Analysis of drivers and constraints in the Kansas grape and wine industry

by

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Abstract

In 1985, The Kansas Farm Winery Act was passed, allowing for the sale and manufacture of wine in the state for the first time since prohibition. In the 35 years since the legalization of Kansas produced wine the market has grown to include over 50 wineries, and generating over $800M in revenue (Wine America, 2017). While the market is growing, interviews from both wine makers and producers suggest that the market growth is constrained by a number of factors (Derksen Schroeder, 2016; Stramel, 2015; Voorhis, 2014). To expand the industry, the stakeholders need to understand the potential drivers and constraints related to resource availability, policy framework, and supply chain governance. This study utilizes a combination of quantitative and qualitative methods to evaluate these constraints. A life cycle analysis was done to evaluate the water resources needed to support the grape production process. A case study method was used to evaluate the policy framework that could be impacting the growth of the market. Transaction Cost Economics framework was used to evaluate the effectiveness of various vertical coordination strategies at the producer-processor interface of grape/wine supply chain.

Upon our analysis we found that grape vines require less water resources than more commonly grown crops in the area. In addition, grape vines can result in profits per acre of $1,062 per acre while the competing crops result in profits of approximately $363.76. This suggests that wine grapes could be a valuable asset to those looking to invest in a crop that is less dependent on available water resources. The case study of the policies impacting the market lead to the hypothesis that the constraining factor in market growth could be the product composition minimum established in the Kansas Farm Winery Act. When more recent data becomes available this hypothesis can be tested. When accounting for the various forms of asset specificity

associated with the production of grapes and wine, our Transaction Cost Economics framework suggests that an equity based alliance could be a more effective governance structure than the spot market or vertical integration. Further study is needed to evaluate this hypothesis.

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Introduction

The passing of the Kansas Farm Winery Act made it possible for a new agricultural industry to reemerge in Kansas, wine. While growth in the region was slow at first, by 2017 the wine and grape market in Kansas had grown to be an $867.8 million industry with over 50 farm winery licensees (Wine America, 2017). As the demand for Kansas wine, and Kansas wine tourism grows, so does the need for Kansas-grown wine grapes. This presents an opportunity for farmers to diversify their crop portfolios. This opportunity does not come without its challenges as constraints of production may exist in this emerging market. Further research is needed to understand these potential constraints.

As Kansas farmers look to diversify crop portfolios with high value crops, wine grapes could be a valuable option. An acre of wine grapes can bring in up to $1000 in profit per acre, making the crop a financially appealing option (Kansas Department of Agriculture, 2011). Before investing in this crop there are considerations that need to be made. There are potential constraints of production associated with the growing and selling of wine grapes in Kansas. Constraints could be in the form of necessary resources such as land, capital, and water. Considering the upfront investment and long-term production horizon, water can be a particularly pertinent resource constrain for grape production. The long-term resource availability could change as a result of global climate change, potentially making a present profitable crop, unprofitable in the future. Additional constraints can exist in policy that dictates the way Kansans make wine. The wine and wine grape market are connected in such a way that the transaction been grape grower and wine maker could experience potential supply chain bottle necks that could impact the profitability of the crop. Understanding the nature of these constraints is important not only from the perspective of agricultural producers, but also other industry stakeholders and policy makers

interested in facilitating the development of alternative high value crops and the resilience of agri-food industry in Kansas. As global climate change intensifies (Ashenfelter & Storchmann, 2016; Moriondo et al., 2013; White et al., 2006), regions formerly known for wine production may no longer be able to produce the quality and quantity the market depends on. In this event, the Kansas grape and wine supply chain could be in a position to capitalize on market demand and expand production to fill the needs of the market. However, the resources and capabilities as well as policy framework needed to facilitate the growing of wine grape in Kansas is relatively understudied. This study aims to fill that gap by examining potential drivers and impediments for the development of grape and wine sector in Kansas from resource, policy, and supply chain governance perspectives. Specifically, this study will assess (a) water resource needs for grape production in Kansas, (b) existing policy framework and its effects on grape/wine industry, and (c) governance structures at the producer-processor interface of grape/wine supply chain.

As a state that is facing diminishing water resources (Wada et al., 2010), evaluating the resource demand of wine grapes can help farmers make more informed decisions on how to diversify their crop portfolio based on both expected profit and expected resource need. Using a Lifecycle Analysis framework, we calculate the water needed in the production of wine grapes to fulfil this need.

When the Kansas Farm Winery Act became law in 1985, it introduced two major constraints to wine makers looking to be granted a farm winery license. First, a licensee can only produce 100,000 gallons of wine per year. This puts a cap on the market for both wine supply and therefore, grape demand. Additionally, 30% of the grape products that a winery uses must be grown in Kansas, creating a market for Kansas specific grapes. These policy stipulations could impact the demand of wine grapes grown by Kansan farmers and should be taken into account

when deciding which high value crop to add to a crop portfolio. A case study on the 2010 wine and grape market will give insight into potential constraints as a result of the policies the govern the market. These policies may still impact the market capacity today. Understanding the role policy has on the market capacity can give stakeholders further insight that results in more informed decision making.

Because of the existing policy framework, Kansas wine makers need Kansas grown grapes and Kansas grape growers need buyers for their crop. Both, grape production and processing require investment in transaction-specific assets. Assets are specific to the transaction if they lose value when redeployed to an alternative use (Williamson, 1983). This can give rise to high transaction costs at the producer-processor interface of grape/wine supply chain and can result in potential bottlenecks, underinvestment, and foregone profit potential. We use a transaction cost economics approach to examine the effectiveness of various governance structure for coordinating transactions at the producer-processor interface of wine/grape supply chain.

Robust wine regions bring economic development to local communities and increased revenue for the state. To expand the industry, the stakeholders need to understand the potential resource, policy, and governance drivers and constraints.

Objectives

Understanding resource constraints: water needs of grape production

As farmers look to diversify existing crop portfolios or transition to high value crops it is important to understand the resources constraints that are specific to a specific crop. While these types of measures exist for more commonly grown crops in Kansas and for grapes in larger markets, a Kansas specific resource analysis has not been conducted. The goal of the resource analysis is to understand the resource situation present in grape production and to compare the resources needed grow grapes in Kansas and the resources needed to grow other crops in Kansas. One way this was achieved is by determining the water need of grapes in Kansas. Previous studies have looked at the water needs in other regions (Castex et al., 2015; Mekonnen & Hoekstra, n.d.; Vázquez-Rowe et al., 2017). These studies evaluate water use in regions that are geographically and atmospherically different from Kansas. By having a Kansas specific water resource need for the grape wine supply chain grape producers, wine makers, and policy makers can make more informed decisions. Due to the delayed period of profitability and the increased upfront resource need that is inherit in wine grape vines but not in other crops, introduces a new dynamic to the agricultural landscape in terms of resource need. By using a life cycle analysis method to evaluate the long term implications of expanding the amount of acres used for wine grape cultivation, both wine and grape producers will have a better understanding of the long term capacity of the wine market in Kansas.

Understanding policy constraints: Kansas grape/wine policy framework

Legislative policy is a tool that can be used by states to manage certain markets. These policies can introduce constraints on the market, both directly and indirectly. By analyzing the policies that govern the wine and grape market in Kansas, stakeholders can better understand what

capacity constraints exist and the source of the constraint. Through quantitative analysis, we want to discover which past and present policies may be constraining the wine and grape market.

Understanding supply chain constraints: governance structures at the grape producer-processor interface

The governance structures that are utilized to facilitate the transaction between wine makers and grape growers could affect the efficient flow of goods and distribution of profit across the supply chain which in turn can impact the capacity the growth of the overall market. Wine grapes exhibit a certain degree of asset specificity. The degree of asset specificity and the governance structure used to facilitate the transaction between the stakeholders in the supply chain could result in costly hold up, which could create capacity constraints. Using Transaction Cost Economics theory this study analyses the effectiveness of various vertical coordination strategies for governing transactions between grape producers and processors in the state of Kansas. The study aims to examine the extend of hold-up risks and coordination problems in existing coordination strategies and propose more effective alternatives based on a Transaction Cost Economics theory.

Background

Wine in Kansas

History of Wine in Kansas

Prior to prohibition, Kansas was the one of the top grape and wine producers in the country. With the Temperance movement and subsequent prohibition, grape and wine production was eradicated in the region until 1985. Since legalization, the industry has grown to support 56 wineries and over 400 acres of grapes. Three distinct wine trails have been marketed to tourists to help the industry grow.

The Kansas wine industry may currently be an emerging market but the history of growing wine in Kansas goes back centuries. Wine grapes have been grown in Kansas dating back to 1857. (Dulin, 2018). Before prohibition Kansas, was one of the top grape and wine producers in the country and produced over 5,000 acres of grapes. However, in 1880 the state of Kansas passed a law the prohibited the sale and manufacturing of alcohol, making the wine grape industry obsolete. When federal prohibition ended in 1933, Kansas continued to be a "dry" state by upholding its 1880 mandate. It was not until 1948 that the state of Kansas allowed counties to decide if they would allow for the sale of alcohol. In this time while it was legal for wine to be sold in Kansas, it was illegal for wine to be made and sold commercially. In 1985, the Kansas Farm Winery Act was passed, allowing for wineries to be established in the state. This act stipulated that only 100,000 gallons of wine could be made by a licensee in the course of a year. In addition, 60% of the products used by the winery have to be products that are grown in Kansas. In 2012 a law allowing for wine tasting was passed and the production composition requirement was lowered to 30%. The timeline of Kansas legislation impacting the wine and grape industry is summarized in Figure 1. Between 1948 and 2012, neighboring states, like

Missouri and Oklahoma, were able to establish mature vines to support the growing interest in local wine and tourism, leaving the growth of the Kansas market stunted by comparison.

