CANNABIS PUBLIC POLICY CONSULTING

Future Adult Use Cannabis Demand & Predictive Modeling

A Behavioral Economic Study

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Prepared For:
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Executive Summary

The current report details the results of comprehensive survey administered by Cannabis Public Policy Consulting (CPPC) in November of 2022 to 4,619 Maryland residents. The purpose of the survey was to use measures of cannabis-related economic, market, and health outcomes to create advanced statistical models that predict market and health outcomes for the present moment and for several years following the implementation of adult use cannabis in Maryland.

The following are key findings from the report:

Cannabis Consumption

- Respondents indicated that price is the most important characteristic impacting their decision to access cannabis, followed closely by safety.
- 50% of respondents stated that they would expect to use cannabis more for the purposes of relaxation if adult use is implemented.
- Many of those who use cannabis reported that they perceive positive effects following their cannabis use.
- Most respondents reported that they do not use cannabis before, during, or at work. When asked how their use of cannabis would change if adult use was legalized in Maryland, respondents indicated that their use of cannabis surrounding work would remain about the same.

Cannabis Demand

- Total cannabis demand in Maryland during the first year of adult use implementation is estimated to be 824 million grams of cannabis across *all possible sources* or 1.8 million pounds. Notably, 148 million grams of this cannabis demand, or 22%, is estimated to be made up from tourists.
- CPPC's modeling suggests 75% of those who use cannabis in Maryland reported being willing to pay $10 per gram of adult use cannabis following opening of adult use stores.
- Predictive sales modeling suggests Maryland's adult use program will reach $1 billion in total (i.e., cumulative) sales at month 20 of adult use implementation.
- Based on CPPC's models accounting for the effects of the three main variables in cannabis market capture, assuming supply is naturally progressing with the modeling made in Section 7, the optimal effective tax rate is between 15-20%.

Drivers of Cannabis Demand

- When an adult use cannabis law is implemented in Maryland, at least 50% will be willing to travel up to 20 minutes to access adult use cannabis, and safety was ranked as the number two driver of cannabis purchases, though remarkably close to being tied with price.

- Respondents who use cannabis indicate that they spent an average of $49 on cannabis over the past month; however, they also indicated that they would be willing to spend $56 on cannabis each month if adult use cannabis is legalized in Maryland, which further validates our predictions of favorable demand and early shifts to adult use sales upon its implementation.

Supply

- The annual demand estimate of 824 million grams would require a supply of approximately 2.4 million cumulative plants across medical and adult use programs in that first year at minimum (supply at 2x of demand).
- The current existing medical cannabis market in Maryland would likely only supply a very insignificant portion of the total regulated demand required and is likely insufficient for the current and future medical program.
- First year of adult use cannabis supply should aim to achieve approximately 1.5M plants to accommodate to scalability and match consumer transitions accordingly.
- Data indicates that adding 199 adult use stores to accompany the existing 101 medical cannabis dispensaries (medical) during the first year of Maryland's adult use implementation for a total of approximately 300 cannabis dispensaries would be an optimal number of dispensaries to shift consumption from illicit markets to the adult use market without adding notable public health risks.
- However, data suggests that up to 500 dispensaries across later years of adult use implementation is unlikely to produce negative public health harms relative to current conditions with a medical-only market.

Taxes

- If there are 100-250 regulated dispensaries in Maryland, and an effective tax rate of 15%, illicit cannabis is predicted to comprise 44% of the cannabis market in Maryland between months 5-8 after adult use implementation. If there are 260-500 regulated dispensaries, and an effective tax rate of 10%, it is predicted that illicit cannabis will comprise nearly 36% of the cannabis market during months 9-12.
- Tables 5-7 provide a sample of over 900 possible outcomes for the percent of regulated cannabis in Maryland which is concurrently informed by the month of adult use implementation, dispensary density, and tax rates (i.e., sales + excise). Although several options among these could be favorable, we recommend between a 15-20% tax rate to maximize rapid shifts to the adult use market during the first six months of adult use implementation. The success of shifting consumers to the regulated market in this period will likely have a disproportionate impact on the trajectory and success of the adult use market for years 1-5.

Public Health

- Over one third of respondents consume cannabis before or during work and had driven under the influence of cannabis (DUIC) at least once in the past month. Among those who reported DUIC in the past month, the average number of days of DUIC was 11 days per month. This equates to at least 57 million instances of DUIC per year in Maryland.
- About 38% of respondents demonstrated problematic cannabis use patterns, consistent with national trends.

- Negative cannabis related public health outcomes in Maryland do not appear to currently be above average relative to other states, and multiple findings are suggestive that a well-executed rollout of adult use cannabis in the state may be associated with less, not more, negative cannabis outcomes.

Section 1. Research Design

Potential participants for the survey resided in 413 Maryland zip codes. A total of 4,619 Maryland residents were screened for the survey, of which 2,147 completed the survey. Figure 1 below shows the relative geographic distributions of participants who were screened for the survey or completed the entire survey.

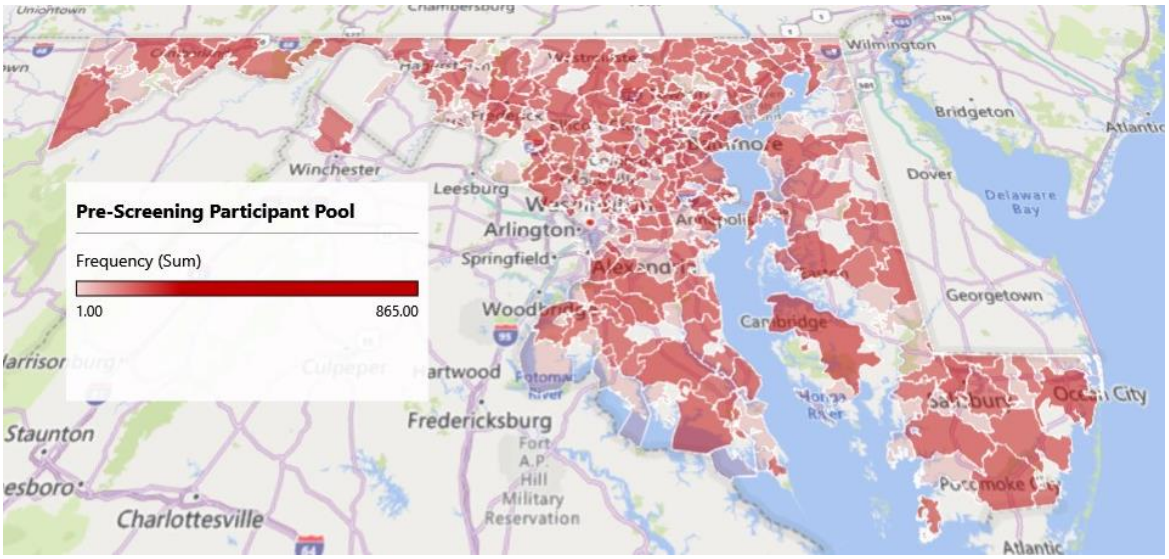

Figure 1. Recruitment Heat Map

Based on these data, those who engaged with our screening survey made up about 87% of all possible Maryland zip codes, suggesting a comprehensive dissemination of the survey throughout the state. Maryland residents were recruited using 49 unique research panels sourced by through a recruitment software, which suggests many different avenues and contexts of recruitment were implemented to recruit a representative sample. The final participant pool of those who used cannabis in the past year was 919 residents of Maryland.

