics are provided in Figure 3. The USTA's estimation techniques are somewhat opaque, but their metrics serve as adequate indicators of overall tourism activity. For this study a single, rather safe assumption must hold: I assume that the USTA's estimation technique is consistent across states, such that cross state analysis produces reliable and meaningful results. For Colorado and Washington, three years of data exist in the post-legalization period, allowing for adequate, if still preliminary, study of the effects of legalization. My analysis focuses on tourism revenues, allowing other indicators to serve as robustness checks.

Tourism revenues for Washington, Colorado, and an average of Donor states are plotted in Figure 2. A clear reaction to the Great Recession can be seen in 2008. This suggests that truncation of the data may be appropriate, since there is a clear break in the trend. Results presented in the Analysis section further suggest the necessity of this truncation. Additionally,

there are preliminary indicators visible: Colorado seems to depart from a high rate of growth in 2014, while Washington continues with high rates of growth.

Figure 2: Tourism Expenditures for Washington, Colorado, and Donor States



Treatment and Matching Variables

A clear definition of treatment and non-treatment is important to understand the treatment of interest and to differentiate clearly between donors and treated states. The treatment of interest is actually "*the presentation of the opportunity for legal marijuana tourism*". This definition serves to exclude several special cases from treatment. The first is states that have only medical marijuana laws. Since these laws pertain only to residents of the particular state, tourists are forbidden from purchasing or possessing. The second special case is states that have decriminalized. A tourist can possess marijuana in these states, but there is

no legal way for them to obtain this marijuana. The last special case is states that have legalized but have no provision for sale. The only states in this category are Alaska and Oregon. Alaska is excluded since it is not one of the contiguous states. Oregon is excluded on the basis that it did not have a system of dispensaries until 2015, leaving too small a number of years for analysis post-treatment.

I choose matching variables to account for economic, environmental, political, and social conditions in each state. These variables can serve two purposes: to improve the fit and to address issues of endogeneity. After inclusion of matching variables, the entire dataset contains a panel of the 47 of the contiguous United States (Oregon excluded) over 12 years (2005-2016) for a total of 564 observations.

Figure 3: Summary Statistics

Variable	N	Mean	SD	Min	Max
Expenditures	564	16124.66	20299.75	1353.90	133469.40
Federal Tax	564	1393.79	1728.56	92.30	10784.40
State Tax	564	718.74	883.79	24.50	5948.30
Local Tax	564	428.07	692.35	17.60	4665.40
Total Tax	564	2535.30	3231.29	197.20	20467.60
Payroll	564	4050.42	5300.87	265.20	33193.50
Employment	564	155557.70	183037.00	13390.00	998540.00
HPI	564	477.21	146.74	280.11	1226.11
Temp Anomaly	564	1.54	1.41	-2.13	5.13
Precip Anomaly	564	0.14	0.52	-1.45	1.88
Blue Migration	564	44893.76	742062.80	-3800000.00	5300000.00

Three variables, housing price index (HPI), temperature anomaly, and precipitation anomaly serve as "fit" variables. These variables are potential drivers of tourism activity, but are assumed to have no effect on a state's propensity to legalize marijuana. Summary statistics are shown in Figure 3. HPI is provided by the Federal Housing Finance Agency for the years 1991-2018 and serves as a proxy for travel cost. I justify inclusion of this variable with the

assumption that a traveler will always choose the less expensive of two identical travel options. Precipitation and temperature anomaly are measures of annual deviation from the relevant 100 year mean. These variables are provided by the National Oceanic and Atmospheric Administration. These variables proxy for weather conditions. I justify inclusion of these variables with the a priori knowledge that Colorado tourism revenues are driven largely by ski tourists, who I assume discriminate between ski resort options on the basis of quality and quantity of snow. These assumptions are minor, since my estimation technique will discard (or weight at nearly zero) any variable seen not to have predictive value with respect to the dependent variable.

One variable serves to correct for endogeneity: blue migration. This variable is assumed to proxy for factors that would both affect tourism activity and a state's propensity to legalize marijuana. It is a measure of net migration from states considered to be generally democrat. The underlying assumption, not entirely true, but functional in this case, is that republicans generally oppose marijuana legalization and democrats generally support it. Data for this variable is provided by the US Census Bureau, which publishes interstate migration data for the years 2005-2017. I determine a state's political orientation based upon whether more than two of the most recent four presidential elections went to one party. I justify this definition on the assumption that the kind of political alignment that leads to marijuana legalization is not ephemeral, but built over many years. Only three states split the elections 2-2 and are excluded from this variable: Iowa, Ohio, and Florida. The resulting variable contains an estimate for the net migration from states that lean generally democrat in a given year (i.e. democratic migration – republican migration = blue migration)

Analysis

Understanding SCM Analysis

Presentation and understanding of SCM analyses are somewhat different than standard regression analysis. SCM does not produce regression tables or coefficients, but rather is best represented graphically. Two varieties of graphical representation are presented in this section:

1) Comparisons of the dependent variable, actual and synthetic, for a given state. If the lines for actual and synthetic differ, an effect is observed.
2) Plots of the cumulated effects (i.e. effect = actual – synthetic) presented both for individual states and averaged across treated states. This is a plot of the difference of the two lines from the first graphical representation.

It is important not to compare these two types of graphs directly, since they report different metrics.

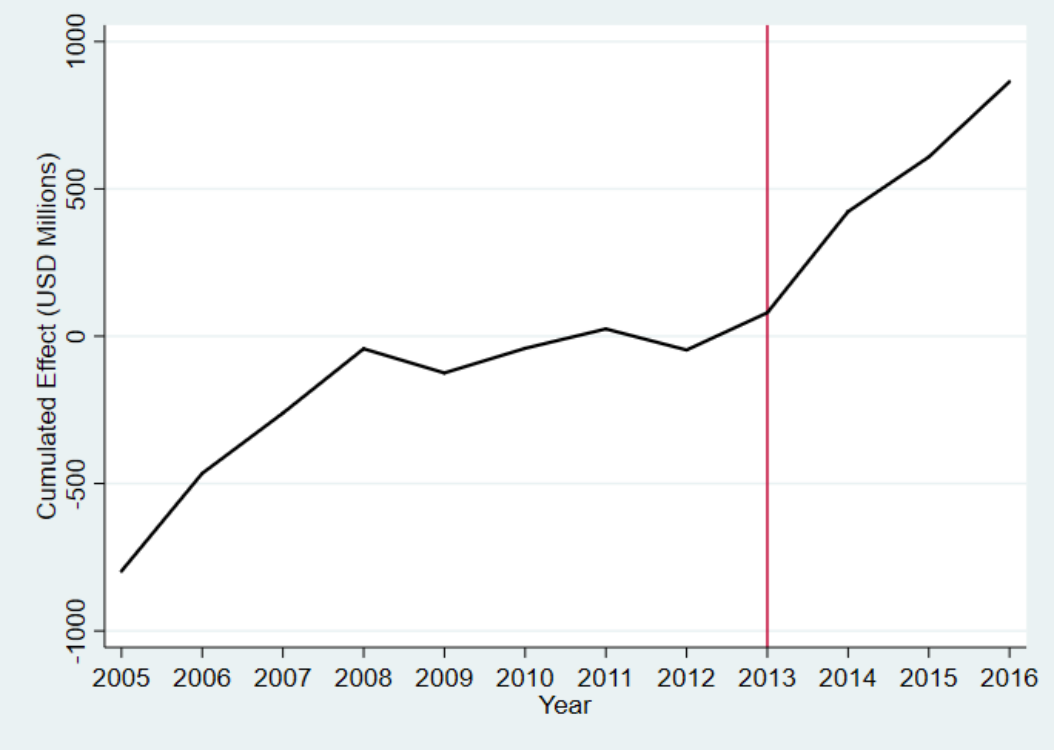
While graphs present the most intuitive understanding, there are important metrics for SCM analysis. The first of these is the p-value, a measure of significance. As stated in the methodology section, since treatment is not randomly assigned amongst states, this p-value can be interpreted as the percentage of other states showing an effect at least as large as that of the treated state(s). Next are the relative weights of donor states and of matching variables, which weights allow for a more detailed understanding of the composition of the synthetic control. These weights come from the W and V matrices, as explained in the methodology section. Finally, synthetic matching variables are generated in the pre-treatment period and are compared to the treated state's actual values and the average of donor states. Examining these values can demonstrate the quality of the fit of the synthetic control, and the preference for SCM over DID. For complete reporting of results see appendix A.

Lastly, it is important to understand the differences of a single treated state versus multiple treated states. When multiple states are treated, similar graphs to those listed above can be created, but they present a hybrid of treated states. The dependent variable graph loses almost all meaning, and the effects graph must be interpreted as an average effect rather than the effect on any given state. P-value is interpreted the same as above. W and V matrices are no longer meaningful, nor are synthetic matching variables. I begin with multiple treated states, but soon move to a single treated state to better understand and display the results.

Marijuana Tourism in Washington and Colorado

This analysis begins with a simple model, showing the hypothesized effect, and proceeds by adding levels of complication to understand the mechanics of the results and to test for robustness. It will be shown that, after complications to the model, the result is not robust and perhaps not even present. The first model, allowing both Colorado and Washington to serve as treatment states and based simply on 3 lags of the dependent variable from 2008, 2010, and 2012, shows the hypothesized positive effect, with a 2016 p-value of 0.216 . Figure 4 shows the average cumulated effect of Colorado and Washington. Despite seeming to confirm the hypothesis of positive marginal effect, there are signs of trouble. The p-value indicates that effects of the same or greater magnitude appear in 21.6% of donor states when a placebo test is performed. Additionally, there appears to be a negative effect prior to 2008. If the hypothesis is to be confirmed, one would expect to see an effect at or near zero for the entire pre-treatment period, but this is only observed post-2008.

Figure 4: Cumulated effects of treatment on tourism revenues 2005-2016, average result of Colorado and Washington, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment



Three robustness tests suggest themselves: truncation of the data pre-2008 and disaggregation of the effects in Colorado and Washington; introduction of explanatory control variables; and substitution of other tourism indicators for the dependent variable. Accomplishing the first robustness test, data truncation and disaggregation of results, produces the results displayed in Figures 5-10

Colorado's actual and synthetic tourism revenues are shown in Figure 5. Colorado's 2016 p-value is 0.978, indicating that 97.8% of donor states experience an effect at least as large in a placebo test. The displayed effects lose significance and no longer display a consistent sign in the treatment period, as can be seen in Figure 6.