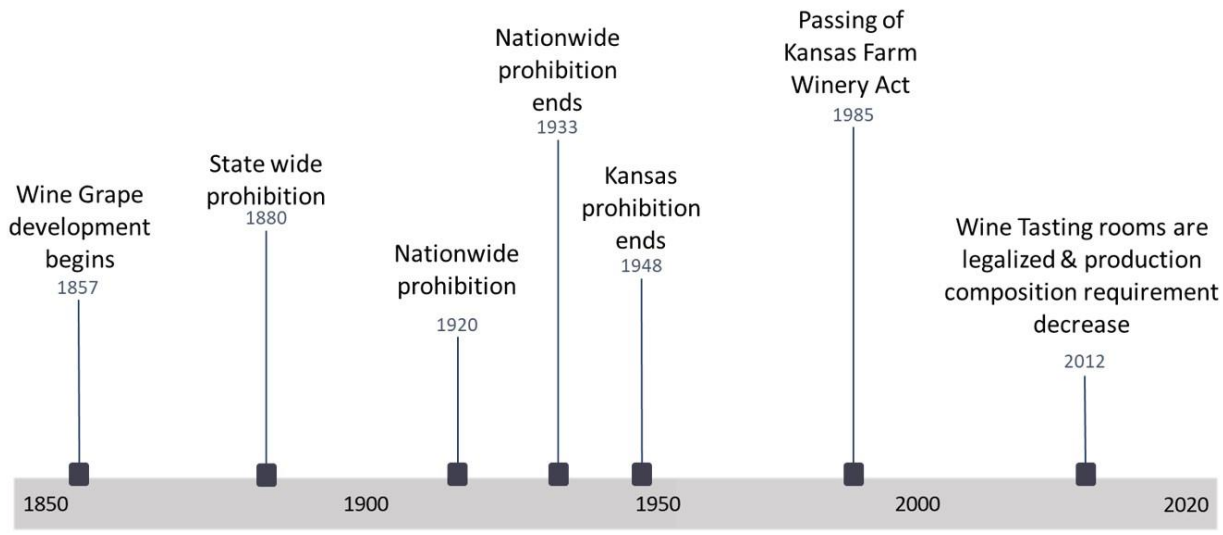

Figure 1. Kansas Wine Policy Timeline

Kansas Wine by the Numbers

As of June 2020, there are 56 active farm winery licenses in Kansas, according to the Kansas Department of Revenue. The increase in active farm winery licenses is illustrated in Figure 2.

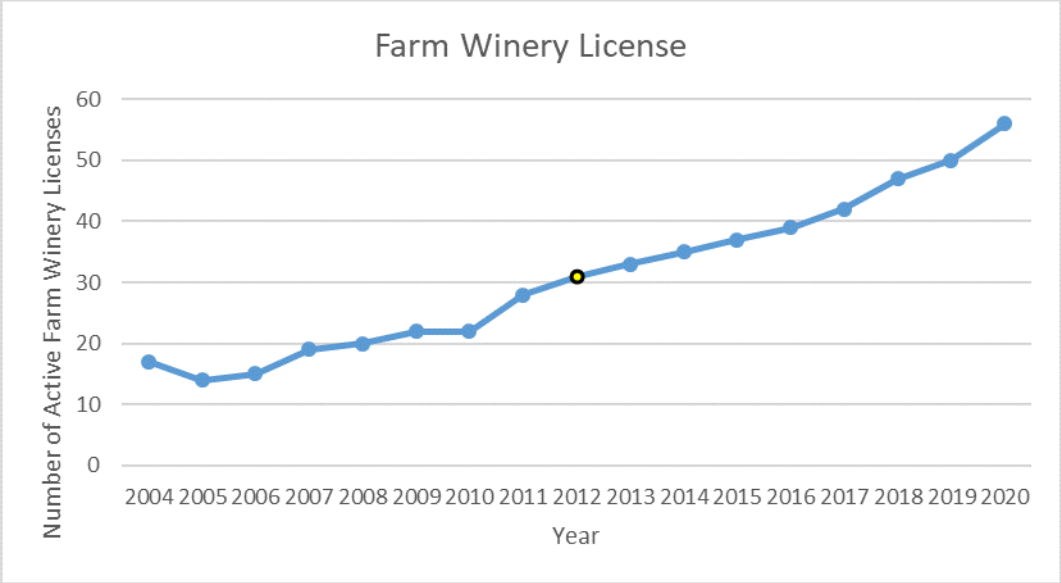

Figure 2. Count of Farm Winery Licenses in Kansas

Over the last four years, the number of active farm winery licenses have been rising at an average rate of 8.7% per year, the percent growth of active farm winery licenses is illustrated in Figure 3.

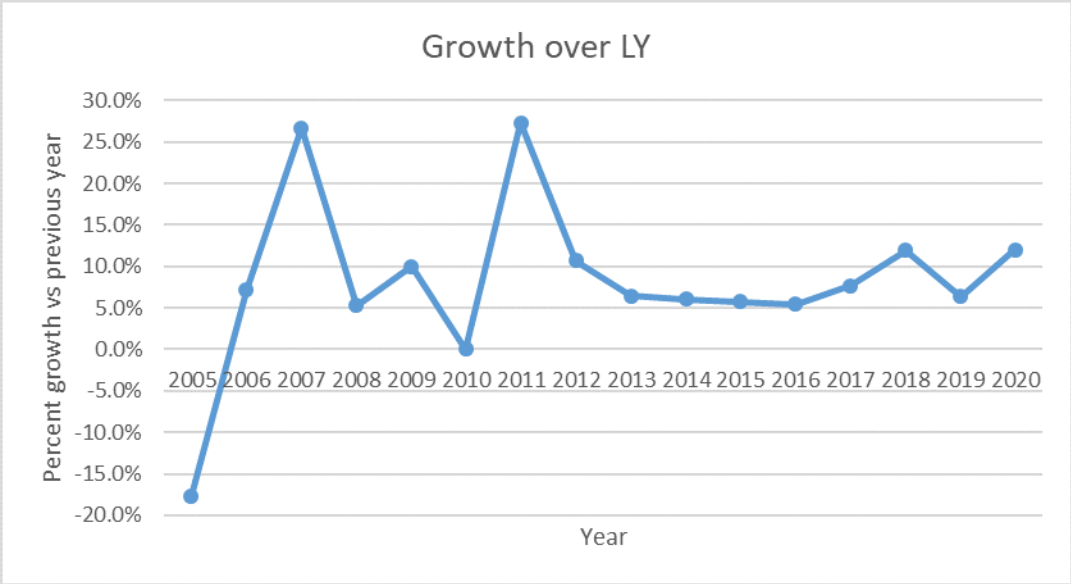

Figure 3. Percentage Growth in Farm Winery License

As seen in Figure 4, the growth of acres planted with grapes is has been steadily rising since 2006, but the acres planted has been rising at an average rate of 4% per year.

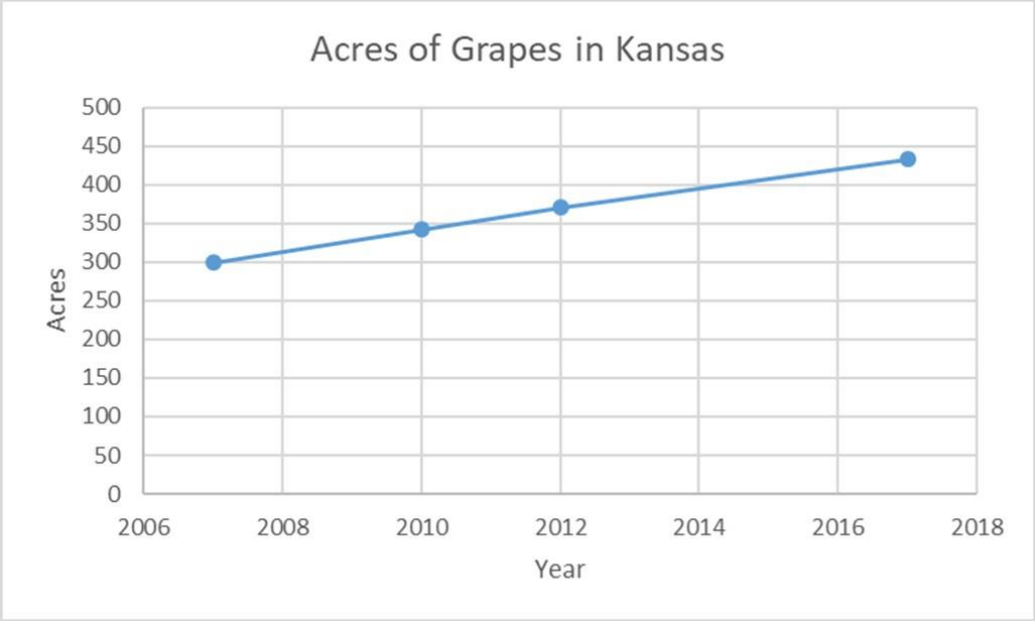

Figure 4. Acres of bearing and non-bearing grapes in Kansas

In order to fulfill the 30% Kansas grown product requirement and the growing demand for Kansas wine, more acres of wine grapes need to be produced.

The limited availability of Kansas grown grapes has the ability to create a supply issue for wineries in Kansas as 30% of all wine products made by these license holders is required to be grown in Kansas as stated in amended Kansas Farm Winery Act. Based on the 2017 census, there are 352 acres of fruit bearing grapes vines planted in Kansas. If all 352 acres were mature enough to produce wine quality grapes and produced the average 4 tons of grapes per acre, this would mean that the current capacity for wine made of only Kansas grapes would be 210,000 gallons. If all 56 wineries were only using the minimum of 30% Kansas grown grapes this would increase capacity to 704,000, based on grape availability. However, the census data does not distinguish between grapes grown for wine and grapes grown for other purposes, such as table

grapes or grapes made for jam. We also know that not all 352 acres have vines that are mature enough to produce wine quality grapes as it can take four to five years before grape vines produce the quality of fruit needed for wine. Thus, the true installed grape capacity is unknown.

Economic Development in Kansas

Regional wine industries can contribute to the regions' economic development efforts through tourism and sales. The national impact of the wine industry is $219.9 billion (Wine America, 2017). In the Midwest, Missouri supports a $3.2B wine industry, where the majority of the revenue comes from tourism and tourism associated spending (Wine America, 2017). When a household decides to partake in wine tourism they may not only spend money at a winery but may also at local businesses such as restaurants and hotels. This provides an income stream to rural areas that may not otherwise see this revenue. In 2017, the Kansas wine market was valued at $867.8 M. Of that total $6.1M was recreational spending in local communities as a result of tourism (Wine America, 2017).

Kansas has a history of growing grapes, and for good reason. The soil is adapted for growing grapes, water is currently available for irrigation, and there is enough sunshine to promote the growing of commercial grapes. This could be good news for producers as grapes are a high value crop and could add diversity into a crop portfolio.

The price of grapes in 2019 ranged from $1,200 to $1,300 per ton (USDA/NASS, 2019). The average yield of wine grapes per acres is 4 tons, meaning that an acre of grapes could bring in up to $5,200 for a producer (USDA/NASS, 2017).

Wine Supply Chain

The wine supply chain can be broken into four basic stages: grape production, wine production, wine distribution, and retail. The vertical coordination strategies used by actors along the supply chain vary.

