FROM PROHIBITION TO PERMISSIBILITY: ANALYZING THE SOCIOECONOMIC DYNAMICS OF MARIJUANA CONSUMPTION POST-LEGALIZATION

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Abstract

This paper investigates the socioeconomic dynamics of marijuana consumption in the United States following legalization, using data from the National Survey on Drug Use and Health (NSDUH) spanning 2014-2020. The analysis employs fixed-effect Ordinary Least Squares (OLS) regression to explore three key stages of legalization: regulation, medical, and recreational. Results reveal a significant increase in marijuana consumption associated with recreational legalization, while medical legalization shows no statistically significant impact. Positive relationships between consumption and median income, along with negative relationships with income inequality and unemployment rates among highly educated individuals, underscore the nuanced effects of legalization. The study contributes insights for policymakers, emphasizing the need for targeted interventions, awareness campaigns, and evidence-based regulations.

Keywords

Marijuana Consumption, Marijuana Legalization, Recreational legalization, Medical legalization, Socioeconomic Dynamics

1. Introduction

Marijuana legalization in the United States has undergone a transformative journey over the past few decades with arguments encompassing economic, social, and public health perspectives. The shift in attitudes and policies surrounding cannabis has prompted extensive research to understand the impact on various aspects of society. Proponents argue that legalization could result in increased tax revenue, reduced criminal activity, and improved public health outcomes, while opponents contend that it may lead to increased substance abuse, negative public health outcomes, and decreased productivity (Miron, J. A., & Waldock, K. ,2010; Caulkins et al., 2012; Volkow et al., 2014; Hall & Lynskey, 2016).

The trajectory of marijuana legalization varies across states. As of 2023, 21 states and Washington D.C. have legalized marijuana for adult recreational use, while 37 states and Washington D.C. have legalized marijuana for medical use under medical marijuana programs (National Conference of State Legislatures, 2021). This rapid expansion of legalized marijuana has led to a burgeoning industry, with legal sales reaching $35 billion in 2022 and projected to continue growing.

Marijuana consumption and its legalization have garnered increasing attention in both academic and public discourse. The evolving legal landscape surrounding marijuana, coupled with its potential socioeconomic implications. Therefore, understanding marijuana consumption and legalization in the United States plays a vital role for comprehensive societal understanding. Post-legalization consumption patterns inform public health strategies, allowing for the development of targeted interventions and the assessment of associated health risks (Volkow et al., 2014). Policymakers benefit from insights into consumption data for crafting evidence-based regulations that balance individual freedoms with public health considerations (Pacula & Sevigny, 2014). Economic implications, such as job creation and tax revenue generation, underscore the need for ongoing analysis to inform economic planning (Anderson et al., 2015). Marijuana legalization also has implications for criminal justice reform and social equity, necessitating ongoing evaluation of the impact on crime rates and efforts toward equitable practices (Ghandour et al., 2020). Henceforth, Understanding the impact of marijuana legalization on consumption patterns is crucial for policymakers. In this study, we would like to evaluate the consumption impacts

of legalized marijuana in the United States by utilizing the data from the National Survey on Drug Use and Health (NSDUH) annual survey, spanning the years 2014 through 2020.

To explore the impact of marijuana legalization on consumption, we utilize a fixed-effect Ordinary Least Squares (OLS) regression applied to panel data. Our study investigates three key stages of legalization – regulation, medical legalization, and recreational legalization. We examine the estimated coefficients of two dummy legalization variables in conjunction with income, unemployment, and education variables. This analysis adds value to current scholarly discussions by offering a thorough investigation into marijuana consumption trends in the United States across distinct legalization stages. Furthermore, our study employs a robust econometric approach, considering state-level variations and dynamic temporal factors in the analysis.

Our findings reveal that marijuana consumption was not increased under marijuana regulation, with consumption under medical legalization not significantly different from regulation. However, we observe a notable shift in consumption following recreational legalization, with an increase of 1.84% per year above the consumption under regulation. These results have important implications for policymakers and stakeholders in the marijuana industry and provide valuable insights into the consequences of marijuana legalization in the United States.

2.   Literature Review

The history of marijuana prohibition and subsequent legalization is crucial in understanding the current landscape. According to Bonnie and Whitebread (1974), the Marihuana Tax Act of 1937 marked the beginning of federal restrictions on marijuana, which persisted for several decades. However, a turning point came with the approval of medical marijuana in California in 1996, followed by recreational legalization in Colorado and Washington in 2012.

