MPG | MARIJUANA POLICY GROUP

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The Economic Impact of Marijuana Legalization in Colorado

Prepared by

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SYNOPSIS

The Marijuana Policy Group (MPG) has constructed a new model that accurately integrates the legal marijuana industry into Colorado's overall economy. It is called the "**Marijuana Impact Model**."

Using this model, the MPG finds that legal marijuana activities generated **$2.39 billion** in state output, and created **18,005 new Full-Time-Equivalent (FTE) positions** in 2015.

Because the industry is wholly confined within Colorado, spending on marijuana creates **more output and employment per dollar spent than 90 percent** of Colorado industries.
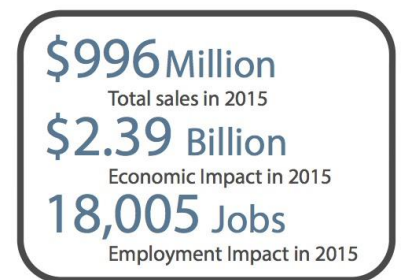
Recent studies have attempted to capture impacts by using proxy data or invalid assumptions. Some of those studies are shown to generate grossly erroneous results. **This study utilizes official data to overcome those mistakes** and sets a clear record for future reference.

Legal marijuana demand is projected to grow by 11.3 percent per year through 2020. This growth is driven by a demand shift away from the black market and by cannabis-specific visitor demand. By 2020, the regulated market in Colorado will become saturated.

Total sales value will peak near $1.52 billion dollars, and state demand will be 215.7 metric tons of flower equivalents by 2020. Market values are diminished somewhat by declining prices and "low-cost, high-THC" products.

In 2015, **marijuana was the second largest excise revenue source**, with $121 million in combined sales and excise tax revenues. Marijuana tax revenues were three times larger than alcohol, and 14 percent larger than casino revenues. The MPG projects marijuana tax revenues will eclipse cigarette revenues by 2020, as cigarette sales continue to decline. Marijuana tax revenues will likely continue increasing as more consumer demand shifts into the taxed adult-use market.

As a first-mover in legal marijuana, the Front Range has witnessed significant business formation and industry agglomeration in marijuana technology (cultivation, sales, manufacturing, and testing). This has inspired a moniker for **Colorado's Front Range as the "Silicon Valley of Cannabis."**

$996 Million	Total sales in 2015
$2.39 Billion	Economic Impact in 2015
18,005 Jobs	Employment Impact in 2015

Secondary marijuana industry activities quantified for the first time in this report include: warehousing, cash-management, security, testing, legal services, and climate engineering for indoor cultivations.

Caveats: The impact of marijuana legalization upon tobacco and alcohol use is not included here. Similarly, issues such as public health, energy use, public education, enforcement costs, incarceration costs, or worker productivity are not considered in this assessment.

SECTION I. THE CANNABIS INDUSTRY IN COLORADO

With almost $1 billion in spending in 2015 ($996 million), the marijuana industry clearly plays an economic role in Colorado. Until now, it has been impossible to accurately characterize how this industry impacts the overall state economy.

In order to estimate the state-level economic effects of legalization, the Marijuana Policy Group (MPG) has constructed the world's first *marijuana economic impact model*. This new model can help voters, policymakers, and regulators understand how marijuana legalization impacts the state economy in terms of output, tax revenues, GDP, and employment.

I-1. INDUSTRY STRUCTURE

The MPG's marijuana impact model divides the industry into three segments: cultivation, manufacturing, and retailing. Each segment is represented using a unique production function with differing inputs, outputs, and linkages to the economy.

These segments are then integrated into Colorado's production and consumption structure, in order to reveal how marijuana spending impacts the economy overall.

State-level control of cannabis creates a highly-localized industry. Almost all spending on marijuana flows to workers and businesses within the state. As a result, *the marijuana industry generates more local output and employment per dollar spent than almost any other Colorado sector*. Only government program spending generates more employment and output per dollar spent.

Figure 1 shows the relative impact of marijuana, in the context of other, more traditional industries in the state.

Figure 1.
Economic Impact of Spending for Major Industries in Colorado

For every [dollar] spent on:

Federal Government =	$2.42
Marijuana Retail =	**$2.40**
Marijuana Manufacturing =	**$2.34**
Business Services =	$2.25
Marijuana Cultivation =	**$2.13**
General Manufacturing =	$1.94
Retail Trade (incl. alcohol) =	$1.88
Mining Activities =	$1.79
Casinos =	$1.73
Racing Track Operations =	$1.51

Note: Impact result will be different in other states and regions.

Applying the marijuana impact model to Colorado, it was found that each dollar spent on retail marijuana generates $2.40 in state output. This compares favorably with general retail trade, which yields $1.88 per dollar. The more traditional (*and sometimes subsidized*) mining sector generates $1.79 per dollar. General manufacturing generates $1.94 per dollar, and casinos generate just $1.73 per dollar of spending. Other industries have lower output yields because their inputs are sourced from outside of the state, or because the profits are remitted to corporate owners that exist primarily outside of the state as well.

Figure 2.
Proposed Industrial Classification for Marijuana Industry Sectors (_Not Actual NAICS Codes_ — Suggested Codes Only)

Cultivation	
111419	Other Food Crops Grown Under Cover
111421	Nursery and Tree Production
111422	Floriculture Production
111810	**Marijuana Cultivation**
111910	Tobacco Farming
111920	Cotton Farming
111992	Peanut Farming

Manufacturing	
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311340	Nonchocolate Confectionery
311345	**Infused Marijuana Product**
311351	Chocolate and Confectionery
311411	Frozen Fruit and Juice Manufacturing
311412	Frozen Specialty Food Manufacturing

Retailing	
453310	Used Merchandise Stores
453920	Art Dealers
453991	Tobacco Stores
453992	**Marijuana Stores**
454111	Electronic Shopping
454210	Vending Machine Operators
454390	Other Direct Selling Establishments

I-2. Integrating the Marijuana Industry into the Economy

Industrial Classification: In order to integrate marijuana activities into the overall economy, each segment of the industry is inserted into the state's economic accounts.

For example, the marijuana cultivation sector is inserted between Floriculture Production and Tobacco Farming. Retail stores and dispensaries are inserted as a type of specialty retail store, and finally, infused product manufacturers are included as part of the food manufacturing sector.

In this way, the production activities for each marijuana segment can be connected with the rest of the Colorado economy.

Business Spending Patterns: Next, the MPG constructed "business spending patterns" for each industry segment, in order to trace how marijuana spending flows through the state's economy. Since marijuana is currently a cash-only business and is confined within the state, most of the cash accrues directly to local cultivation and manufacturing. Financial services are limited, and instead funds are spent on security and cash transportation services, such as armored vehicles. Figure 3 (following page) shows the approximate business spending patterns for each segment of the marijuana industry in 2015.

The largest spending category for retailers is the product itself (marijuana flower),[1] followed by employee payrolls, business rent, security services, compliance, and consulting services.

Cultivation in the Denver region is almost exclusively indoors, making electricity and HVAC the largest portion of spending, next to fertilizers, pesticides, and other agricultural inputs. Payrolls round out the largest components of spending for cultivators.

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[1] Vertically-integrated operations do not explicitly account for the cost of marijuana flower. The MPG uses average market rate pricing to convert the implicit pricing for these firms into an explicit cost for the retail operation and an explicit revenue for the cultivators, even if the cash is not directly transferred between these departments within a single, vertically-integrated firm.

