THE ECONOMIC CONTRIBUTIONS OF MICHIGAN'S HARD CIDER INDUSTRY

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ABSTRACT

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This research investigates the economic contributions of Michigan's growing hard cider industry while accounting for demand changes for its substitute products which are beer, wine, hard seltzer, and mixed drinks. Pooling responses across those instructed to consider on premise and off premise consumption, our discrete choice experiment (DCE) reveals average consumer willingness to pay for a 12 oz unit of hard cider to be $6.98, with an additional $1.41 when it is locally produced. The Michigan cider value-chain is identified and assessed to estimate the economic contribution of in-state cider production and sales. Supply chain modeling is facilitated using a modified regional social account matrix depicting local supply chains of hard cider production. We estimate that the gross economic impact of Michigan's hard cider production on the state's economy is $35.1 million in terms of additional Gross State Product. Should in-state cider demand increase in response to, for example, a concerted marketing effort, the expected economic impact will be moderated by substitution, or reduced sales of competing products. Using substitutability insight from the DCE model, we find that a doubling of Michigan cider sales will result in a net economic impact of $30.2 million to Michigan's Gross State Product. This work is the first estimate to our knowledge of the economic contribution or impact of the budding hard cider industry. While few consumer demand studies on hard ciders have been completed, this report also applies a DCE model to establish willingness to pay benchmarks, including that of local branding, with the additional novelty of incorporating the model results in the economic contribution analysis. The findings have implications for local stakeholders as well as state policymakers

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SECTION 1: INTRODUCTION

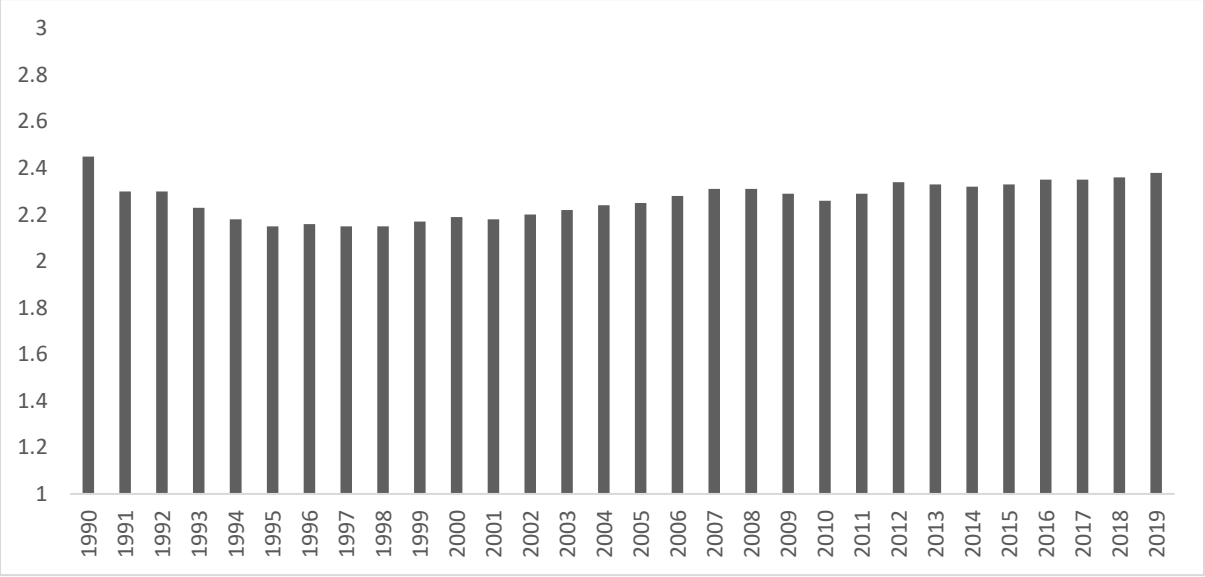
Local food and beverage production has become a darling for state economic development proposals over the past few decades, with "import substitution" being listed as a common mechanism to deliver economic growth (Watson et al. 2017). The economic contributions of craft beverage supply chains have been especially popular, with many studies exploring the industry's regional economic contributions and agritourism potential (Gómez, Pratt and Molina 2019; Malone and Stack 2017; Miller et al. 2019; Rosburg and Grebitus 2021; Kimberly L Jensen et al. 2021). Indeed, the U.S. craft beverage market has revamped demand for locally-sourced inputs such as hops, barley, wine grapes, and cider apples (Atallah et al. 2021; Dobis et al. 2019; Kimberly Lynn Jensen et al. 2021; Tuck, Gartner and Appiah 2017). The popularity of craft beer has been commonly linked to discussions surrounding economic development (Malone and Stack, 2017).