A plethora of research efforts have delved into the consequences of marijuana legalization on consumption, yielding varied outcomes. Anderson et al. (2013) suggested that the legalization of medical marijuana had minimal effects on youth consumption, contrasting with Chaloupka & Laixuthai (1997), who proposed that intensified marijuana regulation led to decreased consumption. Pacula et al. (2015) observed that the impacts on consumption associated with medical marijuana laws depended on the specific details of the legislation, while Wen et al. (2015) reported a significant increase (14-15%) in past-month and daily usage among adults following the legalization of medical marijuana, with no corresponding effect on adolescents. Chu (2014) identified a noticeable surge in illegal adult marijuana usage (approximating 15-20%) coinciding with the introduction of medical marijuana laws. However, it's noteworthy that these studies predominantly focused on the effects of medical marijuana legalization rather than recreational legalization.

2.1.   Trends in Marijuana Legalization
Several research works have revealed a growing body of research assessing the impact of marijuana legalization on consumption patterns in the United States. Kilmer et al. (2017) employed panel data to analyze the effects of marijuana policy changes in the United States. Their findings suggested that legalization leads to increased use among adults, emphasizing the importance of understanding the nuanced relationship between policy changes and consumption behaviors. However, the study by Anderson et al. (2013) examined the economic impact of marijuana legalization and found evidence of job creation and tax revenue generation, highlighting the multifaceted nature of marijuana legalization's socioeconomic consequences. Furthermore, other studies presented varied evidence pertaining to the correlation between marijuana legalization and consumption trends. Hasin et al. (2015) found no substantial evidence until 2014 to suggest that implementing medical marijuana laws led to an increased prevalence of marijuana use among adolescents. Conversely, Cerdá et al. (2020) reported a slight increase in cannabis use disorder among 12-17-year-olds and increased frequent use and cannabis use disorder among adults aged 26 or older following the legalization of recreational marijuana, pointing to potential public health risks.

2.2.   Socioeconomic Factors and Consumption
Some studies also examined the societal and public health impacts of marijuana legalization. Volkow et al. (2014) reviewed the potential negative health implications of marijuana use, such as addiction, cognitive impairment, and mental health disorders. Meanwhile, Hall and Lynskey (2016) offered a comprehensive overview of the public health implications of marijuana legalization, elucidating potential benefits such as reduced criminal justice costs, as well as potential drawbacks, such as heightened marijuana usage and impaired driving. Choo et al. (2014) utilized panel data to investigate the influence of income, education, and employment on marijuana use. Their results indicated that socioeconomic disparities play a role in consumption patterns, with implications for public health interventions and policy design. Additionally, the research conducted by Cerda et al. (2016) delved into the longitudinal relationship between neighborhood socioeconomic status and marijuana use, providing insights into how local economic conditions impact consumption behaviors over time. Pacula et al. (2014) investigated the impact of medical marijuana laws on marijuana use and found evidence of increased consumption for medicinal purposes. Concurrently, they noted potential adverse effects on public health, emphasizing the need for careful

consideration of regulatory frameworks. Furthermore, Di Forti et al. (2019) conducted a longitudinal study exploring the association between high-potency cannabis use and the risk of psychosis, contributing important insights to the ongoing debate on the mental health implications of marijuana consumption.

2.3.   *Economic Impact and Market Dynamics*

The economic implications of marijuana legalization have been a focal point of research. Panel data analyses have explored market dynamics, tax revenues, and employment effects. Anderson et al. (2013) assessed the economic impact of marijuana legalization, emphasizing the potential for job creation and tax revenue generation. These findings underscore the multifaceted nature of marijuana legalization's socioeconomic consequences. In addition, a study by Miron (2018) provided an early analysis of the potential fiscal benefits of legalizing marijuana, offering insights into the economic considerations that policymakers need to weigh. Dave et. al (2023) see the impact of recreational marijuana on employment and earnings. Anderson et.al (2023) review the literature on the public health consequences of legalizing marijuana whereas Caulkins et al. (2012) explored potential tax revenues from legalized marijuana sales and postulated that such revenue would be influenced by the regulatory environment and market conditions. In contrast, Miron and Waldock (2010) suggested that marijuana legalization could yield significant tax revenues and simultaneously lower law enforcement costs.