Figure 3.
Business Spending Categories for the Marijuana Industry
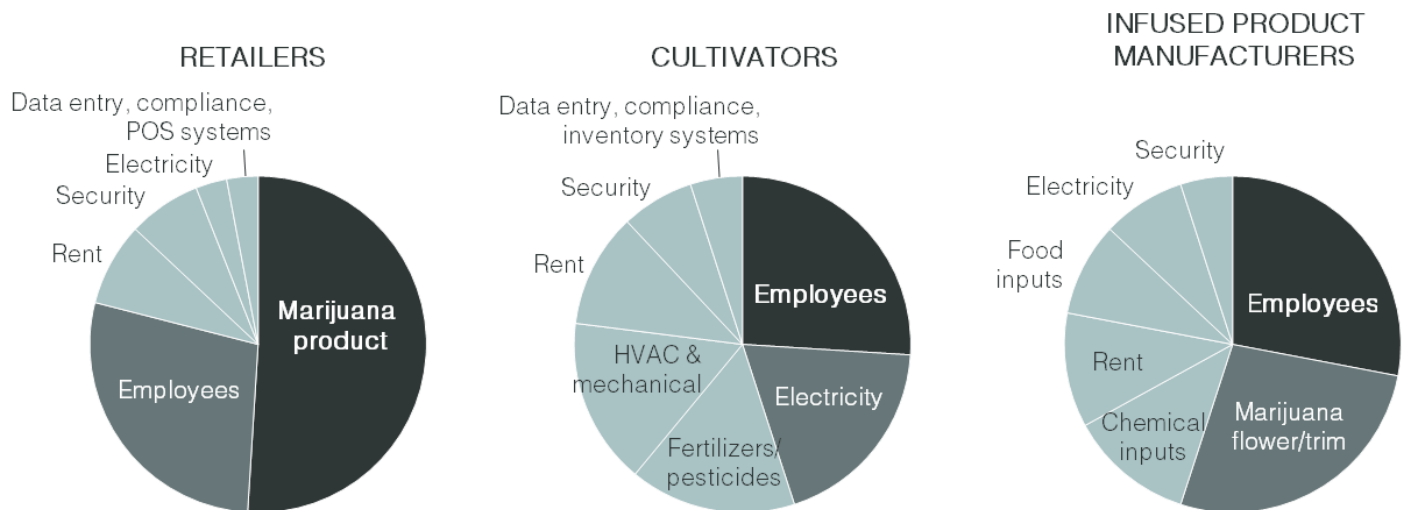
Infused product manufacturers purchase marijuana trim and flower as the primary input to production, followed by other food products, then machinery rents, payrolls, warehouse rental (or imputed rent), security and cash management services, and chemicals. All three segments of the marijuana industry have increased their spending on product safety and testing services. Firms in Colorado are now required to test for potency and product safety, including pesticide residue and other harmful chemicals.

As the marijuana industry has matured over the last two years, it has become more structured, organized, and competitive. This has created demand for specialized law firms, consultancies, and for professional service providers such as the MPG. These firms provide industry-specific analysis and advice to private enterprise and government regulatory agencies.

As the need for analysis and advice grows within the private sector and government agencies, so has the legal and consulting segment of the marijuana industry. Investment banking and business valuation services are additional examples of ancillary demand that are related to the marijuana industry.

By identifying each segment, then classifying and quantifying the activities, they can be inserted into the State Economic accounts for Colorado. From there, an Input-Output model is constructed, and the impact of marijuana spending can be computed for the state. Section 4 contains a full technical description of the model.

In 2014, during Colorado's first year of fully legal regulated sales, there were 71.6 metric tons of marijuana flower sales, and 4.1 million units of non-flower sales from the legal marketplace. Total sales value was $699 million.

SECTION I. THE CANNABIS INDUSTRY IN COLORADO

SALES

Total $996 Million

Total $699 Million

	Retail	Medical
2014	44.8%	55.2%
2015	59.0%	41.0%
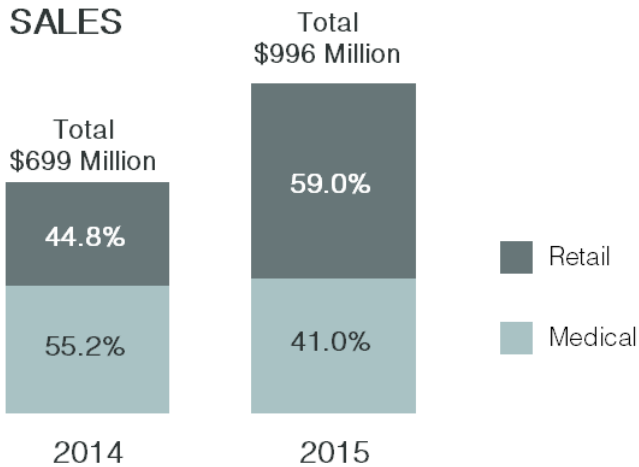
In 2015, sales grew by 42.4 percent, to $996 million, while quantities rose to 112.0 metric tons of flower and (approximately) 10.7 million units of non-flower items. The MPG now uses their *flower-equivalent* system to convert non-flower products (e.g., concentrates, edibles) into a "flower equivalent" amount. Altogether, 132 metric tons of *flower-equivalent* marijuana products were sold in 2015.
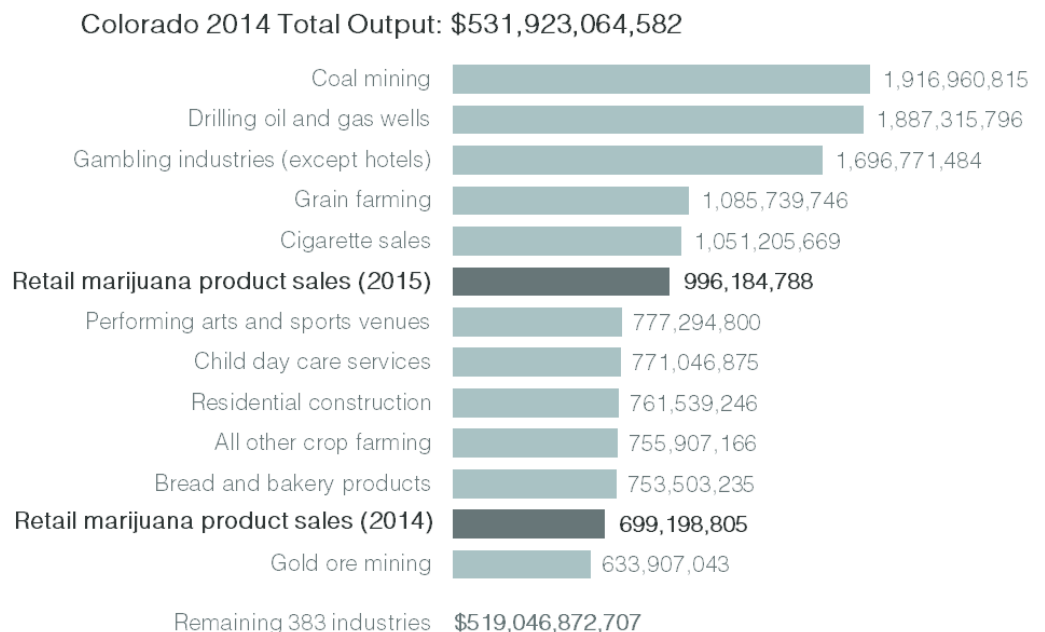
The legal marijuana industry is larger than many familiar sectors in Colorado. The marijuana industry was larger than gold mining ($634 million) in 2014, and was almost on par with 2014 cigarette sales ($1.05 billion) in 2015. Figure 4 compares the economic output for selected industries in Colorado from 2014.

The cannabis industry is now larger than performing arts and sports venues ($777.3 million), new *multi-unit* residential construction ($761.5 million), and bakeries ($753.5 million).

But it is slightly smaller than some other, more traditional Colorado sectors, such as coal mining ($1.92 billion), oil and gas wells ($1.89 billion), and grain farming ($1.09 billion). By 2020, the marijuana industry is expected to surpass some of these traditional sectors. Overall, gross state output in 2014 was approximately $531.9 billion, much larger than any of these individual industries.