Like the much-discussed Michigan craft beer industry, the hard cider supply chain has potential to add value to the state's economy. The state's nascent hard cider industry might create a local cultural identity around the state's own cider brands, further elevated by Michigan's identity as a large contributor to U.S. apple production. As with any industry, growth is likely to create directly observable direct effects such as raising regional incomes, employment, and sales revenues. However, growth in related industries through indirect and induced effects may be less obvious without dissecting linkages within the supply chain (Cooke and Watson 2011; Winfree and Watson 2017). In this paper we trace the cider value chain from the apple tree to the pint glass, allowing us to anticipate the total economic implications of Michigan cider production by documenting and categorizing the supply chain transactions underlying in-state cider production. Hypothetical net economic impacts of expanding the Michigan market for craft hard cider are

considered representing a situation like a concerted marketing effort to advance hard cider consumption in state.

Though U.S. craft beverage demand has increased over the past few decades, U.S. aggregate alcoholic beverage consumption has either fallen or remained flat for the last three decades **(Figure 1)**. This implies an important need for any regional economic impact analysis of craft beverage production to explicitly model the substitution effects associated with promoting one craft beverage over another. These substitution concerns are consistent with studies on "Buy Local" campaigns which often emphasize the importance of modeling the substitution effects associated with promoting one marketing channel over another (Hughes and Isengildina-Massa 2015; Schmit et al. 2019). "Buy Local" campaigns are especially of interest for policymakers with the goal of increasing demand for homegrown food and beverages (Neill, Holcomb, and Lusk, 2020). Despite the policy implications, few economic impact studies have explicitly modeled demand-side substitution effects in the empirical analysis.

Figure 1: Per capita alcohol consumption of all beverages (in gallons of ethanol)



Source: Slater and Alpert 2021

This paper provides a framework of how to empirically integrate craft beverage consumer demand data into an economic impact analysis. Specifically, we use a discrete choice experiment not only to find willingness to pay estimates for local hard cider, but also to estimate cross-price elasticities for alternate products consumed by craft beverage drinkers. These price elasticities are used to incorporate substitution effects in the input-output model of hard cider economic impact analysis. The main contribution of this paper, in addition to providing economic impact estimates of the developing artisan hard cider industry, is the application of choice experiments within an economic impact assessment for capturing and accounting for substitution effects across hard cider and competing beverage choices. That is, we use cross-price elasticities from consumer survey to net out the substitution effects in the regional economic impact analysis, providing future researchers with a method of making more grounded estimates about potential economic gains of any local product or market. The study addresses a gap in the existing peer-reviewed literature as no local value chain assessment of hard cider has been completed in the United States.[1] By focusing the analysis on the Michigan hard cider industry, this study makes a contribution to an industry with relatively little consumer knowledge. Michigan is a state whose residents exhibit a high collective food identity for apples (Moreno and Malone 2021), so industry advocates maintain that Michigan producers are in a prime position to develop a hard cider production identity and a profitable hard cider sector. Even in a state with a relatively large potential cider sector, consumer access to information about product offerings is limited relative to other craft beverages resulting in relatively low consumer prior understanding or expectations (Young 2019). For example, the

[1] Grier et al. (2013) represents one example of an estimate of the economic impact of hard cider in Ontario, Canada, which estimated that hard cider generated approximately $18.3 million in total output, contributed $9.3 million to annual GDP, and supported 130 total full-time equivalent (FTE) employment positions. It went further to estimate that Ontario's budding hard cider industry contributed some $1.2 million (Canada) in total federal tax revenues in 2015. Estimates for 2020 suggest contribution more than tripled, generating approximately $57.7 million in output, contributing $29.3 million to annual GDP, creating 412 total FTE employment positions and $3.9 million in tax revenues respectively.