The goal of grape production is to grow quality grapes that produce the type of wine that consumers want to buy. These grapes could be grown by independent producers who sell their grapes to wine makers and have no involvement in wine making past the point of grape production. The sale of grapes to wine producers can take on many different forms. Exclusive contracts can be made between the grape and wine producers so that one farmer may end up selling all their harvest to one wine maker. The spot market may also be used by some grape producers. Some wine makers choose to vertically integrate grape production into their business model and grow grapes in addition to making wine.

When establishing wine production, the firm has the opportunity to decide how to distribute the product. A firm may choose to not have a private label and instead sell the wine that is made on the wholesale market for a secondary firm to bottle, market, and sell. If a firm chooses to create a private label and brand its product, the two main distribution channels are on-premises sales, such as wine tasting and other tourism activities or off-premises in the form of festivals, farmers' markets, or other retail opportunities through distributors. In emerging wine regions, like Kansas, the majority of revenue made from wine is through on-premises sales (Kansas Department of Agriculture, 2011). Even in established wine regions such as California, the majority of revenue associated with wine making is through agricultural tourism (Thach, 2018).

Overview of Potential Constraints

Wine and grapes are profitable in Kansas (Stramel, 2015). However, many constraints could be holding back the market from its full potential growth. The four most notable being water, land, capital, and a risk of environmental and economic shocks.

Water

Grapes in Kansas are primarily grown in the eastern half of the state where irrigation is not needed. As global climate change increases the likelihood of extreme weather conditions and prolonged changes in temperature and rainfall grape growers could see the need for irrigation in the future (EPA, 2016). The impact of this potential future need is somewhat ambiguous. Irrigation is not a costless activity no matter how necessary it is for plant growth. Currently grapes are a high value crop, in the event that irrigation is needed, would the cost of irrigation outweigh the benefit of having a high value crop in a crop portfolio? The answer is unclear for the state of Kansas. Although there is currently no water constraint in the regions where grapes are mostly produced in Kansas, this might not be the case in future given the climatic change projections (EPA, 2016).

In states with developed wine supply chain, grapes compete for water resources with other crops. In these regions the profit per acre irrigated is highest for grapes than any other major crop (Texas Department of Agriculture, 2004). Kansas faces periods of draught in some years during the summer, making the efficient utilization of water important to producers. As climate change intensifies extreme weather, like drought, understanding what water resources will be needed to continue to support the grape and wine industry, may assist in the decision making process for those interested in adding high value crops to their portfolio (EPA, 2016).

Wine grape vines pose a unique challenge to producers and the natural resources in the area that they are planted. In the first two years of a vine's maturation period, a vine needs one half to 1 inch of water weekly during the growing season. As the vine matures the water resource needs are decreased. It can take up to five years for a freshly planted vine to produce wine quality grapes, making the water resources needed compared to the production profit higher than in other crops that don't have as long of a maturation period.

Studies have found that an increase in wine grape production increases the burden on existing groundwater resources (Castex et al., 2015; Mekonnen & Hoekstra, 2011; Vázquez-Rowe et al., 2017). These studies have used a Lifecycle Analysis approach to calculate the amount of additional water needed. However, these studies use data points specific to major wine regions. Kansas has different water availability than France, Australia, or California. These differences could make the water footprint of wine grapes in Kansas different and either more or less favorable for potential grape producers in Kansas.

Land

The majority of the grapes in Kansas is grown in areas that are not growing wheat. This area is in the eastern part of the state and is often not irrigated. When a producer decides to dedicate land to growing grapes they are forgoing dedicating the land to other crops. Crops that have more established markets, such as corn, hay, or soybeans, could be planted in this area which means that grapes are in competition for this land.

The land that is best for grape production is in the eastern half of the state. This is because of the soil composition, hours of sunlight, topography, and rainfall. The other potential uses for this land are in direct competition with grape production.

Capital

While the revenue per acre of grapes is high, grapes are a capital intensive crop for the first three to five years of production. Grape vines do not mature to produce wine quality grapes until three to five years after planting. During this time the grapes that are harvested have limited outlets to be sold in as wine grapes are not sold as table grapes. In this time period a producer could choose to instead grow a crop that produces a marketable harvest every year. In the event that a grape producer cannot sell their crop to wine makers, or make wine themselves, there are very few options to sell the unclaimed crop.

Risk of Environmental and Economic Shocks

The global wine market has been impacted by both economic and environmental shocks in 2020 (Palley, 2020; Veseth, 2020). While the Covid-19 pandemic has shut down many tasting rooms, and thus restricted a major source of income for wine producers, the west coast wildfires have threatened the longevity of agricultural systems in the path of destruction. The year 2020 is not the first year in which the wine and grape industry has experienced significant shocks. Previous shocks to wine and grape markets could illuminate the characteristics of firms that are more likely to survive shocks than other firms. Understanding what these characteristics are allows for wine and grape producers in Kansas to position themselves in a way that minimizes risk and maximizes potential market longevity.

The two types of shocks to consider are economic and environmental. While the year 2020 may have felt like a year of shocks, both economic and environmental, wine markets have experienced both types of shocks before. In 2008 the global economic recession impacted many wine markets, especially those who were dependent on tourism for profit, as the average income decreased so did the frequency of winery visits which resulted in lower wine sales for local wineries (Gokcekus & Finnegan, 2013). In addition, wildfires have been seen in both the

California and Australian wine region in 2019 (Thach, 2018). In both of these instances some firms were not able to weather the shock while others were able to "bounce back," so to speak. Previous shocks, as well as the Covid-19 crisis, have hindered tourism in wine regions (Good, 2020). While Kansas wine and grape producers may not live with the threat of wildfires there are environmental shocks they could experience such as prolong frost or drought. It is important for both wine and grape producers to understand that certain shocks could have large impacts on the profitability of their business. These should be taken into consideration when developing a business plan to enter either the grape or wine market in Kansas

Policy

Kansas policy could also be causing a hold up in the growth of the grape and wine market in Kansas. The delay of wine and wine making legalization in the state, production limits, and procurement minimums could all cause the stunt of growth of the market.

Wine production was not legal to produce in Kansas until 1985. At this time the Kansas Farm Winery Act was passed, allowing for wine production. In neighboring Missouri, wine production had been legal since 1965 and allowed the state to have a 20-year head start compared to Kansas. This allowed Missouri to grow without local competition. Through first mover advantage Missouri has been able to grow its wine and subsequent wine tourism industry into as $3.2 B industry. As Kansas now enters a similar market the state has to compete with an already established industry.

When the 1985 act made wine manufacture legal the act set production limits associated with each winery. Currently a winery in Kansas cannot make more than 100,000 gallons of wine in a calendar year. This production limit could inhibit firms from fully capitalizing on production of scale benefits.

A recipient of a Kansas winery license has to ensure that all wine made is produced with at least 30% Kansas-grown fruit. Based on this 30% requirement and the recorded acres of grapes planted in Kansas, the current wine capacity for the state is 704,000 gallons. Based on the maximum capacity at the winery level, this means 7 wineries would be able to reach their maximum capacity with a 4,000-gallon remainder. Reports suggests that the procurement minimum set in place by the 1985 Farm Winery act is a constraint on the Kansas wine market (Voorhis, 2014). In order for the wine market to grow, more grapes have to be grown.

The Kansas grape and wine industry is worthy of study. The market for locally made Kansas wine is relatively young, and there are elements of the system that have yet to be fully understood. The study of the systems potential bottlenecks and capacity could be beneficial to grape and wine producers who are looking to grow their businesses, as well as local communities who could profit as a result of agritourism associated with local wineries.

The wine grape production could provide a high profit crop alternative to those who are looking to add a high value crop to their portfolio. In 2017, wine grape producers were seeing revenues as high as $6,000 per acre harvested and with the mandatory 30% Kansas product policy many producers' had local buyers for their harvest which would result in lower transaction costs and higher profits. Before prohibition Kansas was one the country's top grape producers, as a result of growing grapes for centuries the native American and French-American hybrid grapes have adapted well to the soil in Kansas. Understanding how to make this high value crop as profitable as possible by evaluating potential hold ups and bottle necks could be beneficial to producers.

If the grape and wine industry is to grow in the state of Kansas the long term success of grape production is essential. As global climate change impacts the extreme weather across the globe regions that are currently the predominant suppliers of wine grapes may no longer be able to

supply the same quality or quantity of wine grapes to the market. The decrease of supply from established wine regions could allow for Kansas grapes to fill the supply gap and supply more of the wine grape demand. It is important is important to understand what the resource needs would be for wine grapes in order to determine the potential capacity of the market given a change in demand.

Literature Review

Resources

Assessing the magnitude of potential environmental impacts related to water and toxicity in the Peruvian hyper-arid coast: A case study for the cultivation of grapes for pisco production

Vázquez-Rowe et al, used a life cycle analysis method, specifically the ISO 144046, to evaluate the environmental impacts of cultivating grapes for pisco production in Peru (Vázquez-Rowe et al., 2017). The researchers evaluated the impacts on a site specific basis using five different production sites as the sample set. They then established 4 scenarios based on historical weather to determine what the impact to water availability and quality as a result of pisco production. This study affirmed that like other agricultural products along the Peruvian coast, grapes grown in this region suffer from water scarcity. The researchers suggest based on the results that policy makers and grape growers should utilize flood irrigation as a way to lessen the dependence on the scarce water resources.

Within the state of Kansas there are concerns about the declining future water availability for agricultural use. In this event, it could be advantageous for producers and policy makers to understand what the water requirements for the growing wine and grape market would require in order to reach maximum profitability.

Similar to Vázquez-Rowe et al, Castex et al. evaluated the water availability and use in South America, specifically the Mendoza region in Argentina (Castex et al., 2015). Like the Peruvian cost, this region is also currently under resource stress when it comes to the water availability in the region. In this study the researchers used weather station data as opposed to site specific data to understand the impact of agricultural practices in the region and the future water needs to sustain the developed practices. Castex et al used the ENSO climate model to analyze future

weather patterns that could impact the water availability. The study concluded that as the climate changes, the sustainable use of water resources will be the key to the longevity of the established vineyards in the region.

Unlike the study done by Vázquez-Rowe et al. (2017), the Castex et al. study looked at water needs based on regional weather, not site specific conditions (Castex et al., 2015). Region specific data highlights the unique long term advantages and challenges the region may face in an effort to support and established market in that region. This information is particularly useful for regional producers and policy makers. Having a similar analysis for the Kansas grape and wine region would bring greater insight and more informed decision making for stake holders. This study looked at total water footprint and did not discriminate between green water, as a result of rain, and blue water, as a result of irrigation. In an area like Kansas where groundwater is available for irrigation as an additional cost of operation, it is important for farmers to understand how much additional water would need to be applied to their investment in addition to precipitation.