The existing literature on evaluating the impact of marijuana legalization on consumption in the United States presents a multifaceted narrative, marked by varying conclusions regarding the relationship between legalization and consumption trends, along with the economic, public health, and societal impacts of legalization. Researchers employ several sophisticated econometric techniques to disentangle complex relationships and assess causality. Socioeconomic factors, public health outcomes, economic implications, and cross-country comparisons contribute to a comprehensive understanding of the multifaceted impact of marijuana policies. As the legal landscape continues to evolve, ongoing panel data research will be crucial for informing evidence-based policies and interventions in this rapidly changing domain. Our research seeks to augment this literature by providing a comprehensive exploration of marijuana consumption trends under varying stages of legalization, utilizing a rigorous econometric methodology that accounts for differences across states and time-dependent factors.

3.   Data and Methodology

This study utilizes the National Survey on Drug Use and Health (NSDUH) annual survey data as its primary data source. The NSDUH is a cross-sectional, nationally representative survey of the U.S. civilian, non-institutionalized population aged 12 years and older, conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA)by employing a multistage sampling design. The NSDUH ensures representative coverage of the population, incorporating households, group quarters, and individuals experiencing homelessness. NSDUH collects a wide range of information, including substance use patterns, initiation age, perceptions of risk, mental health status, and treatment history. The NSDUH data is publicly accessible which serves as a crucial resource for monitoring and analyzing prevalence, trends, and correlates of substance use behaviors in the United States.

To conduct our study, we collected data for the period of 7 years from 2014 to 2020. The variables we considered in the study are State, Year, Marijuana Consumption, state-specific marijuana legalization status (categorized as medical, recreational, or regulated) over time, median income, Unemployment Rate, College Degree Percentage.

We perform a descriptive statistic to provide a preliminary overview of the data. This included measures such as means, standard deviations, minimum and maximum values, and correlations between variables. These statistics were instrumental in identifying any outliers, assessing the distributional properties of the variables, and detecting potential multicollinearity issues.

To examine the influence of legalized marijuana consumption in the USA, we utilized a fixed-effects ordinary least squares (OLS) regression on our panel data. This fixed-effects approach allows us to control for unobserved state-specific factors that could influence marijuana consumption and that remain consistent over time, as well as for influences specific to each year.

Our empirical model is articulated as:

$$C_{it} = \alpha + \beta_1 ML_{it} + \beta_2 RL_{it} + \beta_3 inc_{it} + \beta_4 unem_{it} + \beta_5 educ_{it} + \beta_6 inc_{it} \cdot unem_{it} + \beta_7 inc_{it} \cdot educ_{it} + \beta_8 unem_{it} \cdot educ_{it} + \beta_9 t + \mu_i + \mu_t + \varepsilon_{it} \qquad (1)$$

where C_{it} represents the marijuana consumption in state i at time t, ML_{it} is a dummy variable equal to 1 if medical marijuana is legal in state i at time t and 0 otherwise, and RL_{it} is a dummy variable equal to 1 if recreational marijuana is legal in state i at time t and 0 otherwise. The inc, $unem$, and $educ$ indicate the annual median income, unemployment rate, and the percentage of people with college degrees, respectively. $inc_{it} \cdot unem_{it}$, $inc_{it} \cdot educ_{it}$, and $unem_{it} \cdot educ_{it}$ are interaction terms for these three variables. Finally, t represents year variables, the μ_i denotes the state fixed effects, μ_t denotes the year fixed effects, and ε_{it} is the error term.

The coefficients of interest are β_1, $\beta_2 \cdots \beta_9$ which capture the marginal impacts of medical and recreational marijuana legalization on consumption. Furthermore, they also shed light on the effects of the three primary explanatory variables and their respective interactions along with time variables.

We evaluated the three stages of legalization by analyzing the estimated coefficients of the two legalization dummy variables. A positive and significant coefficient for β_1 would suggest that medical marijuana legalization is associated with higher marijuana consumption, while a positive and significant coefficient for β_2 would indicate that recreational marijuana legalization is associated with higher marijuana consumption compared to medical legalization.