U.S. Cider Association only recently released their first official style guide in 2017 (McGrath, 2018).

The remainder of this article is organized as follows. Section 2 discusses background on the import substitution development strategy and the role of substitution effects in such analyses. In section 3, we describe the institutional background of the production and consumption of hard cider and other craft beverages in this country. Section 3 maps the Michigan hard cider supply chain and describes important aspects relevant for producer decision-making. Section 5 describes our unique methodology, which incorporates results from a discrete choice experiment into an economic contributions analysis. Section 6 discusses the results, which indicate that direct transactions from the cider value chain give rise to $37.2 million in total transactions, and when secondary and tertiary effects are taken into account, we have an expected contribution of $70.0 million in output to the Michigan economy. 585 jobs are tracked back to the cider value chain, with an associated income of $23.0 million from these jobs. Most of these jobs are related to making, selling, and serving cider. If we adjust our estimates for between-product substitutions, we find that a doubling of Michigan sales of hard cider will support 505 jobs with average annual labor income of about $39.0 million and $61.0 worth sales in terms of annual output. The base scenario adds $35.1 to Michigan's Gross State Product, and the hypothetical demand doubling of cider adds $30.2 million more to that amount. The article then concludes with a description of possible future research and policy implications in section 7.

SECTION 2: BACKGROUND

Replacing consumption of goods that are imported to a region with consumption of locally produced goods is an economic development strategy called "import substitution" (Cooke and Watson 2011). This process is meant to strengthen the local economy by preventing sales dollars from 'leaking' out of the region. Industry sales also create new jobs and new expenditures with income that are subsequently spent in the economy. Methods and models have been developed to evaluate economic influence of import substitution in local food systems (Miller et al. 2015; Watson et al. 2017).

While researching relationships between local markets and regional economies, an increasing amount of literature has expressed concern about substitution effects. Food expenditures stemming from "Buy Local" campaigns are not usually 'new'; rather consumers divert money away from other channels of purchase (McFadden 2017). This involves a trade-off that may or may not result in an eventual gain for the regional economy, depending on market linkages between substitutable and complementary products, and alternative marketplaces. For example, Hughes et al. (2008) used an opportunity-cost framework to evaluate the net economic impact of farmers' markets in West Virginia, explicitly accounting for lost sales from grocery stores. While considering net (as opposed to gross) impact still retained a positive gain in West Virginia, in South Carolina applying the same framework showed no significant impact of "Buy Local" campaigns through farmer market products (Hughes and Isengildina-Massa 2015). Shideler and Watson (2019), while constructing a Local Food Impact Calculator to identify possible linkages of an upcoming market in an area, warned about other local activities displaced by food production. O'Hara and Shideler (2018) found that Direct-to-Consumer (DTC) activities have

trade-off effects with on-premise food expenditures in restaurants and bars in nonmetropolitan areas.

Most existing research in this area studied economic impact of marketing channels of products (e.g. farmer markets) or increased consumption of a single locally-grown/made agricultural product (Low et al. 2015). Our case is somewhat unique in that craft beverages themselves are substitutable. This means that a "Buy Local" campaign for one beverage may have overreaching consequences for other substitutable products. Just like the decision to purchase locally grown cherries will have substitution effects relevant for cherry demand from other states, locally made hard cider may displace consumption of not only non-local cider, but also substitute products such as craft beer, wine, and craft hard seltzer. This is especially true in a market where total alcohol consumption by U.S. citizens has remained mostly unchanged for some time **(Figure 1)**. All craft beverages are relatively new market entries, with "craft" alcohol not being a common phrase until the 1980s. These sales are flourishing now (for example, craft beer sales increased just under 400% between 2005 and 2017 (Brewers Association 2020)), but it remains to be seen what specific beverages emerge as the most popular. Considering these concerns, net economic impact of a local hard cider must be conducted carefully. We do so in our research by linking primary consumer survey data with our input-output impact analysis to account for the substitution effects.

SECTION 3: HISTORY AND CURRENT MARKET SCENARIO OF CRAFT BEVERAGE IN THE U.S.