**Figure 4.
Market Size for Selected Colorado Industries in 2014**

Note:

General economic data is delayed by approximately two years. Both 2014 and 2015 nominal sales are included.

State Output in 2014 was $531.9 Billion, while GDP was $305.4 Billion, and in 2015, GDP was $318.6 Billion.

Colorado 2014 Total Output: $531,923,064,582

Industry	Output
Coal mining	1,916,960,815
Drilling oil and gas wells	1,887,315,796
Gambling industries (except hotels)	1,696,771,484
Grain farming	1,085,739,746
Cigarette sales	1,051,205,669
Retail marijuana product sales (2015)	996,184,788
Performing arts and sports venues	777,294,800
Child day care services	771,046,875
Residential construction	761,539,246
All other crop farming	755,907,166
Bread and bakery products	753,503,235
Retail marijuana product sales (2014)	699,198,805
Gold ore mining	633,907,043
Remaining 383 industries	$519,046,872,707

II-1. Industry Growth: Cause and Effect

The cannabis industry is currently growing faster than any other Colorado sector. The chart below shows a comparison between marijuana sales, state GDP, and national GDP. While Colorado's economy grew at 3.5 percent in 2014—twice the national average—marijuana sales grew by 42.4 percent - making this industry a clear growth leader in the state.
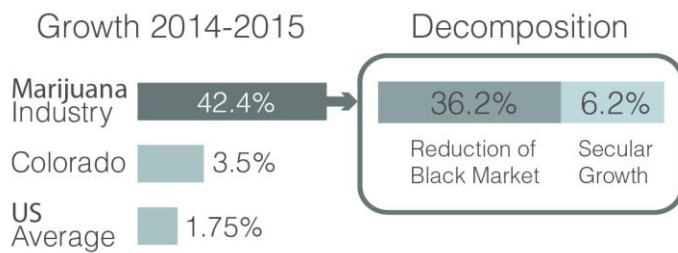
Supply Shift: It would be easy to confuse the rapid growth in marijuana *sales* with an inherent growth in marijuana *demand*. But that is not the case. Legal marijuana sales are increasing due to a supply shift — away from gray and black market suppliers, toward licensed suppliers.

In 2014, approximately 59 percent of total demand was supplied by the regulated market. The remaining 41 percent was split between so-called "gray market" suppliers (contributing 26 percent), which describe the state's caregivers who can grow marijuana legally for patients, but who are not considered part of the regulated market. Legal, but unregulated home-growing for personal use was estimated to account for 9 percent of supply, and the residual between total estimated demand and

the total estimated supply was 7.5 metric tons, or 6 percent of the market in 2014.

Over time, more than 90 percent of the market is expected to be supplied by regulated vendors.[2] The transition from the black-market to the regulated market currently accounts for most of the growth in the official statistics that are quoted by the media.

2014 Suppy Modality Total		
	Metric Tons	**Share**
Medical Retail	55	42%
Recreational Retail	22	17%
Caregivers	33.68	26%
Home Growers	12.14	9%
Total	122.82	94%
Demand	130.3	
Black Market	[7.48]	(residual - 6%)

It is important to understand that a large majority of the market growth in Colorado is not due to secular growth in demand, but rather a transition from the unregulated market to the regulated market.[3]

Effects of a Growing Industry: As the industry grows, the state has benefitted from investments in cultivation and retailing infrastructure. This is similar to the effect of investments in the oil and gas industry between 2009-2014.

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[2] Only private-use cultivation will persist.

[3] Growth is also caused by out-of-state demand and diversion, but cannot be quantified at this time.

Warehouse space that was previously under-utilized is now highly demanded by cultivation operators and manufacturing companies. Retail sales locations have created additional upward pressure for commercial real estate, construction, and related services. In 2015, some office spaces have become available as exclusive "marijuana business incubators" in the Boulder and Denver area, which has inspired the moniker for Colorado's Front Range as "Cannabis Silicon Valley."

Projected Growth: The MPG expects cannabis demand and sales to grow, but at a much lower rate than before. By 2020, the Colorado market will be fully saturated, and will grow moderately at 2.0-3.1 percent per year.

The near-term growth is driven by a combination of a shift away from black and gray markets, surging visitor demand, and

secular demand growth among Colorado residents. This combination led to a growth rate (by weight) of 14.1 percent over the past year (2014-15), and is projected to drive physical demand growth at 11.3 percent per year until 2020.

Figure 5 shows the rate of growth for 1) *quantity sold,* 2) *regulated market demand*, and 3) *sales value* — between 2013-2020, as projected by the MPG.

Figure 5. Cannabis Sales Value and Volume: 2013-2020

Key Sales and Demand Metrics 2013 -- 2020				
	2013*	**2014**	**2015** ...	**2020**
Inherent Demand^				
Resident Demand (21+ Only)	109.0	121.4	134.7 ...	160.6
Visitor Demand	0.0	8.9	14.0 ...	55.1
Total Demand (Resident + Visitor)	109.0	130.3	148.7 ...	215.7
Rate of Growth (Annualized):	N/A	19.5%	14.1% ...	11.3%
Regulated Market Share				
Metric Tons of Marijuana (Buds Only)	42.0	71.6	112.0 ...	184.5
Non-Flower Products (Edibles, Concentrates, etc.)(Millions of Units)	N/A	6.7	10.7 ...	16.78
Growth Rate (Annualized):	N/A	70.5%	56.4% ...	16.2%
Regulated Market Values ($Millions)				
Market Sales - At Constant Prices	**	$699	$996 ...	$1,640
Growth Rate (Annualized):	N/A	N/A	42.4% ...	16.2%
Change in Average Market Price	N/A	N/A	-8.9% ...	-7.4%
Market Sales - At Projected Prices	**	$699	$996 ...	$1,519
Rate of Growth (Annualized - At Projected Prices):	N/A	N/A	42.4% ...	13.1%

Note: * Data is estimated by MPG.

        ** Data Not Available.

        ^ All demand values are listed in units of "Flower Equivalent" demand. See MPG website for more information.

The regulated marketplace remains smaller than the overall market, but demand for regulated products is growing fast. Sales by licensed vendors jumped 56.4 percent from 2014 to 2015 by weight, and regulated product sales are expected to continue growing by 16.2 percent per year through 2020.

Unfortunately, the *sales value* is likely to grow more slowly, caused by declining prices. Although regulated sales *volumes* increased 56.4

percent, regulated *sales values* only increased by 42.4 percent during the same period. The disparity between sales volume and value in in the regulated marketplace is caused by lower prices. The average price for flower, for example, declined by 8.9 percent between 2014 and 2015.

The MPG projects marijuana pricing to continue its decline, by an average of 7.4 percent per year until 2020. This places downward pressure upon total market value, which is a function of both price and quantity. Therefore, the MPG projects regulated sales to be $1.519 billion dollars by 2020 as volume grows but prices decline, compared to $1.640 billion if prices were assumed to remain constant. The cause of this difference is declining prices, due to increasing competition and economies of scale.

Visitor Demand: The disparity between sharply higher sales and the moderate growth in resident demand is perplexing at first glance. However, upon closer examination it becomes clear that surging visitor demand is driving a larger portion of Colorado's regulated market than previously believed. This notion is supported in the observations by Washington state, where sales dropped in counties along the Oregon border following legalization in Oregon.[4]

In particular, previous MPG visitor demand models assumed that the primary purpose of

visitors was tourism (skiing or hiking) or short-term business (conferences, meetings). These models are now being updated to include visitors whose primary purpose is the legal marijuana itself. This visitor demand segment is poised to grow from 14 metric tons in 2015, to 55.1 metric tons by 2020, based upon these new, sole-purpose visitors choosing Colorado as a marijuana destination. These figures could also be lower than expected if more states legalize marijuana in the coming years.