Figure 5: Synthetic and actual tourism revenues for Colorado 2008-2016, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment

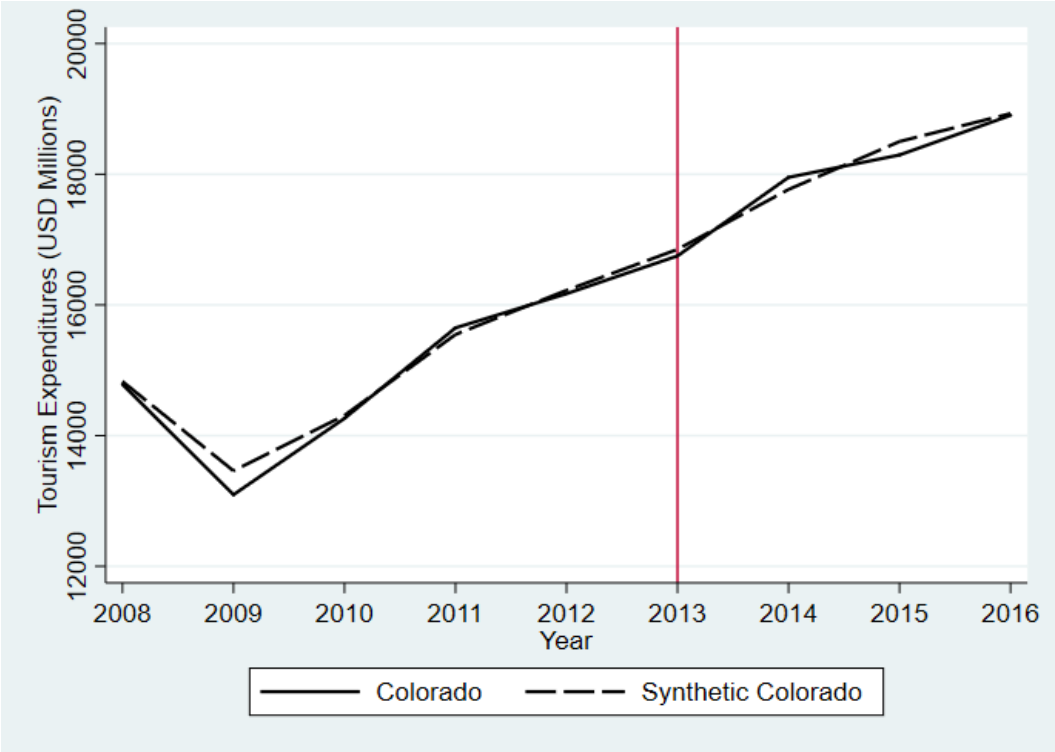
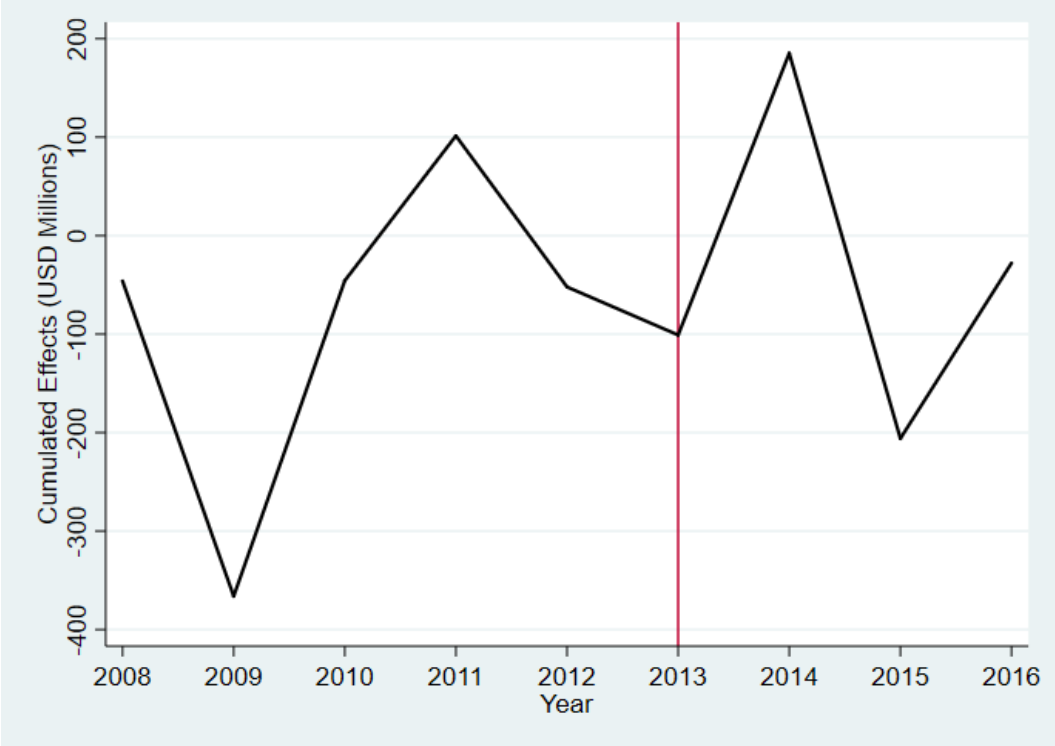


Figure 6: Cumulated effects of treatment on Colorado tourism revenues 2008-2016, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment



Examining the W-matrix for Colorado, presented in Figure 7, reveals which states are weighted heavily in the synthetic control. This is the heart of SCM Analysis; Colorado should be compared to its most relevant and similar peers. With 45 donor states, an equally weighted average would assign each state a weight of 0.022. In this case, the largest contributors to the synthetic Colorado are West Virginina and New Hampshire. Among the remaining states, some are weighted more heavily and others less heavily than in an equally weighted average.

Figure 7: State weights above 0.2 for synthetic Colorado, SCM expenditures 2008-2016, based on 3 lags of the dependent variable, no controls included

State	Weight
West Virginia	0.148
New Hampshire	0.114
Florida	0.037
Illinois	0.032
Nevada	0.032
Missouri	0.022
Ohio	0.022
New York	0.021
Pennsylvania	0.021
Arizona	0.020
Louisiana	0.020
Michigan	0.020
New Jersey	0.020
Other States	0.474

Washington's disaggregated results are shown in Figures 8-10. It is clear that the effect is large and positive with pretreatment effects in the 0 range. Washington's 2016 p-value is 0.111. Only 11.1% of donor states displayed an effect of equal or greater magnitude. While this p-value seems large, the small sample size available limits the significance of this result. In appendix B, I carry out a simple prediction exercise to understand how p-values respond to more years of data. Washington's result sheds some light on the results displayed in Figure 4. Washington seems to drive the positive effect with Colorado acting effectively as a damper in the averaged result.

Figure 8: Synthetic and actual tourism revenues for Washington 2008-2016, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment

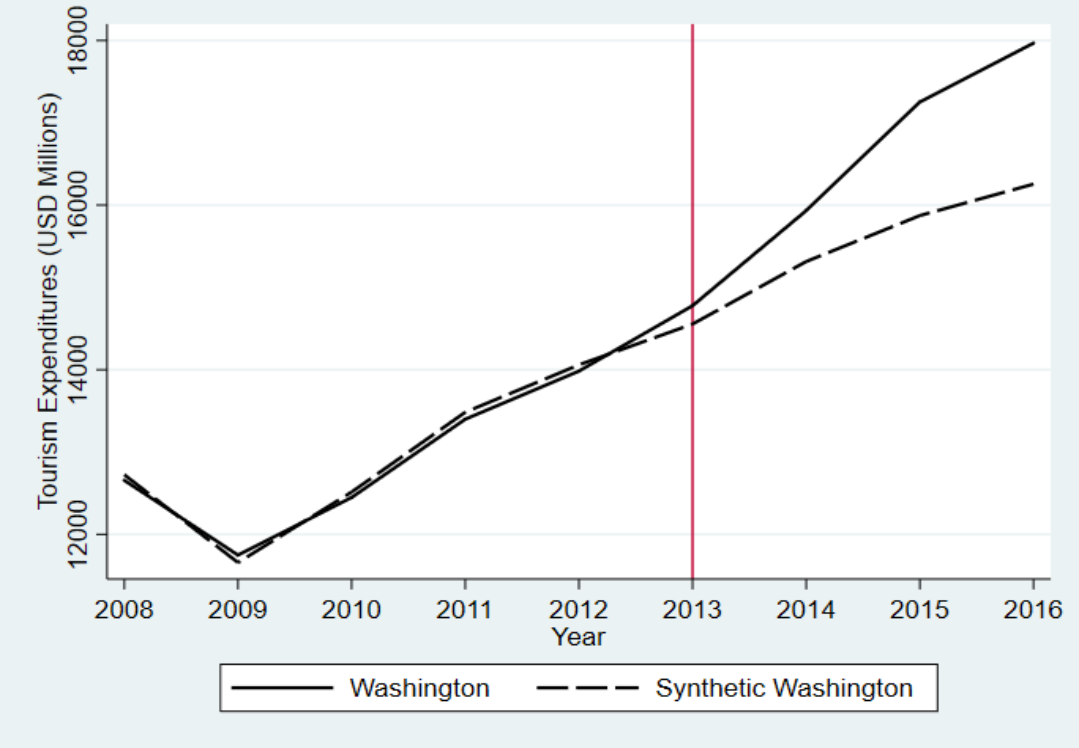


Figure 9: Cumulated effects of treatment on Washington tourism revenues 2008-2016, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment

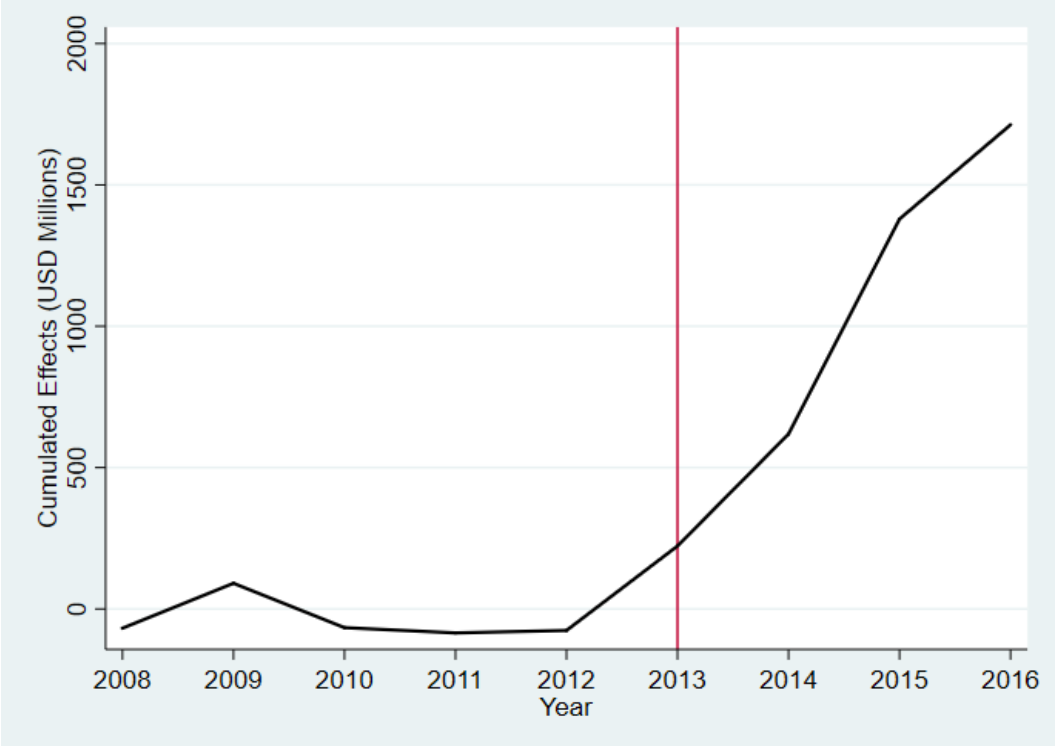


Figure 10: State weights above 0.2 for synthetic Washington, SCM expenditures 2008-2016, based on 3 lags of the dependent variable, no controls included

State	Weight
Maryland	0.052
Maine	0.030
Mississippi	0.030
South Dakota	0.030
Wisconsin	0.030
Vermont	0.029
Alabama	0.028
Minnesota	0.027
Delaware	0.026
North Dakota	0.026
Arkansas	0.025
Kentucky	0.025
Connecticut	0.024
Indiana	0.024
Iowa	0.024
Oklahoma	0.024
Montana	0.023
Wyoming	0.023
Nebraska	0.022
New Mexico	0.022
Idaho	0.021
Louisiana	0.021
South Carolina	0.021
Utah	0.021
Arizona	0.020
Georgia	0.020
Kansas	0.020
Massachusetts	0.020
Michigan	0.020
Missouri	0.020
North Carolina	0.020
Other States	0.234

Examining Washington's W-matrix, presented in Figure 10 shows that synthetic Washington is composed with more equal weighting among many states. Note that synthetic Washington is composed of different states and weights than synthetic Colorado. The key idea is that the treated states are compared to different benchmarks, which presumably best match

the state's trends. While Washington may not outperform the 48-state average, this analysis indicates that it does outperform its peer group as identified by the SCM methodology.

Figures 11-16 show the results of the third robustness test, the introduction of control variables. HPI, temperature anomaly, and precipitation anomaly are each averaged over the period 2011-2014, since these variables are assumed to have an effect over a shorter duration than blue migration. Blue migration is averaged over the entire pre-treatment period. Like the dependent variable, the matching variables are synthetically generated in the treatment period and weighted in the estimation of the synthetic dependent variable. Introduction of control variables shows Washington to have a more significant positive effect and Colorado to have a negative effect with a higher level of significance than previously. Washington's 2016 p-value is 0.089 and Colorado's is 0.511. Colorado is seen to have a more tenuous effect while Washington's positive effect persists.

