The Economic Impact of the Cannabis Industry
Sonoma County, California

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Sustaining Technologies, LLC

Economic Forensics and Analytics, Inc.

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Questions and Comments to the authors: Please go to this Google form (https://goo.gl/forms/aa54zuQnDU0PAP0Z2) and submit your inquiry. We ask that you don't contact the authors directly.

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Executive Summary

With a long history in Sonoma County, the cannabis industry has new challenges and opportunities as a result of Proposition 64 passing and recreational use of cannabis being legal for adults over 21 starting on January 1, 2018. This study estimates the economic impacts from the current state of the legal cannabis business. Conversion of current, illegal businesses and the expansion of new businesses can lead to broader economic impacts. This study was sponsored by several Sonoma County cannabis businesses; this report is not advocating a position for or against cannabis consumption. This report instead shows the gains and economic consequences from more cannabis businesses coming to Sonoma County rather than locating elsewhere or remaining illegal.

The cannabis supply chain, like any other agricultural good, determines its ability to support a broad number of industries and jobs regionally. Local agriculture is likely to produce more products than can be sold within Northern California, which implies export possibilities. As of 2018, the legal cannabis market cannot legally sell products outside California; for Sonoma County cannabis businesses, one challenge is to optimize cultivation, manufacturing, distribution, and retail business opportunities inside the county. This balance between leakages (losses of revenue to vendors outside the local area) and exports (sales outside Sonoma County) is a major part of economic development for any industry. Recent data collected by this study's authors, and available from sources such as BDS Analytics, provide the baseline data as of July 1, 2018.

Key Findings for Sonoma County

- Sonoma County's overall retail sales of cannabis products are projected to be $150 million in 2018 based on the first two quarters of legal, taxable activity and estimates of illegal activity;
- 52 licensed cultivators are currently identified by the state of California as of July 1, 2018 in Sonoma County;
    - Another 178 businesses licenses are in Sonoma County, predominantly temporary cultivation licenses;
- There is an estimated 64.33 million grams of cannabis product or 64,330 kilograms of raw product to be produced in Sonoma County in 2018;
- The estimated amount of cannabis legally cultivated in Sonoma County is $233 million for 2018;
- Estimated sales in Sonoma County are $150 million in 2018 of cannabis products, suggesting some cultivation is exported to other parts of California and beyond;
- In 2018, given the current level of economic activity and supply-chain connections, state and local taxes of over $33 million are estimated from the economic impacts paid across many categories in Sonoma County; and
- In the legal market, as many as 2,800 jobs may be supported in this industry through all the supply chain connections;
- For every kilogram of cannabis produced in Sonoma County, the county economy generates $7,800 of business revenue across hundreds of industries;
    - If all local retail sales came from local production, there would be a 31 percent increase in economic impacts within Sonoma County.

Sonoma County Cannabis	Economic Impact
Full-time Equivalent Jobs	2,814
Wages Paid	$164.0 million
Retail Value of Cannabis Sold	$150.0 million
Cultivator Revenue	$233.3 million
Number of Cultivators	52
Number of Licensed Businesses Beyond Cultivation	178
Taxes Paid: State and Local	$33.4 million
Total Impacts	$504.4 million
Total Impacts per kg harvested	**$7,800**

* Estimated production is 64,330 kilograms in 2018 for Sonoma County for legal cultivation.

Recommendations

- Public policy should focus on incentives for conversion of current illegal businesses, enhancing the hedgers and wait-and-see possibilities for conversion by reducing tax rates and compliance costs;
- Public costs exist for enforcement and compliance in the legal environment and to enforce laws against continued, illegal activity;
- Provide entrepreneurship training and support for business conversions;
- Centralize distribution and use of local product such that benefits can be maximized across county economy;
- Make provisions for local processing of plant material into saleable flower and supply for manufacturers to make concentrates;
- Support cannabis tourism through Sonoma County Tourism; and
- Create a long-term vision for development of the cannabis industry in Sonoma County.

Economic Impact of Cannabis in Sonoma County

1. Introduction

The 2016 passage of Proposition 64 in California allows for recreational adult use of cannabis products beginning on January 1, 2018, opening up the current marketplace for cannabis beyond medical use only. The nationalization of cannabis for recreational use in Canada (October 2018) provides an example of how national policies can provide a framework for further economic opportunities. The U.S. does not have a national policy in place yet, which restricts the economic impacts of California's legalization. It is in production where Sonoma County, the focus of this study, has advantages to generate economic benefits across the county. This report is not advocating a position for or against cannabis consumption. This report instead shows the gains and economic consequences from more cannabis businesses coming to Sonoma County rather than locating elsewhere or remaining illegal.

Public policy continues to struggle with a regulatory framework that both discourages consumption while simultaneously providing incentives for illegal operations to become legal. There are few strong, historic examples: the end of alcohol prohibition in December 1933 has some similarities, but currently California cannabis production does not have a national, legal market. The tax structure for legal cannabis is still evolving with every California municipality left to its own choices. Some risks also exist of having adjacent "dry" and "wet" cities and counties in terms of recreational cannabis availability, while state legislation continues to develop its policies for cultivation to retail and other supply-chain partners in between.[1]

This study's purpose is to look at the legal cannabis industry's potential economic impacts on the Sonoma County. Data remain problematic in defining the market's size: a 2017 study by ERA Economics (see the following link) provides estimates of the supply and demand sides of the state-level market for the medical cannabis market only. ERA Economics' methodology (as discussed later) is one way to consider estimating the total market size; however, the ERA study does not measure Sonoma County directly.

Because an illegal market continues to exist, estimates of total market size with precision are tricky. This study provides projected consumption and production levels in Sonoma County. For each new business that converts somewhere along the supply chain in Sonoma County, there are different regional effects; however, the data reflect the power of regional, vertical integration to capture as much of the supply chain in Sonoma County as possible.[2]

Using information available from various industry sources, we provide a per-kilogram, algorithm by which policymakers can consider how to provide incentives to generate more legal jobs and economic activity through converting activity already occurring in illegal markets. After conversion, those benefits become taxable and traceable as well as safer for all.

This study has the following organization:

[1] The best place to watch this evolution is the California Cannabis Portal of the state government: https://cannabis.ca.gov/
[2] See a study on Oliver's Market for one methodology to examine the capture of local supply chains and the economic impacts.