In 2010, Mekonnen and Hoekstra calculated the global water footprint of crops and derived crop products (Mekonnen & Hoekstra, 2011). To do this they calculated the water footprint based off the water systems that the majority of the crops were grown. For example, when calculating the water footprint of grapes and wine the data used was from established wine regions like France and California. The method that they used is a water foot print calculation that the researchers developed that is based in life cycle analysis.

While this calculation gives insight to the water needs based on the water use and availability in established regions. This metric also does not distinguish between the water footprint in one region over another, instead giving a global water footprint which does not benefit producers or

policy makers in specific wine regions. In addition, it used a calculation method that is not as universally understood like an ISO method.

Governance

Franken and Bacon (2014) analyzed the organizational structure of the emerging Illinois wine market. Using a transaction cost framework, they looked at the degrees of vertical integration on 86 wineries in Illinois. They found that emerging industries and the organizational structures utilized by firms varies from more mature markets. They also found that in the Illinois region, winery size was an indicator of the type of organizational structure a firm would use. Seeing that larger wineries would rely more on buying outside grapes and distributing their product through tasting rooms and distributors while smaller wineries distribute their product through festivals and farmer's markets.

This study illuminated how emerging markets not only differ greatly from more mature and established markets but it also illustrated how there is variability in different emerging markets. The Kansas wine market is young, with tasting rooms not being a distribution option until 2012. Franken and Bacon's work suggests that a Kansas specific analysis would be the most beneficial for producers based on the level of variability between markets. To date research has not been done to understand the governance structures used by Kansas wine producers.

Traversac et al. (2011) studied the French wine market to better understand why producers in France would sell directly to consumers as opposed to selling bulk wine to distributors . Their analysis, using a transaction cost framework, found that larger wineries have an advantage over smaller operations when selling in bulk. In addition to the factors that led firms to sell their product, the researchers found that there was a lack of formal contracts in the mature French

market. It is speculated that this could be due to the maturity of the market where although no formal contracts exist, long standing contract-like relationships exist between producers.

This study highlighted that in mature markets informal organizational structures might be a substitute for more formal ones. In an emerging market such as Kansas new relationships are forming that could one day be seen as substitutive for formal contracts but in this moment in time, the findings in the French market do not as easily apply to Kansas. An independent study of the organizational structures using a transaction cost framework could discern what type of relationships could be most beneficial for producers at this stage in market development.

Fernández-Olmos et al. focused their study on the Rioja dedicated wine region in Spain (Fernández-Olmos et al., 2009). In their research they investigated the factors that influence wine producer's decision to make or buy the grapes for their wine. The make versus buy conundrum is often investigated. This study used a transaction cost framework to analyze the decision. Through this investigation the researchers found that wineries that made higher quality wine were more likely to make instead of buy their grapes. In addition to the quality of wine produced at a given firm, the size of the firm was an indicator of the make or buy decision the firm would eventually use.

The results of this analysis, when compared to the analysis of Traversac et al., illustrates the difference in organizational structures utilized by different mature markets. Both the French and Spanish wine market are well established but because of the differences in the markets different organizational structures are utilized by the firms. Not only is Kansas not a mature market but it also has very unique challenges such as Kansas specific policy involving winemaking. These types of differences illustrate how a market specific analysis can be beneficial to producers, even when market analysis exist for neighboring markets or markets similar features.

Procurement mechanisms and the emergence of new governance structures in the CEECs: evidence from the Bulgarian wine industry

Zaharieva et al. conducted a series of case studies across two years to evaluate the Bulgarian wine market after decentralization, using a transaction cost approach (Zaharieva et al., 2003). They found that vertical integration is the preferred strategy but a fragmented land and incomplete property rights make this governance structure difficult to achieve. Hybrid contracts exist in the region to reduce transaction costs.

This study highlights how the state can influence governance structure in a market. In Kansas policies used to regulate wine making could impact the governance structures used. For example, the quantity of Kansas produced grapes that is not seen in other similar markets could impact the governance structures producers utilize in order to fulfill this requirement. This further illustrates the need for a Kansas specific analysis on the operational structures that could be utilized by the grape and wine making market.

Analysis of Resource Constraints

Methods

The life cycle analysis model is often used in assessing a products environmental impact. It is a preferred method because it mitigates the risk of incorrectly shifting the impact to either a different life cycle phase or to a different region. During a life cycle analysis inventory data is collected about a specific product in a specific region. The data is then evaluated in a comprehensive way. When this type of analysis is done, assessing impacts of comparable products is more accurate and reliable. Methods that do not require inventory data in the same way that a life cycle analysis does risk disregarding variables that may have an impact on a regional analysis.

While many life cycle analysis models exist, the International Standard Organization (ISO) has published peer reviewed models based on specific analysis needs. In this study we followed the ISO 14046: Water Footprint Calculation. The ISO 14046 document outlines the necessary steps and data requirements that need to be taken to evaluate the water needs of a single product based on the life cycle and location of that particular product. This model was used in a similar study by Vazquez et al. when looking at the water footprint of pisco grape production in Peru (Vázquez-Rowe et al., 2017).

The ISO 14046 outlines four phases of a life cycle analysis, goal and scope definition, Life cycle inventory analysis, life cycle assessment, and interpretation (International Standards Organization, 2014).

Goal and Scope Definition

The purpose of the goal and scope definition phase is to clearly define system and life cycle boundaries and goals of the study. This helps to prevent scope creep but also sets clear system

and life cycle boundaries in order to keep the analysis consistent in the event that analyses of similar but different systems are compared. The goal of the analysis is to understand the resource availability and implication that a growing wine and grape market has on Kansas. Other wine making regions have seen an impact to natural resources as a result of increased wine grape cultivation. Understanding what an increase in wine grape production would have on the natural resources in Kansas will allow for better policy and business decisions to be made. The intended audience of the study is policy makers, wine makers, current and future grape producers, and researchers who wish to expand further analyze the industry.

When determining the boundary for the analysis the decision was made to draw the boundary to encompass the life cycle of wine grape production and exclude the wine making process. This is because grape growers can sell their grapes to markets out of state that have different environments that can't be captured by a life cycle analysis. In order to compare wine grapes to other high value crops that could be planted in lieu of grapes, excluding the further processing of crops will allow for equal comparison between the products. The visual system boundary is included below.

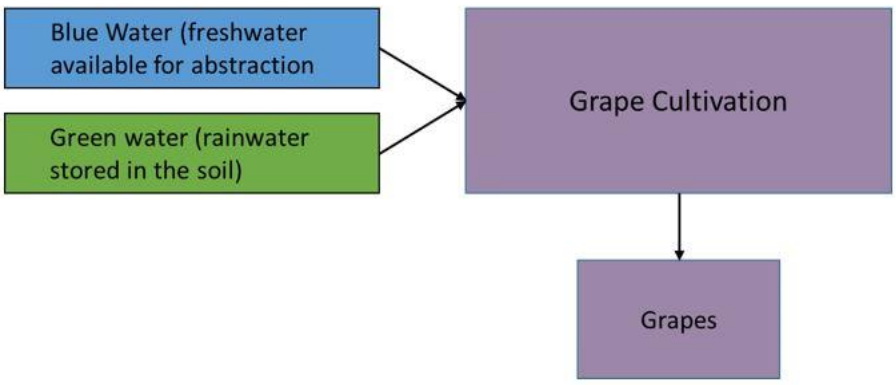

Figure 5. Life Cycle Analysis system boundary

The system we have outlined includes both blue water and green water. Blue water is the freshwater available for use in irrigation. Green water is the amount of rainwater that is stored in the soil that the vines are able to use.

Analysis

Life Cycle Inventory Analysis

The region where grapes are currently being grown is not a heavily irrigated region in Kansas. The current irrigation data does not signify how much irrigation is dedicated to grapes specifically. In the irrigation data there are crop codes that are classified as “other” when combined with other more prevalent crops such as corn or alfalfa. Depending on weather trends this could change in the future. To fully understand the water footprint of wine in Kansas an irrigation estimation based on FAO guidelines was made.

The irrigation estimation was done at the county level for the counties in Kansas that reported to be growing grapes in the 2017 USDA census. To calculate the irrigation estimation certain historical weather data had to be collected, specifically the evapotranspiration.

The evapotranspiration calculation is based on temperature, humidity, precipitation, and wind speed. The data used for the footprint calculation was collected at the daily level. The daily historical data used in this study came from Kansas Mesonet and Food and Agriculture Organization of the United Nations.

After calculating the evapotranspiration, the crop coefficient designated by the FAO was applied for different phases in the growing cycle. This crop coefficient multiplied by the evapotranspiration results in the irrigation needed for the specific crop of wine grapes.

When calculating the irrigation use in Kansas the months of April through September were the months we were most interested in modeling. Late summer droughts are common in Kansas, this

would be the time that if producers were to irrigate, they would. After the month of September most of the grapes have been harvested and the need for irrigation no longer exists.

To calculate the green water used by wine grapes in Kansas the historical weather data used to estimate the irrigation need was aggregated over the same April to September time horizon and over the complete year of 2017.

Life Cycle Assessment

The purpose of the life cycle impact assessment is to understand the magnitude of the potential impacts on the environmental system studied. In our study the primary source of water impacting the production of wine grapes is green water, or natural precipitation. Using historical weather data from the counties where grapes are known to be planted, we can calculate the additional water need by multiplying the evapotranspiration by the crop coefficient and summing over the growing horizon. The formula for such a calculation is as follows:

$$\sum K_{c_i} \cdot ET_i \text{ for months 1 through i.}$$

where K_{c_i} is the crop coefficient for a given crop and ET_i is the total evapotranspiration in month i. This method can be used to evaluate the additional water needs for additional crops that may compete for the same resources that are required to support the cultivation of wine grapes.

Data Discrepancies

Not every county that reported as having grown grapes as of 2017 had weather data available for analysis. However, over 80% of the acres of grapes grown in 2017 were in counties that were included in the analysis. Financial analysis has not yet been collected for grape growing operations in Kansas. An estimation of profit per acre had to be made to understand the profitability and resource needs of grapes as compared to other crops grown in Kansas. Wine grape prices were available through a 2010 study of the wine and grape industry in Kansas

(Kansas Department of Agriculture, 2011). The report does not report the cost associated with grape production. Using a 2011 enterprise report from the University of Minnesota, the costs associated with grape operation in Minnesota were used to estimate the profit Kansas grape producers may have received in 2010.