1.1 Statistical Analysis and Methods

All statistical models and methods in the current paper are focused on either providing Maryland-wide or region-specific assessments and predictions. For region-specific estimates, we broke down Maryland into a series of regions based on available sample sizes from our survey recruitment and based on matching adjacent counties by degree of ruralness using criteria from the USDA. Figure 2 below shows the 12 regions used for all within-state analyses for this study.

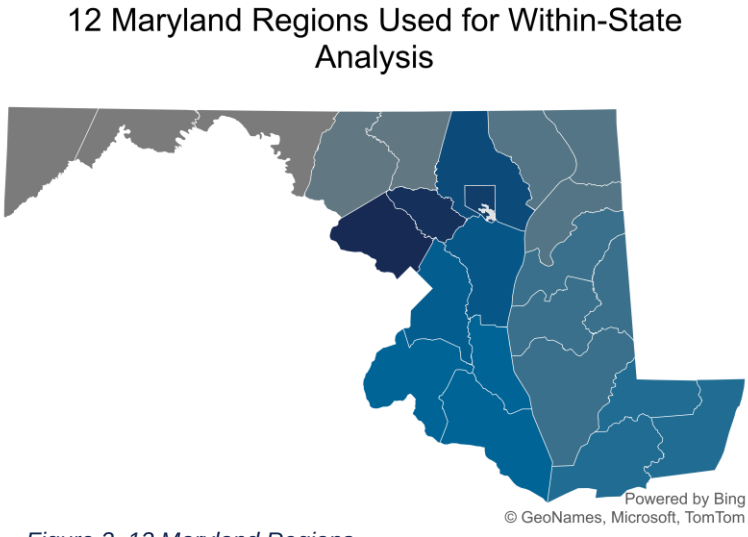

Figure 2. 12 Maryland Regions

Several multiple linear regression models were used to model data derived from the aforementioned survey and from our national survey, the Regulatory Determinants of Cannabis Outcomes Survey[1], which uses identical survey questions to assess other states across the United States. Questions in the Maryland survey included explicitly asking participants to report their intentions regarding whether, how much, and how much they will pay per gram of adult use cannabis in Maryland once adult use cannabis is implemented. Other predictive outcomes leverage monthly seed to sale data and our survey data from other states to provide predictive analytics on future outcomes.

Survey questions administered for the current report were directly and indirectly informed from the Principal Investigator's experience validating survey questions through scientific peer review[2,3,4] or through commissioned research reports from other cannabis-related state agencies[5,6]

1.2 Survey Demographic Information

Most respondents in this sample were White (49.3%), or Black and African American (37.4%), with an average age of 38. This is approximately equivalent to the population of Maryland (i.e., within an average of 5% per demographic characteristic); however, those who are Black and African American and individuals with lower family incomes were oversampled in this study, which increases the likelihood that equitable impacts of legalization are assessed. A total of 59.3% of the sample identified as female. The average family income was $63,000, which is lower than the average for Maryland's population ($87,000). Nearly all (96%) of the individuals in this sample obtain a high school degree or higher. The survey sample was strongly aligned with the demographic characteristics of the general Maryland population, which improves confidence that the findings reported in the survey are indicative of those seen in the general population. Table 1 demonstrates the similarity of survey respondents to the general population by distributions of age, race, gender identity, family income, and educational attainment.

Notably, across all demographic characteristics listed in Table 1, the demographic distribution of the sample collected here corresponded with that of the state of Maryland at a 95% match rate. That is, there was only a 5% difference on average between the values per demographic characteristic of our sample with the distributions found in the actual population of Maryland. This considerably increases the extent to which the current findings detailed in this report can be generalized.

Table 1. Demographic Distributions

	AU Survey	Maryland
Age	38.6	38.8
Race		
American Indian, Native American, or Alaskan Native	2.1%	0.3%
Asian	2.4%	6.4%

[1] https://www.cannabispublicpolicyconsulting.com/regulatory-determinants-of-cannabis-outcomes-survey/
[2] Greater delay discounting and cannabis coping motives are associated with more frequent cannabis use in a large sample of adult cannabis users - PMC (nih.gov)
[3] Sifting Through the Weeds: Relationships Between Cannabis Use Frequency Measures and Delay Discounting - PMC (nih.gov)
[4] APA PsycNet
[5] Maine OCP AHP Report 06-22.pdf
[6] Estimating-Cannabis-Demand.pdf (cannabispublicpolicyconsulting.com)

Black or African American	37.4%	29.9%
White	49.3%	54.24%
Native Hawaiian or other Pacific Islander	0.3%	0.04%
Other	3.2%	4.7%
Multi-race	5.3%	4.5%
Gender Identity		
Female	59.3%	51.3%
Male	38.1%	48.4%
Family Income	$63,000	$87,000
High School Degree or Higher	96%	91%

Section 2. Maryland Cannabis Consumption

2.1 Cannabis Use & Prevalence

Approximately 36% of respondents in this sample indicated using cannabis at least on a monthly basis and 43% indicated using cannabis within the past year. National population prevalence shows past year cannabis consumption at approximately 46%. Of those participants,19% report using cannabis daily or almost daily. 40% of the entire sample of survey participants indicated that they have never used cannabis. Importantly, the average age of initiation of cannabis use in this sample was 16 years old.

Of those who used cannabis within the past year, smoking (63%), ingesting edibles (51%), and vaping cannabis (44%) were the most frequently reported methods of administration in this sample. Those who reported smoking cannabis over the past month indicated using cannabis an average of 11 days. Those who reported ingesting edibles and those who reported vaping indicated using cannabis an average of 6 days over the past month. The average typical potency of cannabis respondents indicated consuming over the past month was around 29% THC, which is right in line with other states with legal medical and legal medical and adult use laws.

Notably, there were no statistically significant differences in the frequency of cannabis use days for smoking, consuming edibles, vaping, or dabbing when comparing Maryland's data from a national sample collected in the Regulatory Determinants of Cannabis Outcomes Survey.[7] However, there was a trend-level difference in typical THC potency such that Maryland's was slightly lower than the national average.

Table 2. Maryland and National Consumption Patterns

	Smoke	Edibles	Vape	Dabbing or Similar	Typical THC Potency
Maryland	11 days	6 days	6 days	4 days	27%
National Data	11 days	5 days	6 days	4 days	31%

2.2 Cannabis Decision Characteristics

[7] Regulatory Determinants of Cannabis Outcomes Survey | Cannabis Public Policy Consulting

Respondents indicated that price is the most important characteristic impacting their decision to access cannabis, followed closely by safety. Whether or not cannabis can be delivered ranked as the least important characteristic by respondents which provides reason that cannabis consumers are willing to participate in a regulated market with limited convenience should price be within a precise point.