- Section 2 provides research examples and basic concepts to consider both caveats and opportunities in estimating this marketplace and monitoring its evolution;
- Section 3 explores the supply chain of cannabis and how each part has its own economic impacts;
- Section 4 provides the economic impact analysis showing the greater economic effects. The IMPLAN® model is used to identify the business revenues, wages, jobs and estimated tax revenue amounts supported by this industry per kilogram of product, regardless of recreational or medical use[3]; and
- Section 5 offers conclusions and policy recommendations.

2. Basic Concepts and Literature Review

This section provides a brief overview of a nascent, expanding literature on the cannabis industry's economics based on a legal marketplace.

Basic Concepts

The current, overarching issue in the cannabis industry is the Schedule 1 drug designation by the United States government: an illegal drug for recreational use. Because Sonoma County is located in California's premium wine area, we are able to point out some similarities and connections between the cannabis and wine industries as they exist:

- Cannabis, like wine grapes, is an agricultural product;
- Each have harvest cycles that create local labor and vendor demand annually at a minimum, however unlike wine grapes, cannabis has multiple harvests per year;
- Both harvests then go to a processor for conversion into at least one "value-added" product from raw materials;
- These products manufactured from raw agricultural materials are then packaged and distributed to a wholesale entity or direct to a retail or consumer endpoint;
    - After wholesale, a retail entity delivers product to consumers; and
- Each step of this process has some taxation and governmental monitoring involved.

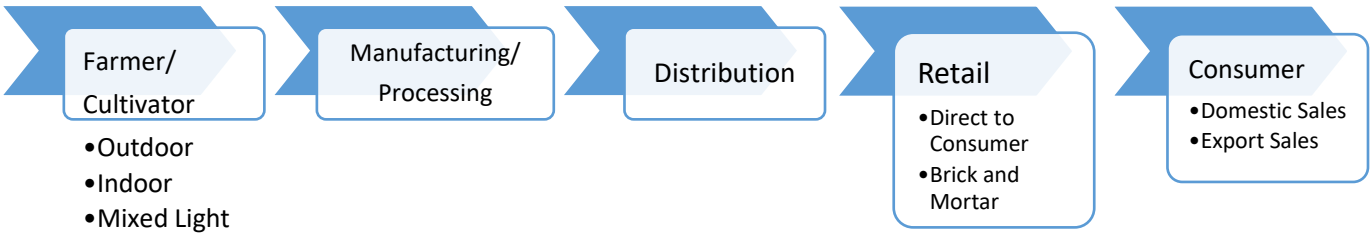
Each supply-chain link, as shown in Figure 1, is a step where value is added to the previous step's product, then tracked and traced. Chemical testing happens as required by California's regulations, creating scientific jobs to process legal cannabis as it moves from one link in Figure 1's chain toward the consumer.

Wine and beer and spirits are different than other products that come from agricultural raw materials in terms of compliance and governmental regulations because they contain alcohol. Each state in the United states regulates alcoholic beverages differently, though some states are "reciprocal" and have very similar laws (California and Colorado are examples in the alcohol industry).

Until cannabis is a federally legal product, reciprocity and exporting are only future possibilities. Vertically integrating the supply chain in Figure 1 is critical in taking advantage of regional connections from cultivator to retail. This can happen in one business or through regional economic development.

[3] See http://www.implan.com for more on this model and economic impact examples.

Figure 1: The Cannabis Supply Chain



As of 2018, California grows more cannabis than it consumes. Estimates suggest there may be $10 to $12 billion of market value of legal cannabis in California in terms of potential supply; for the United States overall, the retail sales number may be as high as $40 billion, where California is a major potential supplier.[4]

Demand is nationwide. For Sonoma County, legitimate export markets for now are the rest of California outside of Sonoma County. However, because demand is nationwide, incentives remain to grow and ship through long-standing interstate markets illegally unless incentives to convert and redirect focus on California's market are a norm for policymakers.

Recreational use and availability of cannabis does not stop illegal activity; it simply changes how markets compete and the costs of continuing to operate in an illegal marketplace. What should concern policymakers is placing taxes on a product where competition is fierce. The illegal market, where no taxes are collected, is a mature substitute for a legal market where costs are relatively large to conform and comply.

Concerns over costs of enforcement are somewhat alleviated by new tax revenue, but data so far do not allow any precise conclusions as to how law enforcement and other city and county agencies adapt to new regulations and compliance support needs. There are generations of cannabis business entrepreneurs regionally in Sonoma County, and circumvention of taxes and laws has been a long-standing part of that industry. Making both compliance costs and tax rates a relatively low barrier to entry allows new, legal markets to start more easily with these revenues generating new government revenue.

Throughout this study the idea of "leakage" or loss of economic value from a market is addressed. A legal seller of cannabis cannot export from California if the seller wants to remain legal. For Sonoma County specifically, local growers historically have been able to outpace local demand by a factor of around ten, generating "export" (outside of Sonoma County) sales from a base of approximately $1.5 billion in production.[5]

To summarize, Sustaining Technologies' estimation model, surveys by the authors and third-party sources like BDS Analytics and the California Department of Tax and Fee Administration (CDTFA) suggest the following baseline estimates in 2018:

- Sonoma County consumes about $150 million in cannabis, of which $20 million is due to non-residents visiting Sonoma County and making purchases;

[4] See https://bdsanalytics.com/press/new-report-legal-marijuana-industry-to-generate-40-billion/ for more.
[5] Sustaining Technologies estimates that at least $1.5 billion in cannabis flower/buds were sold before 2018, which connects to the estimate of $150 million in local consumption.

- There is a mix of legal and illegal production of $1.5 billion in final value, perhaps as much as $2 billion in market value from Sonoma County growers as 2018 began (pre-legalization); and
- California has a $10 billion retail marketplace (combined illegal and legal) and the United States has as much as $40 billion retail nationally.