Figure 11: Synthetic and actual tourism revenues for Colorado 2008-2016, based on 3 lags of the dependent variable and all controls, vertical line at first year of treatment

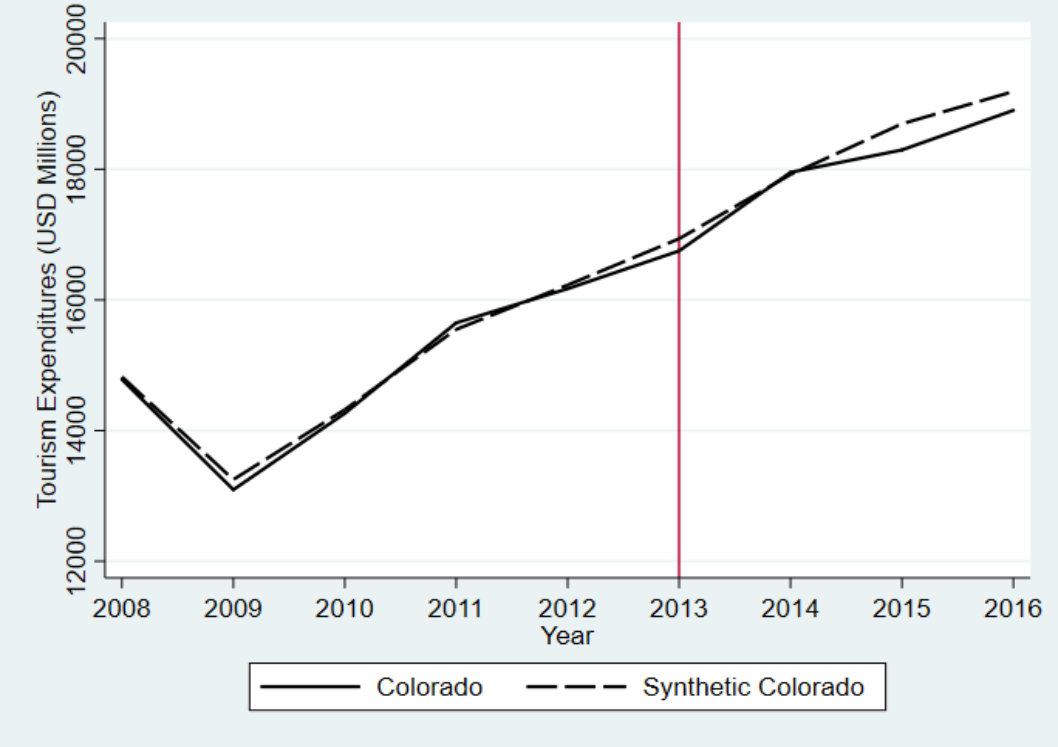


Figure 12: Cumulated effects of treatment on Colorado tourism revenues 2008-2016, based on 3 lags of the dependent variable and all controls, vertical line at first year of treatment

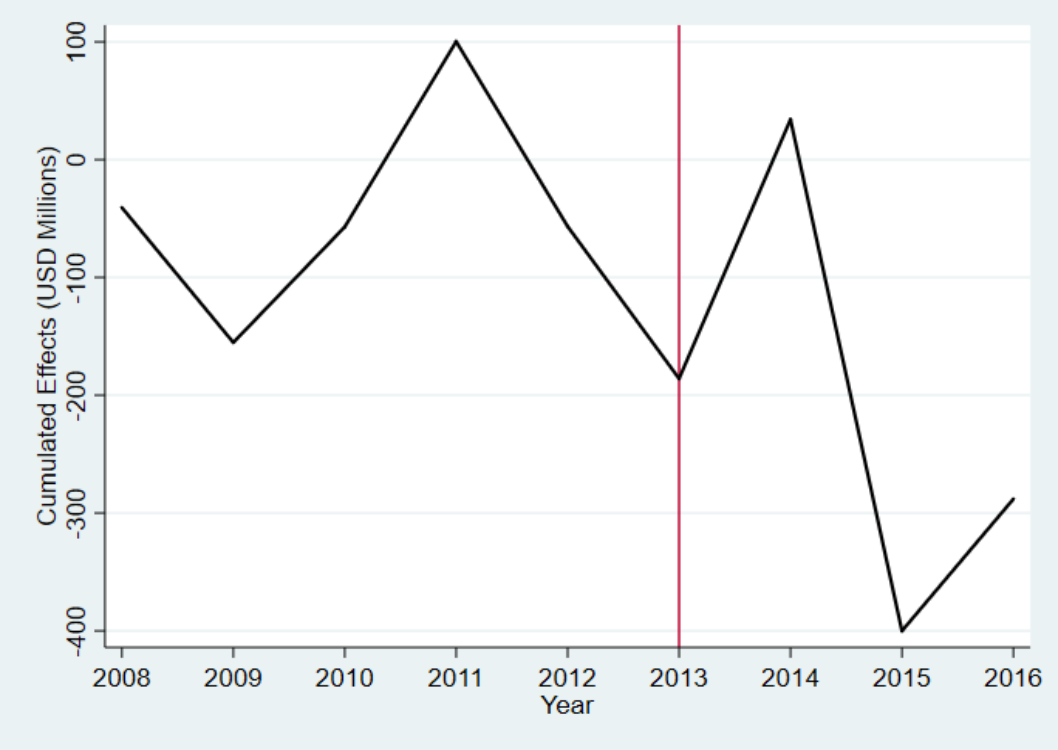


Figure 13: Synthetic and actual tourism revenues for Washington 2008-2016, based on 3 lags of the dependent variable and all controls, vertical line at first year of treatment

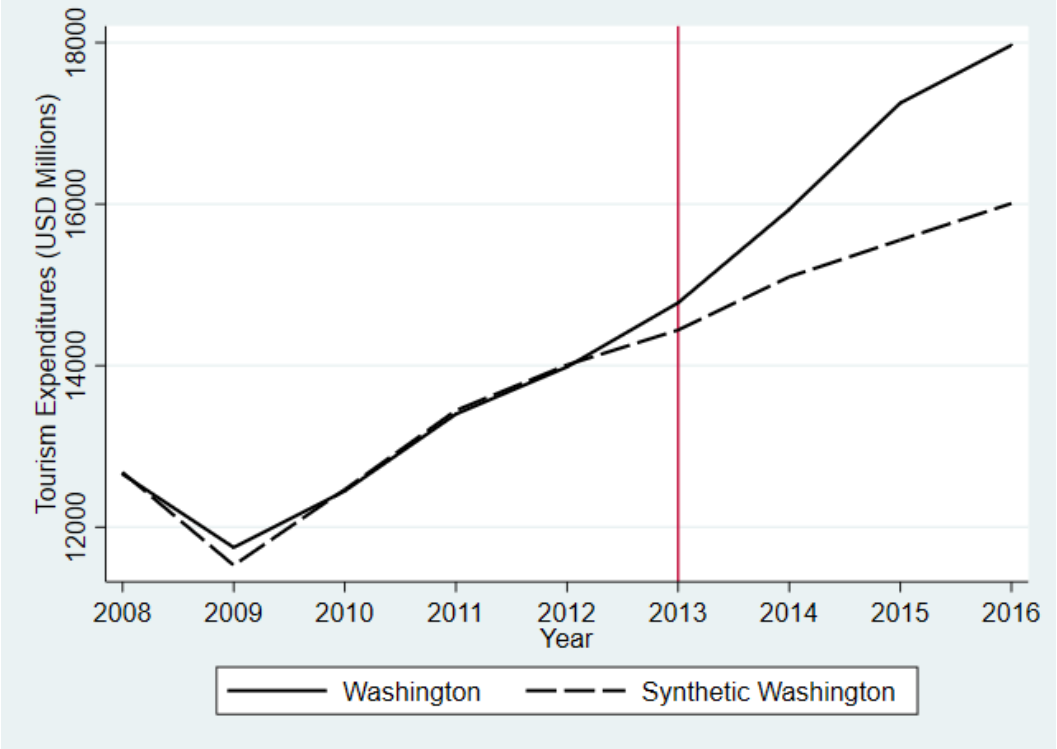
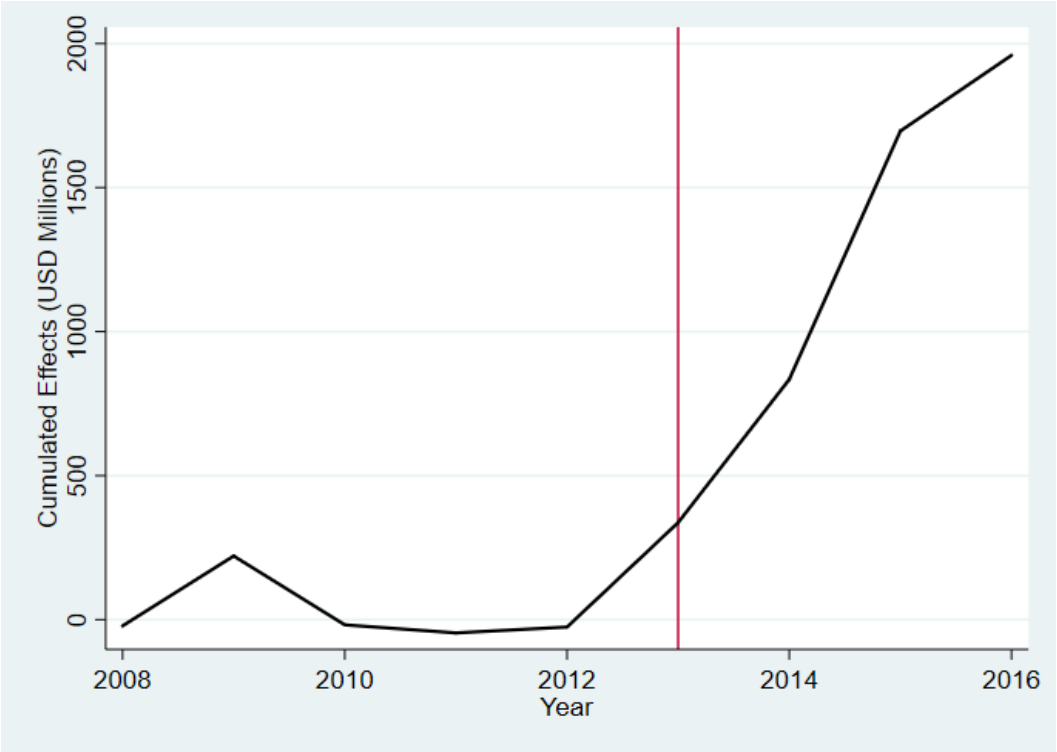


Figure 14: Cumulated effects of treatment on Washington tourism revenues 2008-2016, based on 3 lags of the dependent variable and all controls, vertical line at first year of treatment



Examining the V-matrices for each of these cases, presented in Figures 15 and 16, reveals that the control variables are weighted at very low levels compared to lags of the dependent variable. This indicates that these variables have low predictive power on the dependent variable. I leave these controls in place while accomplishing the final robustness test, since there is no strong reason to remove them. Although the weights of these variables are low, their weighting is determined by the SCM methodology to minimize pre-treatment RMSPE. In short, they improve the fit, if only minimally.

Figure 15: Matching variable weights for Colorado, SCM expenditures 2008-2016, based on 3 lags of the dependent variable and all controls

Matching Variable	Weight
HPI	0.000003
Tempanom	0.000001
Precipanom	0.000004
Bluemigration	0.000015
Expenditures(2008)	0.182
Expenditures(2010)	0.281
Expenditures(2012)	0.537

Figure 16: Matching variable weights for Washington, SCM expenditures 2008-2016, based on 3 lags of the dependent variable and all controls

Matching Variable	Weight
HPI	0.000006
Tempanom	0.000004
Precipanom	0.000004
Bluemigration	0.000012
Expenditures(2008)	0.179
Expenditures(2010)	0.282
Expenditures(2012)	0.539

The final robustness test shows that across all other indicators, both Washington and Colorado show weakly significant positive effects. I present analyses for total traveler-generated taxes, tourism industry employment, and tourism industry payroll in appendix A. For each indicator, Washington has a more significant effect of greater magnitude than that of Colorado. Overall p-values for Colorado are lower than those associated with expenditures, and p-values for Washington are higher than those associated with expenditures. This additional information indicates that the effects in both states are tenuous at best. Overall, however, the results clearly indicate that, if marijuana is attracting additional tourist activity, it is occurring to a greater degree in Washington than in Colorado.