Rankings from most important to least important:

1. Price
2. Safety
3. THC or CBD Potency
4. Source
5. Cannabis Strain
6. Convenience
7. Whether it can be delivered

Potential Policy Considerations

- Begin testing cannabis as early as the market will allow for without jeopardizing initial supply
- Ensure labeling requirements prioritize product safety information such as access to Certificates of Analysis for all products

The Regulatory Determinants of Outcomes Survey from August of 2022 found that cannabis consumers residing in states with adult use cannabis programs ranked cannabis product safety to be the 4th most important decision factor. With Marylanders ranking safety second, and extremely close to price, it is suggested that cannabis consumers may adopt the regulated market much faster than observed in other states, particularly when cannabis is tested.

2.3 Reasons for Cannabis Use

Many of those who use cannabis report that they perceive positive effects following their cannabis use. For example, many respondents indicate that their use of cannabis relieves stress, anxiety, or depression (80%), provides feelings of relaxation (78%), helps them feel good or have fun (76%), and helps them get through the day (71%). Few indicate that they experience negative side effects from cannabis use, such as psychotic or paranoid feelings (18%), headaches or migraines (17%), and nausea (13%).

Table 3. Reported Effects Following Cannabis Use

Experiences Following Cannabis Use	No	Yes
Nausea	87%	13%
It helps me get through the day	29%	71%
It relieves stress, anxiety, or depression	20%	80%
It causes headaches or migraines	83%	17%
It makes me feel more focused, aware, or enhances my thinking	38%	62%
It causes elevated anxiety or nervousness	76%	24%
It helps me socially	42%	58%
It gives me suicidal thoughts	89%	11%
It helps me treat symptoms of issues other than stress, anxiety or depression	33%	67%
It gives me psychotic or paranoid feelings	82%	18%

It gives me general feelings of relaxation	22%	78%
It helps me feel good or have fun	24%	76%
It helps improve my appetite	33%	67%

2.4 Reasons for Cannabis Use Post Adult Use Implementation

Participants were asked to indicate how they expect their reasons for using cannabis would change if adult use is implemented in Maryland. Results are shown in Table 4. Respondents typically indicated that their reasons for use would remain the same; however, 50% of participants responded that they would expect to use cannabis *more* for the purposes of relaxation if adult use is implemented. Participants also indicated that they would use cannabis *more* to have fun with others (34%) and to treat medical symptoms or conditions (39%). Participants indicated that they would use cannabis *less* to enhance the experience of using another substance (34%) and to reduce the unpleasant aspects of using another substance (33%) if adult use is implemented.

Table 4. Expected Changes in Cannabis Use Following Adult Use Implementation

Reasons for Cannabis Use After AU	More	The Same	Less
Relaxation	50%	44%	5%
To enhance the experience of using another substance	16%	50%	34%
To reduce the unpleasant aspects of using another substance	16%	50%	33%
Loneliness	16%	53%	31%
To have more fun with others	34%	49%	17%
Treat medical symptoms or conditions	39%	46%	15%
It is part of my identity	20%	51%	29%

Section 3. Demand

3.1 Anticipated Total Cannabis Demand Across All Sources

Total cannabis demand in Maryland during the first year of adult use implementation is estimated to be 824 million grams of cannabis across all sources of cannabis. Notably, 149 million grams of the total cannabis demand, or 22%, is estimated to be made up from tourism from the surrounding states where adult use cannabis is not yet accessible.

- This calculation was acquired by taking the average number of total grams per individual who uses cannabis in the past year in Maryland as is estimated for when adult use begins (25.4 g a month).
- 78% of Marylanders are 18+ years of age[8][9]. We then took the 4.81 million Maryland residents

[8] https://www.census.gov/quickfacts/MD
[9] To stay consistent with other publications on the topic, we utilize the 18+ population as opposed to the 21+ population when deciphering demand. This allows us to account for medical cannabis users under the age of 21 and provide predictive estimates of future market transitions for those coming of age to a regulated system. The quantity of cannabis consumed from respondents aged 18-20 without medical cannabis certifications are considered illicit and have been accounted for initial illicit market demand projections within this report.

who are 18 years old or older, and multiplied by our empirically derived percentage of the population who are estimated to use cannabis in the past year (46%)[10]

- We then take 46% of the approximately 4.81 million residents, which equates to 2.2 million residents who will use cannabis at least once during the first year of implementation of the adult use law.
- We then multiply 2.2 million residents by 25.4 grams by 12 months to arrive at 675 million total grams of demand across all cannabis sources.
- We then added an additional 22% of anticipated sales from tourism, which equates to a final total of 824 million grams
- When converting to grams to pounds, this figure is approximately 1.8 million pounds.

Importantly, this demand is for all cannabis sources (i.e., adult use, medical, home grow, gifting, illicit sources). Based on data from those reporting obtaining an active medical cannabis patient registration in Maryland, medical demand will likely reflect 132M grams of the 824M grams with all things held equal. In a separate survey performed for the Maryland Medical Cannabis Commission, we found that it is unlikely that the medical cannabis program will see attrition at the point of adult use market legalization.

Over the next few years, the regulated cannabis market (i.e., adult use + medical) should work to achieve meeting the *total* empirically derived demand of 824M grams, or 1.8 million pounds, despite this demand figure being observed across other sources, in the hopes of transitioning consumers away from unregulated or illicit cannabis sources to regulated sources.

Finally, Maryland is surrounded by Pennsylvania, Virginia, West Virginia, Delaware, and the District of Columbia, all of which do not currently have adult use cannabis markets. Given COVID interruptions in already deficient tourism data, it is challenging to assess potential tourism sales accurately and empirically. However, given the unique characteristic of the state and its immediate proximity to consumers in five different regions where population density may exist on the boarders, the tourism figure provided may be low. The tourism figure calculated for this study (22%) is based on a Forbes analysis[11].

3.2 Delivery

While delivery was listed as the least important factor among Maryland consumers, having access to delivery would increase regulated sales. Based on survey findings, the demand for cannabis delivery represents a 13% increase in the percent of regulated sales after launching the cannabis market.

New cannabis markets can take anywhere between 12 to 24 months to stand up after passing legalization. With Ballot 4 permitting personal cultivation on July 1, 2023, Maryland will likely have a period of time where cannabis home grows will be utilized before regulated adult use cannabis storefronts are able to open. With the ability to grow cannabis for personal use and an existing illicit market, Maryland may benefit consumers with the ability to procure cannabis from regulated delivery options without retail storefronts to help expedite sales. Given that delivery demand is estimated to

[10] Taken using national cannabis data from the Regulatory Determinants of Cannabis Outcomes (August 2022) on past year prevalence to improve accuracy of estimate as opposed to Maryland specific prevalence.
[11] Cannabis Tourism Is Now A $17 Billion Industry—And It's Just Taking Off (forbes.com)

represent a 13% increase of regulated sales at the point of market launch, providing this procurement option prior to full market launch (i.e., adult use stores open) may increase consumer capture. As such, delivery options that are not dependent on licensed retail store fronts or a privilege of a retail license may be worth pursuit.

3.3 Urban vs Rural Analysis

With respect to present illicit percentage, public health, and demand outcomes, no differences were found for rural vs. urban regions assessed. Notably, when combined with the findings displayed in Section 7.2, this finding suggests that rural vs. urban scores themselves were much less important than factors linked to regions themselves.