Taxation

Taxation faced by converting businesses concerns both advocates and policymakers. The potential economic impact of this industry may fall because taxes lead to an artificial constraint on growth. There are two basic truths related to this issue:

Tax Rates, Sonoma County, July 1, 2018

Outdoor Cultivation	
Cultivation License Type	**Rate per Sq ft**
1C - Specialty Cottage	$1.00
1 - Specialty Outdoor	1.50
2 - Small	2.00
3 - Medium	2.00

Indoor Cultivation	
Cultivation License Type	**Rate per Sq ft**
1C - Specialty Cottage	$3.75
1A - Specialty Indoor	7.50
2A - Small	11.25
3A - Medium	11.25

Mixed Light Cultivation	
Cultivation License Type	**Rate per Sq ft**
1C - Specialty Cottage	$2.25
1B - Specialty Mixed-light	4.50
2B - Small	6.50
3B - Medium	6.50

Operator Type	**% of Gross Receipts**
Manufacturer	3.0%
Transporter	0.0%
Distributor	0.0%
Cannabis Nursery	0.0%
Dispensary	2.0%
Testing Laboratory	0.0%

- The tax structure for cannabis businesses is a key marginal variable in decisions converting an illegal market business into a legal business as compliance with tax codes is another cost; and
- In Sonoma County and California, so many of the value-chain and supply-chain relationships are already in place, albeit in ways that violate state and federal laws.

Economic development is most effective when there is regional, vertical integration that captures as much of an industry's supply chain (see Figure 1) locally as possible. This includes local capture of sales, use and excise taxes placed on the cannabis market. The literature on cannabis as a legal, recreational product and the economic impacts is limited as of September 2018.

Literature Review

Three main strains to this nascent research field affect our economic impact analysis. First are some economic impact analyses available as of September 2018.[6] Tax collection and compliance at the cultivation, manufacturing, distribution, and retail levels are similar in structure (not exactly the same in terms of full compliance) to the wine industry. The supply-chain relationships define "allied" industries and other business dependent on the core industry. Related literature includes studies on the wine industry. There are scores of these studies now, some of which are about California and Sonoma County (see http://www.wine-economy.com/ for the latest version for California from 2017 and at this link for the Sonoma County report in 2014 link).

The second literature thread is on measuring market activity, perhaps to be combined with economic impact studies. This literature looks at how to measure a market where there is illegal activity as the basis or parallel to

[6] Two such studies are used here as ways to model thinking about the market's structure and the supply-chain relationships that help proliferate the economic impacts. University of the Pacific (UOP) has produced two studies on Sacramento and Calaveras counties as models (see the UOP studies here). UC Davis' Agricultural Issues Center has also released a study on the cut flower industry and how legal cannabis may intrude on their growth (see the UC Davis study here).

a legal marketplace. The medical cannabis market provides one way to look at demand and supply, thus pricing and volume. How large and precise an indicator the medical market is of the legal, recreational market remains to be seen. ERA Economics completed an extensive study in 2017 for the California Department of Finance that helped inform our analysis (see the ERA Economics study here).

ERA Economics' analysis centers on the decision function for cultivators: the core risk premium, the direct cost of regulation, and the regulatory risk premium. The core risk premium for a cultivator is continuing to operate in an illegal market at the potential cost of losing their business and personal freedom. The direct cost is initial compliance of making the conversion, including permitting, fees, taxes, and other requirements. The regulatory risk premium is keeping the compliance in place, including ongoing tax payments (which may rise in cost over time) and increased costs and regulatory complexities. The regulatory risk premium also includes costs of local permits, fees and other compliance processes; this includes the cost of not producing while waiting for local government to provide legal clearance. Currently, the cost of outdoor and mixed light are by far the most expensive growing operations and styles.

Another important insight comes directly from the ERA Economics study. One might argue that the economic impacts of this industry already exist, and the conversion from illegal to legal business is simply a transfer of the same market to a different environment. We argue that because the choice to convert is costly and the legal marketplace is "new" and complex in structure, the economic impacts of the illegal market loses an enormous amount of supply-chain partnerships, and new, legal businesses from formerly illegal operators are like new market entrants.

ERA Economics estimated a total supply of 13.5 million pounds in 2016 (650,000 lbs. was for medical use), of which 1/3 comes from the "North Coast" region of California that includes the "Emerald Triangle" counties and Sonoma County (as well as Lake, Marin and Napa counties).

Other studies are more academic in nature and have extensive bibliographies in terms of recent studies. Butsic, et al. (2017) investigates the ecological economics of where cannabis production is located. Its focus is on Humboldt County, California. Humboldt along with Del Norte and Mendocino counties make up the "Emerald Triangle" of major, historic cannabis production in California. Locations in this area tend to be close to each other, and the authors see positive, "cluster" effects in terms of where cannabis is grown. Doussard (2017) examines the labor market for cannabis supply-chain jobs with a focus on the Colorado market. Many of the gains come from import-substitution effects, where due to the lack of potential imports, the legalization of recreational cannabis in Colorado created jobs across the supply chain to fulfill the demand for legal cannabis. The gains may not last, especially if there is nationalization, and Colorado is generating gains from being a first mover. These two studies elucidate how economic development efforts need to support initial gains when conversion takes place.

Firms like BDS Analytics are using big data to follow the cannabis market. Studies such as Caulkins, et al. (2018) look at data available in Washington State after two years of legal use. Data show where market opportunities may lie and how data perhaps increase competition in some areas and lower the current 3:1 retail to wholesale price ratio for value-added products. Yates and Speer (2018) look at the Colorado market and how data of all kinds can help inform regulatory decisions and evolution to maximize social welfare or gains to Sonoma County from market activity being legal. Their results suggest that increasing the amount of available data is better for all and may inform how other states or national decisions evolve.

Costs to Public Sector: Enforcement and Compliance

Some concern exists over increased costs to the public sector as a result of cannabis legalization for recreational use in California. Since Proposition 64 passed, law enforcement and city and county agencies have been concern with shifting burdens and rising costs versus estimated new tax revenues. Data to draw conclusions are not available as of this writing, but the literature has a couple of studies that provide some perspective. Carnavale, et al. (2017) uses recent evidence in Colorado and Washington to investigate the public costs, benefits and concerns of cannabis legalization for recreational use without a parallel federal policy. Their study suggests a need to align public policy with public goals. This study advocates for a single, state-wide system, a public health approach, and practical goals as primary. Reducing youth exposure and use and increasing transparency are examples. For each stage of the supply chain, this study shows examples (page 75, Table 3) of regulatory considerations. Their conclusions provide specific recommendations for a well-balanced, regulatory environment where public costs are balanced with business support.