Results

The results of the analysis indicate that the additional water needed to produce wine grapes in Kansas in 2017 ranged from 8.97 to 11.25 acre-inch, depending on the county. Within the total water needed calculation, it is important to note that the additional water needs calculation represents the amount of water need to fully replace the water that was lost to evapotranspiration for maximum fruit growth. In the case of wine grapes, there is some research to support the practice of restricting water to the vines in the late stages of harvest that results in a quality of wine grape that is more desirable by wine makers. Grape producers may choose to not fully replace the water lost to evapotranspiration to fulfill the needs of the market. We are not able to ascertain the level of water replacement desired by wine makers. Due to the fact that this was not something we could estimate and test, it was excluded from the analysis.

We used the same method to determine the additional water needs of other more commonly planted crops in Kansas. Calculating the additional water need by crop instead of using irrigation data allows us to compare the resource needs of each crop more fairly by reducing the variability of irrigation use that could result from producer preference or site specific irrigation technology. Upon analysis, we see that the grape profit per acre is the more profitable and requires less additional water resources than the other major crops grown in Kansas. In Table 1 we see how the profit per acre of grapes and the additional water use compares to other non-irrigated crops.

Table 1. Non-irrigated crops profit per acre

Most profitable non-irrigated crops		
Crop	Profit/acre	Additional Water Needs (in.)
Wine Grapes	$1,062.00	9.83
Corn	$ 199.10	20.76
Alfalfa	$ 188.14	24.86
Sorghum Silage	$ 165.98	16.87
Double Crop Soybeans	$ 158.36	20.33
No Till Sunflowers	$ 157.96	17.88
Soybeans	$ 147.69	20.33
Grain Sorghum	$ 127.66	16.87
No Till Wheat	$ 102.91	21.74
Wheat	$ 57.80	21.74

We see that corn, the next most profitable non-irrigated crop, requires twice as much additional water resource but results in a profit that is 19% of the profit associated with the 2010 wine grape profit per acre. A similar result occurs when comparing wine to commonly irrigated crops in Kansas as seen in Table 2.

Table 2.Irrigated crops profit per acre

Most profitable irrigated crops		
Crop	Profit/acre	Additional Water Needs (in.)
Wine Grapes	$1,062.00	9.83
Corn	$ 363.76	20.76
Corn Silage	$ 302.55	20.76
Alfalfa	$ 233.06	24.86
Soybeans	$ 200.07	20.33
Sunflowers	$ 145.26	17.88
Pinto Beans	$ 123.75	22.78
Wheat	$ 120.29	21.74
Cane Hay Sudan	$ 76.60	25.66

The full effects on climate change in Kansas are projected to result in higher temperatures in the summer and decreased frost in the winter (EPA, 2016). These impacts have future implications on the water needs of grapes and other crops in the state. In the event that Kansas experiences warmer summers with prolonged drought, the water needed to produce grapes is going to

increase. A decrease of frost in the winter could be beneficial for crop production. However, a shorter and milder winter could also increase the growth and development of weeds and pests, as well as make perennial crops, like grapes, more susceptible to losses associated with any spring frosts (EPA, 2016). As climate change projections for the state of Kansas are refined, the impact on grape production can be better assessed.

Analysis of Policy constraints

The Kansas legislature has had an impact on the scale of grape production since 1880, when statewide prohibition was enacted. At the time Kansas was one of the largest grape and wine producers in the country and over 2,000 acres of grapes were cultivated (Dulin, 2018). This policy decision left winemakers without legal right to continue their business and grape growers without local buyers for their product. Into the 1900s, grape producers continued to cultivate their vineyards and sell their grapes to bootleggers or to wineries in Missouri where wine making was still legal. This Kansas specific legal policy did put many wine makers out of business but it did not have devastating effects to the grape market that was already established.

In 1920, nationwide prohibition was declared and the grape growers of Kansas lost all of their legal outlets to sell their product for wine. While bootlegging continued, so did crime associated with the sale and manufacturing of alcohol. Ultimately, nationwide prohibition eliminated the demand for a Kansas grape industry. Thirteen years later nationwide prohibition ended but the temperance ideology in Kansas had not. When given the opportunity to repeal the 1880 state prohibition mandate the citizens of Kansas voted to keep prohibition in place, further hindering the growth and revival of the grape and wine industry within the state. Statewide prohibition was replaced with county level prohibition in 1948. In the time it took for Kansas to repeal statewide prohibition Missouri was reviving their grape and wine making markets. Before nationwide prohibition Missouri winemakers were the main buyers of wine grapes from Kansas grape producers, by the time that Kansans could reestablish their vineyards Missouri winemakers were no longer in need of Kansas grapes. The demand for Kansas grapes would not return until 1985. The passing of the 1985 Kansas Farm Winery bill allowed for Kansans to produce and sell wine for the first time since 1880. This piece of legislature outlined what permits, fees, and constraints

the market had to adhere to. This policy introduced three constraints that could be impacting the market capacity in the grape and wine market today. The three constraints introduced in the original Kansas Farm Winery act are the limiting of wine production, product composition requirements, and the ability to conduct wine tastings.

Methods

The available data on the wine and grape industry in Kansas is limited. This lack of quantitative data results in the inability to evaluate changes in the market that could be attributed to certain changes in policy. A qualitative analysis approach to understanding the impact state policies have on the wine and grape market is more applicable until more complete quantitative data is collected. Using the most recent available data, written policy and policy changes, and publicly available accounts from producers, we can analyze and hypothesize about the existence and impact policy has on the grape and wine capacity in Kansas.

The Kansas Department of Agriculture did a survey on the impact of grapes and wine within the state in 2010 (Kansas Department of Agriculture, 2011). This report offers important quantitative data on the production capacity of the market at that time. In 2012, wine and alcohol policies that directly affected the wine industry were put into place. We can use this ex-ante data to develop and evaluate hypotheses. These can be tested when ex-post data becomes available.

Published interviews with grape and wine producers give can give insight to the lived experienced of firms in the industry. The number of available interviews is limited and don't reflect all perspectives. Interviews and public statements from a small sample of grape and wine makers may indicate validity, or invalidity, of formed hypotheses. In the future a larger sample set could be used to robustly test formed hypotheses.

Analysis

Production Capacity

An original limitation introduced in 1985 and still enforced today, is that a firm that has a farm winery license can only produce 100,000 gallons of wine in a year. This production maximum could be a binding constraint on both firms and the market as a whole. In order to determine if this is a binding constraint we need to understand what the installed capacity of the wine market is, and how much of that capacity is being used and if this capacity is at the 100,000 gallons per firm maximum.

The Kansas department of agricultural conducted a thorough market analysis in 2010. As a part of this analysis they determined the installed capacity and how much of that capacity was used in 2010. In 2010, there were 22 active farm winery licenses. If the production capacity limit was a binding constraint for each of these firms, we would expect that the installed capacity at the time would be close to 2.2 million gallons of wine. At this time the installed capacity was recorded as being 134,075 gallons, only 6% of the maximum production legally allowed (Kansas Department of Agriculture, 2011). The actual production in 2010 was 107,419 gallons, which is 80% of the installed capacity of 134,075.

We can see that not only is the installed capacity less than 10% of the total production limitation as stated in the farm winery act, the actual production value is 7,419 gallons over what would be a production maximum for a single firm. It can be reasonably assumed that the majority of the firms did not meet the 100,000-gallon policy maximum. The limited installed capacity as compared to the number of licensed wineries does suggest that there is a constraint in the market recognized by wine makers, but the production maximum does not appear to be the binding constraint.

Production Composition Requirements

In effort to rebuild the wine grape industry in Kansas the farm winery act included the requirement that, 60 percent of the products used in the manufacturing of wine needed to be grown in Kansas (Shepherd, 2012). This requirement applies to total production not to each individual wine produced. In theory a wine maker could make 60 gallons of wine using only Kansas grapes and 40 gallons of wine not using any Kansas grapes would satisfy this requirement. This policy could potentially be a binding constraint on wine makers. Under this 60 percent requirement, the potential wine making capacity is limited based on the production of grapes in Kansas. To determine if this is a binding constraint on the market we need to know how many tons of grapes were grown in Kansas and how many were used in Kansas wine production. If the production of grapes is just enough to produce the 107,419 gallons produced in the year there is reason to believe that the product composition requirements is a binding constraint for the market.

According to the same 2010 report, Kansas grape producers harvested 354.7 tons of grapes that year. Of these, 213.7 tons were used in production by the same firm that grew the grapes. The remaining grapes were sold to other firms within the state. A ton of grapes can make anywhere between 120 and 180 gallons of wine in normal conditions (Gerling, 2011). Based on this conversion factor the gallons of wine that could be produced using Kansas grapes in 2010 ranges from 42,564 to 63,846. Based on the actual production of 107,419 gallons, the 60 percent composition requirement is fulfilled with 64,451.4 gallons. Using the conversion estimation of gallons, the amount of grapes produced in Kansas fulfilled anywhere between 66% and 99% of the composition requirement. This suggests that the 60% minimum is not being fulfilled completely.

There could be a few reasons why the production estimation does not exactly meet the 64,451.4 minimum. First, there are waivers available for wine producers who are not able to make the minimum if there is a circumstance where Kansas grown products are unavailable due to events out the control of the winemaker such as weather, insects, or disease. Additionally, the 60% production composition policy doesn't just apply to the grapes used in production, it applies to all products used to make wine, including any other additives like raspberries or honey. Between the potential for waivers and additional Kansas grown additives, the minimum Kansas grape requirement could be lower than 64,451.4 gallons, which could reasonably be fulfilled by the grape production in Kansas. This does not disprove the hypothesis that the composition requirement is the binding constraint in the market. It was recorded that of the grapes grown in Kansas were either used or sold to companies in Kansas. This suggests that there is not a surplus of wine grapes in the state and that the grapes that are being grown just fulfill but do not exceed the minimum production composition as stated in the policy.

In 2012 the production composition minimum was lowered to 30%. To further test this hypothesis and updated study on grape and wine production and sales would need to be done. However, evidence from firsthand accounts suggests that the demand for wine grapes is still greater than the supply even after the composition minimum was lowered (Jones, 2016; Stramel, 2015; Voorhis, 2014). Discovering the actual production composition used by winemakers across the state could determine whether to accept or reject the hypothesis.