Additional results are reported in appendices A and B. I encourage the reader to examine these appendices for further detail on this analysis.

Conclusions

Overall the results of my analysis show that there is a tenuous positive result present in both states, but it is clear that Washington shows more significant effects of greater magnitude. The obvious question is to what one might attribute the difference between the two states. Ultimately, further research will be necessary to answer this question, but I will explore some possibilities. In this section I also compare my results with other results and offer policy recommendations for Colorado.

Differences in Washington and Colorado

There are no discernable, material differences in the legal frameworks of Colorado and Washington that might affect marijuana tourists. Timing of legalization, if it matters, would seem to favor Colorado, since it was the first to receive the treatment of interest, inconsistent with my results. I address the possible effects of marketing initiatives in the Limitations and Further Research section, but I do not observe material differences between the states, and do not suspect that these initiatives play a role.

The difference between the states may be attributable to the different types of travelers to each state. A traveler to Colorado is likely drawn to outdoor recreation activities and mountain resort towns. Denver seems to serve mostly as a hub for arrivals and departures. One might call Colorado travelers, "mountain destination travelers." In contrast, travelers to Washington are likely often drawn to Seattle. One might call these travelers, "urban travelers."

The possible effect at play is that on the margin, the legal status of marijuana affects urban traveler's decisions to a greater degree than mountain destination traveler's decisions.[4] A

[4] Imagine a mountain destination traveler choosing between Vail, CO; Jackson Hole, WY; Whistler Blackcomb, BC; and Heavenly, CA. Imagine an urban traveler choosing between Seattle, WA; Boston, MA; Austin, TX; and San Francisco, CA.

mountain destination traveler choosing between mountain destinations might most heavily consider factors like snow, ease of travel, or variety of outdoor recreation. These factors are unaffected by marijuana legalization, so access to legal marijuana may be a bonus for these travelers, but not a purchasing decision. An urban traveler faces largely similar options and the ability to consume marijuana may become a purchasing decision. The hypothesis I posit is that marijuana differentiates urban travel destinations more so than it differentiates travel destinations with other major draws (skiing, beach, golf, etc). Further research would be needed to confirm this hypothesis, but it seems to present an intuitive explanation for the differences I observe.

Reconciling with Other Results

It remains that there is a large popular media representation for an effect that my results indicate is tenuous at best. The sources I discuss in the Marijuana Tourism: A Hot Topic with Limited Study section indicate that successful marijuana tour operators exist in Colorado. The existence of these operations only indicates that *some* tourists are traveling to Colorado at least partially to consume marijuana. The fact that I observe a negligible effect on expenditures in Colorado indicates certain potential spending patterns. Marijuana related activities may be a substitute for other tourist activities: instead of spending a day at a museum, a tourist might choose to go on a marijuana tour. Marijuana may have equal positive and negative effects: the same number of travelers are encouraged as discouraged by marijuana. There may be fewer travelers with higher spending: some travelers are motivated by marijuana and spend more on their vacations, but this additional spending is offset by travelers who are discouraged by marijuana. Lastly, marijuana, being a psychoactive drug, may have a direct effect on tourists'

ability or motivation to engage in additional activities and spending.[5] Disaggregation of expenditures could begin to get at which, if any, of these patterns is occurring, but given the data available, I can only present these many possible patterns.

In July 2014, the Colorado Department of Revenue published a report estimating that approximately 90% of demand for marijuana in heavily-visited, mountain-destination communities came from out of state visitors (Light, Orens, Lewandowski, & Pickton, 2014). Additionally, rises in marijuana sales upon legalization in these communities were several times greater than in Denver, indicating that tourists were very interested in purchasing marijuana. The results of that study seem counter to the findings of this study. However, as mentioned above, an effect in marijuana demand but not in tourism expenditures can be explained away through certain potential tourist spending patterns. Ultimately, further study will be required to link the results of that study to the results of this study.

Policy Implications and Possibilities

Lastly I want to turn to potential policy implications for Colorado and Washington. Generally there seem to be few, if any policy implications for Washington. The state appears to be reaping the benefits of marijuana tourism across the board. The same cannot be said for Colorado, which was the true first mover, but does not seem to be reaping the rewards, at least to the same extent. It looks as though Colorado may have missed an opportunity, but it may not be too late to rectify the relevant policies. It is perhaps helpful to return to the four major motivations for marijuana tourism: curiosity, recreation, authenticity, and drug smuggling (Belhassen, Santos, & Uriely, 2007). If Colorado could encourage marijuana tourists with these motivations, the state might be able to turn the tables on what appears to be a stagnating new

[5] There is no academic way to say that tourists might get too intoxicated to leave their hotel rooms (decreasing spending) or conversely get intoxicated and order a family size dinner for one (increasing spending).

tourism market segment. One of the four motivations must be thrown out from the list, drug smuggling. While there is strong evidence that a number of visitors from nearby states visit Colorado communities close to the border for the purpose of carrying marijuana across state lines, the state cannot support this activity. However, it may be discovered that these visitors could be switched to other classes of motivation if presented with the right opportunities.

The first motivation, curiosity, refers to inexperienced marijuana users who are wishing to try the drug in a safe and legal environment. Colorado has already taken some steps towards attracting these marijuana tourists. The state imposed limits on the maximum THC permissible in a single serving of edible marijuana product, so that dosing is easier for inexperienced users. Many dispensaries pride themselves on their friendly and knowledgeable bud-tenders, who are willing and able to help novices navigate the unfamiliar terrain of marijuana purchase and consumption. Perhaps the biggest hurdle for these tourists is the location of consumption of marijuana, especially if they choose to smoke. Colorado, with good reason, does not allow public marijuana smoking, similar to tobacco smoking bans or open container laws. The state has proposed the idea of marijuana clubs which do not sell marijuana, but provide a space where one could bring their own marijuana and consume in a semi-public setting. If Colorado allowed such, a hotel or a nearby bar could be suitable locations for consumption, allowing tourists to navigate the legal framework more easily.

The second motivation, recreation, refers to tourists who likely have experience with marijuana and consider it part of a pleasure-seeking vacation. Increasing the ease of use in adult only spaces seems an easy and logical way of encouraging these marijuana tourists. Allowing consumption in bars or at select events like concerts or festivals might sway these tourists to visit the state. For these tourists marijuana is a complement to other standard tourist activities.

The last motivation, authenticity, is where I feel the state has the largest potential to position itself uniquely and competitively. Colorado has the potential to join Amsterdam as a global marijuana destination. Colorado already has some of the highest quality marijuana with a well-developed market, but they do not yet have a full system in place to capitalize on the potential tourism boost. A first general step for the state is to own the decision to become a marijuana capital. The state might recognize major marijuana landmarks, like its first dispensaries, or offer locations to learn about the plant and its safe use. It could encourage events like the 2018 World Cannabis Week. April 20th has the potential to be a known local festival like New Orleans' Mardi Gras or New York's Thanksgiving Day Parade. The second step is to make use easy, enjoyable, and safe. The draw of Amsterdam is approximately 250 different shops in the city that allow visitors to purchase and consume marijuana on their premises. Colorado should heavily consider allowing purchase and consumption in the same location, even if only in select portions of the state like Denver and Boulder. Colorado should push to establish itself early as a marijuana destination while it has a head start on legalization, so that its reputation will persist as more states decide to legalize.

Above and beyond attracting only tourists of the authenticity motivation, this reputational positioning could encourage tourists of the other motivations. If Colorado is the most authentic place to consume marijuana it is likely also a good place to try it, or a good place to consume it with other standard vacation activities. Even those whose original motivation was drug smuggling might be convinced to stay if their marijuana experience was substantially better in Colorado than their neighboring home state.

Limitations and Further Research

This study has a number of potential limitations, as would be expected given its position as the forerunner in the quantitative analysis of marijuana tourism. A number of interesting areas of inquiry present themselves as extensions to this study. I suggest a few possible lines of inquiry, but I encourage the reader to see Kang, O'Leary, & Miller (2016) for a full research agenda.

Some limitations stem from the data provided by the USTA. While the USTA presents a number of indicators, it does not provide information on estimation techniques. As mentioned in the data section, as long as the assumption that estimation technique is consistent across states holds, then my results are meaningful. There may be unknowable and unforeseeable complications due to this lack of information on estimation, but there are several foreseeable complications. First, it is unclear if direct spending on marijuana is captured in tourist expenditures or tax data. The inclusion or exclusion of these specific expenditures is not important for the validity, significance, and sign of the results, but would affect their magnitude and interpretation. If marijuana expenditures are not included, then the effects indicate tourism impact above and beyond spending on marijuana. If they are included, then the results indicate overall tourism impact. Related to this point, my USTA dataset does not disaggregate types of tourist spending. One cannot assume that marijuana tourist expenditures look like those of standard tourists. If a tourist knows that they wish to smoke while on vacation, they might choose different accommodations or modes of transportation. Additionally, the consumption of marijuana and the drug's psychoactive effects might actually influence the types and amount of spending by marijuana tourists. It is unclear if the dataset captures all components of marijuana tourist spending, and it does not allow for any analysis of how marijuana tourist spending is different than standard tourist spending. Finally, an important data point is missing from the

data set, tourist numbers. For a better understanding of the effects of legalization, it would be helpful to know whether marijuana had caused more or fewer visits to each state.

This study also has some standard statistical shortcomings, namely a limited amount of data and the ever-present possibility of endogeneity and omitted variable bias. My data is limited in that there are only 45 donor states, but no other entities exist that could reasonably be included in the panel. Additionally, there are only 3 years of data available post legalization. My dataset is limited in both the size of the panel (number of states) and in the number of panels (years). Due to these unavoidable limitations, the significance of my results is not easily determined. A repeat of this study in several years might yield more definitive results (see Appendix B for an exploration of significance). On the topics of endogeneity and omitted variable bias, I do not have strong reason to believe that these complications are present in my analysis, but their presence is always a possibility. A possible critique is that both Colorado and Washington are engaged in long term tourism marketing initiatives, but their timing does not match the effects I observe, and the initiatives do not seem materially different or particularly more successful than other similar initiatives. It is possible that a different endogenous factor drives both a state's propensity to legalize recreational marijuana and is a major determinant of tourism revenues, but I do not suspect this to be the case. Measurement error in the USTA's dataset is also a possible source of endogeneity, but I do not have detailed estimation information. Overall, I feel that these potential statistical shortcomings do not affect this study in a serious way.

I have already hinted at possible avenues for further study, but I would like to outline several more formally. The first and most obvious is the repetition of this study given more years of data post-treatment. Significance would be more easily determined, but it would also show whether the effects persist through the legalizations of more states. A potential remedy to the issue of a limited panel is to examine smaller regions than states, like counties or specific

tourist destinations. The Colorado Department of Revenue publishes excellent marijuana-specific data on revenues, taxes, medical card holders, and dispensaries that captures these local geographic levels[6]. Paired with tourist data for the same geographic levels, the foundations for an illuminating analysis are present.

Another issue left unexamined in my study is marijuana tourist motivations and spending profiles. Disaggregation of expenditures by type begins to get at these factors, and it seems that the USTA does offer data with this kind of breakdown. However, these factors are likely best examined through survey data. The Colorado Tourism Office seems to collect the kind of survey data necessary for this analysis, but does not publish its full results.

I hope for this study to function as a timely forerunner in the field of marijuana tourism, but more research is necessary to understand how the marijuana tourism market functions. If already legalized states wish to make policy decisions regarding marijuana tourism, they must do so quickly, since the tide of legalization is turning. Colorado and Washington may have the opportunity to establish themselves as marijuana tourist destinations, but their unique position is rapidly eroding.