The depth and breadth of literature will also change. The next section explores market entry and the basics of how new business may come into the cannabis space in Sonoma County.

Market Entry and Industry Challenges

A key challenge is to provide the correct incentives and entice current illegal businesses to become legitimate. Tax and regulatory environments must balance between conditions of temperance and also business support to keep local businesses as involved as possible. Sustaining Technologies in Santa Rosa has identified four different types of market entrants.

All in	Businesses that see the potential and are willing to do the initial heavy lifting to convert to a legitimate business
Hedgers	Businesses that have both legal and illegal operations where full conversion (becoming “all in” businesses) depends on cost of legal market entry
Wait and See	Businesses that are illegal and considering conversion but are not going toward legitimate businesses yet
Not in	Businesses that have no intention to convert

These categories are important to understand moving forward. There is some evolution of hedgers into all-in businesses and wait-and-see operators into hedgers. The speed at which this evolution happens may be slow; however, local policy can help shape and augment such choices. Local governments should want entrepreneurs in this market to convert from illegal to legal businesses.

Another challenge is determining how much supply-chain revenue can stay local versus being lost to adjacent counties due to lack of raw materials supply or capacity along the supply chain. More established industries (such as agriculture and food systems) vertically integrate by connecting local and regional raw materials sources with local processors/manufacturing, distribution and retail. For example, a grocery store is both a retailer and manufacturer simultaneously in cases where a full-service grocery store includes amenities such as a bakery, deli, taqueria, etc.

A recent study commissioned by Oliver's Market in Sonoma County shows the power of vertical integration as an approach to retail.[7] By sourcing local inputs, Oliver's Market revenues in Sonoma County were increased by 55 percent compared to a grocery store that sourced from outside Sonoma County. Tax revenues generated were increased by approximately 73 percent due to multiple layers of additional taxes paid by local vendors and wholesalers versus similar entities paying other counties and cities those taxes. We provide a similar analysis below to show the economic power of local, vertical integration and monitoring licenses in a way to fill supply chain gaps. Doing such work is the essence of economic development.

Suppose there is a Sonoma County business that sources raw cannabis from Mendocino County farmers. Farmers and suppliers in Mendocino County are generating income where Sonoma County farmers could be gaining that income instead. This represents a leakage and loss to the county economy. This is precisely the situation in October 2018 because of regulations related to land use in Sonoma County that have rendered 80-90 percent of the incumbent cultivators illegal.

Manufacturing and testing and distribution have similar outcomes. If local growers need to send their product to another county, for instance, to Yolo County as businesses choose to locate close to UC Davis and its scientific talent, that location choice represents a leakage to Sonoma County. By encouraging such businesses to locate in Sonoma County and take on local contracts with local farmers, one part of the supply chain links to another through vertical integration. Retail works the same way; local retailers should attempt to source as much local product as economically feasible and possible to maximize the local economic impacts.

Cannabis businesses may not only grow their own supply, but may combine manufacturing, testing, packaging, distribution, and retail in one space as a business model (microbusiness licensing allows supply-chain links to be integrated inside the same license). A cannabis business may hold other links within supply chain.

3. Cannabis Supply Chains

Earlier, we introduced similarities between cannabis and other agricultural crops. Some simple differences between cannabis and other "crops" are:

- Cannabis remains federally illegal, thus no legal exports from California to other states;
- It is a high-value product to weight; and
- The compliance network is vast and costly.

Labor resources also make up a large part of the value chain as raw cannabis is converted to various products by adding value.

Sonoma County Cannabis Industry: Transition from Illegal to Legal Marketplace

The cultural divide between the cannabis marketplace and mainstream culture is more evident now that cannabis is legal statewide. In a pre-legal environment, there was little need for non-cannabis consumers (around 70 percent of the general population) to pay much attention to the marketplace. It was mostly out of sight, out of mind.

[7] See the Oliver's Market study from 2016 at https://bit.ly/2QpE4Oe

That changed dramatically on January 1, 2018 when recreational cannabis consumption became legal. Cities and counties throughout California had to wrestle with regulatory apparatus in short order to align with the ever-changing state regulations. Decisions about where to legally grow and manufacture cannabis products and where to sell them became a source of controversy and disagreement between residents.

The distribution of Sonoma County cultivators (farmers) was in the thousands pre-2016. Most were small growers operating on small parcels of land and, in some cases, in residential neighborhoods. Some farmers could make a living wholly, but most saw cannabis as a supplement to their household income. Their transition to a legally-sanctioned pathway has slowed in Sonoma County in the face of restrictive land-use policies balancing temperance and legal production incentives.

While pre-2018 production was illegal, it represented an economic presence that was difficult to ignore due to its multiplier effects in the local economy. Thousands of people have been employed in the cannabis market over past decades, and their expenditures for commercial and private consumption stimulated local economic activity.

In 2018, very little grown flower has made it to the legal Sonoma County retail marketplace. Local manufacturers likewise have relied on biomass supplies from outside Sonoma County. This loss of local biomass supply clips the wings of economic growth as it represents a major leakage at a time when retail sales are growing statewide in search of high-quality product.

The downside for the legal market at this critical time is that the illegal market is thriving in 2018. Since track and trace does not kick in until 2019, available product from illegal cultivation and even in some cases from legally-sanctioned operations are found in the illegal market. A portion of the illegal market supplies the California consumer market through legacy channels that are comfortable to long-time consumers. In reality, most of the illegal market production leaves the state in the forms of flower and concentrates. Due to massive oversupply in Oregon, that product is also finding its way into the national supply and illegal market prices have fallen significantly—to approximately $700 per pound for outdoor and $1,600 for indoor. That's a price decline of nearly 40 percent over the past two years.

Legal cultivators will find it more difficult to divert production to the illegal market once track and trace begins, but not impossible. While it is not ideal for cultivators and manufacturers to bifurcate into markets, it is a matter of survival due to regulatory costs rising quickly for most operators, slow permit process in cities and counties, and rising taxes from all levels of government. These concerns are at the heart of the ERA economics study mentioned above.

Two years ago, Sonoma County was perched to become a robust center of supply chain activity largely due to the presence of thousands of small cultivators. Given the drastic reduction of local suppliers, it is not clear the role Sonoma County will play on the state, or national, stage in the coming years.