4.   Results

Table 1 provides a detailed statistical overview of various socioeconomic indicators alongside marijuana consumption trends across states. On average, states reported marijuana consumption of around 790 thousand. The spread ranged from as low as 51 thousand in Wyoming to a staggering 7.13 million in California. When observing the percentage of marijuana consumption, the average figure stood at 13.3%. The spectrum varied from a minimum of 7.1% in Mississippi to a maximum of 35.5% in New York.

	Marijuana Consumption (thousands)	Population (thousands)	Marijuana Percentage (%)	Median Income ($)	Unemployment Rate (%)	College Degree (%)
Mean	790	5,996	13.31	61,867	4.85	31.2
Std	964	6,823	4.63	11,229	1.68	5.4
Min	51	570	7.10	35,521	2.10	19.2
25%	221	1,833	10.19	54,094	3.60	27.5
50%	497	4,412	11.79	60,430	4.50	30.5
75%	982	6,841	15.71	69,999	5.90	34.8
Max	7,133	39,280	35.47	95,572	13.50	46.9

Table 1. Data Statistic Summary

Figure 1 illustrates the change in marijuana consumption by states from 2014 to 2020. It shows an increase in the percentage of marijuana use, rising from the lowest to the highest consumption percentage among the state population.
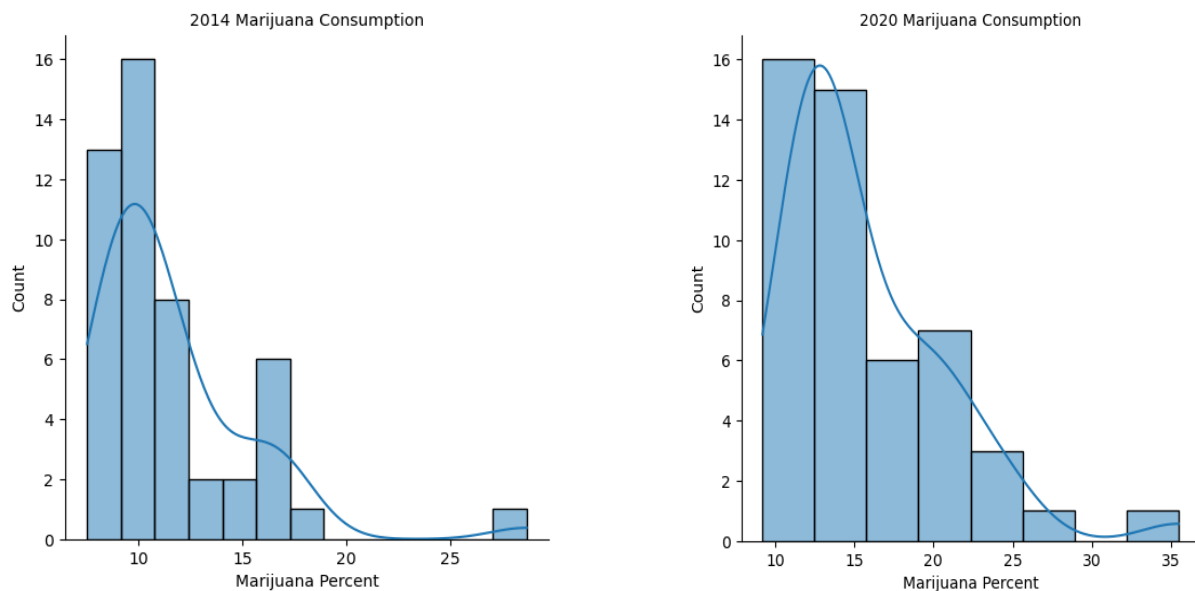