II-2. EMPLOYMENT EFFECTS

Legalization of marijuana created 18,005 full-time equivalent (FTE) jobs in 2015. Among those jobs, 12,591 were employees directly involved with the marijuana business — either in stores and dispensaries, cultivations, or infused product manufacturing operations. The remaining 5,414 full-time equivalent positions were generated by intermediate input purchases made by the cannabis industry for general business goods and services, and through general spending by marijuana industry employees and proprietors.

These ancillary jobs include security guards, commercial real-estate agents, construction and HVAC specialists, consulting, legal, and advisory services, and other business services. Additional employment is also generated when marijuana employees and proprietors

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[4] Lerch, Steve, et. al. 2016. "Washington State Economic and Revenue Forecast, Preliminary Analysis of the WA Recreational Cannabis Market."

spend their income on local housing, food and entertainment. This is called an "induced employment effect." Figure 6 (following page) shows an estimation of these employment types.
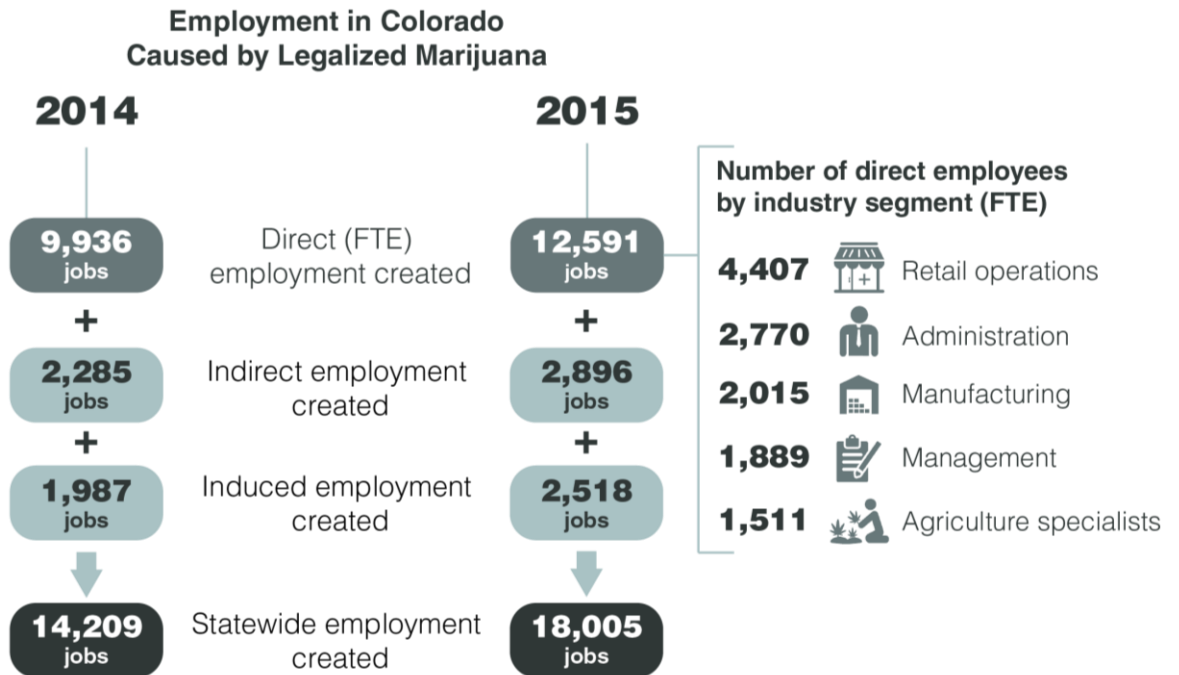
Each segment of the marijuana business has a unique employment profile. Retail stores and dispensaries hire sales clerks, called "bud-tenders," followed by back-office staff that performs data-entry and general business administration. Cultivators employ "trimmers" — individuals who hand-trim the marijuana buds from the leaves — as well as agronomists

Since many firms in Colorado are vertically-integrated, it is difficult to pinpoint specific roles for some company workers, as they transition between different posts. For example, a retail worker may also provide data entry and compliance services during the mid-day hours, but then transition into the "budtender" role and serve patrons during the peak hours of operation.

Trimmers are generally only needed during harvest periods. In Colorado, the fact that cultivation is primarily indoors means that harvest periods can be determined by the

**Figure 6.
Employment estimates by type in Colorado, 2015**

Source:
Marijuana Policy Group.

Employment in Colorado
Caused by Legalized Marijuana

2014
9,936 jobs — Direct (FTE) employment created
+
2,285 jobs — Indirect employment created
+
1,987 jobs — Induced employment created
↓
14,209 jobs — Statewide employment created

2015
12,591 jobs — Direct (FTE) employment created
+
2,896 jobs — Indirect employment created
+
2,518 jobs — Induced employment created
↓
18,005 jobs — Statewide employment created

Number of direct employees by industry segment (FTE)
4,407 — Retail operations
2,770 — Administration
2,015 — Manufacturing
1,889 — Management
1,511 — Agriculture specialists

and back-office workers for data-entry and compliance. Manufacturers and edibles companies hire "chefs" and other factory floor staff, while concentrates manufacturers primarily hire machine operators.

company, independent from the natural seasons. Thus, trimmers typically move between cultivations in order to minimize down time. Some operators choose mechanized methods for trimming.

Approximately 2,232 FTE employees are estimated to work in the cultivation segment of the market, including indoor agriculture specialists, trimmers, management, and other staff.

Finally, infused product manufacturers, which bakeries are counted as part, are the least labor-intensive subsector in the marijuana industry.

Each quarter, the State Marijuana Enforcement Division (MED) reports the number of "occupational licenses" that are active on the last day of that quarter. These licenses, or 'badges,' are required for employees to begin

Badges vs. FTEs

work in the marijuana industry. While more active badges clearly indicate that there are more workers in the industry, one badge does not necessarily correspond to one full-time worker.

At any given time, there are more badges than FTE positions because some workers are part-time, other people are in transition between jobs, and other badge holders are

consultants, managers, or investors who work on an irregular basis.

In order to clarify this issue, the MPG compared the total number of active licenses with the MPG estimate of actual, full-time employment in the industry (direct employment only). The result is that for each new MED badge, there are 0.467 new FTE positions created. Conversely, it means that one FTE in Colorado is created for every 2.14 new MED badges.

At the end of 2015, state officials reported that 26,929 occupational licenses were active. MPG estimates that there were 12,591 FTE positions in Colorado in 2015 based on the 2.14 ratio described above.

II-3. TAX REVENUES

In 2015, marijuana taxes were the second largest revenue source among excise products in the state (e.g., tobacco, alcohol, and gaming).

Combined marijuana excise and sales tax revenues were $63.4 million in 2014, and $121.2 million in 2015.[5] For 2015, they were 14 percent larger than casino/gaming revenues,[6] about 5 percent less than lottery revenues, and almost three times larger than alcohol revenues. Cigarette revenues remain the largest excise

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[5] Licensing fees are counted separately because they are used for administration and enforcement within the Marijuana Enforcement Division. Fees in 2014 and 2015 were $12.7 million and $14.5 million, respectively.

[6] Calendar year 2015 marijuana and alcohol taxes were compared with Fiscal Year 2014/15 tobacco and gaming revenues.

source, at $180.1 million for 2015, but this revenue source is declining due to a general downward trend in cigarette sales. The MPG projects that marijuana revenues will surpass cigarette revenues by 2020. A full listing of excise-type revenues and related dynamics is shown in Figures 7 and 8 on the following page. The next subsection explains why tax revenues grew more quickly than total sales volumes.