Modeling the Legal Cannabis Industry

A major challenge is finding a model of what legitimate businesses are currently doing to measure what the benefits are for illegal businesses to convert to legal businesses in Sonoma County. Aggregating these benefits over the entire county economy is the next step. The data here are based on the grams of cannabis involved, the standard unit of measure in a final product and the basis of pricing in cannabis markets. Figures 2 and 3 provide the licenses volume as of July 1, 2018 for California across different parts of the supply chain. These data also provide some perspective on how many potential businesses may spring up in this marketplace and the economic possibilities if more conversions and entrepreneurships take place.

Like the wine industry, the cannabis industry has allied industries as part of its normal operations. These include fertilizer, commercial real estate, trucking/transportation, crop management, field design and maintenance, fencing, water, packaging, printing, labeling, marketing, track and trace, and research. Each of these "allied" industries have their own connections to cannabis and also help accelerate and proliferate the economic impacts of these jobs.

Cannabis Cultivation

Outdoor cultivation is the classic growing condition associated with forested areas. Sonoma County is part of the "Emerald Triangle" region, but is at its southern vertex. Being proximate to the central counties of Mendocino, Humboldt and Del Norte, exporting product out of state remains illegal but still exists (interstate trade will not be allowed legally until a national policy is passed); Sonoma County remains a hub for logistics and retail in the illegal market.

Indoor cultivation is associated with a highly-controlled environment, where cultivators set up optimal growing conditions as possible. Pests and other agricultural concerns can be mitigated through an indoor setting, but space management, energy and other costs of such cultivation can be relatively large. New innovations in LED lighting design and environmental control can significantly lower energy consumption.

Mixed light cultivation is similar to indoor with less control and a focus on manipulating the light as the key factor in growing. Greenhouses or hoop houses are a classic example of such agricultural practices, which use artificial light, as with indoor growing, that can be controlled in combination with the use of natural light. Because of the similarities, some areas may see a conversion to indoor grow if product prices are high enough to cover the additional cost.

ERA Economics (2017) identifies three types of cultivation as the cornerstone of cannabis supply:

- Outdoor;
- Indoor; and
- Mixed Light.

Figure 2: Cannabis Supply Chain Licenses Across California, July 1, 2018 (number of licenses)

Manufacturing Licenses	
Alameda	111
Los Angeles	80
Riverside	76
Humboldt	53
Monterey	36
Sacramento	32
San Bernardino	32
San Francisco	31
Santa Cruz	29
Sonoma	22
San Diego	16
Santa Clara	13
Yolo	11
All Others	61
Totals	**603**

Temporary Cultivation Licenses	
Santa Barbara County	1,288
Humboldt County	843
Mendocino County	616
Monterey County	405
Calaveras County	195
Trinity County	191
Riverside County	189
Los Angeles County	156
Sonoma County	103
Yolo County	91
Sacramento County	88
Alameda County	81
All Others	310
Totals	**4,556**

Retail Storefront	
Los Angeles	130
Riverside	32
San Francisco	32
Sacramento	27
Orange	18
San Diego	18
Stanislaus	16
Santa Cruz	14
Mendocino	13
Solano	13
Alameda	12
Sonoma	11
Santa Clara	10
All Others	68
Totals	**414**

Retail: Non-store	
Alameda	44
Sacramento	25
San Francisco	23
Los Angeles	8
Marin	6
Monterey	3
Riverside	2
San Bernardino	2
SLO	2
Colusa	1
Lake	1
Orange	1
Totals	**118**

Testing Facilities	
Los Angeles	7
Alameda	6
Humboldt	3
San Diego	3
Monterey	2
Sacramento	2
Sonoma	2
Marin	1
Orange	1
Riverside	1
San Francisco	1
Santa Cruz	1
Ventura	1
Totals	**31**

Each license type has a financial performance model unique to its link in the supply chain, but ultimately each is based on weight and value. For example, indoor growing operations with 22,000 square feet (sq ft) of canopy produce 17,600 kg in volume (weight) per year at $5,000 per kg in value (dollars). These models were developed over the past two years by interviewing cultivators and researching average performance metrics. Cultivators employ many different techniques that produce many different results, even within the same license class. Survey interviews noted differences among different yield levels and best practices in pursuit of higher yields.

Figure 3: Cannabis Supply Chain Licenses Across California, July 1, 2018 (number of licenses)

Microbusiness	
Los Angeles	25
Alameda	18
Santa Clara	10
San Francisco	8
Riverside	7
Humboldt	4
Santa Cruz	4
Siskiyou	4
El Dorado	2
San Diego	2
Santa Barbara	2
Sonoma	2
Stanislaus	2
Mendocino	1
Sacramento	1
San Bernardino	1
Shasta	1
Solano	1
Totals	**95**

Distributor – Transport	
Mendocino	25
Humboldt	16
Alameda	4
Riverside	2
Monterey	1
Sacramento	1
Sonoma	1
Trinity	1
Totals	**51**

Distributor	
Los Angeles	74
Alameda	57
Monterey	32
Humboldt	30
Riverside	29
Sonoma	26
Santa Cruz	19
San Francisco	15
San Diego	11
Mendocino	10
San Bernardino	10
All Others	70
Totals	**383**

Sources: California Cannabis Portal (https://cannabis.ca.gov/) and Bureau of Cannabis Control (https://www.bcc.ca.gov/) and California Department of Public Health (https://www.cdph.ca.gov/Programs/CEH/DFDCS/MCSB/Pages/LicenseeLookup.aspx)

Figure 4 provides the data that lead to $233.3 million in wholesale value of recreational cannabis product produced in Sonoma County by legal, licensed cultivators.