3.4 Transit to Walking Analysis

At least 50% of those likely to use cannabis at least once annually during the first year of adult use cannabis in Maryland reported being willing to travel up to 20 minutes to access adult use cannabis. This equates to an average walking distance of about 1 mile. In densely populated cities of Maryland, principally the city of Baltimore, walking is a prevalent mode of transportation. If using the dispensary density calculations used for the rest of the state where travel by car is the predominant travel method, about 37 dispensaries would be recommended. However, given the fact that travel by walking and public transportation is much more common in densely populated metropolitan areas such as the city of Baltimore, we would recommend approximately 70 dispensaries eventually provide adult use cannabis in the city of Baltimore to provide sufficient coverage to about 75% of those interested in accessing adult use cannabis in the city without potentially increasing risk of negative public health outcomes.

POTENTIAL POLICY CONSIDERATIONS

- Permit the adult use market to begin with non-storefront delivery to quickly capture consumer market share and boost regulated sales in the long-term
- Given that delivery licenses have lower start-up costs and barriers to entry than traditional storefronts, this may be an optimal license to reserve for industry members who have been disproportionately impacted by the War on Drugs

Notably, demand for accessing cannabis from adult use stores is multifaceted. The number 2 most important purchase factor impacting cannabis purchase decisions among the sample was safety, following price very closely. This contrasts sharply with most other states with legal cannabis, wherein safety is rarely in the top 3 most important cannabis purchase factors. This suggests that if residents are generally confident in the safety of the cannabis they can access at adult use stores in Maryland, they may be more likely to travel a little further or pay a little more for their adult use cannabis. Relatedly, the median willingness to pay per gram of adult use cannabis is $14, which is very high compared to other legal cannabis states. Maryland residents in this sample also ranked convenience of dispensary as number 6 of 7 purchase factors and if delivery is provided upon implementation of adult use sales, it should be even less important as a decision factor. Together these findings suggest that Maryland is well-positioned to provide adult use cannabis within the confines of demand for the majority who are likely to consume adult use cannabis early in the implementation of adult use cannabis stores.

Section 4. Predicted Adult Use Sales

4.1 Sales Projections Years 1-5

When comparing data from other states with adult use cannabis laws, our data suggest a relatively linear growth in sales that will reach over $240 million per month. This model suggests Maryland's adult use program will reach $1 billion in total cumulative sales at month 20 of adult use implementation. The linear model fits the data well (i.e., 99%), which suggests it is likely an accurate prediction of future sales.

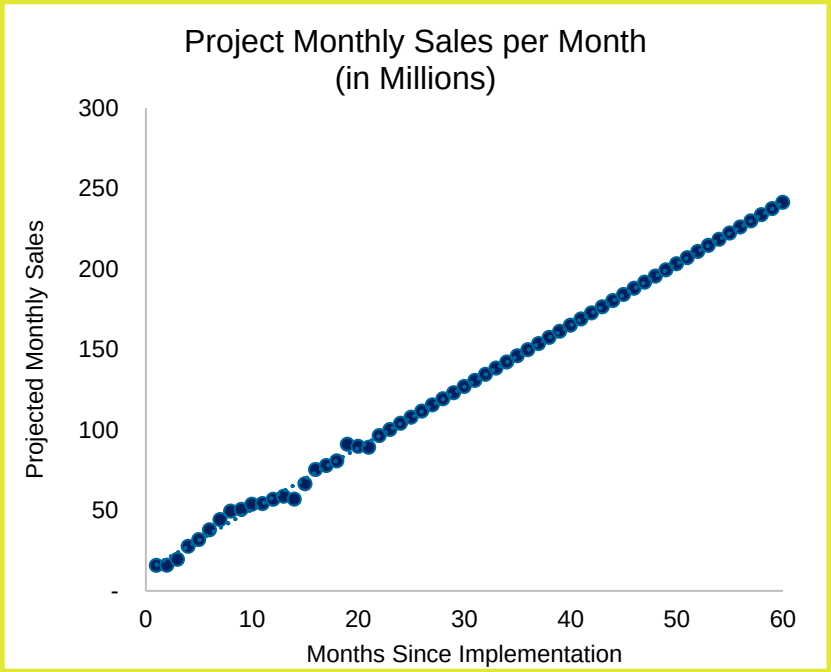

Figure 3. Adult Use Sales Projections by Months

Notably, Figure 3 provides an overall view of the trend in projected adult use cannabis sales for Maryland. In contrast, Figure 4 details the percent change from one month to the next in adult use cannabis sales.

4.2 Month to Month Predicted Sales Changes

As can be seen in this figure, the first 6 or 7 months after the adult use market opens are by far the most flexible in terms of potential for change, although there does appear to be a small resurgence in opportunity around 1.5 years after implementation, which may be due to disproportionate price drops, in turn driving consumer shifts to the adult use market. Notably, this graph provides more insight than predictive month to month changes in sales alone as it also indicates two important market takeaways that have been validated by observing other state trends and with our professional experience.

First, this statistical modeling shows that the first 6 or 7 months of adult use cannabis market launch set the predictive trajectory for long-term market outcomes further demonstrating that cannabis markets are subject to path dependence. This can be interpreted to mean that a state with a successful cannabis market launch without *significant* programmatic interruptions in the first 6 months of sales are more likely to see successful long-term market outcomes like sales and percentage of consumer market share (i.e., regulated vs illicit). Examples of policy or programmatic interruptions may range from significantly insufficient supply as a result of improperly low cultivation, to insufficient retail access points due to common litigation and injunctions in the licensing phase, to

considerable locality opt-outs. These types of programmatic dependencies should be avoided to increase the likelihood of market success in the first 6 months, and months thereafter. Markets that do experience considerable interruptions in the early days of launch can be expected to have a challenging time catching up to where their market's performance should predictively be.

Second, the model shows that the cannabis market is particularly volatile the first few years of implementation. This is likely a result of the market adjusting to new entrants, supply chain efficiencies, and consumer demand changes. With a concerted implementation and launch effort that attempts to meet demand in the first two years, Maryland can expect the market to become more stable around year 3, as shown in Figure 4, when market share is expected to increase. This finding has been substantiated across other states and indicated generally in other studies[12].