Figure 1: Percentage change of marijuana consumption in states over the years

Figure 2 displays the percentage of marijuana consumption by legalization or regulation status, indicating that higher levels of legalization lead to an increased average consumption percentage among the state population. However, there is a larger variation in consumption for states with medical marijuana legalization.
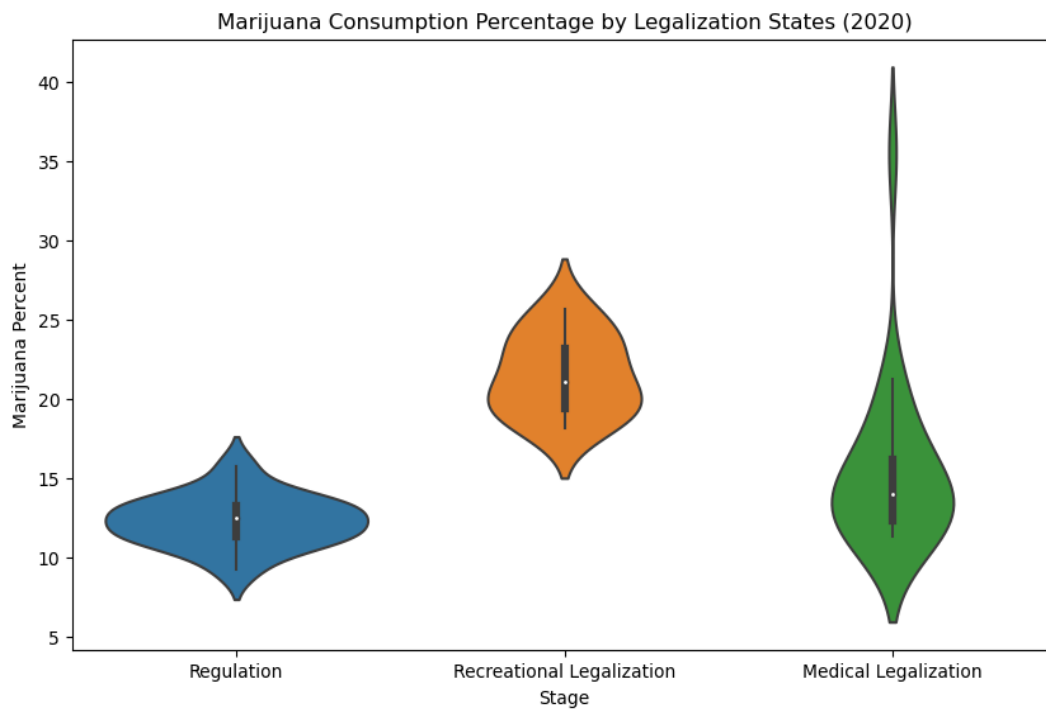
Figure 2: Marijuana consumption percentage by legalization levels in 2020

Figure 3 showcases the marijuana consumption percentages by state for 2020, segmented by their legalization stages. States appear in descending order based on their consumption rates. It is evident that states with 'Recreational Legalization' have consistently higher consumption percentages than those under 'Medical Legalization' or 'Regulation'. Despite being under medical legalization, New York stands out with an unusually high deviation. The group with recreational legalization, comprising VT, OR, CO, WA, ME, MA, NV, MI, AK, and CA, consistently ranks among the highest in consumption percentages. Within the medical legalization category, states such as NY, RI, MT, NH, and CT align closely with recreational legalization figures, while states like VA, UT, GA, WV, LA, ND, HI, AR, NJ, IN, and MO more closely mirror the percentages of regulated states. Among the states under regulation, NM, ID, and NC hover around a higher 15% consumption, while IA, TX, SD, and MS reflect a notably lower consumption around 10%.
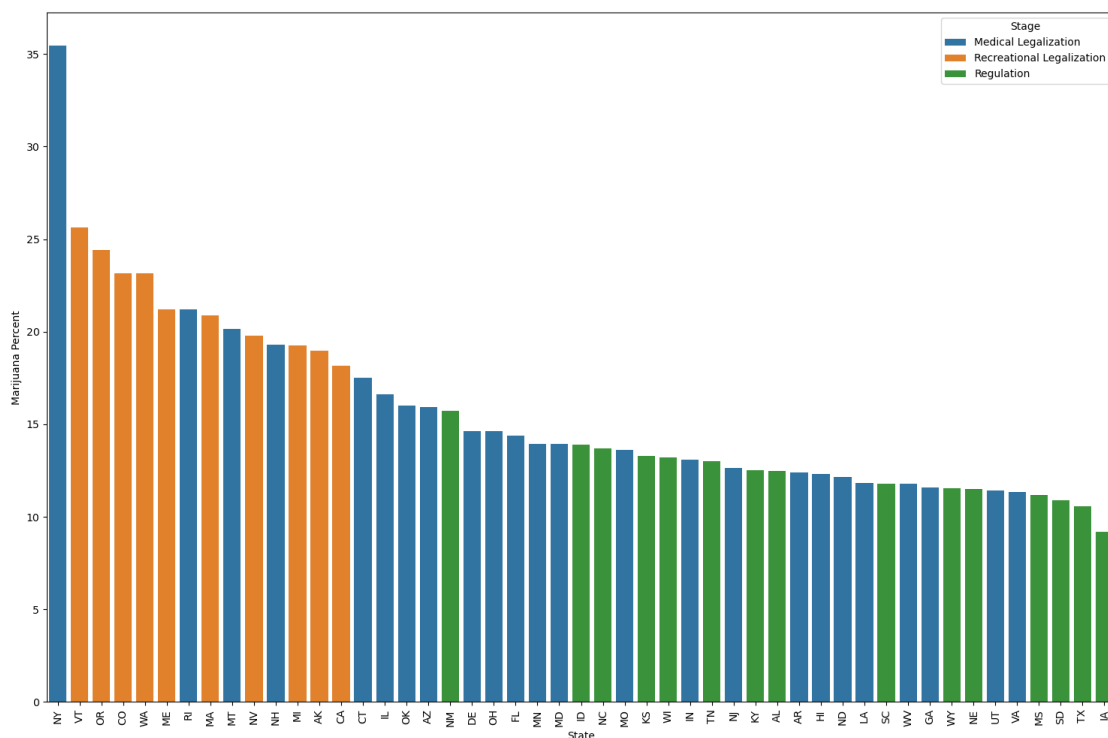