Figure 4: Estimated Wholesale Value from 52 Cultivator Licenses in Sonoma County, as of July 1, 2018

Cultivation License Type	**# of licenses**	**Sq Ft**	**Grams per license**	**Total Grams**	**Price per gram**	**$ value per license**	**Estimated Total Value**
Medium Indoor	4	88,000	4,400,000	17,600,000	$5.00	$22,000,000	$88,000,000
Medium Outdoor	13	567,450	1,658,700	21,563,100	$2.00	$3,317,400	$43,126,200
Small Indoor	2	20,000	2,000,000	4,000,000	$5.00	$10,000,000	$20,000,000
Small mixed light Tier 1	1	10,000	1,400,000	1,400,000	$3.00	$4,200,000	$4,200,000
Small Outdoor	12	120,000	380,000	4,560,000	$2.00	$760,000	$9,120,000
Specialty Cottage Mixed Light Tier 1	1	2,500	350,000	350,000	$3.00	$1,050,000	$1,050,000
Specialty Cottage Mixed Light Tier 2	2	10,000	700,000	1,400,000	$3.00	$2,100,000	$4,200,000
Specialty Indoor	12	60,000	1,000,000	12,000,000	$5.00	$5,000,000	$60,000,000
Specialty Mixed Light Tier 1	1	5,000	700,000	700,000	$3.00	$2,100,000	$2,100,000
Specialty Outdoor	4	20,000	190,000	760,000	$2.00	$380,000	$1,520,000
Total	**52**	**902,950**	**12,778,700**	**64,333,100**			**$233,316,200**

Cannabis Manufacturing

Categorically, refined oils, the flowers/buds, and biomass (the remaining, usable parts of the cannabis plant) are main products for value-added goods. Value-added goods and services have many forms and many directly and indirectly related components to take raw materials to finished products. Equipment purchases, commercial space, heating and air conditioning (HVAC), transportation, mechanical engineering, architects, and many other sub-industries may need to be engaged to complete value-added services.

Compliance is another value-added component in terms of track and trace and understanding each product's chemistry and origin (like "terroir" and viticultural areas in the wine industry). Hence, quality assurance and quality control are also major elements of cannabis manufacturing. The possibilities of final products may be somewhat unlimited. From gummies to candies to simply refined buds, the craft-manufacturing process is analogous to wine or beer or confection making, and likely has a lot of the same processing elements. Market possibilities are vast.

Starting with a harvested, agricultural product, the raw inputs become products based on adding value. Each of these allied industries are potential places of economic development and business growth in Sonoma County once legalization and conversion begins in earnest:

- Quality control and sorting;
- Preparation;
- Extraction and processing;
- Post-processing and quality assurance;
- Drying or initial storage;
- Packaging and final processing; and
- Final Storage.

Cannabis Distribution

Distribution in the legal form has compliance (taxation and track and trace) and involves many of the same costs as any other food distribution:

- Warehousing;
- Logistics (trucking, last-mile delivery, refrigeration, etc.); and
- Security.

Additional expenses follow other business settings: electricity, water/sewer, roadway maintenance, building maintenance, etc. Each step or link in these relationships generates more economic activity and more connections to households throughout Sonoma County as more workers are affected. Because distribution companies look to optimize scale and perhaps take on multiple clients to spread risk and to grow, as the cannabis industry evolves and matures, California locations where distribution is most likely to thrive will also evolve.

Cannabis Retail

Once distribution takes place, retail begins. Retail is a cash activity for now. This is likely not the preference of legitimate businesses long-term. Because the United States government's scheduling does not allow for credit market activity, merchant activity in banks and credit unions (depository institutions where cash can be stored) may be limited also. Due to consistent cash needs, cannabis businesses, from farmer to retailer, are faced with additional security costs and concerns to complete transactions.

Some debate exists on what retail analog best describes cannabis. While the future likely includes a mix of specialty shops and grocery shelf space, regulated retail is the only, current choice. Three major issues apply to a tightly monitored environment where cannabis retail is handled more like a high-end jewelry shop than a specialty food store:

- Until removal from Schedule 1 status with the federal government, merchant banking services are going to be largely unavailable and thus all transactions continue to be in cash;
- The product by volume is relatively high value, like diamonds in glass cases, and thus have different security conditions and transport needs/costs; and
- The nascent market aspects suggest something more like an educational wine-tasting experience rather than a mass marketing and shelf space competition.

There are some inherent inefficiencies from such models, and this industry's evolution and success as it moves forward legally depends on innovations and regulatory generalizations to help reduce costs.

Cannabis Supply Chain Summary and Direct Economic Impacts

As shown above, this study used multiple sources of data to estimate the current (as of June 30, 2018) level of economic activity in the cannabis markets in Sonoma County. These "direct impacts" are the basis of estimates for the broader economic impacts of this industry; the amount of economic activity possible with more regional, supply-chain integration; and the benefits of conversion of illegal regional businesses into legitimate ones. Figure 5 summarizes the direct impacts from the full supply chain including allied industries.

Figure 5: Direct Economic Impacts, Legal Cannabis Industry, June 30, 2018
(per kilogram (kg) based on 64,330 kilograms produced in Sonoma County in 2018)

Category	Direct Impacts: Aggregate	Direct Impacts per kg
Cultivation – Greenhouse	$11,550,000	
Cultivation – Indoor Grow	$168,000,000	
Cultivation – Outdoor Grow	$53,766,200	
Manufacturing	$70,427,000	
Distribution – Transport	Allied	
Distribution	Allied	
Testing	Allied	
Retail – Storefront (Added Value)*	$27,571,200	
Totals	**$331,314,400**	**$5,150**

*Note: There is an estimated amount of gross retail sales of $140,584,000, but due to leakages along the supply chain, only $27.5 million remains local in Sonoma County.

These direct impacts are new to the economy because they generate new tax revenues for city, county and state government. Sonoma County's economy, according to the Bureau of Economic Analysis, is approximately $25 billion in 2009 dollars as of January 1, 2018. The methodology below provides one way to measure the current market size.

Methodology

We initially arrived at a range of $54 million low end and $65 million on the high end using estimated, legitimate sales in Sonoma County from statewide customers for 2018. These estimates are based on current tax collection with the other period forecasts divided by all retailers currently licensed in the state. No weights were applied for location. We then multiplied that average with the number of licensed dispensaries in Sonoma County to arrive at a $70 million estimate. This estimate is very close to the one implied by CDTFA data extrapolating tax collections on legal cannabis sales from Sonoma County after 2018 quarter 2 (July 1, 2018).

Sustaining Technologies LLC has developed a consumption model multiplying an estimated percent of the population that consumes cannabis with average consumption (seven consumer segments at varied volumes of annual consumption derived from Colorado's data and two other sources). The results suggest that Sonoma County residents consume around $130 million of product per year. Another $20 million are likely sold to tourists for a total sales projection of $150 million per year. That would produce a conclusion that the legal retail is around 47 percent ($70 million of $150 million) of total sales with the rest coming from illegal or imported sales.