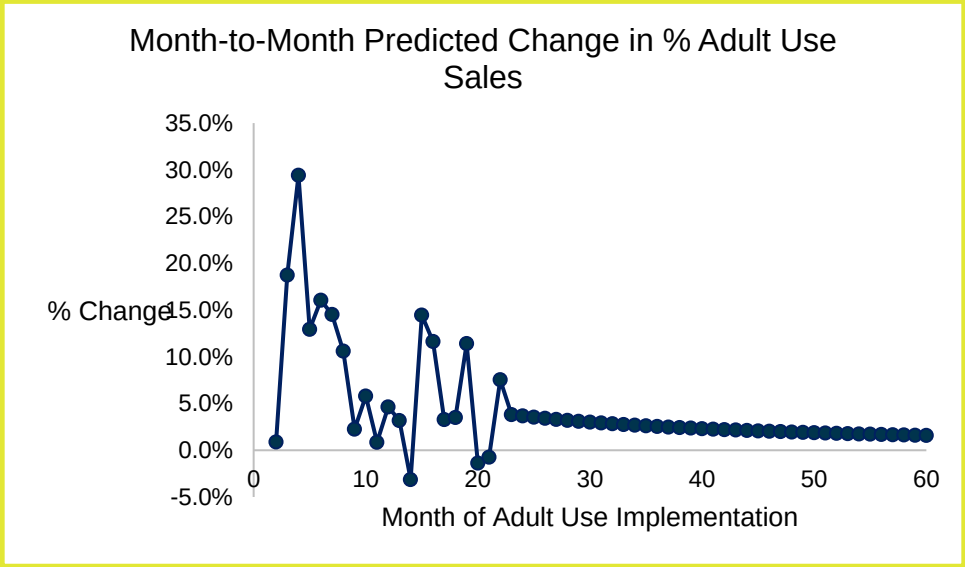

Figure 4. Month-to-Month Predicted Change in %

Section 5. Taxation and Market Share Modeling

To best regulate adult use cannabis and limit illicit cannabis, it is important to consider that the effects of the number of regulated adult use dispensaries, the tax rate, and time (months) after beginning adult use implementation each interact to impact the percentage of illicit (and regulated) cannabis use accessed over time.

Tables 5, 6, and 7 detail the predicted percent of cannabis in Maryland that is estimated to be illicit cannabis by month after adult use implementation, the range of number of total regulated dispensaries upon implementing adult use, and presumed tax (i.e., sales and excise). These tables represent predictions for the first, third, and fifth years after adult use implementation, averaged across every 3 months. For example, Table 5 presents the predicted percent of illicit cannabis during the first year after adult use implementation. If there are 100-250 regulated dispensaries in

[12] https://www.rand.org/pubs/research_reports/RR3138.html

Potential Policy Considerations

- While cannabis taxation can occur multiple times throughout the supply chain and be a represented as a flat rate or a percentage, remaining within a total *effective* taxation range of 15-20% will result in greater market share year over year
- Should adult use cannabis dispensary licenses be limited, remaining within a range of 260-500 would benefit regulated market share without likely impacting public health

Maryland, and an effective tax rate of 15%, illicit cannabis is predicted to comprise 44% of the cannabis market in Maryland between months 5-8 after adult use implementation. If there are 260-500 regulated dispensaries, and an effective tax rate of 10%, it is predicted that illicit cannabis will comprise nearly 36% of the cannabis market during months 9-12. Table 7 presents the predicted percent of illicit cannabis use in year 3 after adult use implementation, when regulated market share is expected to increase as discussed in the prior section. If there are 500-800 regulated dispensaries with a tax rate of 25%, illicit cannabis is estimated to comprise 33% of the cannabis market during months 33-36.

These predictions suggest that a higher effective tax rate (e.g., 30%), will lead to a higher amount of illicit cannabis on the market, regardless of year after adult use implementation and number of dispensaries. Conversely, a lower tax rate will lead to a lower amount of illicit cannabis. These findings also indicate that overall illicit cannabis availability will remain highest during the first year after adult use implementation and will gradually decline in the following years, as consistently observed with other states. This is sensible considering the time it will take to increase the number of dispensaries in the state and the time it will take for individuals to become acquainted with the adult use market. Generally, illicit cannabis is predicted to decline as the number of dispensaries increases, since individuals have more access to obtain regulated adult use cannabis.

Based on findings from this study and the national Regulatory Determinants of Health Outcomes data, greater illicit cannabis use is negative for market, tax, and public health outcomes. Further the first 6-months of adult use implementation carry disproportionate weight in regard to the degree of shift to regulated market. Moreover, we found that the dispensary density range consistent with the 260-500 dispensary range in tables below would produce notable decreases in illicit use while likely *not negatively impacting cannabis-related harms* relative to existing trends (see Section 7 below).

Table 5. Predicted illicit cannabis % between months 1-12 after adult use implementation.

Number of Dispensaries	Effective Tax Rate	Month of Implementation		
		1 – 4	5 - 8	9 - 12
100-250	10%	43%	42%	41%
	15%	45%	44%	43%
	20%	47%	46%	46%
	25%	49%	49%	48%
	30%	52%	51%	50%
260-500	10%	38%	37%	36%
	15%	40%	39%	38%
	20%	42%	41%	41%
	25%	44%	44%	43%
	30%	47%	46%	45%
500-800	10%	33%	32%	31%
	15%	35%	34%	33%
	20%	37%	36%	36%
	25%	39%	39%	38%
	30%	42%	41%	40%

Table 6. Predicted illicit cannabis % between months 25-36 after adult use implementation.

Number of Dispensaries	Effective Tax Rate	Month of Implementation		
		25 – 28	29 - 32	33 – 36
100-250	10%	38%	37%	36%
	15%	40%	39%	38%
	20%	42%	42%	41%
	25%	45%	44%	43%
	30%	47%	46%	45%
260-500	10%	33%	32%	31%
	15%	35%	34%	33%
	20%	37%	37%	36%
	25%	40%	39%	38%
	30%	42%	41%	40%
500-800	10%	28%	27%	26%
	15%	30%	29%	28%
	20%	32%	32%	31%
	25%	35%	34%	33%
	30%	37%	36%	35%

Table 7. Predicted illicit cannabis % between months 49-60 after adult use implementation.

Number of Dispensaries	Effective Tax Rate	Month of Implementation		
		49 - 52	53 - 56	57 - 60
100-250	10%	33%	32%	31%
	15%	35%	34%	34%
	20%	38%	37%	36%
	25%	40%	39%	38%
	30%	42%	41%	41%
260-500	10%	28%	27%	26%
	15%	30%	29%	29%
	20%	33%	32%	31%
	25%	35%	34%	33%
	30%	37%	36%	36%
500-800	10%	23%	22%	21%
	15%	25%	24%	24%
	20%	28%	27%	26%
	25%	30%	29%	28%
	30%	32%	31%	31%

Based on these models accounting for the effects of the three main variables in cannabis market capture, assuming supply is naturally progressing with the modeling made in Section 7, the optimal effective tax rate (i.e., the total percent of taxation that can be passed among the supply chain as an overall function of price) is between 15-20%.

Section 6. Drivers of Demand

6.1 Anticipated Driving Time

Currently, respondents indicate that they travel between 5-10 minutes to purchase cannabis. Respondents indicated that if an adult use cannabis law is implemented in Maryland, they would be willing to travel up to 11-20 minutes to purchase cannabis. This is significant for modeling optimal regions of where the 260-500 dispensaries should be positioned (see Section 7.2).

6.2 Willingness to Pay

The above findings suggest that upon reaching $10 per gram pricing, between 75%-90% of all cannabis accessed in Maryland will be through regulated sources. Upon launching the adult use market in Maryland, the average cost of cannabis from a production standpoint without consideration of taxes is likely somewhere between $12 and $17 per gram if following other state standards. Importantly, prior to our simulations of potential optimal cannabis tax rates for the adult use market, we first contextualized how sales and excise taxes can impact the core price of cannabis. In other words, if market conditions cost $17 per gram to supply, a 40% combined sales

and excise tax would lead to a point-of-sale cost of $23.80 per gram. In contrast, a 15% combined tax would only lead to a $19.60 per gram cost. The closer the market can get to achieving $10 per gram with the effective tax as a function of total price, the better for short and long-term outcomes.