Figure 3. Marijuana Consumption Percentage by State in 2020 Grouped by Legalization Stages

Figure 4 traces the evolution of marijuana consumption as a percentage of the population from 2014 to 2020 in selected states. The graph accentuates New York's significant uptick in consumption over these years. States with recreational legalization like VT and CA exhibit a consistent rise. On the other hand, medical legalization states, notably NY, RI, and VA, exhibit a plateaued consumption trend until 2018, followed by an upward trajectory. Contrastingly, regulated states such as NM and IA maintain relatively stable consumption rates over the period.
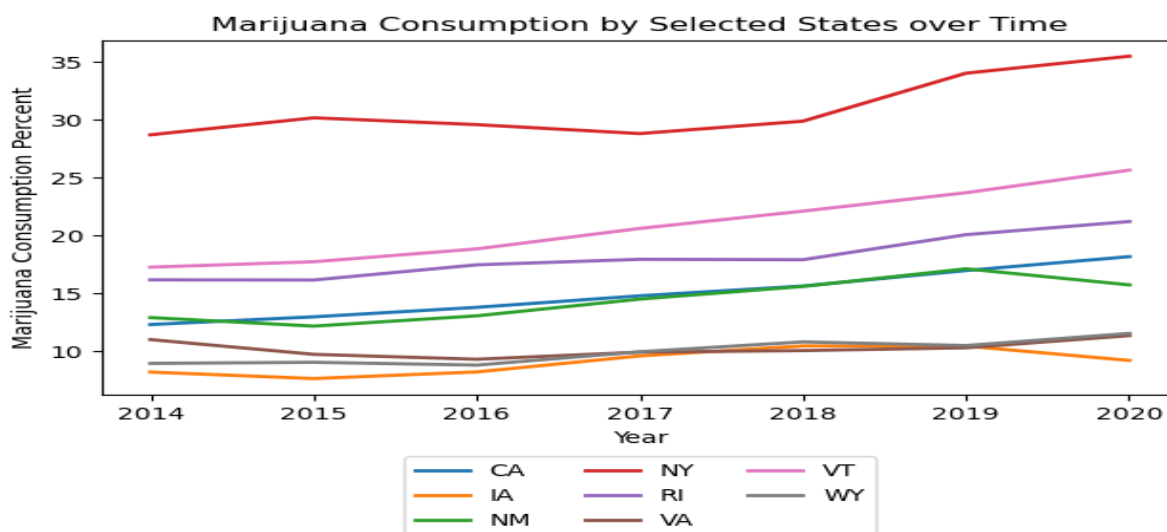

Figure 4. Marijuana Consumption Trends across Selected State (2014-2020)

Table 2 presents the outcomes of our fixed-effects OLS regression, shedding light on the effects of different marijuana legalization stages on its consumption. The crux of our examination lies in the estimated coefficients for the Medical Marijuana and Recreational Marijuana dummy variables. These coefficients provide a deeper understanding of the distinct ways in which both medical and recreational legalizations influence marijuana consumption.