Tax Revenue Dynamics: Marijuana tax revenues are growing more quickly than any other tax type in the state. Tax revenues grew by 91.1 percent between 2014 and 2015, while at the same time, total sales of marijuana grew by 42.4 percent.

Figure 7.
Excise Tax Revenue Comparison: 2014-2020

| Colorado Revenues from Excise and Sales Tax (by Source)			
	2014	**2015**	**2020***
Cigarettes	$177,100,000	$180,100,000	$147,682,000
(% Growth)		1.7%	-18.0%
Marijuana	$63,414,883	$121,202,211	$149,579,813
(% Growth)		91.1%	23.4%
Alcoholic Beverages	$41,423,481	$43,027,741	$47,330,515
(% Growth)		3.9%	10.0%

Note: 2020 Projections based on MPG Research.

Sources: Colorado Legislative Council. Tobacco Products Tax. 2016. Colorado Department of Revenue. Colorado Liquor Excise Tax Report. December 2015. Colorado Department of Revenue – Office of Research and Analysis. Monthly Marijuana Taxes, Licenses, and Fees Transfers and Distribution Reports, 2014-2015.

How is this possible? The revenue shift reflects a combination of demand growth and a demand *shift* from the untaxed black and gray markets into the taxed retail market.

Sales for medical marijuana increased just 5.4 percent in 2015 to $408.4 million, from $386.0 million in 2014. Meanwhile, adult-use (recreational) sales increased by 87.7 percent, from $313.2 million in 2014 to $587.8 million in 2015. This sharp increase in adult-use sales combines with the higher tax rate on those products to generate the sharp revenue increase of 91.1 percent. These gains are helping the Department of Revenue to offset losses from other tax streams.

Figure 8.
**Marijuana Tax Collections by Market Segment, 2014 and 2015.**
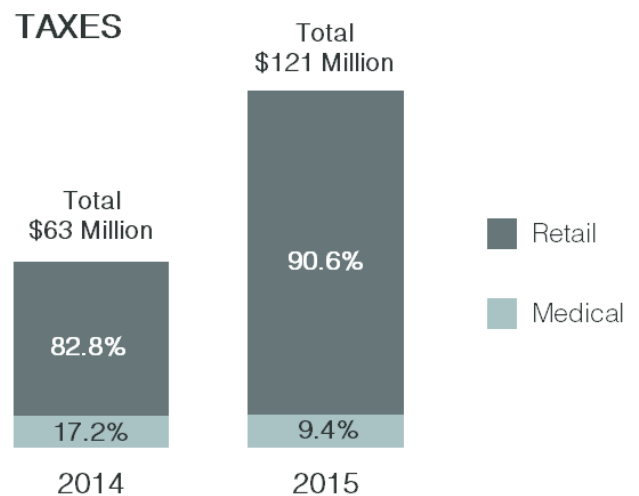
This revenue dynamic is expected to continue through 2020, as consumers continue to shift into the regulated (and taxed) market, and as consumers within the market shift toward adult-use (recreational) stores. The MPG projects revenues will continue growing to $149.6 million by 2020, due to these dynamics. However, at the same time, sales and excise tax revenues will be offset by declining prices.

Cigarette revenues increased slightly, from $177.1 million to $180.1 million between 2014 and 2015. However, cigarette sales have been declining steadily since 2005. Barring additional rate increases, the MPG estimates that cigarette tax revenues will decline to $147.7 million by 2020, an 18 percent reduction from 2015 levels. Alcohol revenues grew from $41.4 million in 2014 to $43.0 million in 2015, partially due to a growing population base in the state. Recent and forecasted tax revenues for each of these goods are shown in Figure 9.

Figure 9.
Revenue Dynamics for Marijuana Compared to Traditional Excise Revenue Streams, 2010-2020
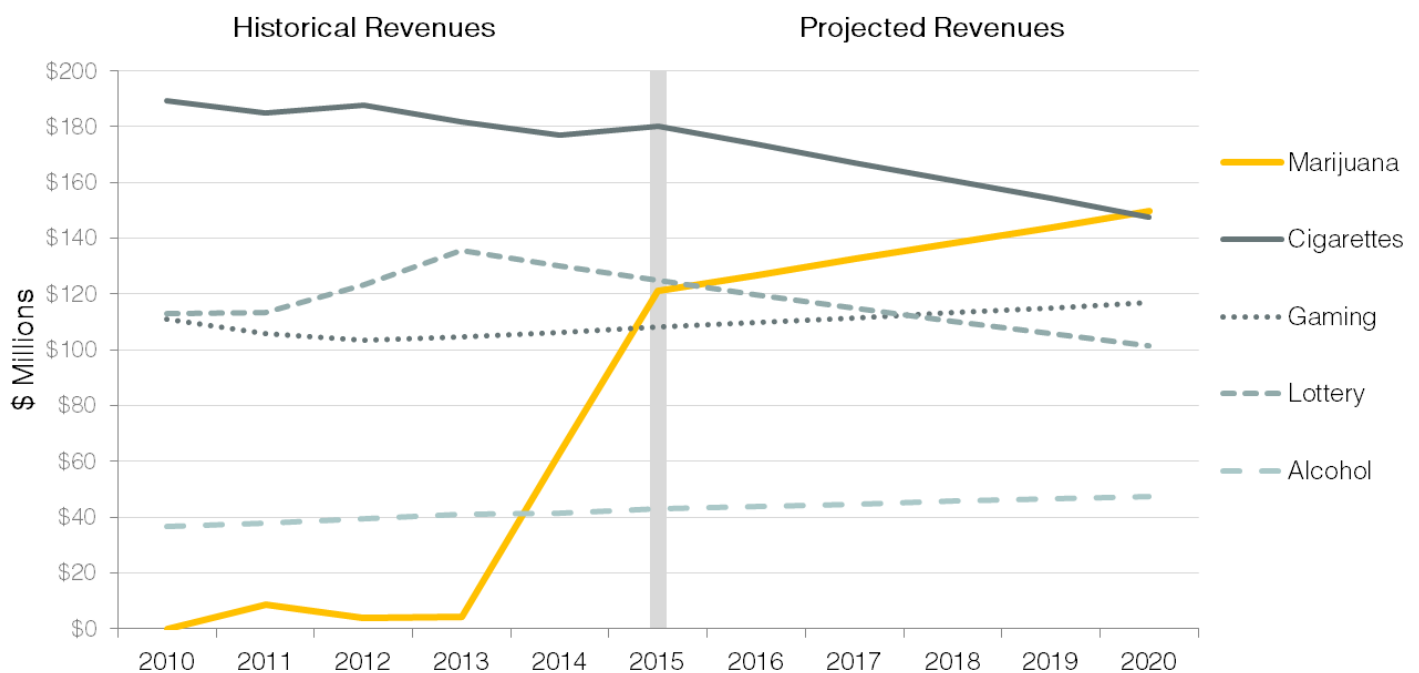
# Section III. The Marijuana Impact Model—Technical description

This section describes Input-Output modeling in general, and how the marijuana impact model was constructed as the world's first Input-Output Model that integrates the cannabis industry in its entirety.

Input-Output models are used to define the linkages between different economic sectors, and between buyers and producers of different goods and services. These linkages are described through the purchases of intermediate inputs and final demand spending. This inter-connected spending creates a multiplicative effect, where spending in one sector creates demand for intermediate inputs from other sectors, culminating in a multiplier effect, where the total effect upon state output increases more than the original spending amount.

III-1. COLORADO-SPECIFIC OUTPUT AND EMPLOYMENT MULTIPLIERS

The notion of a *multiplier* comes from Leontief Input-Output analysis, which traces out how consumer spending expands from the original spending (called the direct impact), through intermediate suppliers (called the indirect impact), and finally through the hands of employees from that sector, who spend their money on general goods and services (called the induced effect). When combined, these three impacts represent the "economic multiplier" for a particular industry in Colorado or another target region, illustrated in Figure 10.