Section 7. Supply

7.1 Anticipated Supply Needs for All Demand to Be Met

The total demand estimate of approximately 824 million grams is an estimate of all cannabis for the state of Maryland. In year 1, we anticipate regulated medical and adult use cannabis will make up about 48% of total cannabis accessed in Maryland, which equates to 872,000 pounds and about 1.16 million plants. To achieve double the supply per demand, which has been observed as a positive ratio, there would need to be 2.3 million plants at minimum (supply at 2x demand) for both the medical and adult use program combined. This proportion has been observed in Maine, a state with successful market capture in only a few months since implementation. At the end of year one of their market launch, supply represented approximately the same figure[13]. There is limited data and no validated research on how to arrive at an "ideal" supply number given the challenge of conversions to products and the anticipation of cannabis waste and destruction that occurs notably in the beginning of new cultivation. As always with research, using real data from Track and Trace data sets with comparable markets and populations is the superior approach to arriving at a methodology for assuming supply as opposed to making vast mathematical assumptions. However, Track and Trace data from first years of adult use cannabis programs are extraordinarily limited and disparate across the country. Moreover, criticism of other state's market launch and a pervasive narrative of under supply, or the jeopardizing of medical cannabis supply, has posed challenges to say what market should serve as a benchmark.

POTENTIAL POLICY CONSIDERATIONS

- Consider the total adult use cannabis demand figure as a goal to be met through scalability of supply, as opposed to a day 1 figure for increased positive future market outcomes

Given these limitations and the success observed in Maine, we defer to the 2x marker as a general rule of thumb and use figures derived from them as estimates. However, this rule of thumb is likely a low-end estimate and should not be misconstrued to be a precise ceiling.

As stated before, the adult use supply figure is based off all *possible* adult use consumers, and as such cannabis supply should be aimed to meet this total figure over the next three years of market launch. Scalablity is vital to discuss in the context of supply modeling.

Based on our experience and what we have observed in various data sets, it may be advantageous to meet a substantial portion of the total adult use demand in year one by allocating a significant portion of total cultivator licenses in year 1, and then scale up in subsequent years.

[13] https://www.maine.gov/dafs/ocp/sites/maine.gov.dafs.ocp/files/inline-files/Maine%20OCP%20AHP%20Report%2006-22_0.pdf

The argument for scalability from year to year as opposed to attempting to meet all demand in year one is to prevent an immediate onset of supply matching, or outpacing demand. Inevitably, and as our models show us, consumers who are not yet ready or unwilling to transition to a regulated market will remain within an illicit market (35-45%). If all adult use cannabis supply matches the total figure of demand in year 1 (824M g), but cannabis demand does not *yet* meet supply even, when employing policy levers that enhance the adoption rate for the regulated market (i.e., delivery, testing, 15% taxation and 260-500 dispensaries), the market may be at risk for immediate oversupply. When oversupply happens quickly, the market may fluctuate to what has been referred to as a Boom-and-Bust Cycle, observed most notably in Oregon's market in 2019.[14] These are cycles where cannabis supply exceeds demand so greatly that prices drop significantly. As a result, cultivators and processors either pause production until products move, or operate at a reduced capacity. When demand eventually begins to meet supply, prices increase again. This can alter total cannabis market share.

Balancing the needs of supply to meet that of demand is a very fine line to walk because of these very specific nuances that are challenging to quantify. It is because of this that, if limiting cultivation licenses, it may be opportunistic to be generous in license and subsequent canopy allocation in the first year as a function of the total allotment required to meet total demand, while scaling up in later years.

Additionally, it is becoming increasingly common to begin sales with medical cannabis cultivators that can jump start the market quickly. For the calendar year of 2022, Maryland's medical cannabis program has transferred between 250,000-275,000 lbs of cannabis from processors to dispensaries.[15] Presuming a dual licensing opportunity for medical cannabis cultivators to grow for adult use purposes and should the medical cannabis market launch the program with current and existing capacity, this figure would only make up 8% of the total regulated market supply needs based on below modeling. Notably, the portion of regulated medical cannabis demand is about 16% of the total demand across all sources. Given the precise alignment of these proportions, it is important that medical cannabis supply is not jeopardized for adult use purposes, and there appears a need to increase medical cannabis supply.

Unlike the former tables that exclusively employ advanced statistical models, Table 8 utilizes statistical modeling in combination with practical real-world experience and sensible market observations to identify the targeted scalability goals for supply to meet demand by the end of Year 5. This modeling accounts for anticipated growth rates in the percent of total cannabis that is purchased from adult use sources.

Figures presented below are estimates using conversative 1.33 plant to pound ratios empirically observed in other studies with Track and Trace data.[16] It is important to note that indoor and outdoor cultivation will produce different plant yields and have different harvest cycles, with outdoor cultivation being substantially less. For indoor cultivation, different lights and growing techniques will also produce a variance in yield. While we use the 1.33 plants to pound ratio, or 1 plant produces approximately 0.75 pounds, for this modeling, it should be noted that this figure will be largely dependent on the types of cultivation allowed and utilized across the state. Additionally, this conversion ratio is likely to be higher-end estimate for new cultivators as they perfect their growing practices to produce higher yields.

[14] https://www.latimes.com/nation/la-na-oregon-legislature-tackles-supply-marijuana-20190624-story.html
[15] Provided by MMCC
[16] https://docs.wixstatic.com/ugd/32d78a_ef4e83d7017e4258b77787216ce8e966.pdf

Table 8. Scaling Supply to Meet Demand and Capture Market Share by Year.

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Demand (g)	824M	824M	824M	824M	824M
AU Demand	264M	321M	404M	453M	470M
AU Sold as Proportion of All Cannabis Sources	32%	39%	49%	55%	57%
Minimum AU Supply (2x Demand) in Total Harvested Plants	**1.5M**	**1.9M**	**2.4M**	**2.7M**	**2.8M**
Medical Demand (g)	131M	131M	131M	131M	131M
Total Medical + AU (g)	395M	452M	535M	584M	601M
Minimum Medical + AU Supply in Total Harvested Plants	**2.32M**	**2.66M**	**3.14M**	**3.42M**	**3.52M**

Individual plants counts are a primary modeling metric used in cannabis research, however, when drafting policy, the use of canopy as a primary metric is more common. Canopy sizes (SqFt) are typically set as parameters for allowable plants within states, particularly in seen cultivation license tiers. Some states such as Washington define canopy as for all plant production[17], whereas other states like Oregon employ immature and mature canopy limitations as to differentiate the stages of production[18]. Importantly, the figures identified above are assumed as the total harvested plants. Mature cannabis plants can have multiple harvest cycles. Prior to translating these figures into assumed canopy sizes, we must approximate the mature plants that Maryland should have in their adult use system at any given time. To do this, we assume 4 harvest cycles per plants in Table 9.

Table 9. Scaling Supply to Meet Demand and Capture Market Share by Year – Mature Plants.