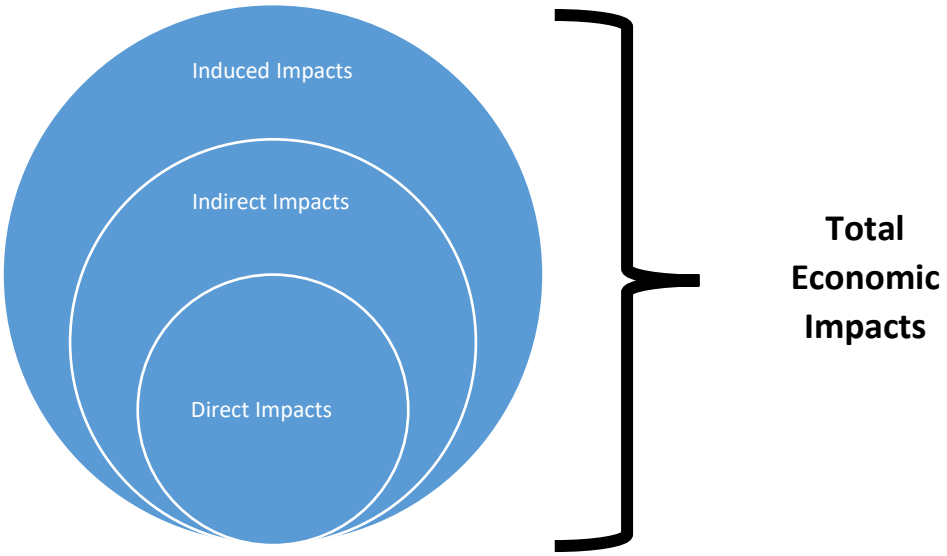
The next section provides the economic impacts generated from these direct impacts.

4. Broader Effects (IMPLAN®)

Economic impacts come in three "flavors" that start the same way ripples come from throwing a rock into a still pond. The rock, in this case, is a new cannabis cultivator, manufacturer, distributor, or retail business. The new revenues ripple out as additional economic impacts produced from by new employers.

Direct effects come from these projects and the subsequent business and worker gains. **Indirect** effects come from workers employed by vendors to these cannabis businesses or allied businesses (wholesale, testing, etc.), producing broader spending. For example, a testing business may purchase more office furniture due to new cannabis businesses providing more demand for services. This spending supports some portion of office furniture businesses and its employees locally as an example. This type of spending has **induced** effects on the broader economy. The furniture store's employees spend wages on groceries, medical visits, restaurant meals, and various other industries that have nothing to do with the original businesses affected. Figure 6 shows the multiplier effect of these rounds of new spending.

Figure 6: Economic Impacts



Description of Direct to Total Impacts

In each figure below, we assume 64.33 million grams or approximately 64,330 kilograms of product annually. Notice the breadth and depth of industries and workers affected by an expansion and the current economic footprint of this industry in Sonoma County. The business revenues derived from the cannabis industry involve its licensee businesses and allied industries (as shown in each figure from Figures 7 through 11) as well as hundreds of other industries that have nothing to do with Figure 1's supply chain, but everything to do with the regional economy.

From these revenues, wages are paid to support full-time employment and taxes of various kinds are paid indirectly due to the new economic activity. Per kilogram of raw product produced in Sonoma County, there is approximately $7,800 of business revenue spread throughout countywide businesses. If Sonoma County did not cultivate cannabis, allied industries (manufacturing, distribution and testing) would have less incentive to locate here; the $7,800 acts as an algorithm for the economic impact of one additional kilogram of raw cannabis biomass grown in Sonoma County **legally.**

Estimated wages of $2,549 are paid per kilogram, while $519 in tax revenues (including the excise taxes paid to the state of California) are supported per kilogram. One job full-time worker is supported per 25 kilograms. These numbers are connected by the general activity of $7,800 per kilogram in business revenues. Other costs, profits and leakages to businesses and workers outside Sonoma County make up the remaining amount.

Figure 7: Business Revenues

Category	Direct Impacts	Indirect and Induced Impacts	Overall Impacts	Per kg
Cultivator – Indoor	$11,550,000	$7,761,600	$19,321,600	
Cultivator – Greenhouse	$168,000,000	$94,882,000	$262,882,000	
Cultivator – Outdoor	$53,766,200	$11,943,000	$65,709,200	
Manufacturing	$70,427,000	$35,830,900	$106,257,900	
Distribution	$0	$8,650,100	$8,650,100	
Testing	$0	$103,200	$103,200	
Retail ($140,584,000)				
Retail margin	$27,571,200	$13,970,200	$35,541,400	
Total	**$331,314,400**	**$173,141,000**	**$504,455,400**	**$7,840**

*Note: There is an estimated amount of gross retail sales of $140,584,000, but due to leakages along the supply chain, only $27.5 million remains local in Sonoma County.

Cultivation gains are seen as being local by definition, and it is in manufacturing and retail where the gains expand. The more those processes can use local markets, the better. We assume that Sonoma County cultivators are producing more cannabis than is consumed in Sonoma County, thus there is an intrastate export market where Sonoma County's economy is the "domestic" market.

Figure 8 shows how sourcing more local products affects manufacturing, allied industries and retail environments in such a way to increase the economics gains of conversion to a legitimate business per raw cannabis kilogram. We estimate the sum of these additional, integration gains as 31.2 percent more than the status quo. By connecting Sonoma County links in the supply chain more completely, the Sonoma County economy reaps 31 percent more economic benefits.

Figure 8: Sourced Locally Versus Outside Sonoma County, Manufacturing and Retail Value-Added 2x (from current amount of economic activity)

Category	Direct Impacts	Indirect and Induced Impacts	Overall Impacts	Per kg
Cultivator – Indoor	$11,550,000	$7,761,600	$19,321,600	
Cultivator – Greenhouse	$168,000,000	$94,882,000	$262,882,000	
Cultivator – Outdoor	$53,766,200	$11,943,000	$65,709,200	
Manufacturing	$140,854,000	$71,661,800	$212,515,800	
Distribution	$0	$17,300,200	$17,300,200	
Testing	$0	$206,400	$206,400	
Retail ($140,584,000)				
Retail margin	$55,142,400	$27,940,400	$71,082,800	
Total	**$429,312,600**	**$231,695,400**	**$661,008,000**	**$10,275**
Percentage gain from baseline in Figure 5				**+31.2%**

Figures 9, 10 and 11 complete the data summary by providing the annual wages, jobs supported and annual tax revenues at the state and local level collected from our estimated level of cannabis cultivated, manufactured and sold in Sonoma County.