Hard cider production largely pre-dates beer production in the United States. English settlers in the 1600s started planting apple trees in North America, and they thrived. One way of preserving apple juice was by processing it into hard cider. Early colonial settlers also planted barley and grains, but production struggled to gain as much traction as did apple trees. Beer is made from barley and grains, but beer failed to gain prominence while cider made from apple won favor (Watson 2013). Hard cider was also life-sustaining, as bacteria causing then-fatal diseases like typhoid and cholera often occurred in untreated water. So, the alcohol-containing cider became a preferable drink, or a way to sanitize water.

Hard cider remained a common and popular beverage in America into the nineteenth century, even migrating west with the American expansion. However, its popularity began to decline alongside the arrival of German and Eastern European immigrants whose drink of choice was beer. After settling in Midwestern cities such as Milwaukee, Wisconsin and St. Louis, Missouri, these immigrants quickly established barley and grain operations, allowing for beer to be produced cheaply (Lender and Martin 1987). The early and subsequent temperance movements also contributed to declined hard cider and alcohol consumption through to Prohibition (Watson 2013).

After Prohibition was lifted in 1933, beer consumption became widespread while cider popularity faded out (Baker 2018). Interest in craft beer followed federal legalization of homebrewing in 1978 but the cider industry remained mostly non-existent until the late 20th century. Significant changes in consumer food and beverage preferences over the last few decades has led to increased emphasis on product health attributes, novel flavor profiles, and local

production. This has given rise to increased consumer interest in craft beer, and while hard cider occupies only 1% of the alcoholic beverage market, hard cider has experienced a recent resurgence in consumer demand (Nielsen 2019).

Table 1: Timeline of the U.S. hard cider industry

Year(s)	Event
1623	First cultivated apple tree planted in Boston
1647	First grafted apple tree arriving from Europe
1726	A single Boston village (40 families) reported to have produced 10,000 barrels of cider
1767	1.14 barrels (more than 35 gallon) per person yearly cider consumption reported for Massachusetts
1774-1884	Lifetime of 'Johnny Appleseed' (John Chapman), nurseryman who travelled from Pennsylvania to up to Ohio and Indiana plating apple seeds and selling seedlings to farmers, creating varieties of cider apples
(By) 1775	10% New England farms owned and operated cider mill
1810	198,000 barrels of cider made in Essex County, New Jersey
1825-1855	First wave of temperance movement
1860-1910	Rural population drop from 84% to 30% due to urban migration, replacement of homemade farm cider from village to beer from breweries in cities
1880s	Cutting down of many orchards due to widespread insect damage
1899-1919	Drop of yearly cider production in the country from 55 million to 13 million gallons
January, 1920	Effect-taking of Prohibition: ban of production, transportation and sales of alcoholic beverages
October, 1920	Amendment of Prohibition to make production of hard cider up to 200 gallons a year legal as long as the juice fermented naturally, but selling still illegal
1933	Lifting of Prohibition
1978	Home brewing made legal
1990-2004	Hard cider consumption increase from 271,000 gallons to more than 1.33 million gallons yearly in America
2008-2018	Total off-premise cider sales rise from $44 million to $504 million

Source: Watson 2013; Bedford 2021; Aaron and Musto 1981; Tobia 2021

Today hard cider retains a relatively small share of the overall alcohol market with current market size of $569.1 million (Lombardo 2020). For comparison, the total market for craft beer in the U.S. is about $22.2 billion (Brewers Association 2020). Regardless, the growth in hard cider sales now outpaces that of other growth segments in the alcoholic beverage markets. For example, the market for hard cider expanded by over 900% between 2001 and 2017 (Swift 2017). Total off-premise sales of cider rose from $44 million to $504 million between 2008 and 2018, with growth rates reaching levels higher than those of beer, wine, or hard spirits (Nielsen 2019). Alternatively,

craft beer sales increased just under 400% between 2005 and 2017 (Brewers Association 2020). Besides beer and hard cider, other craft drinks like wine, liquors, mead, perry and other fermented beverages have also seen increase popularity and production in recent years. Annual sales of the craft beverage are now estimated to be about $32 billion, which is roughly 8% of total annual alcohol sales (Johnson and Lowry 2021).