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Demand (g)	824M	824M	824M	824M	824M
AU Demand	264M	321M	404M	453M	470M
AU Sold as Proportion of All Cannabis Sources	32%	39%	49%	55%	57%
Minimum AU Supply (2x Demand) in Total Harvested Plants	1.5M	1.9M	2.4M	2.7M	2.8M
Minimum AU Supply (2x Demand) in Mature Plants at Any Given Time	**375K**	**475K**	**600K**	**675K**	**700K**

As previously discussed, the variance in canopy definitions make conversions from plants to canopy imperfect. Past studies indicate a range of 1 plant for each square foot, to 2.44 plants for each square foot.[19] To be conservative and use the most empirical figure (i.e., a number derived by data

[17] WAC 314-55-010
[18] OAR 845-025-2000
[19] https://docs.wixstatic.com/ugd/32d78a_ef4e83d7017e4258b77787216ce8e966.pdf

as opposed to assumptions), we model out the total adult use plants required by a 1 plant per 2.44 square foot ratio in Table 10.

Table 10. Scaling Supply to Meet Demand and Capture Market Share by Year – Mature Plant Canopy.

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Demand (g)	824M	824M	824M	824M	824M
AU Demand	264M	321M	404M	453M	470M
AU Sold as Proportion of All Cannabis Sources	32%	39%	49%	55%	57%
Minimum AU Supply (2x Demand) in Total Harvested Plants	1.5M	1.9M	2.4M	2.7M	2.8M
Minimum AU Supply (2x Demand) in Mature Plants at Any Given Time	375K	475K	600K	675K	700K
Assumed Mature Plant Canopy (SqFt) to meet AU Demand	**915K**	**1.16M**	**1.46M**	**1.65M**	**1.7M**

The assumed mature plant canopy required to meet adult use demand is specific to that of mature plants. Based on this modeling, there is likely a need for additional canopy square footage to account for immature and vegetative plants to ensure a continuous supply.

Identifying a feasible and scalable supply projections for an emerging market is important to ensure successful long-term market outcomes. However, because conversion ratios are imperfect, cultivation and production practices will be new, and the nature of the market may be subjected to things beyond that of regulatory control, identifying a precise number is less vital than identifying the policy levers that allow for production management.

POTENTIAL POLICY CONSIDERATIONS

- Annual license capitation may be a possible policy solution for a controlled market launch as demand modeling shows opportunity for new entrants each year even when providing a large proportion of total supply in year one
- Ensure production management policy levers and necessary powers are provided to the regulatory body to allow for real time reactions to market conditions

The most fundamental policy lever to ensure a controlled roll out is capitation for cultivation licenses, and subsequently the canopy associated with each license. Some states have included annual licensing limits as to ensure a controlled roll out, while allowing new market entrants over time. Our modeling showcases that there will be room in the market for new entrants every year as consumers transition, should limitations be put on supply. A secondary policy lever states utilize is the ability to increase the market, be it in canopy sizes or by all license types if capitated, based on an annual market analysis. Should an oversupply be observed, regulatory bodies must have the authority and powers to be able to limit new entrants. States like Oregon have had to issue a moratorium on cannabis licenses as an attempt to

remedy an oversaturated market.[20] Providing these powers and opportunities for real-time reaction for production management may be more important and more realistic than identifying a perfect supply number.

7.2 Dispensary by Region Optimization

Based on our modeling across 20 legal cannabis states juxtaposed with our Maryland specific data, adding 101 adult use stores during the first year of Maryland's adult use implementation for a total of approximately 300 cannabis dispensaries in Maryland may be an optimal number of dispensaries to shift consumption from illicit markets to the adult use market *without adding notable public health risks*. Specifically, comparisons of existing dispensary numbers by county did not relate to increased risks of any public health outcomes in the current medical system. Moreover, when extrapolating to use patterns upon implementation of adult use, the number of dispensaries had even less impact on negative cannabis-related outcomes such cannabis use disorder prevalence and driving under the influence, likely the two most costly negative cannabis-related outcomes. Indeed, several findings corroborate that greater illicit access is linked to such negative cannabis-related outcomes whereas anticipated regulated use from medical and adult use sources either is unrelated or is related to a lesser extent.

POTENTIAL POLICY CONSIDERATIONS

- 300 dispensaries will facilitate market capture without diminishing returns on cannabis related health outcomes
- Montgomery County, Prince George's County, Baltimore County, and Anne Arundel County are imperative regions for cannabis retail activity to be permitted to capture market share

Figure 5 represents the percent of regulated cannabis in each Maryland County at the end of the first year of adult use implementation. This map indicates that Frederick and Carroll counties will have the highest estimated percentage of regulated cannabis in the state at the end of the first year, at 79% each. Garrett, Allegany, Washington, Harford, Cecil, Kent, and Howard counties have similar estimated percentages of regulated cannabis, at 72-73%. This map also suggests that Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Worcester, and Somerset counties will have the lowest estimated percentage of regulated cannabis at the end of the first year. In other words, these counties are expected to have the highest percent of illicit cannabis in the state; therefore, it is important that the regional distribution of dispensaries be addressed to combat the high expected percentage of illicit cannabis particularly expected in these counties.

[20] https://www.cannabisbusinesstimes.com/article/oregon-olcc-cannabis-license-moratorium-cease-issue/

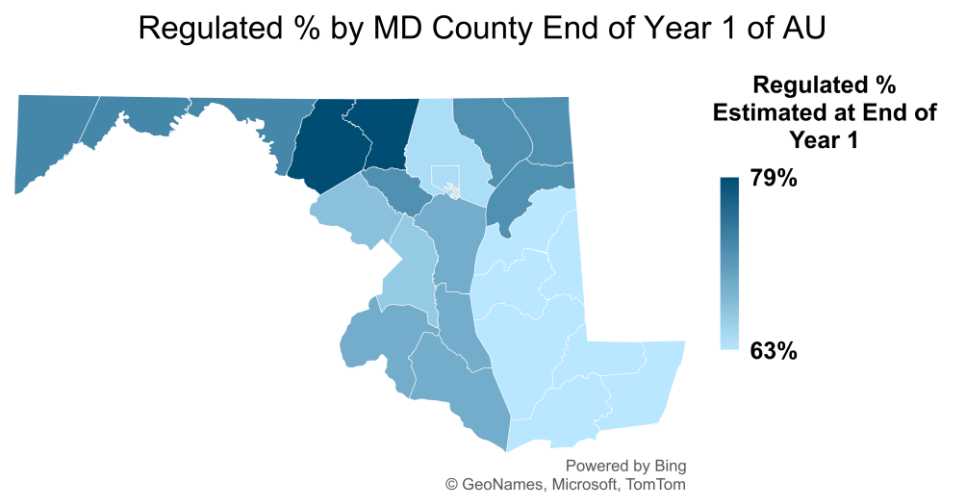

Figure 5. Percent of Regulated Cannabis expected After the First Year of adult Use Implementation by County

That being said, individuals in these counties also indicate willingness to pay a higher price per gram for adult use cannabis relative to surrounding counties, as represented in Figure 6. This is suggestive of a high relative demand for adult use cannabis in these counties as individuals in these counties are willing to pay more to have access to adult use cannabis. Considering this, it may be important to concentrate dispensary distribution efforts disproportionately, particularly in these counties to reduce rates of illicit use. By contrast, many counties expected to have a low percentage of illicit cannabis (Frederick, Carroll, Harford, Cecil, and Kent counties) indicate being willing to pay the lowest amount per gram compared to other counties, suggestive of a lower demand for adult use cannabis in these areas.