[6] An original research design for this study utilized this data, and I would love to see the results of analyses with this data

Appendix A

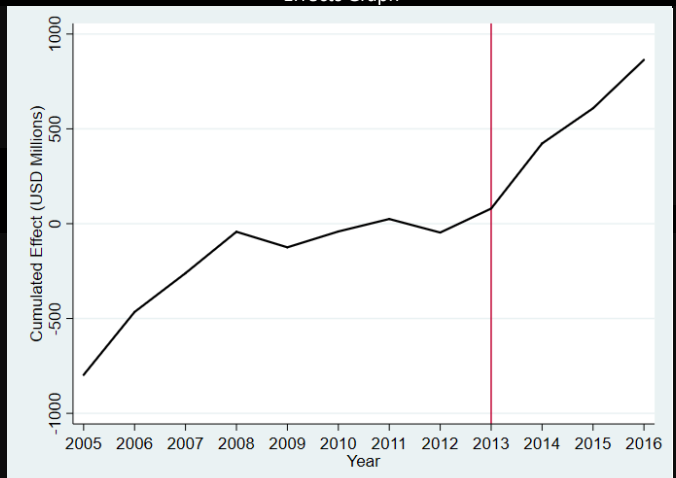
Regression Info

Dependent Variable:	Expenditures
Timeframe:	2005-2016
Treated States:	Colorado & Washington
Matching Variables:	Expenditures (2008, 2010, 2012)

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	422.87	0.335	0.314
2015	608.33	0.297	0.227
2016	863.96	0.216	0.144

Effects Graph



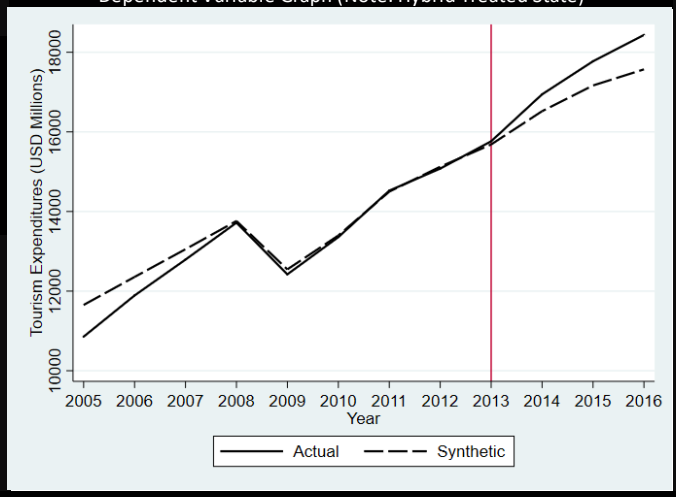
W-Matrix State Weights (5 Largest)

State	Weight
NA	NA

Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	10855.15	11652.44
2006	11890.25	12355.808
2007	12791.7	13052.602
2008	13719.65	13762.19
2009	12421.95	12546.61
2010	13355.80	13397.01
2011	14523.80	14499.07
2012	15077.40	15124.17
2013	15763.80	15684.05
2014	16942.50	16519.63
2015	17773.55	17165.22
2016	18434.25	17570.29

Dependent Variable Graph (Note: Hybrid Treated State)



V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	NA
Tempanom	NA
Precipanom	NA
Bluemigration	NA
Depvar(2008)	NA
Depvar(2010)	NA
Depvar(2012)	NA

Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	NA	NA	NA	NA	NA
Tempanom	NA	NA	NA	NA	NA
Precipanom	NA	NA	NA	NA	NA
Bluemigration	NA	NA	NA	NA	NA
Depvar(2008)	NA	NA	NA	NA	NA
Depvar(2010)	NA	NA	NA	NA	NA
Depvar(2012)	NA	NA	NA	NA	NA

Appendix A

Regression Info

Dependent Variable:	Expenditures
Timeframe:	2008-2016
Treated States:	Colorado
Matching Variables:	Expenditures (2008, 2010, 2012)

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	185.09	0.533	0.711
2015	-205.97	0.578	0.756
2016	-27.90	0.978	1.000

W-Matrix State Weights (5 Largest)

State	Weight
West Virginia	0.148
New Hampshire	0.114
Florida	0.037
Illinois	0.032
Nevada	0.032
Other States	0.640

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	NA
Tempanom	NA
Precipanom	NA
Bluemigration	NA
Depvar(2008)	0.174
Depvar(2010)	0.288
Depvar(2012)	0.538

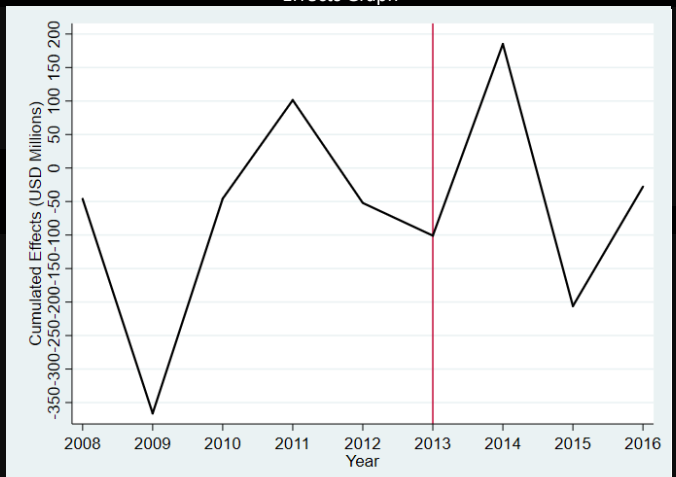
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	14783.10	14829.23
2009	13095.70	13461.80
2010	14263.60	14309.30
2011	15648.70	15547.34
2012	16171.70	16223.82
2013	16749.80	16850.70
2014	17952.10	17767.01
2015	18294.80	18500.77
2016	18900.90	18928.80

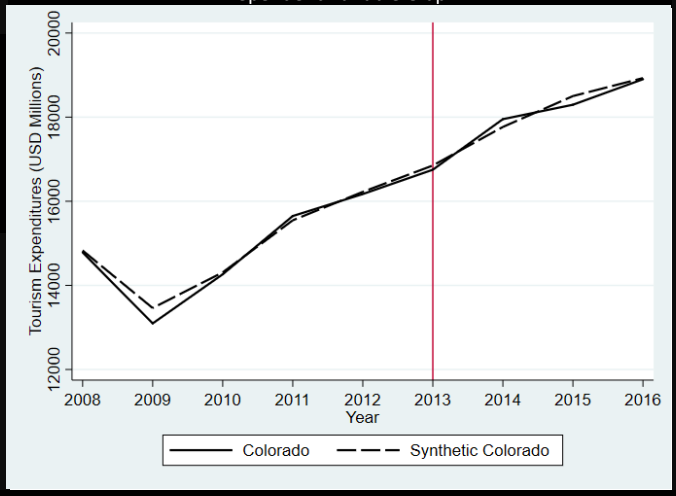
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	NA	NA	NA	NA	NA
Tempanom	NA	NA	NA	NA	NA
Precipanom	NA	NA	NA	NA	NA
Bluemigration	NA	NA	NA	NA	NA
Depvar(2008)	15388.97	14783.10	14829.23	NA	NA
Depvar(2010)	15051.88	14263.60	14309.30	NA	NA
Depvar(2012)	16984.49	16171.70	16223.82	NA	NA

Effects Graph



Dependent Variable Graph



Appendix A

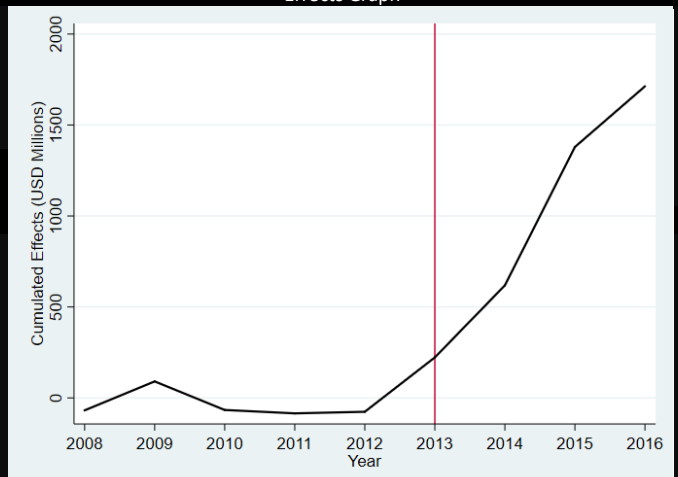
Regression Info

Dependent Variable:	Expenditures
Timeframe:	2008-2016
Treated States:	Washington
Matching Variables:	Expenditures (2008, 2010, 2012)

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	618.64	0.222	0.156
2015	1379.37	0.156	0.044
2016	1712.54	0.111	0.044

Effects Graph



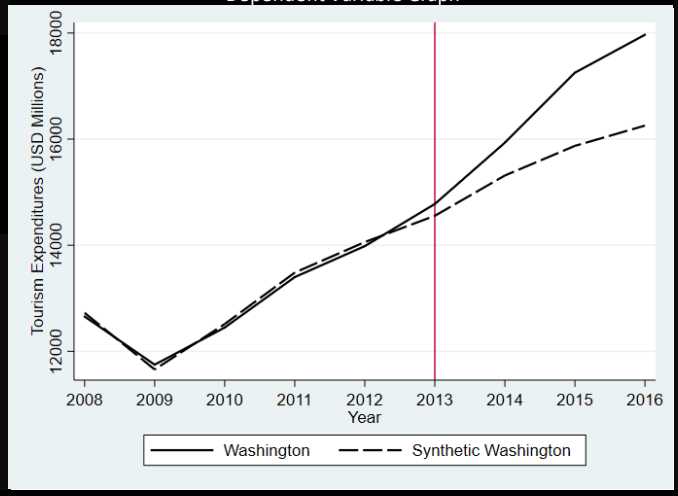
W-Matrix State Weights (5 Largest)

State	Weight
Maryland	0.052
Maine	0.030
Mississippi	0.030
South Dakota	0.030
Wisconsin	0.030
Other States	0.830

Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	12656.20	12724.48
2009	11748.20	11657.45
2010	12448.00	12514.18
2011	13398.90	13483.63
2012	13983.10	14059.19
2013	14777.80	14555.15
2014	15932.90	15314.26
2015	17252.30	15872.94
2016	17967.60	16255.06

Dependent Variable Graph



V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	NA
Tempanom	NA
Precipanom	NA
Bluemigration	NA
Depvar(2008)	0.174
Depvar(2010)	0.287
Depvar(2012)	0.538

Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	NA	NA	NA	NA	NA
Tempanom	NA	NA	NA	NA	NA
Precipanom	NA	NA	NA	NA	NA
Bluemigration	NA	NA	NA	NA	NA
Depvar(2008)	15388.97	NA	NA	12656.20	12724.48
Depvar(2010)	15051.88	NA	NA	12448.00	12514.18
Depvar(2012)	16984.49	NA	NA	13983.10	14059.19

Appendix A

Regression Info

Dependent Variable:	Expenditures
Timeframe:	2008-2016
Treated States:	Colorado
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Expenditures (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Wyoming	0.677
Nevada	0.153
Rhode Island	0.089
California	0.080
New Jersey	0.002

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000006
Tempanom	0.000004
Precipanom	0.000004
Bluemigration	0.000012
Depvar(2008)	0.179
Depvar(2010)	0.282
Depvar(2012)	0.539

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	34.05	0.844	0.844
2015	-400.06	0.378	0.378
2016	-288.11	0.511	0.556

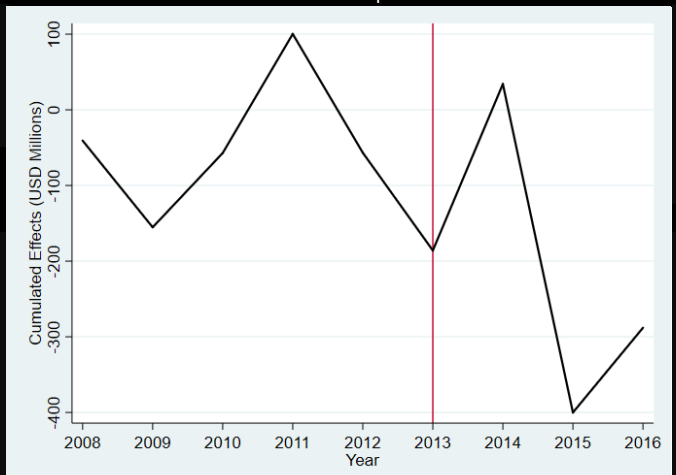
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	14783.10	14823.79
2009	13095.70	13250.94
2010	14263.60	14320.69
2011	15648.70	15548.45
2012	16171.70	16228.43
2013	16749.80	16935.72
2014	17952.10	17918.06
2015	18294.80	18694.86
2016	18900.90	19189.01