Gains in cider market share has attracted the attention of large brewing conglomerates like the Boston Beer Company, Anheuser-Busch and MillerCoors, who have started their own cider labels. In 2013, the Boston Beer Company's fastest growing brand was a cider (Waterhouse 2013). Despite entry of national brands, one-third of total cider sales are made by local or regional brands, and 17 of the top 25 cider brands are considered regional or local (PennState Extension 2018).

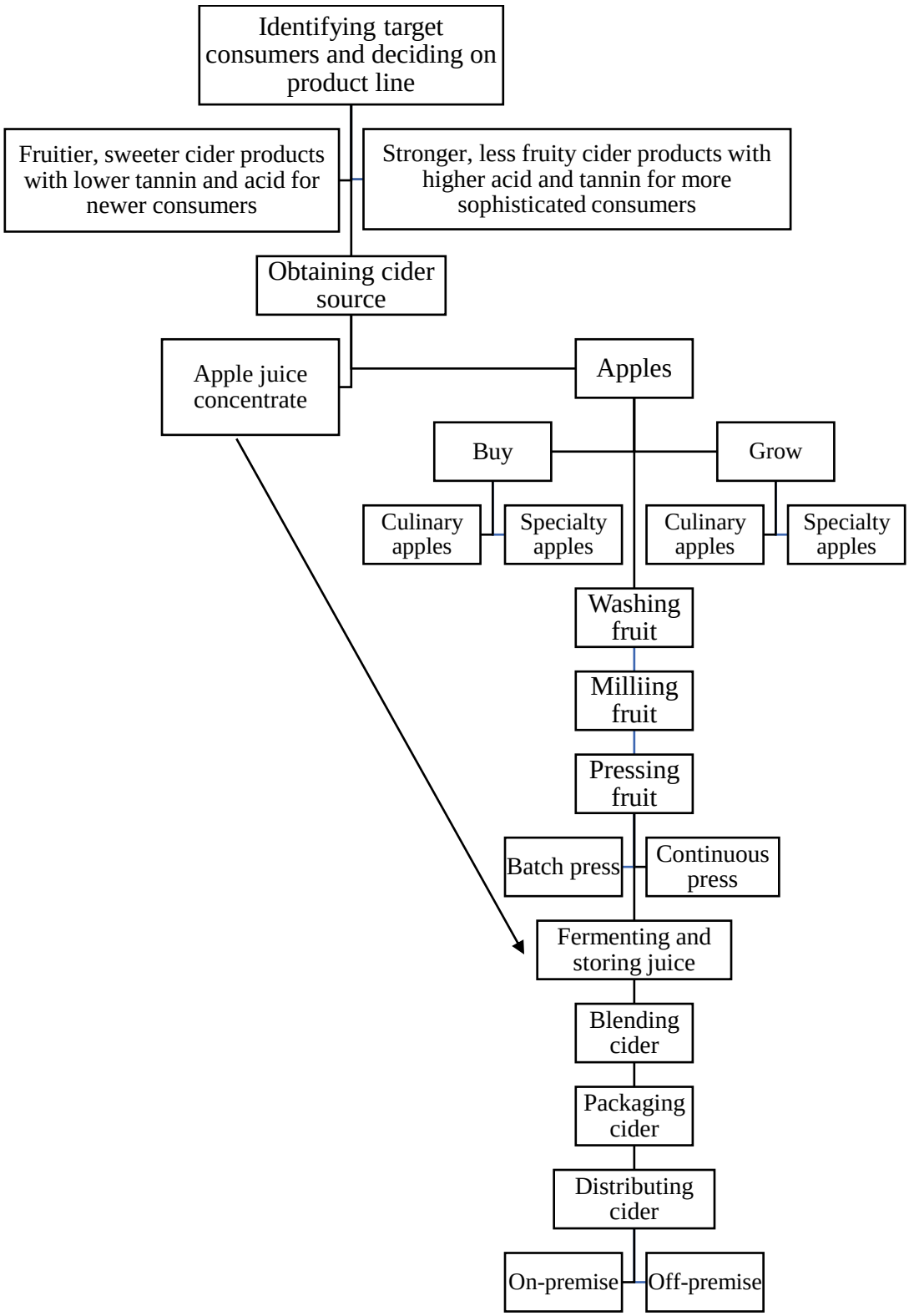
It is worth mentioning that the recent hard cider boom coincides with that of another alcoholic beverage- hard seltzer. Banking on similar appeals of health benefits (low-calorie, low ABV, gluten-free) and diverse natural flavor options, hard seltzer has managed to post astounding growth. From a $39 million dollar industry in 2017, the market grew to a size of $4.5 billion in 2021 (Meisenzahl 2021). We largely conjecture that both hard ciders and hard seltzers follow similar economic profiles and consumer interests. Both being newly popular drinks that attract a younger and more gender balanced demographic interested in experimenting with flavors, hard cider and hard seltzer are in direct competition to claim market share in the alcohol industry.