Wine Tasting Capability

In wineries across the world, the tasting room is the primary method of selling wine (Thach, 2018). The same is true for Kansas. In 2010, 81% of Kansas wine was sold directly to the consumer at the winery. Farm winery licenses are allowed to sell wine on their premises but

allowing customers to taste the wine before purchase is not allowed unless there is a financial transaction. The remaining 19% of wine was sold through local distributors, liquor stores, or other avenues. Liquor stores are an integral part of the wine supply chain and is the only retail outlet in the state that can sell wine, as grocery stores are not allowed to sell wine. Although these retail outlets are an important part of the wine supply chain, 3.8% of wine made in Kansas is sold in liquor stores. The limited liquor store sales could indicate that the demand of Kansas wines outside of the winery is small. One reason that could be is that Kansas is an emerging wine market and consumers are unaware of the product and its flavor profile and do not want to take a chance on buying a local wine at a premium and then not liking it. One way that new brands can educate consumers is through complementary tastings. One study found that the presence of on-site tasting increased purchases by 400% on the day of the tasting, and small but significant purchasing increase in the four weeks that followed the tasting (Lockshin & Knott, 2009). Tastings could be a tool used by wine makers to educate consumers. Reports from retailers suggests that wineries on the eastern border are more effected by this policy because the neighboring state of Missouri allows complementary tastings(Shepherd, 2012). However, this tool was not available to firms until 2012. The lack of consumer education and demand could have been impacted by this policy. Meanwhile the neighboring wine market had decades to develop and educate consumers on Missouri wine, allowing Missouri made wine to have a first mover advantage over Kansas. The delay of enacting this policy could have hindered the growth of the industry both in the short term and in the longer term. To determine if this policy has constrained the market more consumer data would have to be available.

The first set of data that could be used to test the hypothesis that the delay in making tastings available to consumers constrained the market is to look at consumer purchasing data before and

after tastings were offered. Looking at both overall market sales post law change and sales at individual locations where tastings were taking place could suggest if the lack of tastings and subsequent consumer education was a market limiting factor. Surveys could also be used to further understand consumers' knowledge of Kansas wine before and after a tasting and to determine if the tasting had influence on the customers' preference. To further test this hypothesis, consumer surveys could be conducted with a population of wine consumers in Missouri. This survey could help illustrate if the practice of complementary tasting influenced the consumer population over a longer period of time. Brand recognition and consumer knowledge could be impacted by many factors, the lack of public education in the form of wine tastings could have limited the market capacity for Kansas wine.

Results

The policies that govern the manufacturing and selling of alcohol in Kansas impact the wine and grape industries within the state. While there is a policy to restrict the production capacity of a wine making firm in Kansas, this specific policy does not seem to be hindering the production of wine or wine grapes to support the industry. However, there does appear to be a capacity constraint as evidenced by the limited installed capacity relative to the allowed capacity under current policy. One potential capacity constraint is the minimum production composition requirement. Production data and firsthand accounts, suggest that the demand for wine grapes is greater than the supply and is the limiting factor for wineries who are trying to increase their capacity (Voorhis, 2014). Further studies are needed to determine if this hypothesis is correct. If this is the case, the grape growing business could be an attractive industry to those looking to diversify their crop portfolio with a higher value crop. Kansas has a history of being slow to adopt alcohol policies relative to their neighboring states, the introduction of wine tastings is a

singular example of this trend. Allowing neighboring states to have time to develop a market and capitalize on their first mover advantage could also be a constraint on the market for Kansas made wine and subsequently, Kansas grown grapes. Consumer surveys could reveal the full extent that consumer education and demand have on the market for both wine and grapes in the state.

Analysis of Supply Chain and Governance Structures

In addition to the resources needed to support an expanded wine and grape market in Kansas there are other factors to consider. One of which being the governance structures that are utilized by grape producers and wine makers. Reports from producers suggests, that in some years there is a larger demand for wine grapes than there is a supply (Stramel, 2015; Voorhis, 2014). An evaluation of the governance structures using a transaction cost approach could reveal causes to this hold up for both grape and wine producers. With more efficient governance structures both grape and wine producers have the opportunity to increase profitability of their respective firms. Grapes are a specific asset that take three to five years before the vines become mature enough to produce wine quality grapes. Thus firms wanting to enter the wine making market, but don't have vertically integrated mature vines, must buy grapes from producers who are not using the grapes for their own production. As the wine market grows and more wine firms enter the market, one would expect that more grape producers would enter the market in order to fill this demand. The opposite is true in Kansas. Between the year of 2012 and 2017 there was a 16% increase of grape acreage planted but a 12% decrease in total operations growing grapes. In the same time period the amount of farm winery licenses increased by 35%. If the demand for Kansas grown grapes exceeds the supply, why are there not more people entering the grape growing market? One potential reason is because wine grapes are a highly specific asset and therefore costly to produce and market.

Methods

Many methods exist to aid in the evaluation of governance structures. One such method is Transaction Cost Economics (TCE) theory. The objective of Transaction Cost Economics is to minimize the transaction costs in supply chains that are a result of hold ups in the market. This

framework also assists in the make versus buy decision many firms make as they try to optimize their supply chain. According to TCE is that asset specificity increases transaction costs and increases the potential for hold up. However, the asset specificity can vary by region and varietal, making each market unique. It was found that when Transaction Cost Economics is applied to a hypothesis about asset specificity, Transaction Cost Economics predicts the outcome correctly the majority of the time (David & Han, 2004). Using a Transaction Cost approach, both grape growers and wine makers may be able to minimize losses and increase their profits

Transaction Cost Economics states that as asset specificity increases so do the transaction costs. The increase of transaction costs ultimately results in an increase in the degree of vertical integration a firm will choose as its governance structures. A firm that is more reliant on very specific assets will more likely choose a governance structure that more closely resembles vertical integration and a firm that relies on a less specific commodity may more heavily rely on the spot market. The current grape and wine supply chain includes firms that use a variety of governance structures. In 2010, at least 60% of grape growers exhibited some degree of vertical integration by using their own grapes in their own production operations. In the same year 44 farm winery license holders claimed that they used their own grapes to make wine. We have evidence that in the same year, grapes that were not used by growers in production were sold to Kansas firms, indicating that while vertical integration may exist among a number of the active firms, the supply demanded is not completely fulfilled through vertical integration. There have been multiple reports that the demand of Kansas grown wine grapes is greater than the supply which could be a result of inefficient governance structures (Jones, 2016; Stramel, 2015; Voorhis, 2014).

Analysis

Asset Specificity

Physical asset specificity occurs when physical assets are tailored to a specific transaction (Vita et al., 2011). Wine grapes as an output are physical assets that are tailored for a specific transaction, wine production. In addition, the other physical assets required in the grape growing process add to the asset specificity of wine grape production.

Wine grapes are grown for one purpose, to make wine. The varietals that are grown in Kansas are not suitable to be sold for table grapes. Meaning that if a grape producer is not able to find a wine maker to purchase their product, there are limited selling options. This would result in grape growers having both capital and fruit tied up due to the transaction cost inherit in the system. Kansas grown grapes are a required input in the Kansas wine making supply chain as a result of state policy. A result of this policy adds to the specificity of Kansas grown grapes. For wine makers these grapes serve the additional and specific purpose of reaching a state mandated requirement. Wine makers have to use Kansas grown grapes meaning that a transaction must occur between wine grapes grown within the state and wine makers.

Once a grape vine is planted it may take three to five years for these grapes to produce the quality of grape that wine makers would be willing to buy. In that time a producer dedicates resources to achieve the specific goal of growing wine quality grapes. In the same amount of time a producer chooses to dedicate their resources such as land, capital, or water, these resources could have been dedicated to other crops that have less asset specificity and are less costly. The opportunity cost associated with the decision to plant grape vines increases the cost associated with production. Meaning that if a producer decides to exit the market, that decision is

costlier if they are trying to exit the grape market than if they were to be exiting a market with less asset specificity.

Temporal asset specificity also exists in wine grapes, as it does with many perishable products. Temporal asset specificity occurs when the timing of the transaction impacts the quality of the asset. Grapes are ready to be harvested at a specific time, and if there are no intended buyers at the time, the harvest may perish before a buyer can be found, further adding to the costs incurred by a grape producer. Some of these costs could be mediated with an appropriate governance structure that would be mutually beneficial for both wine makers and grape producers.

Current Governance Structures

When looking at the levels of vertical integration utilized by both Kansas grape growers and wine makers it is important to understand the constraints placed on the market due to policy requirements. In Kansas it is mandatory for those who hold a Farm Winery license to insure that of the materials used to make wine 30% of the materials were grown in Kansas. In other markets where this requirement is not present wineries have the option of using the global spot market to procure the entirety of their grape stock if needed. The state of Kansas does offer waivers for wineries who cannot make the 30% requirement due to unforeseen circumstances. However, being a new winery is not considered and unforeseen circumstance and waivers are not given to new firms to aid in startup costs. Grape vines dedicated to wine making take 3 to 5 years to mature to a point where the fruit can be made for wine making. This lead time requires wineries who wish to vertically integrate to either wait for the in house vines to mature, or to utilize and additional governance structure to procure grapes grown by producers that are not yet dedicated to another purpose.

Vertical Integration

Transaction Cost Economics suggests that because of the high transaction costs and hold up in the Kansas grape and wine supply chain a more integrated governance structure should be considered. Vertical integration may be an attractive governance structures to wineries. When one or many firms are responsible for suppling a winery with the required 30% Kansas grown grapes, those grape producing firms have the upper hand and are able to control the price of Kansas grapes and what grape varietal is planted. If a winery is able to vertically integrate there could be two possible outcomes: 1) the transaction between grape grower and wine maker is no longer needed. 2) In the event that wine makers are able to plant and maintain enough wine grape vines to meet the 30% Kansas grown grape threshold, the producers that were previously suppling those wineries with grapes have lost a market to sell their grapes in. Which could allow for wineries to buy additional grapes from the grape producers at a lower cost than before as the asset specificity attributed to the policy is satisfied by vertically integrated production. Vertical integration may theoretically be attractive to wine makers; it may not be the most efficient governance structure. If a winery does chose to vertically integrate the firm could use the spot market or another governance structure to obtain grapes for the first 3 to 5 years of production. Depending on the type of governance structure utilized in this time period the possibility of hold up and the price of grapes could be high. This transaction cost is even higher if a wine maker is seeking a specific varietal to use in production. At the time of vine maturation, the firm can rely solely on in house vines to produce the fruit needed. When vertical integration is realized, a winery may have lower transaction costs. They also accept the risk and cost associated with the production of grapes, which is higher than other crops or wine due to the asset specificity inherent in grape production. The wine maker would gain control over the grape varietals planets and the management of the vines, but the skill set needed to make wine and to

cultivate grapes is entirely different from one another. For certain firms it may be costlier to maintain their own grape vines as opposed to buying Kansas grown grapes from a producer who is knowledgeable about grape growing.