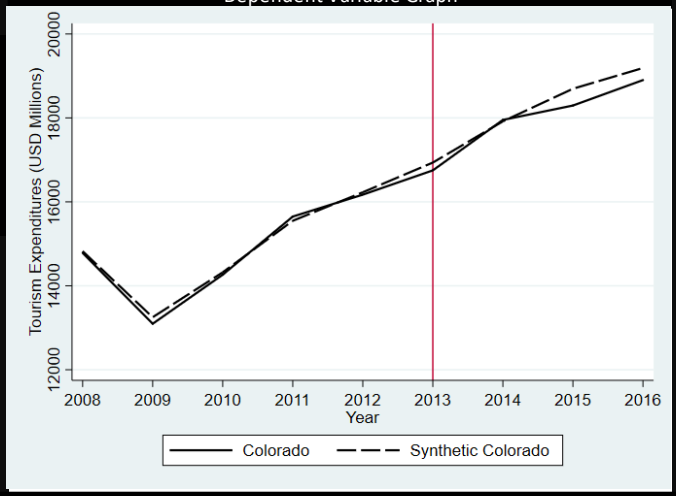
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	553.27	524.11	NA	NA
Tempanom	1.29	1.26	1.25	NA	NA
Precipanom	0.19	-0.08	0.01	NA	NA
Bluemigration	22801.70	221935.20	156683.40	NA	NA
Depvar(2008)	15388.97	14783.10	14823.79	NA	NA
Depvar(2010)	15051.88	14263.60	14320.69	NA	NA
Depvar(2012)	16984.49	16171.70	16228.43	NA	NA

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Expenditures
Timeframe:	2008-2016
Treated States:	Washington
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Expenditures (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Montana	0.582
New Jersey	0.225
Wisconsin	0.092
Maryland	0.051
California	0.050

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000003
Tempanom	0.000001
Precipanom	0.000004
Bluemigration	0.000015
Depvar(2008)	0.182
Depvar(2010)	0.281
Depvar(2012)	0.537

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	833.96	0.156	0.222
2015	1696.29	0.089	0.044
2016	1959.01	0.089	0.067

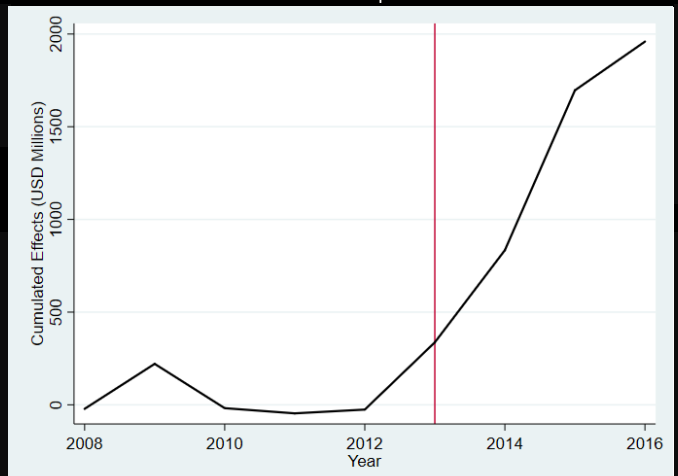
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	12656.20	12677.97
2009	11748.20	11527.31
2010	12448.00	12466.08
2011	13398.90	13444.98
2012	13983.10	14008.79
2013	14777.80	14440.88
2014	15932.90	15098.94
2015	17252.30	15556.01
2016	17967.60	16008.59

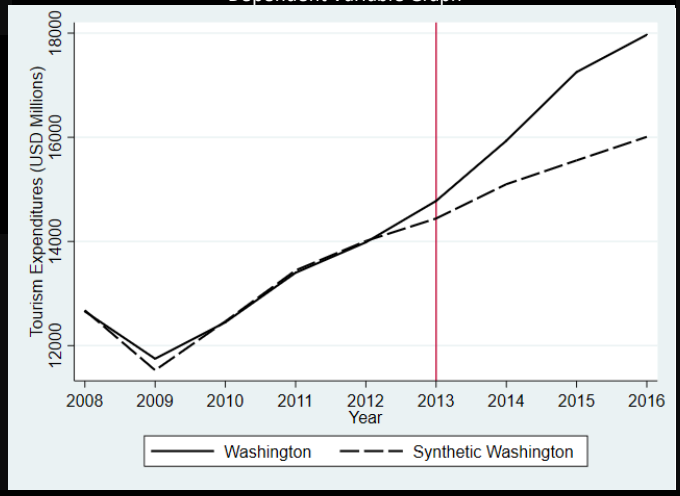
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	NA	NA	723.29	588.02
Tempanom	1.29	NA	NA	0.36	1.48
Precipanom	0.19	NA	NA	0.07	0.15
Bluemigration	22801.70	NA	NA	334878.70	171226.70
Depvar(2008)	15388.97	NA	NA	12656.20	12677.96
Depvar(2010)	15051.88	NA	NA	12448.00	12466.08
Depvar(2012)	16984.49	NA	NA	13983.10	14008.79

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Total Taxes
Timeframe:	2008-2016
Treated States:	Colorado
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Total Taxes (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Montana	0.363
New Mexico	0.233
Wyoming	0.131
Minnesota	0.127
California	0.116
New Jersey	0.031

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000018
Tempanom	0.000013
Precipanom	0.000001
Bluemigration	0.000001
Depvar(2008)	0.193
Depvar(2010)	0.322
Depvar(2012)	0.485

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	59.81	0.289	0.311
2015	92.25	0.400	0.422
2016	105.84	0.400	0.378

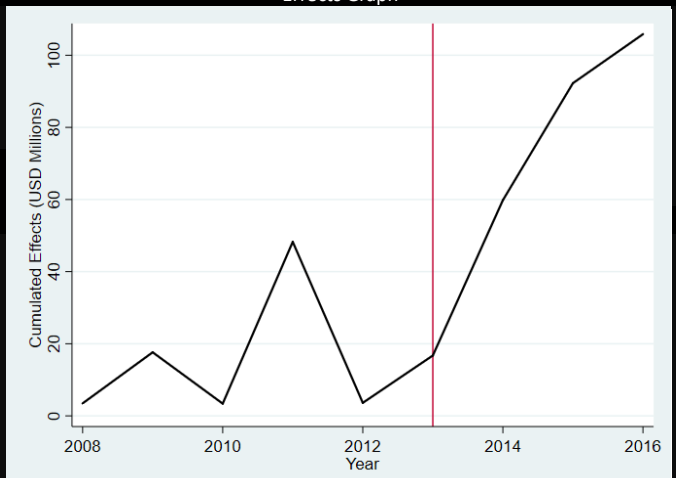
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	2598.30	2594.83
2009	2490.60	2472.97
2010	2581.60	2578.20
2011	2702.30	2654.05
2012	2767.80	2764.18
2013	2904.50	2887.76
2014	3138.70	3078.89
2015	3316.60	3224.35
2016	3512.20	3406.36

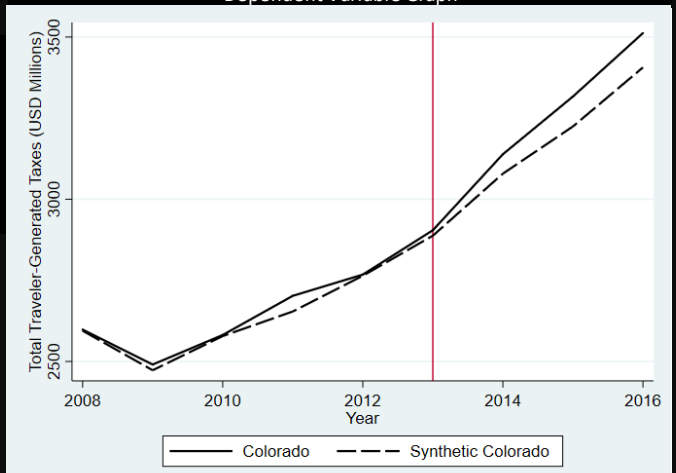
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	553.27	552.30	NA	NA
Tempanom	1.29	1.26	1.27	NA	NA
Precipanom	0.19	-0.08	0.00	NA	NA
Bluemigration	22801.70	221935.20	202346.50	NA	NA
Depvar(2008)	2383.23	2598.30	2594.83	NA	NA
Depvar(2010)	2379.14	2581.60	2578.20	NA	NA
Depvar(2012)	2577.35	2767.80	2764.19	NA	NA

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Total Taxes
Timeframe:	2008-2016
Treated States:	Washington
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Total Taxes (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Montana	0.710
Massachusetts	0.110
Minnesota	0.081
California	0.074
Maryland	0.025

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000008
Tempanom	0.000006
Precipanom	0.000001
Bluemigration	0.000003
Depvar(2008)	0.194
Depvar(2010)	0.322
Depvar(2012)	0.484

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	39.59	0.378	0.422
2015	109.29	0.356	0.289
2016	134.19	0.311	0.289

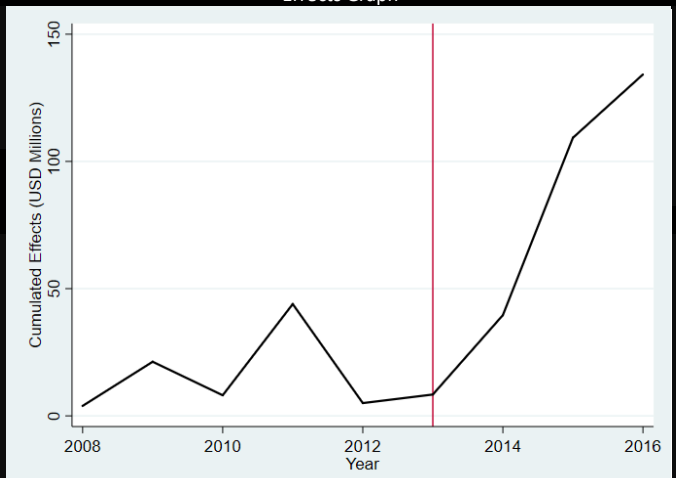
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	1929.00	1925.08
2009	1856.50	1835.23
2010	1934.40	1926.30
2011	2032.60	1988.65
2012	2079.40	2074.37
2013	2179.40	2171.01
2014	2355.60	2316.01
2015	2560.50	2451.21
2016	2726.30	2592.11

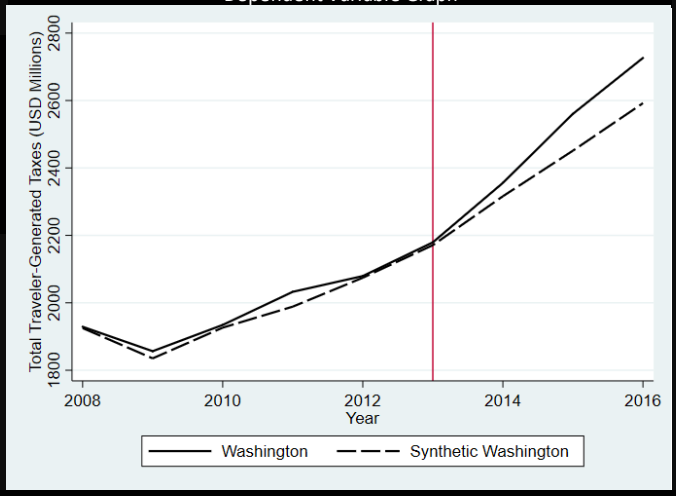
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	NA	NA	723.29	594.53
Tempanom	1.29	NA	NA	0.36	1.22
Precipanom	0.19	NA	NA	0.07	0.13
Bluemigration	22801.70	NA	NA	334878.70	159860.10
Depvar(2008)	2383.23	NA	NA	1929.00	1925.08
Depvar(2010)	2379.14	NA	NA	1934.40	1926.30
Depvar(2012)	2577.35	NA	NA	2079.40	2074.37

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Employment
Timeframe:	2008-2016
Treated States:	Colorado
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Employment (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Wyoming	0.555
New Mexico	0.205
California	0.130
Montana	0.075
Massachusetts	0.023
Utah	0.012