SECTION 4: CONCEPTUAL FRAMEWORK

Figure 2 describes a cidermaker's decision tree. Large-scale cider makers use apple juice concentrate to ferment and make cider. Smaller 'craft' cider makers, on the other hand, often source fruit or juice locally or from their own orchard (Merwin 2014). A benchmark survey by Pennsylvania State University Extension (PennState Extension 2018) found among businesses producing 1,000-10,000 gallons of cider yearly (about 41% of sample of 276), 40% purchase bulk fresh juice, and 36% either grow or purchase apples for making cider. Among cideries producing 1,000-20,000 gallons yearly, 60% purchase juice in bulk while 40% grow or purchase apples. About 71% of cideries producing 20,000-50,000 gallons and 70% producing over 100,000 gallons yearly use fresh juice, while 57% of cideries producing 50,000- 100,000 gallons yearly grow their own fruit for cider.

Michigan has about 200 wineries and cideries (West 2021) where most are producing artisan brands. However, there is a supply shortage of ideal cider apples in Michigan. So, cideries must pay a higher price for cider-specific apples or use regular culinary apples for creating their products (Gottschalk, Rothwell and van Nocker 2017). Michigan Liquor Control Commission (MLCC) considers cider with an ABV (alcohol by volume) of "not less than 1/2 of 1% and nor more than 8.5% of alcohol" an alcoholic beverage (Michigan Liquor Control Commission 2020). It therefore requires that sellers of such cider to acquire a Certificate of Label Approval (COLA) with the state's Alcohol, Tobacco, Tax & Trade Bureau (TTB).

Figure 2: Hard cider production process



Source: Matson Consulting; Virgina Fairs 2012

To produce cider, apples are first cleaned thoroughly. They are put through a mill and ground to a fine pulp called ‘pomace’. Using equipment like rack-and-cloth presses or belt presses, pomace is pressed to yield juice. After the juice is extracted, it is chilled to a temperature of 40 to 60 Fahrenheit. Fermentation is the breakdown of the apple sugar to ethyl alcohol and carbon dioxide. Hence, the fermentation process gives hard cider its alcoholic content. Cider makers can let the juice ferment naturally with ambient yeast, or they can manually add yeast nutrients to effectively manage the process. Decontaminating and/or fermentation-assisting additives are also included. Natural yeast results in slower fermentation (2-3 months) which is regarded to be better for retaining desired qualities like aroma and flavor (Home Brew Journal 2021). Fermented cider is racked off to age. The extent of fermentation and the duration and environment of aging depend on the choice of individual cider producers. These choices result in varieties like dryer or sweeter taste, lower or higher alcohol content, still or carbonated cider. Depending on desired flavor of cider, different types of fermented cider may be blended.