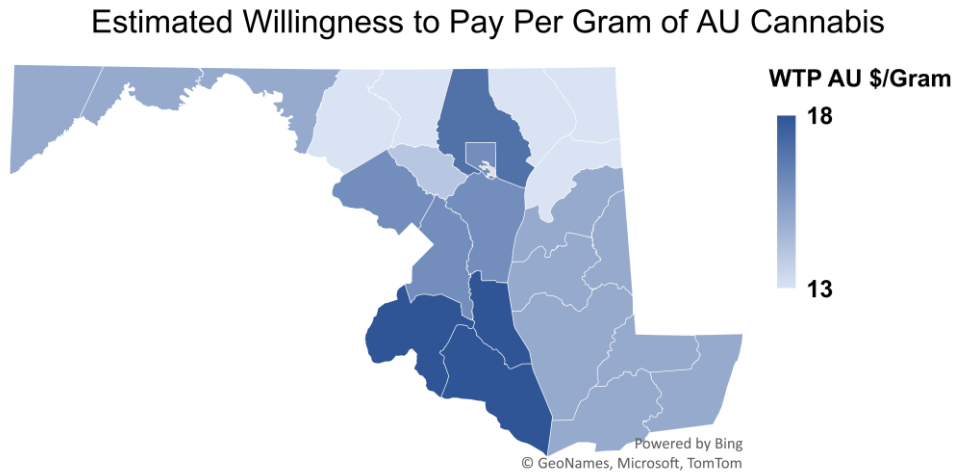

Figure 6. Expected Willingness to Pay Per Gram of Cannabis After Adult Use Implementation by County

Based on our suggestion to reach 300 dispensaries providing adult use cannabis to consumers, we have provided recommendations for total dispensaries per county in Maryland, presented in Figure 7. This estimation was based on a previous dispensary density calculation specifically for this report

Potential Policy Considerations

- Much like supply, dispensaries may also be best scaled into years 2 and 3, with a generous proportion allocated in year 1

which determined a ratio of 17,000 residents per dispensary. For example, we suggest a total of 6 dispensaries in Harford, Cecil, Kent, and Frederick counties. The counties with the highest total recommended number of dispensaries are in Montgomery County (48), Prince George's County (43), Baltimore County (39) and Anne Arundel County (27). It is important to note that one additional dispensary was added to our recommendations in Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Worcester, and Somerset counties to assist in shifting individuals to the regulated market in these areas.

Although we have recommended a total of 300 dispensaries within the state of Maryland, it is critical to note that this number is an estimate and not an exact number. In general, 260-500 dispensaries is the optimal range of total dispensaries over the course of several years, and not immediately upon adult use implementation. The addition of adult use dispensaries to fit within this range is particularly important come years 2 and 3.

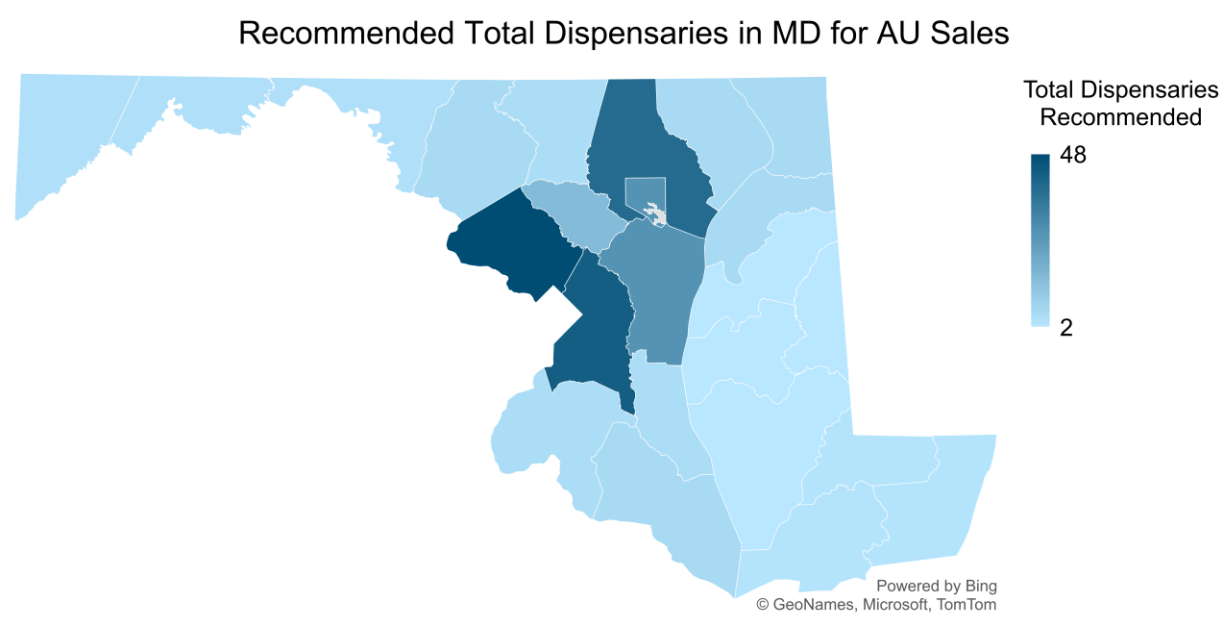

Figure 7. Recommended Number of total dispensaries in Maryland by County

Section 8. Public Health and Safety Outcomes

Most respondents currently report that they do not use cannabis before, during, or at work (64%). 9% report that they use cannabis before work and during/at work. When asked how their use of cannabis would change if adult use is legalized in Maryland, respondents indicate that their use of cannabis surrounding work would remain about the same.

Each of the following cannabis-related public health prevalence estimates are contextualized within the 2.2 million Maryland residents who use cannabis at least annually. For this population, our survey findings show the following:

- Over one third consume cannabis before or during work (36%) and have driven under the influence of cannabis (DUIC) at least once in the past month (37%). Among those who reported DUIC in the past month, the average number of days of DUIC was 11 days per month. This equates to at least 57 million instances of DUIC per year in Maryland.
- About 38% demonstrated problematic cannabis use patterns exemplified by reporting at least occasional issues with not able to stop using cannabis once they started, experiencing memory and/or concentration issues from cannabis, or devoting a great deal of your time to getting, using, or recovering from cannabis.
- Participants reported prevalent experiences with negative, acute, cannabis-related experiences including cannabis-induced suicidal ideations (11%), psychotic or paranoid feelings (18%), and elevated anxiety or nervousness (24%).

Importantly, respondents within this sample in Maryland demonstrate statistically comparable rates of negative health outcomes compared to 25 other surveyed states across the United States including:

- Cannabis use during/before work
- Driving under the influence of cannabis use
- Problematic cannabis use
- Elevated anxiety and nervousness
- Suicidal ideations
- Psychotic/paranoid thoughts