Figure 10.
The Multiplier Effect
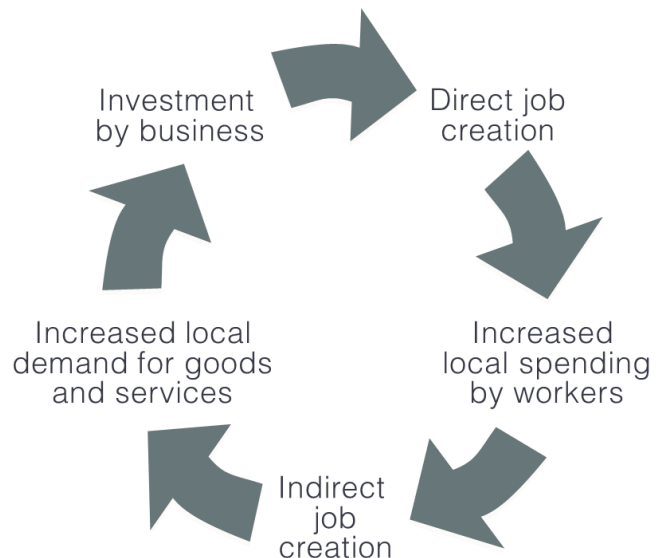
This impact is different for every industry and region. Products that are imported do not generate large output multipliers, because most of the spending is remitted to an out-of-state producer.

The marijuana industry is unique because sales of marijuana are exclusive to in-state producers. Retailers and manufacturers are required to purchase all of their marijuana inputs from in-state suppliers. For this reason, the marijuana industry in Colorado has a relatively large multiplier.[7]

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[7] More technically, the "Regional Purchase Coefficient" for this industry is close to one, because the main ingredient for retail stores and manufacturers (marijuana flower and trim) must be purchased exclusively within the state of Colorado.

Before July 2016, Colorado also required all licensees, owners, and workers to be state residents.[8] In that case, all profits and wages would also accrue entirely to Colorado residents. New state legislation, passed in 2016, will waive this requirement. The original in-state ownership requirement was intended to help small marijuana businesses, but it also impaired small business growth by restricting the supply of potential investors.

Figure 11 shows the direct, indirect, and induced impact multipliers for marijuana compared to other industries in the state. The aggregate output multiplier for marijuana retailing equals 2.398, which ranks high among Colorado industries. This sector produces more output and employment per dollar spent than Manufacturing but is slightly lower than Federal Government Enterprises.

Figure 11.
Direct, Indirect, and Induced Effects for the Colorado Marijuana Industry, compared to other state industries.

Description	Type of Impact			
	Direct	Indirect	Induced	Total
Local government passenger transit	1.000	1.497	0.994	3.491
Other federal government enterprises	1.000	1.031	0.389	2.421
Marijuana Retail	1.000	1.029	0.369	2.398
Marijuana Manufacturing and Baking	1.000	0.984	0.355	2.340
Religious organizations	1.000	0.837	0.443	2.281
Architectural, engineering, and related services	1.000	0.500	0.751	2.251
Dry-cleaning and laundry services	1.000	0.442	1.033	2.475
Environmental and other technical consulting services	1.000	0.428	0.822	2.250
Promoters of performing arts and sports and agents for public figures	1.000	0.788	0.455	2.242
Business and professional associations	1.000	0.314	0.922	2.236
Offices of physicians	1.000	0.377	0.841	2.218
Independent artists, writers, and performers	1.000	0.804	0.389	2.193
Marijuana cultivation	1.000	0.793	0.332	2.126
Wholesale Trade	1.000	0.543	0.443	1.987
Manufacturing	1.000	0.584	0.357	1.940
Retail trade	1.000	0.522	0.363	1.884
Mining	1.000	0.292	0.497	1.789
Gambling industries (except casino hotels)	1.000	0.401	0.332	1.733
Racing and Track Operation	1.000	0.228	0.278	1.506
Amusement parks and arcades	1.000	0.273	0.213	1.486

Source: MPG calculations and comparative IMPLAN sector multipliers.

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[8] In July 2016, this rule was removed, so Colorado will allow out-of-state ownership of minority stakes in businesses beginning in 2017. Owners remain predominantly Colorado residents.

SECTION III.   THE MARIJUANA IMPACT MODEL—TECHNICAL DESCRIPTION

III-2. INPUT-OUTPUT TABLE CONSTRUCTION

In order to compute the output multipliers above, the specific linkages for Colorado must be constructed using an input-output table. The original Colorado input-output dataset has been extended by MPG researchers to include the marijuana industry. An aggregated version of the so-called "direct requirements" table is shown below, in order to highlight that both the size of the industry, the share of each segment, and the production structure are needed in order to construct a true and accurate model.

Note that retailing, cultivation, and manufacturing for marijuana must be combined with all other sectors in the economy. But at the same time, the outputs from marijuana cultivations and manufacturers are sold exclusively to marijuana retailers.

The unique production structure for each sector in an economy is derived from data that is collected by the federal, state, and local governments. The primary data source for the non-marijuana data is the U.S. Bureau of Economic Analysis (BEA). The BEA constructs highly detailed input-output tables for each sector of the economy. Economists use these input-output tables to perform regional input-output modeling across a wide variety of activities.

However, since marijuana is a federally illegal "Schedule 1" narcotic, the BEA does not collect or construct data related to the cultivation, processing, or retailing of marijuana.

Until 2014, the market for marijuana was restricted to medical patients and inventories and transactions were not consistently monitored using a standardized seed-to-sale tracking system.

Due to this lack of data, it was impossible to estimate how the medical marijuana industry impacted the state economy. At the same time, all registered businesses must have a federally-assigned Employer Identification Number (EIN) and must register to pay unemployment insurance and workers' compensation insurance. This data can be combined with private-side data in order to construct the model.

III-3. CALCULATION OF OUTPUT AND EMPLOYMENT MULTIPLIERS

Once the marijuana-specific tables are constructed, the industry-specific multipliers can be computed using standard I-O techniques.

- The input-output table is combined with a table of *Regional Purchase Coefficients* (RPCs) that have been originally constructed by the BEA and subsequently by the IMPLAN Corporation. These RPCs indicate the share of each intermediate input that is purchased from within the state of Colorado, versus inputs that are purchased from outside of Colorado.

- For example, the RPC for most manufactured goods is approximately 12 percent. This indicates that 88 percent of manufactured goods purchased in Colorado come from outside of the state.