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000007
Tempanom	0.000001
Precipanom	0.000003
Bluemigration	0.000006
Depvar(2008)	0.279
Depvar(2010)	0.304
Depvar(2012)	0.417

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	859.61	0.489	0.156
2015	734.92	0.711	0.467
2016	1235.98	0.667	0.311

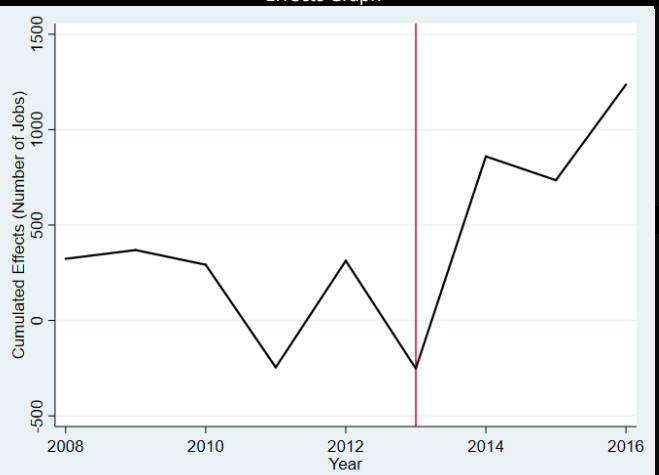
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	148570.00	148246.94
2009	140810.00	140441.07
2010	140060.00	139768.12
2011	141920.00	142165.68
2012	149450.00	149137.09
2013	154020.00	154271.95
2014	158940.00	158080.39
2015	164240.00	163505.08
2016	169130.00	167894.02

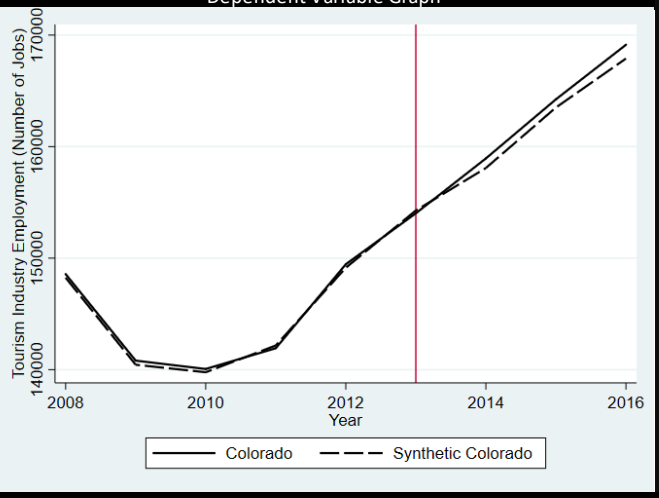
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	553.265	544.8973	NA	NA
Tempanom	1.29	1.261111	1.23008	NA	NA
Precipanom	0.19	-0.0780555	-0.0410038	NA	NA
Bluemigration	22801.70	221935.2	199136	NA	NA
Depvar(2008)	154386.40	148570	148246.9	NA	NA
Depvar(2010)	147281.60	140060	139768.1	NA	NA
Depvar(2012)	156814.70	149450	149137.1	NA	NA

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Employment
Timeframe:	2008-2016
Treated States:	Washington
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Employment (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Montana	0.455
Massachusetts	0.323
Utah	0.146
Virginia	0.038
California	0.039

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000005
Tempanom	0.000001
Precipanom	0.000004
Bluemigration	0.000004
Depvar(2008)	0.281
Depvar(2010)	0.304
Depvar(2012)	0.304

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	-95.32	0.978	0.978
2015	-573.98	0.800	0.778
2016	2231.31	0.533	0.311

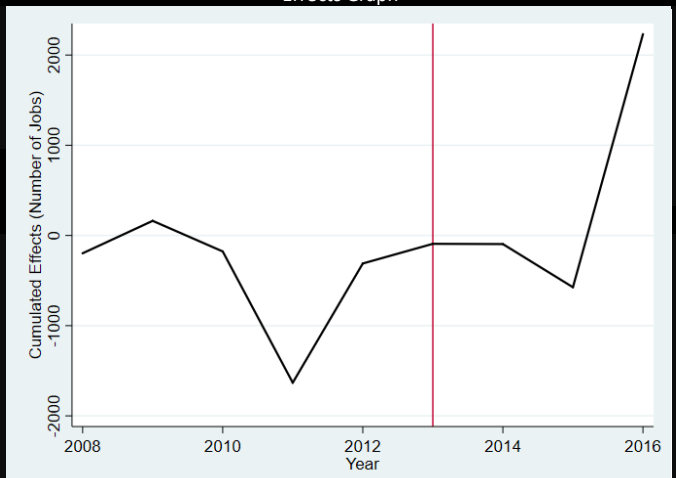
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	108500.00	108697.68
2009	103270.00	103107.95
2010	102510.00	102687.07
2011	103030.00	104662.25
2012	107890.00	108200.65
2013	111030.00	111122.61
2014	113700.00	113795.32
2015	118420.00	118993.98
2016	124750.00	122518.69

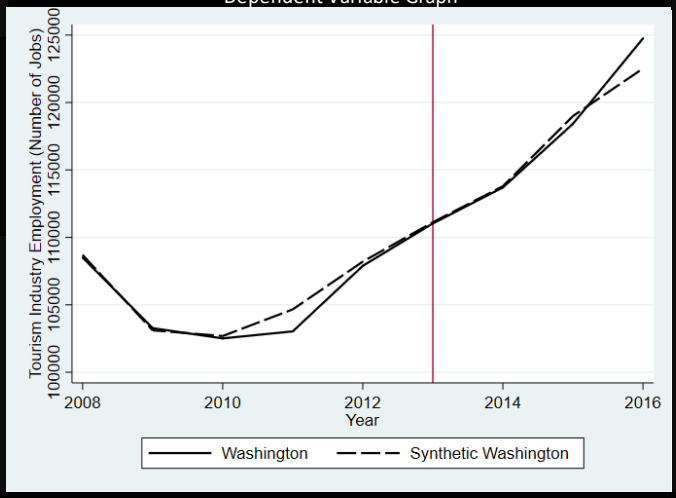
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	NA	NA	723.29	626.84
Tempanom	1.29	NA	NA	0.36	1.49
Precipanom	0.19	NA	NA	0.07	0.23
Bluemigration	22801.70	NA	NA	334878.70	146596.40
Depvar(2008)	154386.40	NA	NA	108500.00	108697.70
Depvar(2010)	147281.60	NA	NA	102510.00	102687.10
Depvar(2012)	156814.70	NA	NA	107890.00	108200.60

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Payroll
Timeframe:	2008-2016
Treated States:	Colorado
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Payroll (2008, 2010, 2012)

W-Matrix State Weights (5 Largest)

State	Weight
Wyoming	0.537
Virginia	0.153
California	0.089
Utah	0.074
Maryland	0.061
Other States	0.086

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000023
Tempanom	0.000020
Precipanom	0.000020
Bluemigration	0.000016
Depvar(2008)	0.254
Depvar(2010)	0.240
Depvar(2012)	0.506

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	107.74	0.333	0.067
2015	128.77	0.356	0.111
2016	84.30	0.400	0.267

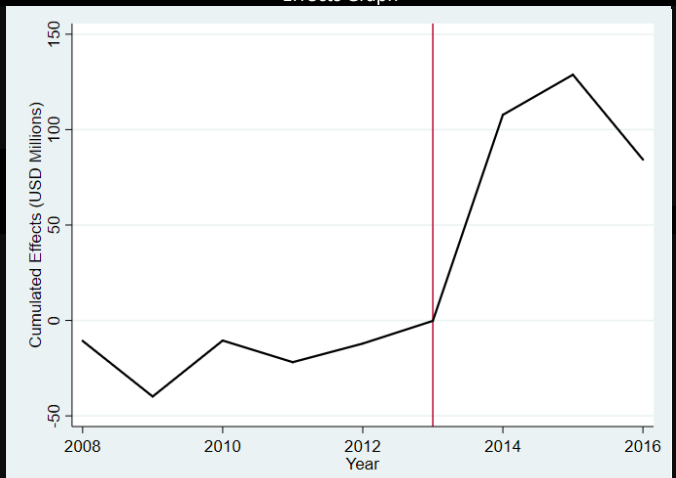
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	3598.30	3609.00
2009	3413.90	3453.76
2010	3590.70	3601.22
2011	3724.00	3745.86
2012	3934.80	3946.91
2013	4076.00	4076.23
2014	4464.80	4357.06
2015	4733.70	4604.93
2016	4969.90	4885.60

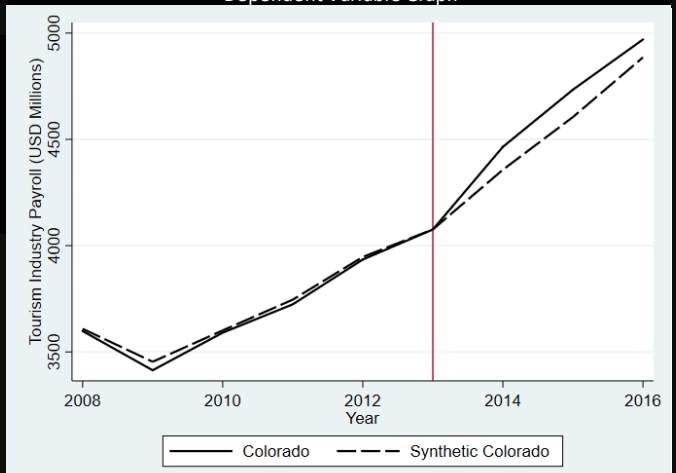
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	553.27	550.81	NA	NA
Tempanom	1.29	1.26	1.26	NA	NA
Precipanom	0.19	-0.08	0.05	NA	NA
Bluemigration	22801.70	221935.20	209056.90	NA	NA
Depvar(2008)	3842.95	3598.30	3609.00	NA	NA
Depvar(2010)	3802.13	3590.70	3601.22	NA	NA
Depvar(2012)	4162.49	3934.80	3946.91	NA	NA

Effects Graph



Dependent Variable Graph



Appendix A

Regression Info

Dependent Variable:	Payroll
Timeframe:	2008-2016
Treated States:	Washington
Matching Variables:	HPI, Tempanom, Precipanom, Bluemigration, Payroll (2008, 2010, 2012)

W-Matrix State Weights (All Donors)

State	Weight
Montana	0.694
Pennsylvania	0.096
Maryland	0.083
Virginia	0.073
California	0.054

V-Matrix Matching Variable Weights

Matching Variable	Weight
HPI	0.000009
Tempanom	0.000009
Precipanom	0.000009
Bluemigration	0.000019
Depvar(2008)	0.255
Depvar(2010)	0.241
Depvar(2012)	0.504

Treatment Period Effects

Year	Effect	P-val	P-val std
2014	94.32	0.333	0.044
2015	90.51	0.400	0.089
2016	194.88	0.333	0.022

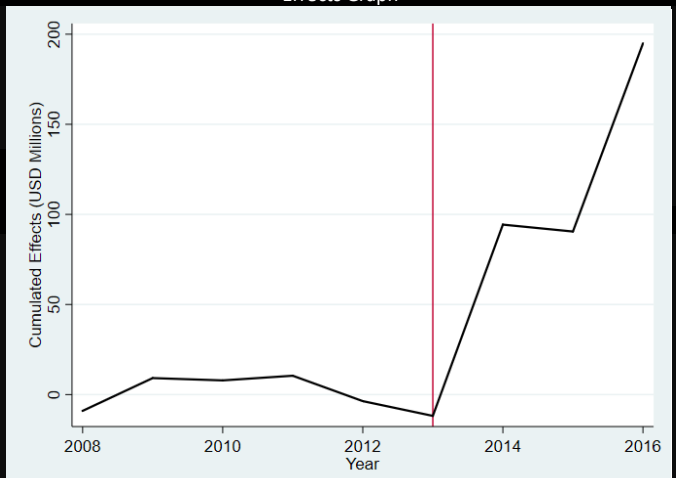
Dependent Variable: Actual & Synthetic

Year	Dependent Variable	
	Actual	Synthetic
2005	NA	NA
2006	NA	NA
2007	NA	NA
2008	2729.90	2738.93
2009	2656.20	2647.04
2010	2779.00	2771.12
2011	2894.50	2884.02
2012	3043.00	3046.63
2013	3118.90	3130.71
2014	3448.30	3353.98
2015	3620.10	3529.59
2016	3905.50	3710.62