Figure 9: Wages

Category	Direct Impacts	Indirect and Induced Impacts	Overall Impacts	Per kg
Cultivator – Indoor	$5,625,900	$2,976,700	$8,602,600	
Cultivator – Greenhouse	$46,886,900	$23,885,600	$70,722,500	
Cultivator – Outdoor	$23,498,000	$17,270,000	$40,768,000	
Manufacturing	$13,771,700	$13,248,500	$27,020,200	
Distribution	$0	$2,703,600	$2,703,600	
Testing	$0	$47,000	$47,000	
Retail	$9,425,000	$4,681,800	$14,106,800	
Total	**$99,207,500**	**$64,813,200**	**$164,020,700**	**+$2,549**
Gain from baseline in Figure 5 if more local				**+$3,344**

Jobs, wages and taxes come from business revenues. For the jobs numbers, notice that the per-kilogram figures are less than one full-time equivalent job. An alternative way of viewing the estimate of 0.04 jobs per kilogram produced is that one full-time equivalent worker is supported somewhere in the cannabis supply chain for every 25 kg of raw product cultivated. The projected production in 2018 for Sonoma County is estimated to support 1,674 jobs in cannabis directly and over 2,900 jobs throughout the county **just in the legal market**.

Taxes include those projected through the end of the year from California Department of Tax and Fee Administration (www.cdtfa.ca.gov) and are reflected on the line item called “Excise Taxes” (excise tax on retail sales is 15 percent).

Figure 10: Jobs Supported, Direct, Indirect, Induced and Total Impacts

Category	Direct Impacts	Indirect and Induced Impacts	Overall Impacts	Per kg
Cultivator – Indoor	86.0	61.0	147.0	
Cultivator – Greenhouse	712.0	478.0	1,190.0	
Cultivator – Outdoor	412.0	249.0	761.0	
Manufacturing	256.0	218.0	474.0	
Distribution		37.0	37.0	
Testing		0.6	0.6	
Retail	208.0	97.0	305.0	
Total	**1,674.0**	**1,140.6**	**2,814.6**	**+0.04 jobs**
Gain from baseline in Figure 5 if more local				**+0.05 jobs**

Figure 11: Tax Revenues Supported Annually

Type of Tax	Amount	Per kg
Employment Taxes	$840,800	
Sales taxes	$6,854,800	
Excise Tax	$10,500,000	
Property taxes	$6,026,500	
Personal Income	$6,752,500	
Other Taxes and Fees	$2,451,200	
Total State and Local taxes	**$33,425,800**	**+$520**
Gain from baseline in Figure 5 if more local		**+$680**

As Sonoma County considers the use of agricultural and commercial space for economic development, it would be wise to study and compare cannabis to other agricultural industries in Sonoma County and regionally to gain a complete perspective on land use choice and the economic impacts conversion. It is difficult to imagine another crop that has as much economic impact and value per kilogram of raw production for Sonoma County agriculture.

5. Conclusions and Policy Recommendations

This study shows the economic impacts from the current state of legal cannabis business, where conversion of illegal businesses and the expansion of new businesses can lead to broader economic impacts. This study was sponsored by several Sonoma County cannabis businesses. The cannabis supply chain, like any other agricultural good, determines its ability to support a broad number of industries and jobs. Agriculture grown locally is likely to produce more products than can be sold locally, which implies export possibilities. The legal cannabis market cannot sell products outside California legally as of 2018. For Sonoma County, the challenge is determining how to maximize the opportunities of cultivation, manufacturing, distribution and retail businesses within the county versus purchasing those goods and services from outside the county. This balance between leakages and exports is a major part of economic development and support for legal cannabis. Major findings include:

- Sonoma County's overall retail sales of cannabis products are projected to be $150 million in 2018 based on the first two quarters of legal, taxable activity and estimates of illegal activity;
- 52 licensed cultivators are currently identified by the state of California as of July 1, 2018 in Sonoma County;
    - Another 178 businesses licenses are in Sonoma County, predominantly temporary cultivation licenses;
- There is an estimated 64.33 million grams of cannabis product or 64,330 kilograms of raw product to be produced in Sonoma County in 2018;
- The estimated amount of cannabis legally cultivated in Sonoma County is $233 million for 2018;
- Estimated sales in Sonoma County are $150 million in 2018 of cannabis products, suggesting some cultivation is exported to other parts of California and beyond;
- Public costs exist for enforcement and compliance in the legal environment and to enforce laws against continued, illegal activity

- In 2018, given the current level of economic activity and supply-chain connections, state and local taxes of over $33 million are estimated from the economic impacts paid across many categories in Sonoma County; and
- In the legal market, as many as 2,800 jobs may be supported in this industry through all the supply chain connections;
- For every kilogram of cannabis produced in Sonoma County, the county economy generates $7,800 of business revenue across hundreds of industries;
    - If all local retail sales came from local production, there would be a 31 percent increase in economic impacts within Sonoma County.

Recommendations

- Public policy should focus on incentives for conversion of current illegal businesses, enhancing the hedgers and wait-and-see possibilities for conversion by reducing tax rates and compliance costs;
    - Encourage the development of a craft, artisanal sector;
- Provide entrepreneurship training and support for business conversions;
- Centralize distribution and use of local product such that benefits can be maximized across county economy;
- Make provisions for local processing of plant material into saleable flower and supply for manufacturers to make concentrates;
- Support cannabis tourism through Sonoma County Tourism; and
- Create a long-term vision for development of the cannabis industry in Sonoma County.

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Data:

BDS Analytics provided data that helped complete the estimation of market size. See https://bdsanalytics.com/ for more.

California Department of Tax and Fee Administration Staff provided sales/excise tax information for each quarter of quarter 1 and 2 in 2018 directly through e-mail. See https://www.cdtfa.ca.gov/ for more.

Sustaining Technologies provided both survey and estimation data that helped inform this report. Those surveyed were told they would remain anonymous.