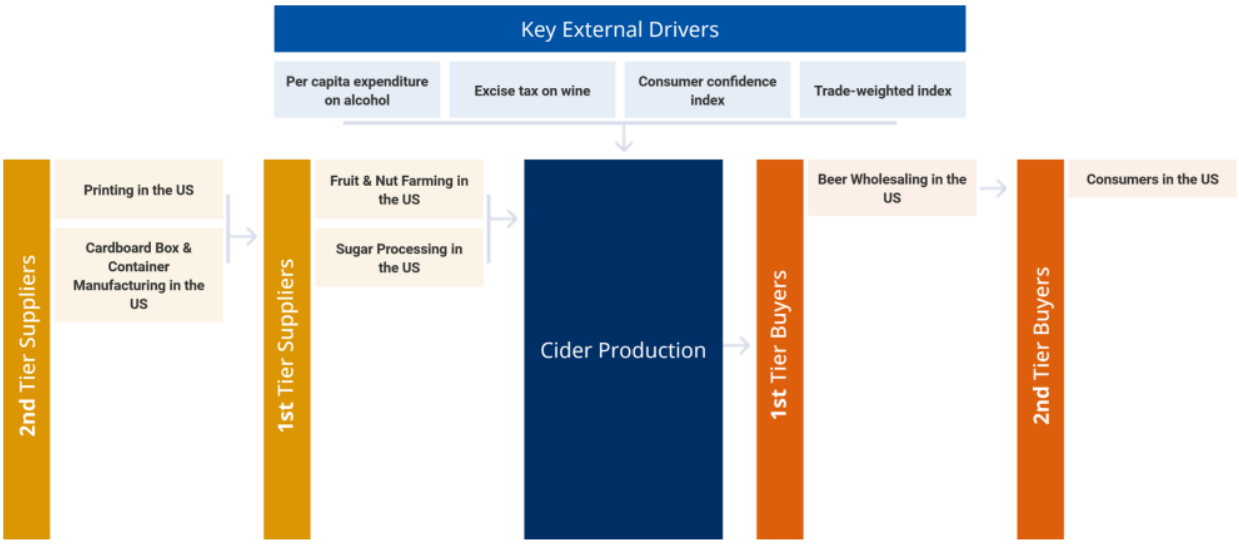
Representatives of the Michigan cider industry, the Michigan Apple Committee, the Michigan Department of Agriculture and Rural Development (MDARD), and Michigan State University Extension collaborated to develop Good Manufacturing Practices (GMPs) for Michigan apple cider (Department of Agriculutre & Rural Development 2018). These guidelines include recommendations and requirements tied to existing law regarding every stage of the cider production process. To ensure food safety, state law in Michigan requires all cideries to have a certified specialist as an active staff member.

Hard cider packaged in cans or bottles are distributed to select grocery stores. However, a big part of the craft cider appeal comes from on-location touring and tasting. Consequentially, cider varieties are available for tasting and purchase at winery/cidery premises. Cider is also sent

out of state via online orders: Blake's Hard Cider in Michigan, for example, delivers their products to 18 other states (Press release 2020). But for most craft producers, the market remains regional.

Figure 3 shows the general hard cider supply chain. Key costs of the cider producers come from buying raw materials (packaging material, apples, sugar, yeast) and paying for labor, marketing and utility (Lombardo 2020). Recognizing unique attributes, especially for locally focused value chains, is necessary to understand the full implications of industry formation, as most inter-industry data necessary for understanding regional supply chains are derived first from national value chains.

Figure 3: Hard cider supply chain



Source: Lombardo 2020

SECTION 5: METHODS

The overall intent of this paper is to integrate between-product substitution effects into an estimate of the economic impact of Michigan's hard cider value chain. We begin by developing a consumer demand system to track the contribution of the Michigan hard cider industry and then track how money transfers from individual consumers up the value chain to the input suppliers of hard cider. As such, we identify economic contributions generated through direct, indirect, and induced "ripple" effects. This study integrates a demand system into the impact analysis framework modified to account for craft beverage supply chains for assessing economic impacts under different scenarios.