The long term effects of vertical integration could be a binding constraint on the capacity of wine market in Kansas. If enough firms vertically integrate and no longer have a demand for Kansas grown grapes outside of their own production, grape producers may exit the market as they become more exposed to the costs of production. This may not initially concern firms who are able to rely on their own production until the demand for a specific firm's wine out grows the vertically integrated grape capacity. The product composition policy requires that as a firm's overall production increase, the amount of Kansas grown products must also grow proportionally. Due to the time it takes for grape vines to mature a firm would have to correctly forecast wine demand three to five years in advance. Because of the asset specificity of wine grapes, it is costly to over or under produce. In a vertical integration governance structure the winery assumes all the risk and costs related to forecast inaccuracy. In order for the currently established wine makers to be flexible enough to adapt to changes in demand, wine makers need to be able to purchase Kansas grown grapes.

Not only could vertical integration impact the potential capacity of established firms, it could hinder the entry of new firms. If grape producers exit the market, new firms will not be able to achieve the product composition requirement until they can procure Kansas grown grapes. While the entry of competitive firms may not be a concern for established wine makers, the existence of multiple wineries in the same area has been shown to increase profitability for all firms. When a wine trail composed of many firms in a similar geographic region can be formed and marketed to tourists, all firms are more likely to see a greater amount of traffic in their tasting rooms (Gibson,

2016). If the objective is to increase the potentially capacity in the grape and wine market in Kansas, vertical integration may not be the ideal governance structure.

Contracts

To overcome the cost associated with the temporal asset specificity, an upfront investment from a wine maker to a grape grower in the form of a commitment to purchase the grapes at the time of harvest could be utilized. This form of governance structure would benefit the wine maker as well as the grape producer. Having an estimate of the input supply can allow a winery to more accurately forecast production needs. The grape farmer benefits by avoiding the costs associated with being unable to sell their product. A contract could be made for either the short term or the long term. A contract may not reduce hold up or risk for the grape producers or the wine makers. Grape producers who enter into short term contracts face the risk of their buyer vertically integrating and no longer needed to purchase their product, leaving the producer with all the costs of production. A wine maker who enters into a short term contract with a grape producer is reliant on the grape producer to cultivate the desired grape varietal and quality. A short term contract may not be enticing enough offer for a grape producer to dedicate their assets to a specific wine makers demand. Coupled with the risk that the wine maker may choose to vertically integrate in 3 to 5 years, a grape producer would be taking on a long term risk for a short term contract. Even a long term contract may not mitigate enough hold up to be lucrative to grape producers when the potential of vertical integration could result in costly hold ups. A long term contract could provide security for grape producers for a longer time it does not decrease the possibility that a wine maker will decide to vertically integrate once the contract has been fulfilled, again exposing grape producers to the hold up and subsequent cost associated with

producing a specific asset. Therefore, contracts are not the ideal governance structure as they could result in high transaction cost to the grape producers.

Predictive Governance Structures

Vertical integration and contracts may not be the most efficient governance structures to utilize to ensure long term success of both parties. Based on the nature of grape growing and the policies that are in effect in Kansas an equity based alliance may be the better governance structure to utilize in this market. An equity based alliance would allow for the wine maker to have some input in the type of grape grown for wine production while guaranteeing to the grape producer that their harvest will be sold. Hold up associated with temporal asset specificity could be reduced if there was a dedicated buyer. Additionally, a grape producer may have more incentive to tailor their crop to a wine maker's preferences when the possibility of vertical integration is decreased, depending on the structuring of the alliance.

This is a hypothesis that would require further testing. This hypothesis could be tested using qualitative and quantitative analysis. A quantitative analysis could be performed that examine the prevalence of vertical integration among Kansas wine makers. Data could also be taken to determine the product composition as it relates to the state's 30% product composition minimum requirement. If vertically integrated firms are only producing enough grapes to just meet the 30% requirement and do not account for growth in production, there could be reason to believe that vertical integration is not the ideal governance structure. This could also suggest that the 30% policy is a binding constraint on the market. Qualitative analysis could also reveal the best governance structure for the grape and wine industry. Focus groups, surveys, and case studies can all be used to further understand the challenges, costs, and hold ups both grape producers and wine makers are facing.

Results

The available evidence suggests that the current structures governing the relationship between grape growers and wine producers is inefficient for either one or both parties. Kansas grown grapes are a requirement for the market but the asset specificity is creating hold up and inefficiencies for both grape growers and wine producers. While the market is currently utilizing some degree of contracts and vertical integration, producer reports supports that a different governance structure could decrease hold up and result in better out comes for firms. Using the principals of transaction cost economics, we hypothesize that an equity based alliance could facilitate better payoffs and increase the overall market capacity. Additional data on the nature of the transaction between grape producer and wine producers needs to be collected in order to test this theory.

Discussion

Available resources, policy mandates, and supply chain structures could all potentialy constrain the capacity of the grape and wine industry in Kansas. Some of these constraints may be binding constraints while others may become binding constraints in the future.

When looking at potentially binding resource constraints such as land, capital and water, we find that wine grapes are less water intensive than more commonly grown crops and return a potentially larger profit per acre. As global climate change increases the likelihood of extreme weather such as drought or flood, this could change the water intensiveness of grapes in the future. Currently the available water resources don't appear to be a binding constraint.

The policies that govern the grape and wine industry introduce potential constraints in the way of production capacity and product composition requirements. Based on the 2010 data, the production capacity limits do not appear to be a binding constraint as the installed capacity is lower than the limits established. The production composition requirement could be a binding constraint. Based on producer interviews, and grape and wine production data, the 30% Kansas grown production minimum could be a binding constraint in this market (Voorhis, 2014). Further analysis would need to be done to accept or reject this hypothesis. In the event that the product composition policy is the binding constraint in the market, a potential solution to increasing the potential market capacity would be to grow more grapes in Kansas.

Based on our resource analysis, growing wine grapes in Kansas could return a higher profit per acre and be less water intensive than other crops and policies exist to create a market for Kansas grown grapes. However, producers are still not growing enough grapes to expand the market and some grape growers report not being able to sell all their grapes. Through analyzing the

governance structures we may discern a better understanding of the capacity constraint and the causes.

When firms vertically integrate to just fulfill the 30% product composition requirement they no longer have the requirement to buy grapes from producers, potentially leaving producers with surplus grapes. This surplus is very costly to producers who had to dedicate their land to grape production for two to three years before seeing a profit. Due to the asset specificity inherent in wine grapes these producers have reduced markets to sell their product if they can't find buyers. The risk of dedicating land, water, and capital into a crop that takes three to five years to establish and the threat that their buyers will vertically integrate, which would leave the grape producers with an expensive surplus. The resource, policy, and supply chain constraints, could be reinforcing each other in a way that creates a binding constraint in the market.

With widespread vertical integration, Kansans take on the risk that the resources dedicated to grape growing do no cover the expense, thus discouraging risk adverse producers from planting grapes. Without independent grape producers in Kansas, the market cannot expand and continue to meet the 30% production composition requirement. This cycle is illustrated in Figure 6.

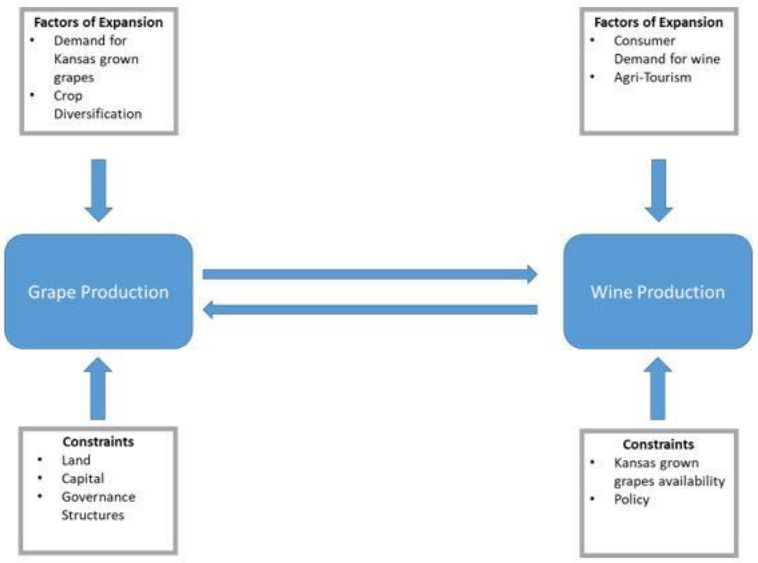

Figure 6. Factors of Expansion and Constraints

We can hypothesize that without policy or governance structure intervention this cycle will continue to constrain the potential capacity of the wine and grape industry in Kansas.

Conclusion

A strong wine industry can be beneficial for a state. It brings in state revenue in both tax revenue and economic development for the communities that support wineries and vineyards. In the event that stakeholders in the Kansas wine industry look to expand the capacity in the market, it is important to understand what potential binding constraints exist. We identified three potential sources of binding constraints, available resources, policies, and supply chains.

To evaluate the resource constraints, we used a lifecycle analysis method to evaluate the water resources needed to support a wine grape operation. We then compared the water resources and the potential profit of grapes and other commonly grown crops in the state to better understand land, capital, and water need of grapes. Through this analysis we found that grapes bring in larger profits per acre and need few additional inches of applied water than many commonly grown crops. However, it would take a grape growing operation three to five years to see the profit per acre reported. In that time the producer could use the same resources dedicated to grapes to grow an annual crop that would produce profits in the first year of planting, despite the added expense associated with the increased water need.

When the state of Kansas passed the 1985 Farm Winery Act, Kansans were allowed to make and sell wine. The Farm Winery Act also dictated certain requirements that could be binding constraints. Using a case study framework, we can hypothesize which of these policies is a potential constraint on expanding capacity. We identified that the product composition requirement and the delay in passing policies to establish a wine industry could be binding constraints. Further studies would be needed to test these hypotheses.

The governance structures utilized by stakeholders in the grape and wine supply chain could be causing costly hold up making the grape and wine industry unattractive for those looking to enter

the market. Transaction Cost Economics suggests that as asset specificity increase so does the potential for hold up. An analysis of the supply chain, using a Transaction Cost Economics approach, revealed that since Kansas grown wine grapes are a specific asset that is required of the system due to current policies a governance structure that more resembles vertical integration, rather than the spot market, could prevent costly hold ups for both grape and wine producers. Further analysis suggests that vertical integration is not the ideal governance structure and that an equity based alliance may be more beneficial to both parties. If stakeholders wish to expand the current capacity of the market a larger case study could be done to test this hypothesis.

Limitations

As the grape and wine industry is an emerging market within the state, resources have not been assigned to collecting and publishing data on the industry. As a result, a limitation of our study is the age of the data used to create conclusions and hypotheses. The majority of the data used in this study comes from a 2010 statistical report published by the Kansas Department of Agriculture and producer interviews published in news reports. Kansas grape policy was amended in 2012 which could influence the results found in this study. In addition, Covid-19 has changed the way many wineries do business. Most winery sales occur on site, the Covid-19 crisis in America resulted in the closing of many tasting rooms but the approval to sell alcoholic beverages to go. There could be long lasting implications of this crisis that is not yet reflected in publicly available data.