Figure 12.
Aggregated *Marijuana-Based* Input-Output Example — Provided for Exposition Purposes Only

	Traditional Economic Sectors					Marijuana Industries			Traditional Economic Sectors					
	Financial Services	Agriculture, Forestry, Livestock	Oil, Mining, Gas & Water	Construction	Food & Beverage	Marijuana Retailing	Marijuana Cultivation	Marijuana Manufacturing	Light & Heavy Manufacturing	Communications	Transport & Distribution	Other Services	Government & Non-Profit	Private Households
Financial Services	28.2%	4.6%	1.5%	1.5%	0.7%	XX%	XX%	XX%	0.7%	1.2%	3.7%	2.7%	15.7%	9.6%
Agriculture, Forestry, Livestock	0.0%	14.3%	0.1%	0.2%	30.6%	XX%	XX%	XX%	12.8%	0.0%	0.0%	0.0%	0.0%	0.6%
Oil, Mining, Gas & Water	0.2%	3.3%	6.0%	1.4%	2.3%	XX%	XX%		1.6%	0.6%	1.0%	0.2%	0.8%	2.2%
Construction	0.6%	0.5%	2.7%	0.1%	0.5%	XX%	XX%	XX%	0.6%	1.1%	1.1%	0.2%	1.2%	0.0%
Food & Beverage	0.0%	0.1%	0.0%	0.0%	23.0%	XX%	XX%	XX%	0.0%	0.0%	0.0%	0.0%	0.3%	5.1%
Marijuana Retailing						XX%								
Marijuana Cultivation						XX%		XX%						
Marijuana Manufacturing						XX%		XX%						
Light & Heavy Manufacturing	0.8%	18.8%	7.6%	28.2%	7.4%	XX%	XX%	XX%	31.7%	4.3%	14.4%	5.8%	3.3%	12.0%
Communications	2.8%	0.1%	0.3%	1.1%	0.4%	XX%	XX%	XX%	0.9%	12.4%	0.9%	1.5%	1.6%	1.7%
Transport & Distribution	0.9%	4.4%	1.4%	7.1%	8.2%	XX%	XX%	XX%	9.6%	1.0%	9.2%	2.8%	2.4%	15.4%
Other Services	15.9%	11.9%	12.0%	13.9%	9.5%	XX%	XX%	XX%	9.7%	18.0%	11.2%	30.8%	17.0%	37.3%
Government & Non-Profit	1.3%	0.1%	0.1%	0.3%	0.1%	XX%	XX%	XX%	0.2%	0.3%	1.1%	0.5%	0.7%	3.1%
Business Taxes	1.7%	1.8%	8.4%	0.6%	0.3%	XX%	XX%	XX%	0.7%	5.8%	3.9%	1.1%	0.0%	0.0%
Payrolls	24.5%	11.2%	15.4%	27.3%	9.3%	XX%	XX%	XX%	11.9%	16.7%	33.9%	23.8%	46.6%	0.0%
Rent and Cost of Capital	20.9%	28.9%	43.9%	18.2%	7.6%	XX%	XX%	XX%	19.4%	37.2%	16.7%	29.1%	10.2%	0.0%
Misc. Expenses	2.2%	0.0%	0.5%	0.0%	0.2%	XX%	XX%	XX%	0.0%	1.4%	2.8%	1.3%	0.0%	13.1%
Total Spending:	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Marijuana Policy Group — Marijuana sector coefficients have been replaced by "XX%" to protect firm privacy and potential proprietary information.

Of course, all purchases of marijuana inputs have an RPC of 100 percent. However, intermediate inputs for marijuana cultivators and for non-marijuana products can be purchased normally. Thus, the non-marijuana purchases utilize standard RPCs for the rest of the economy.

- The output multiplier is computed by using the standard I-O formula. This formula reflects the share of spending for each intermediate input, or household purchase. Subsequent spending by intermediate suppliers and by employees is included as well. The culmination of this spending can be represented using the summation of an infinite-series. The sum of this series can be concisely written using the equation below:

$$X = [I - A]^{-1} Y$$

- Each element of the equation is a matrix or vector. X represents the total change in output, the symbol I is the Identity matrix, A is the Direct Requirements Table, and Y is a vector representing the change in spending for different sectors. For example, if Y = $1 of spending on marijuana retailing, then X would equal $2.40 dollars, using the current model. This is the sum of changes in output for all sectors in the economy, in addition to the original $1 dollar of spending.

- The employment impact is computed by combining the output multiplier together with sector-level employment ratios. Once the total change in output is computed for each sector, then the employment ratios are applied.

For example, if output in the Financial Services sector increases by $100 million, and if the average employment in this sector equals 1.7 employees per million dollars in output — then the change in output would support an additional 170 workers, holding all else equal.

Each sector has a different ratio of employment per dollar of output. Some sectors are more labor intensive, such as farming, while others are more capital intensive, such as manufacturing or finance.

Marijuana retailing is relatively labor intensive, and has a relatively high employment ratio compared to the state average. However, most of these positions have relatively low average wages and few fringe benefits.

SECTION IV. ECONOMIC RESULTS IN CONTEXT

IV-1. COMPARISON OF MPG RESULTS WITH OTHER RECENT STUDIES

The economic implications of marijuana legalization have received significant attention by the press. As a result, some previous studies have attempted to quantify the impact of legalization, with mixed results. This section of the report briefly reviews these studies and compares their results to those produced by the MPG.

Because the marijuana business is cash-based and was recently wholly underground, each of these studies had to make some tenuous assumptions due to the lack of data. Not surprisingly, the studies either over-estimate the impact of legal marijuana or under-estimate the impact, sometimes by a wide margin.

Study #1, written by a University of Denver professor in 2014 (J. Strauss), uses BEA "RIMS" multipliers to compute the output and employment effects.[9] But since "marijuana sales" does not exist in RIMS dataset, the author chose to use a *proxy-sector* to represent the marijuana industry — the "large retail" industry. However, since the RIMS multiplier for retail reflects 50 percent of purchases from outside of the state, the total output and employment effects were *under-estimated*.

Study #2, written by New Frontier, a financial services company that serves the marijuana industry, did not use an input-output model at all.[10] Instead, the study combines anecdotal observations with official sales figures, and then assumes that they are fundamental relationships. For example, the New Frontier authors state that "the U.S. market in 2020 will be $20.6 Billion USD" for adult-use and medical marijuana.

However, this declaration incorrectly assumes that the U.S. market growth is due to increasing *inherent* demand, rather than a shift between black markets and regulated markets. As a result, their projections grossly over-estimate potential sales over the medium term.

Study #3, by New Economy Consulting and Whitney Economics, based in Portland, Oregon, estimates the total employment caused by marijuana legalization in the state.[11] This study is focused solely upon employment, rather than output, and therefore does not rely upon an I-O model to generate results.

Instead, the study relies upon a survey of existing marijuana dispensaries that asks questions about their employee count, and whether new employees were hired before or after adult-use marijuana was legalized.

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[9] Strauss, Jack. 2016. "The Economic Impact of Marijuana Taxation and regulation in Colorado." *Council on Responsible Cannabis Regulation.* Denver, CO. https://www.crcr.org/wp-content/uploads/2016/04/The-Economic-Impact-of-Marijuana-Tax-and-Regulation-in-Colorado_031716.pdf

[10] "4th Edition of the State of Legal Marijuana Markets." New Frontier Data & Arcview Market Research. 2016.

[11] Hinkel, J.H., Halle, M., Chapman, S., and Whitney, B.R. (2016). Oregon Cannabis Jobs Report – Retail Sales and Job Creation in Oregon's Burgeoning Cannabis Sector. *New Economy.* http://www.cannabisjobsresearch.com/

SECTION IV. ECONOMIC RESULTS IN CONTEXT

The report findings are a tabulation of these survey results, combined with a linear projection of employment if sales were to grow further in the state. The last chapter of this study mentions use of the IMPLAN model, but does not supply specific details regarding the inputs or outputs of that exercise.

Study #4, by CIBC World Markets Inc. reflects the inability for the press to discern credible research apart from blind speculation in the cannabis industry.[12]

The study combines data from Colorado, British Columbia, and Statistics Canada to estimate potential sales and tax revenues when adult-use cannabis is legalized in Canada.

In doing so, the authors over-estimated potential tax revenues by a gross margin — approximately 300 percent. The miscalculation of these results becomes clear when they are held for comparison against actual data.

During the first year of legalization, tax revenues in Colorado, Washington, and Oregon were approximately $23, $18, and $6 per resident.[13] In contrast, the CIBC study suggests that tax revenues in Canada will be more than $142 CAD ($106 USD) per resident,

or more than five times the highest tax yield in the United States. The study findings were released and published by all major newspapers in Canada and among the marijuana-specific publications in the United States.