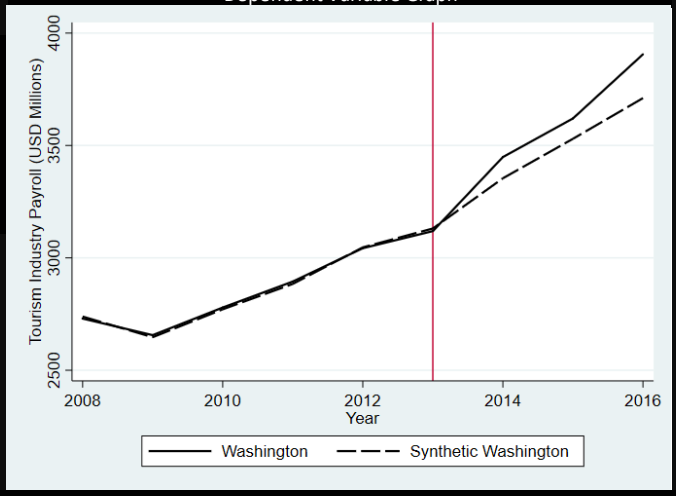
Matching Variables: Actual, Synthetic, and Donor Averages

Variable	Average of Control States	Colorado		Washington	
		Actual	Synthetic	Actual	Synthetic
HPI	449.95	NA	NA	723.29	565.62
Tempanom	1.29	NA	NA	0.36	1.16
Precipanom	0.19	NA	NA	0.07	0.12
Bluemigration	22801.70	NA	NA	334878.70	162755.00
Depvar(2008)	3842.95	NA	NA	2729.90	2738.93
Depvar(2010)	3802.13	NA	NA	2779.00	2771.12
Depvar(2012)	4162.49	NA	NA	3043.00	3046.63

Effects Graph



Dependent Variable Graph

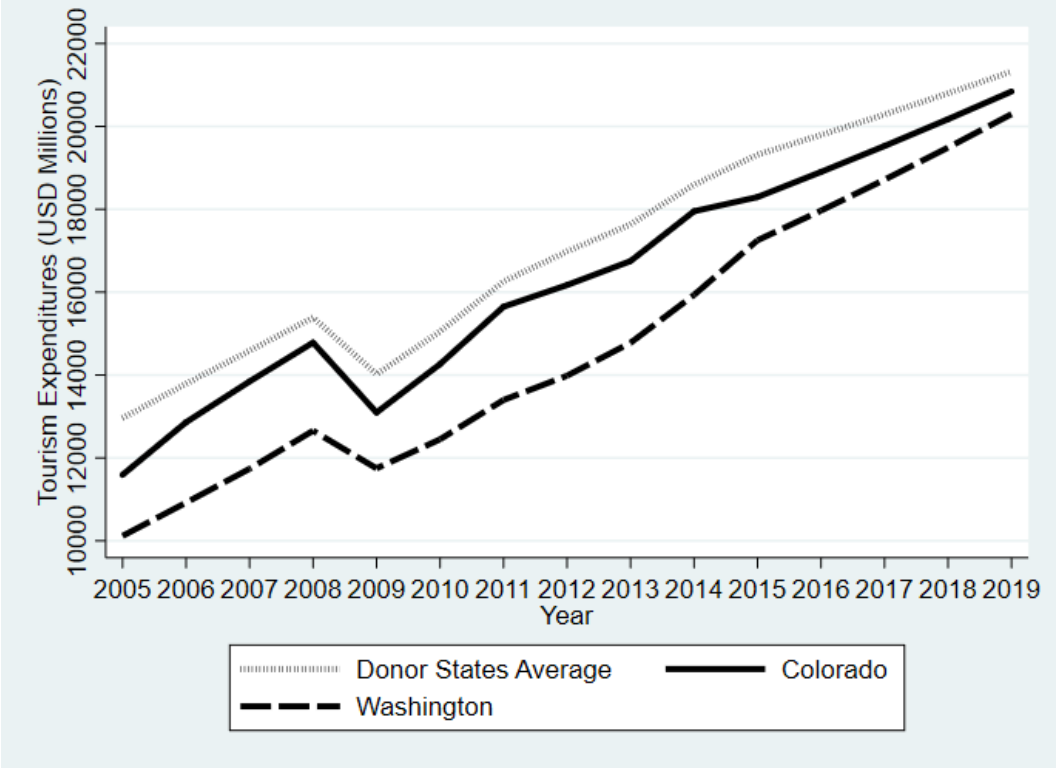


Appendix B

In this appendix, I carry out a simple exercise to understand how p-values respond to additional years of data. Motivation for this exercise comes from the fact that the magnitude of the potential effects of treatment are relatively small compared the magnitude of the dependent variables. In the first several years, it is possible that the effect is overshadowed by standard fluctuations in the dependent variables. However, over time, a positive effect would compound and might show greater significance.

For expenditures only, I generate predicted values for the years 2017-2019. I use straight line estimation with the one year growth rate from 2015 to 2016. I first present Colorado and Washington relative to the donor average of expenditures.

Tourism Expenditures for Washington, Colorado, and Donor States



Appendix B

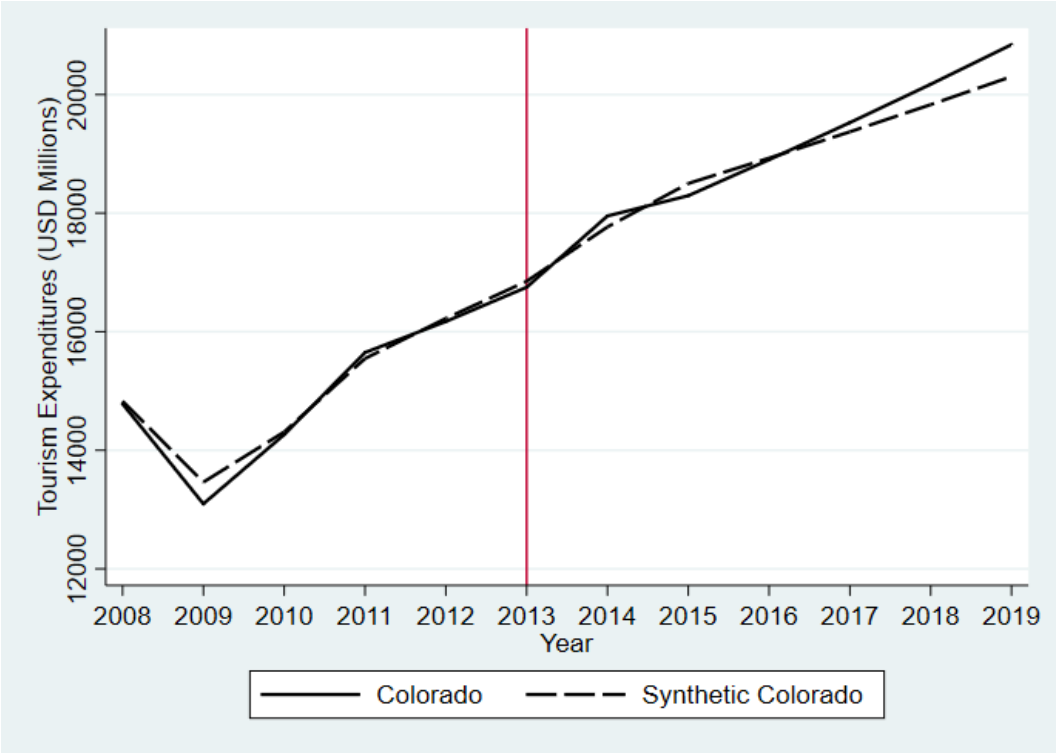
Next, I run the synthetic control analysis using 3 lags of expenditures and dropping years prior to 2008. Below are abbreviated results of these analyses for Colorado and Washington:

Cumulated effects of treatment on Colorado tourism revenues, based on SCM 2008-2019 with 3 lags of the dependent variable, 2017-2019 estimated, no controls included

Colorado

Year	Effect	P-val	P-val std
2014	185.09	0.533	0.711
2015	-205.97	0.578	0.756
2016	-27.90	0.978	1.000
2017	155.22	0.800	0.867
2018	343.67	0.600	0.667
2019	537.73	0.511	0.600

Synthetic and actual tourism revenues for Colorado 2008-2019, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment, 2017-2019 estimated



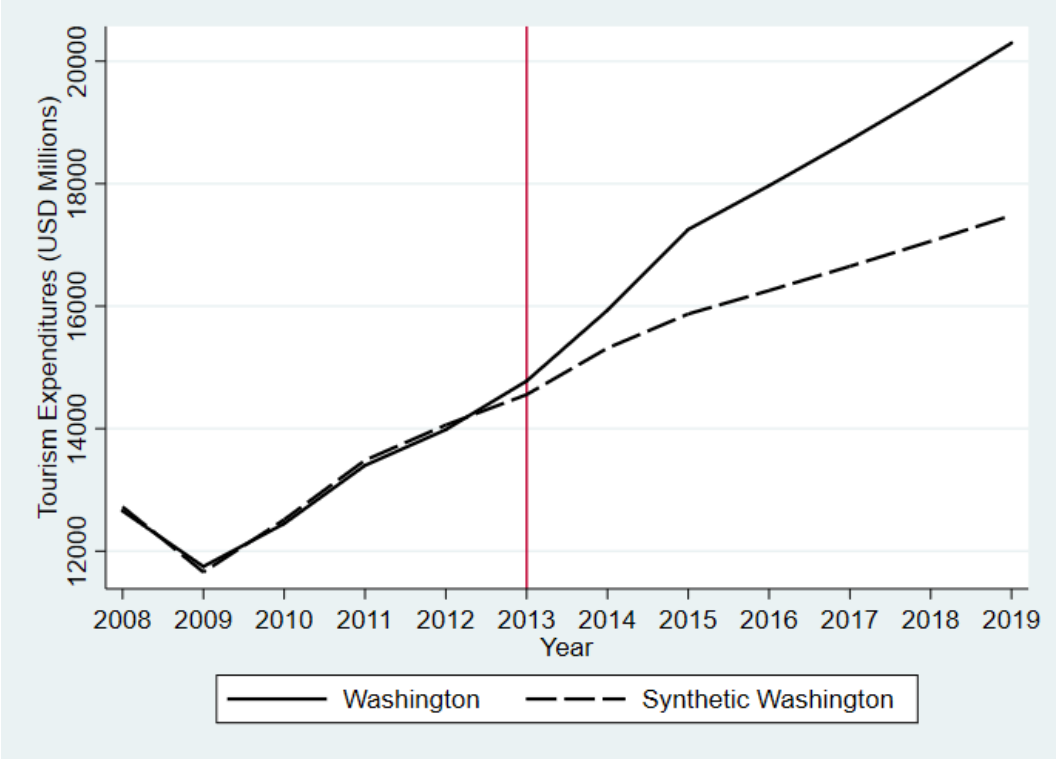
Appendix B

Cumulated effects of treatment on Washington tourism revenues, based on SCM 2008-2019 with 3 lags of the dependent variable, 2017-2019 estimated, no controls included

Washington

Year	Effect	P-val	P-val std
2014	618.64	0.222	0.156
2015	1379.37	0.156	0.044
2016	1712.54	0.111	0.044
2017	2062.30	0.133	0.089
2018	2429.55	0.111	0.111
2019	2815.22	0.089	0.133

Synthetic and actual tourism revenues for Washington 2008-2019, based on 3 lags of the dependent variable, no controls included, vertical line at first year of treatment, 2017-2019 estimated



As can be seen, p-values improve as growth rates persist for several years. However, as one might expect, p-values do not experience extreme improvements, so the results of this exercise do not change the assessments presented in this paper. This analysis further supports the conclusion of a "tenuous positive result" and strengthens the force of the policy recommendations. Such policies would seek to incur a growth rate greater than that of 2016.

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