Additionally, enterprise data for grape producers is yet to be publicly available. In order to estimate the profit per acre the price of Kansas grapes was applied to the cost to operate an acre of grapes in Minnesota, as reported by the FINBIN data source.

Future Studies

The analysis completed resulted in additional hypotheses to test. The first being the hypothesis that the policy dictating that 30% of the materials used in wine production must be grown in Kansas, is a binding constraint. To test this hypothesis a study could be done using firm specific production data, as well as surveys and interviews with wine producers. If it is found that the majority of wine producers are only using the minimum Kansas grown requirements, the hypothesis could be accepted.

The second hypothesis that was constructed as a result of the policy case study is that the delay in policy adaptation allowed other markets to achieve first mover advantage and has benefited from increased consumer education on local wine as a result. This hypothesis could be tested through surveys of wine consumers in both Missouri and Kansas. Through assessing the degree of demand of local wine and local wine education in consumers, the hypothesis that the first mover advantage utilized by other wine regions, specifically the neighboring state of Missouri, has created a binding constraint on the market can be tested.

Using a Transaction Cost Economics framework, a hypothesis was formed that an equity based alliance may be the best governance structure for both grape growers and wine producers to reduce costly hold up. To test this hypothesis surveys and interviews of grape growers and wine producers could be used to collect data on current governance structures used and what current hold ups exist, and to what extent. If wine makers are primarily using a vertical integration governance structure but hold ups still occur, it could suggest that the hypothesis is valid. Inversely, if firms who use a vertical integration governance structure don't experience hold up and those that do not use a vertical integration structure, do then the hypothesis could be rejected.

When more recent Kansas grape and wine data is available the methods used in the analyses conducted can be replicated to ensure relevancy.

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Appendix A - Evapotranspiration Sum By County By Month

Evapotranspiration Sum by County by Month

	Sum of ETo												
County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Grand Total
Butler	1.63	2.48	3.71	3.9	4.78	5.79	6.51	4.85	4.21	3.43	2.05	1.52	44.86
Miami	1.51	2.56	3.71	4.27	5.32	6.75	6.71	5.08	4.29	3.21	1.78	1.42	46.61
Olathe	1.24	2.36	3.26	3.91	5.06	6.05	6.16	4.8	3.93	3.03	1.75	1.48	43.03
Rossville	1.17	2.35	3.73	4.18	5.9	6.95	6.62	4.63	4.31	3.61	2.13	1.62	47.2
Silver Lake	1.27	2.33	3.56	4.29	6.06	6.96	6.93	5.31	4.55	3.62	2	1.6	48.48
Sterling	1.72	2.55	3.99	4.23	6.29	7.63	8.12	5.76	5.48	3.91	1.6	0.02	51.3
Grand Total	8.54	14.63	21.96	24.78	33.41	40.13	41.05	30.43	26.77	20.81	11.31	7.66	281.48

Appendix B - Additional Inches Applied Needed by County by Month (Grapes)

Kc used	0.3	0.3	0.7	0.7	0.45	0.45	
Irrigation need	Apr	May	Jun	Jul	Aug	Sep	Yearly inches needed
Butler	1.17	1.434	1.737	1.953	1.455	1.263	9.012
Miami	1.281	1.596	2.025	2.013	1.524	1.287	9.726
Olathe	1.173	1.518	1.815	1.848	1.44	1.179	8.973
Rossville	1.254	1.77	2.085	1.986	1.389	1.293	9.777
Silver Lake	1.287	1.818	2.088	2.079	1.593	1.365	10.23
Sterling	1.269	1.887	2.289	2.436	1.728	1.644	11.253

Appendix C - Additional Inches Applied Needed by County by Month (Other Crops)

Corn											
Crop coefficient			1.2	1.2	0.475	0.475					
	Apr	May	Jun	Jul	Aug	Sep	Total				
Butler	0	0	6.948	7.812	2.30375	1.99975	19.0635				
Miami	0	0	8.1	8.052	2.413	2.03775	20.60275				
Olathe	0	0	7.26	7.392	2.28	1.86675	18.79875				
Rossville	0	0	8.34	7.944	2.19925	2.04725	20.5305				
Silver Lake	0	0	8.352	8.316	2.52225	2.16125	21.3515				
Sterling	0	0	9.156	9.744	2.736	2.603	24.239				
Corn Average	**20.76433**										
Soybeans											
Crop coefficient			1.15	1.15	0.5	0.5					
	Apr	May	Jun	Jul	Aug	Sep	Total				
Butler	0	0	6.6585	7.4865	2.425	2.105	18.675				
Miami	0	0	7.7625	7.7165	2.54	2.145	20.164				
Olathe	0	0	6.9575	7.084	2.4	1.965	18.4065				
Rossville	0	0	7.9925	7.613	2.315	2.155	20.0755				
Silver Lake	0	0	8.004	7.9695	2.655	2.275	20.9035				
Sterling	0	0	8.7745	9.338	2.88	2.74	23.7325				
Soybean Average	**20.32617**										
Wheat											
Crop coefficient	0.7	0.7	0.7	0.7	1.15	1.15	1.15	0.325	0.325	0.325	
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Butler	0.098233	0.077452	0.047833	0.034323	0.060468	0.101857	0.137629	0.04225	0.050112903	0.062725	0.712883
Miami	0.1001	0.072484	0.041533	0.032065	0.056016	0.105143	0.137629	0.046258	0.055774194	0.073125	0.720127
Olathe	0.0917	0.068419	0.040833	0.033419	0.046	0.096929	0.120935	0.042358	0.053048387	0.065542	0.659184
Rossville	0.100567	0.081516	0.0497	0.036581	0.043403	0.096518	0.138371	0.045283	0.061854839	0.075292	0.729085
Silver Lake	0.106167	0.081742	0.046667	0.036129	0.047113	0.095696	0.132065	0.046475	0.063532258	0.0754	0.730985
Sterling	0.127867	0.08829	0.037333	0	0.063806	0.104732	0.148016	0.045825	0.065943548	0.082658	0.764472
Wheat Average	**0.719456**										
Grain Sorghum											
Crop coefficient			1.05	1.05	0.55	0.55					
	Apr	May	Jun	Jul	Aug	Sep	Total				
Butler	0	0	6.0795	6.8355	2.6675	2.3155	17.898				
Miami	0	0	7.0875	7.0455	2.794	2.3595	19.2865				
Olathe	0	0	6.3525	6.468	2.64	2.1615	17.622				
Rossville	0	0	7.2975	6.951	2.5465	2.3705	19.1655				
Silver Lake	0	0	7.308	7.2765	2.9205	2.5025	20.0075				
Sterling	0	0	8.0115	8.526	3.168	3.014	22.7195				
Grain Sorghum	**19.44983**										
Alfalfa											
Crop coefficient	0.4	0.4	0.4	0.95	0.95	0.9	0.9				
	Apr	May	Jun	Jul	Aug	Sep	Oct	Total			
Butler	0.052	0.061677	0.0772	0.18335	0.148629	0.1263	0.099581	0.748737			
Miami	0.056933	0.068645	0.09	0.21375	0.155677	0.1287	0.093194	0.806899			
Olathe	0.052133	0.06529	0.080667	0.191583	0.147097	0.1179	0.087968	0.742638			
Rossville	0.055733	0.076129	0.092667	0.220083	0.141887	0.1293	0.104806	0.820606			
Silver Lake	0.0572	0.078194	0.0928	0.2204	0.162726	0.1365	0.105097	0.852916			
Sterling	0.0564	0.081161	0.101733	0.241617	0.176516	0.1644	0.113516	0.935344			
Alfalfa Average	**0.817857**										

Cotton							
Crop coefficient			1.175	1.175	0.6	0.6	
	Apr	May	Jun	Jul	Aug	Sep	Total
Butler	0	0	6.80325	7.64925	2.91	2.526	19.8885
Miami	0	0	7.93125	7.88425	3.048	2.574	21.4375
Olathe	0	0	7.10875	7.238	2.88	2.358	19.58475
Rossville	0	0	8.16625	7.7785	2.778	2.586	21.30875
Silver Lake	0	0	8.178	8.14275	3.186	2.73	22.23675
Sterling	0	0	8.96525	9.541	3.456	3.288	25.25025
Cotton Average	**21.61775**						
Sunflower							
Crop coefficient			1.075	1.075	0.35	0.35	
	Apr	May	Jun	Jul	Aug	Sep	Total
Butler	0	0	6.22425	6.99825	1.6975	1.4735	16.3935
Miami	0	0	7.25625	7.21325	1.778	1.5015	17.749
Olathe	0	0	6.50375	6.622	1.68	1.3755	16.18125
Rossville	0	0	7.47125	7.1165	1.6205	1.5085	17.71675
Silver Lake	0	0	7.482	7.44975	1.8585	1.5925	18.38275
Sterling	0	0	8.20225	8.729	2.016	1.918	20.86525
Sunflower Average	**17.88142**						
Pinto Bean							
Crop coefficient	0.4	0.4	1.15	1.15	0.35	0.35	
	Apr	May	Jun	Jul	Aug	Sep	Total
Butler	1.56	1.912	6.6585	7.4865	1.6975	1.4735	20.788
Miami	1.708	2.128	7.7625	7.7165	1.778	1.5015	22.5945
Olathe	1.564	2.024	6.9575	7.084	1.68	1.3755	20.685
Rossville	1.672	2.36	7.9925	7.613	1.6205	1.5085	22.7665
Silver Lake	1.716	2.424	8.004	7.9695	1.8585	1.5925	23.5645
Sterling	1.692	2.516	8.7745	9.338	2.016	1.918	26.2545
Pinto Bean Average	**22.7755**						
Hay (Other							
Crop coefficient	0.4	0.4	1.15	1.15	0.35	0.35	
	May	Jun	Jul	Aug	Sep	Oct	Total
Butler	0.061677	0.0772	0.2415	0.179919	0.049117	0.038726	0.648139
Miami	0.068645	0.09	0.248919	0.188452	0.05005	0.036242	0.682308
Olathe	0.06529	0.080667	0.228516	0.178065	0.04585	0.03421	0.632597
Rossville	0.076129	0.092667	0.245581	0.171758	0.050283	0.040758	0.677176
Silver Lake	0.078194	0.0928	0.257081	0.196984	0.053083	0.040871	0.719012
Sterling	0.081161	0.101733	0.301226	0.213677	0.063933	0.044145	0.805876
Hay Other Average	**0.694185**						