The broad acceptance of this report shows how the press remains unfamiliar with the legal cannabis market, and can easily be misled, especially when the reports come from intuitions that are perceived to be reputable.

Study #5, by ICF International, a large multidisciplinary consulting firm based in Washington DC, considers the economic impacts marijuana legalization in California.[14]

We believe the authors have *over-estimated* potential sales by over 100 percent. Their projected market value is $15.9-$20.2 billion, while MPG experts project the size to be $7.0-$9.8 billion. Their key difference is the ICF's assumed price. Through oversimplification, they assumed an average price of $11.37 per gram. In reality, marijuana pricing is more complex, with volume discounts and non-flower products, such as concentrates and edibles. In Colorado, the average price paid for flower was $5.03 and $9.85 in 2015 for medical and adult-use consumers, respectively. This difference leads to a large over-estimation of market value in California.

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[12] Shenfield, A. "Growing Their Own Revenue: The Fiscal Impacts of Cannabis Legalization." *CIBC World Markets Inc. Economic Insights.* January 28, 2016. http://research.cibcwm.com/economic_public/download/eijan16.pdf

[13] Indicates total excise and sales tax revenues for the first "representative" 12 months after legal markets were opened, divided by the total population of the state. Oregon's estimate is extrapolated from the first 2 months of taxation in 2016.

[14] Cooper, W., Johnston, E., and Segal, K. (2016). "The Economic Impacts of Marjiuana Sales in the State of California." *ICF International.* https://www.icf.com/perspectives/white-papers/2016/economic-impact-of-marijuana-sales-in-california

SECTION IV.   ECONOMIC RESULTS IN CONTEXT

Alternatively, the authors could have cross-checked their estimates with existing markets in Colorado and Washington. If Colorado's sales in 2015 sales are simply be scaled to fit California's population (38.8 million vs. 5.1 million). The result would suggest a market size of $7.2 billion — about 55 percent less than the lower-bound estimate by ICF.

At the same time, the ICF study *under-estimates* the most likely direct and indirect employment effects. They missed because they chose a proxy industry, food and beverages, which has a lower multiplier than MPG calculates in this report. The result is that they under-estimate the employment impact, when measured per dollar of spending.

While the ICF study is more carefully constructed than other studies that were reviewed, it highlights the fact that economists can no longer utilize inappropriate proxy data or make invalid assumptions. Highly precise data now exists in the legal marijuana market, and researchers are obligated to find and utilize this data to cross-check their assumptions and to inform their baseline economic estimates.

Summary: These report examples reveal two key issues related to marijuana legalization. First, there is a need for "fact-based" and "data-driven" studies that can clearly explain how marijuana legalization impacts state budgets, output, and employment.

Second, the marijuana industry and press should be cognizant that many studies are either purposely misleading, or they are ill-informed due to a lack of proper data. Publishing or referencing these studies without proper fact-checking leads to a general misunderstanding of the cannabis industry overall, and a mistrust for related research.

IV-2. TRENDS IN COLORADO'S CANNABIS INDUSTRY

The legalization process has evolved differently in each U.S. state. As a result, the industrial and regulatory structure varies greatly across different regions. This section describes some specific facets of Colorado's situation, and explains how these issues impact the results in this report.

VERTICAL INTEGRATION. Until October 2014, all marijuana licensees were required to be vertically integrated, where cultivation, processing, and sales were part of the same business.

As a result, many marijuana entities in Colorado remain vertically integrated in 2016. Most companies integrate their cultivation and retail operations. Some infused product manufacturers also cultivate their own marijuana inputs. In contrast to Colorado, The State of Washington initially banned vertical integration, forcing retailers and MIPs to purchase from separately-owned cultivation operators.

Vertically-integrated firms utilize employees across each industry segment, which convolutes the employment types that are outlined in this report. The MPG used information from both stand-alone entities and

vertically-integrated entities, in order to ascertain the specific job duties for different employee types in each segment.

These job types and employment ratios were then applied to the industry sector, as if they were separate entities within the vertically-integrated firms.

Another challenge presented by vertical integration relates to inter-business transfers of wholesale products. Vertically-integrated companies do not explicitly account for the market value of the wholesale marijuana that is grown and then transferred to the storefront for sale. In order to assign a market price to the wholesale production for cultivators, the MPG assumed that the arms-length transaction price is equal to the "Average Market Rate". This is the price assigned to wholesale marijuana flower and trim by the Colorado Department of Revenue (DOR).

Wholesale marijuana that is grown for medical consumption is not subject to excise taxation, so the DOR does not assign an average market rate to it. Although the markets are segmented, the MPG makes the assumption that both medical and adult-use marijuana have the same price at the wholesale level. This allows us to apply the Average Market Rate to both types of cultivated product. In July 2015, for example, the official rate cited by the Colorado Department of Revenue was $1,868/lb. for flower, and $370/lb. for trim.

INDUSTRY CONSOLIDATION AND MARKET SHARE. In order to characterize the "typical" or "average" rate of employment in the industry, the MPG

examined and reviewed a combination of large and small firms. Large firms typically employ several hundred employees, across different industry segments, while the small firms are sometimes sole-proprietorships. Among the 2,677 marijuana licensees that are currently active in Colorado, just seven companies account for approximately 25 percent of total sales.

As the Colorado market matures, it is becoming more consolidated. Larger, more competitive companies are growing, while smaller, less competitive companies struggle and eventually exit the market. This is a natural dynamic within any competitive market.[15]

Private industry owners purport that consolidation is not being caused purely by price competition, but instead by high compliance costs. For example, the owner of one of Colorado's largest retailers recently stated that many small operations are unable to properly comply with the state's complex regulations, leading them to exit the market.[16]

ACCOUNTING FOR THE UNDERGROUND MARIJUANA ECONOMY. Clearly, the business of illegally growing and selling marijuana existed before this report was written. Therefore, some portion

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[15] There is currently a policy debate about whether the natural dynamic of industry consolidation should be allowed or if it should be mitigated through government intervention, but that issue is beyond the scope of this report.

[16] Denver Post, *The Cannabist*, interview with John Lord, Feb. 3, 2016. http://www.thecannabist.co/2016/02/03/livwell-john-lord-colorado-oregon/47630/ . Visited on May 30, 2016.

of the economic impact computed here is simply a conversion from the un-reported, underground activity into the officially-reported economy. It would be reasonable to ask: "Does this activity properly count as *new* economic activity?"

This section suggests the answer is "yes." The first and most important reason is that the legal activity is being officially reported, while the underground economy is not. In order to be comparable and consistent between years, the official output and production statistics should be used as much as possible. The BEA does make adjustments for some aspects of the economy that are not officially reported — such as imputed rents for owner-occupied housing. However the methodology they use is transparent and documented, and remains the same over time.

As the underground marijuana economy shrinks and changes (from illegal cultivation to illegal retailing), there is no pre-defined methodology to account for the non-reported activity. Therefore, the MPG has chosen to consider all of the official sales as if they are "new spending" on marijuana. The MPG is interested to hear from readers about how to partition underground activity during the transition into the legal market.

A second reason the MPG has omitted the underground economy is related to cultivation and trade. Under prohibition, a large portion of illegal demand in Colorado was supplied by out-of-state cultivators from Oregon, California, Mexico, or elsewhere. This activity is now performed completely inside of the state. This

represents a true increase in activity that did not exist before legalization.

Similarly, a large share of the purchase price accrued to drug trafficking — the activity of illegally transporting and distributing the product between the cultivator and customer.

Like cultivators, some portion of the drug smugglers were not Colorado residents. Only the retail drug dealer was likely to be a resident who spent their income inside of Colorado's borders. After legalization, all of the distribution and transport activity has shifted to in-state entities. Thus, the MPG believes that the full economic impact can accurately be described as "new spending."