To ensure the robustness of our results, we adopted a tiered analytical approach:

- Model 1: An OLS regression devoid of any fixed-effects treatments.
- Model 2: An OLS regression that incorporates fixed effects to account for unobservable state- and year-specific variations.
- Model 3: This model extends the OLS regression of Model 2 by introducing three primary explanatory variables and their respective interactions, further enhancing the granularity of our findings.

This layered methodology ensures that our conclusions are not only grounded in data but also resilient to potential biases or oversights.

Variables	Model 1		Model 2		Model 3	
	coefficients	t-statistics	coefficients	t-statistics	coefficients	t-statistics
Intercept	-730.86***	-3.84	-0.026***	-15.92	-0.021***	-5.64
Time	0.368***	3.89	0.008***	33.99	0.003	1.03
Medical Marijuana	3.512***	8.84	-0.316**	-1.43	-0.275	-1.25
Recreational Marijuana	8.863***	14.85	1.834***	4.80	1.810***	4.79
Income($1K)					0.378**	2.36
Unemployment Rate (%)					-0.080	-0.34
Education (% of BS degree)					0.151	0.92
Income*Unemployment					-0.00032**	-2.20
Income*Education					-0.000054	-1.39
Unemployment*Education					0.00031***	2.67
State-Fixed Effects Treated	No		Yes		Yes	
Year-Fixed Effects Treated	No		Yes		Yes	
Adjusted R^2	0.463		0.962		0.963	

Table 2: Fixed-Effects OLS Regression Results

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2 offers a comprehensive examination of the marijuana consumption patterns influenced by its various legalization stages. Model 1 serves as a representation of potentially skewed parameters, resulting from data estimation without fixed-effect treatments. Remarkably, its coefficient values tower over those in Models 2 and 3. However, the strikingly close coefficient values in Models 2 and 3, coupled with an elevated adjusted R^2 of 0.96, underscores the necessity for fixed-effect treatments in this panel data estimation.

Intriguingly, in Models 2 and 3, the time trend effects lose their significance in the latter. This implies that the yearly progression is neutralized by both the time-fixed effect and the impact of the three variables. Consequently, under the time-fixed effects, any annual incline is not statistically pertinent and can be sidestepped.

Additionally, the influence of medical marijuana legalization becomes statistically insignificant in Model 3. This indicates that the effect of medical legalization is overshadowed by the three primary variables and their interplay. Hence, based on Model 3, both the annual trends and the implications of medical legalization can be disregarded in terms of statistical relevance.

Contrarily, the legalization of recreational marijuana manifests a significant surge in consumption, elevating it by 1.81% annually ($\beta\_2 = 1.81$) compared to regulated consumption. This effect is statistically concrete at the 1% level (p-value = 0.00). It unequivocally highlights the potency of recreational legalization in driving consumption, outstripping the influence of its medical counterpart.

Delving into the three primary explanatory factors, only median income emerges with a statistically notable positive bearing on marijuana consumption. Specifically, consumption rises by 0.38% for every $1,000 increment in annual median real income. Notably, when juxtaposed with the interactivity effects, both income and unemployment rates show significant negative relation with marijuana consumption. This suggests that states experiencing both elevated median incomes and unemployment rates also witness lowered marijuana consumption, possibly alluding to the repercussions of income disparity. Additionally, the interplay between higher unemployment rates and a greater percentage of college degree holders reveals a significant rise in consumption— potentially a reflection of the heightened stress levels among unemployed graduates.

To encapsulate, our analyses substantiate that while recreational marijuana legalization significantly boosts consumption, the ramifications of medical legalization remain statistically indistinct from regular marijuana regulations. Furthermore, U.S. marijuana consumption exhibits a positive relation with median income and unemployment rates among the highly educated populace, while showing a negative relation with income inequality.

5. Discussion

5.1. Repercussions for Policymakers and the General Public

Our study sheds light on several pivotal aspects that hold substantial relevance for both decision-makers and the common populace. From a policymaking standpoint, it's paramount to factor in the pronounced surge in marijuana uptake following the endorsement of its recreational use. Interestingly, our study suggests that the legitimization of marijuana for medical purposes might not noticeably influence its consumption in comparison to regular regulations on marijuana.

In light of the potential repercussions linked with heightened marijuana uptake, it's imperative for policymakers to roll out precise preventive measures and awareness campaigns. The focal point of such initiatives could range from curbing the uptake among the younger populace, advocating judicious use among the adult segment, to spotlighting the plausible risks encompassing impaired driving, mental health ramifications, and the pitfalls of substance misuse.

For the layperson, comprehending these alterations in marijuana uptake patterns within their vicinity, and recognizing the possible aftermaths of increased consumption is crucial. Armed with this knowledge, individuals can judiciously ponder over their marijuana consumption choices and partake in meaningful discourse about the wider implications of marijuana legalization in the realm of public health and safety. Notably, it's also paramount to champion ongoing scrutiny into the extended consequences of sanctioning recreational marijuana use. Upcoming research endeavors should delve into the broader effects of marijuana consumption on facets like public health, crime trajectories, and economic implications, not forgetting the potential interplay between marijuana and other substances.

5.2. Constraints of the Study and Potential Avenues for Future Research

Our investigation isn't devoid of certain limitations. Primarily, our study encompasses data up until the year 2020. Given the burgeoning trend of states moving towards marijuana legalization, the dynamics of its consumption are bound to metamorphose. It's essential for subsequent studies to rejuvenate the analysis by roping in data from the subsequent years once they're accessible.

Additionally, our study zeroes in predominantly on the collective repercussions of marijuana legalization on consumption trends. An interesting tangent for forthcoming research would be to decipher the varied impacts of

this legalization, fragmenting it based on diverse demographic segments, economic indicators, and regional backdrops. Such an approach can offer a more layered and detailed comprehension of the ramifications stemming from marijuana legalization.

6.   Conclusion

In this study, we ventured to analyze the repercussions of marijuana legalization on consumption patterns within the United States, drawing from the National Survey on Drug Use and Health (NSDUH) annual datasets spanning from 2014 to 2020. Through the prism of fixed-effect OLS regression and by focusing on the panel data, we meticulously assessed the tripartite stages of marijuana legalization.

The findings of this analysis paint a clear picture: there's no significant annual rise in marijuana consumption, when observed under the lens of marijuana regulations. Notably, the trends in marijuana consumption under medical legislation showcased negligible variance when juxtaposed against those under mere regulations—underlining the non-significance statistically. This facet is intriguing, especially given it flies in the face of prior studies by figures like Wen et al. (2015) and Chu (2014). On the other hand, the endorsement of recreational marijuana use resulted in a spike, translating to an additional 1.8% consumption annually vis-à-vis the norms under regulation—a statistically pronounced uptick.

These revelations fortify the discussions around marijuana's legalization policy, shedding light on the possible ripple effects it could have on public health, societal safety, and overarching regulations. What becomes evident is the distinct divergence in impacts stemming from medical versus recreational legalization, which underscores the need to account for the intricacies of legalization blueprints during the policy-making process.

That said, it's pivotal to acknowledge certain constraints in the study, notably the susceptibility to omitted variable bias. Future endeavors could diversify their lens—utilizing varied data reservoirs, weaving in a broader spectrum of control variables, or even delving into the varying impacts of legalization on disparate demographic clusters. A deeper dive into the long-term ramifications of shifts in marijuana consumption, particularly in areas like public health, criminality metrics, and fiscal outcomes, is warranted.

Our study crystallizes the notion that marijuana's legalization, especially in the recreational domain, has catalyzed its heightened consumption—a trend that neatly aligns with the demand-centric economic theory. This theory purports that the decriminalization and subsequent cost reduction of marijuana would inevitably stoke its demand, as posited by Caulkins et al. (2012).

However, a caveat remains: the study primarily hinges on the repercussions of legalization on self-reported marijuana consumption. There remains a possibility that the real-world consumption overshadows the reported figures, given potential underreporting or certain marijuana derivatives evading the NSDUH's purview, as highlighted by Pacula et al. (2015).

Subsequent scholarly pursuits should probe deeper into the lasting impacts of marijuana legalization on consumption trajectories. It's equally essential to gauge the ramifications of policy tools, including tax impositions or curbs on advertising, on marijuana uptake. An in-depth analysis of the rising marijuana consumption and its implications on public health, crime trends, and economic factors is critically important today.

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