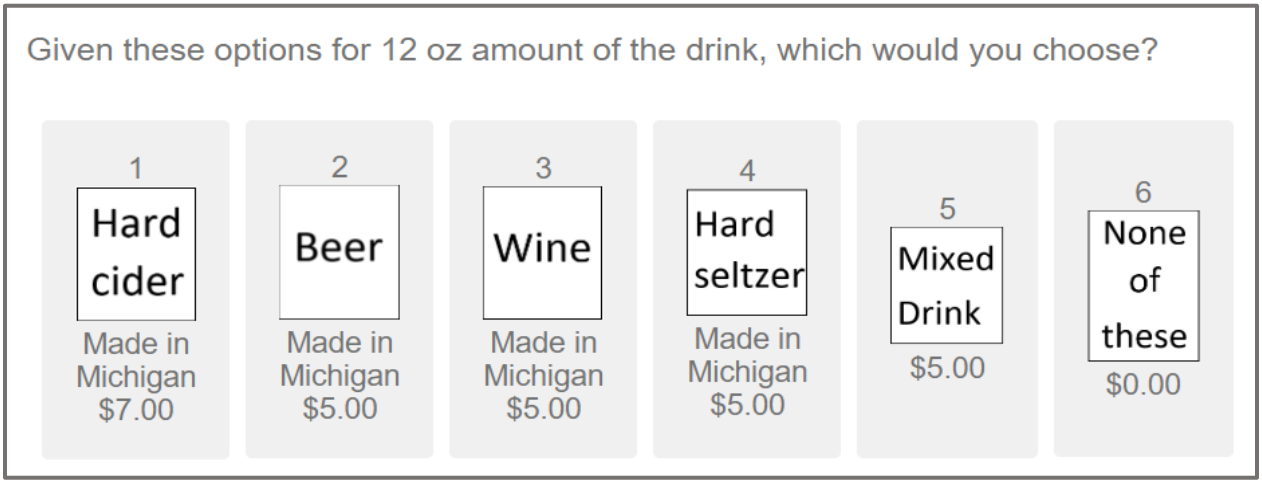
DISCRETE CHOICE ANALYSIS

We conduct a Discrete Choice Experiment (DCE) with a representative sample of Michigan consumers to establish baseline willingness to pay (WTP) and for estimating substitution across related products. DCE's are widely applied to investigate preferences for food and beverages as they allow researchers to identify certain elements of consumer tastes and preferences for which they are willing to pay a premium (Loureiro and Umberger 2007; Lockshin et al. 2006). Prior studies indicate that hard cider consumers are willing to pay a premium for sensory attributes such as aroma and taste (Tozer et al., 2015) and 'organic' cider (Smith and Lal 2017). The prior consumer demand literature also indicates that hard cider drinkers are willing to pay a premium for 'local' hard cider, as consumers attach a higher social value to ciders produced within their own state (Farris et al., 2019). This consumer attachment to locally produced hard cider translates to dollar values and they show higher WTP for locally made cider (Farris et al., 2019, Jensen et al., 2021; Outreville & Le Fur, 2019). Previous studies suggest consumers value localness in wine and beer as well (Hart, 2018; Schäufele & Hamm, 2017).

That said, "localness" is generally more dependent on geographical and socio-economic boundary rather than physical distance (Farris et al., 2019). Considering this and the Michigan residents' food identity attachment with apples, consumers could be expected to value local input of apples as well as local production process using input (fruit/juice concentrate) from different locations as different desirable attributes. However, discussions with cider producers suggests that most cideries in Michigan do not use local apples as input for their product. Therefore, for this study we define 'localness' as localness of production process ('Made in Michigan') and include this as the attribute to study. The other attribute, common to all DCEs, is price.

Figure 4 depicts a sample discrete choice question posed to our consumer panel. We include wine, beer, hard seltzer, and mixed drinks as alternative alcoholic beverages in the DCE to estimate substitutability within the Michigan craft beverage market. Beer, wine and mixed drinks are other common alcoholic beverage substitutes. As the growth in hard cider coincides with hard seltzer, we also include hard seltzer as an alternative for analyzing the substitution effect in the final analysis.

Figure 4: Example choice question



Each beverage option has its own price. Beverages with local attributes also are allowed to have price premiums. 'Craft' drinks or drinks made by smaller local businesses are generally priced a little higher, and there is generally a markup on every beverage when it is being served in a restaurant. For example, in different grocery stores of Michigan, 12 oz cider 6-packs may be priced between $8.99 to $11.49 while beer 6-packs may cost $5.99 to $10.99. At local cideries, a pour of 12 oz cider may cost $6.00 while in bars a draft of 16 oz beer may cost between $5.00 to $7.00. Considering everything, the base price for a 12 oz amount of the alternatives was set at $3.00 and two other price levels were included in $2 increments- $5.00 and $7.00. The 'localness' attribute had two levels- 'local' (present, with a dummy value of 1) or 'non-local' (absent, with a dummy value of 0).

We estimate customer's willingness to pay for local cider. We also focus on cider substitutes like wine, beer, seltzer, and mixed sprits in the labeled DCE to examine the existence and magnitude of the opportunity cost of increased cider demand. Price elasticities of demands for cider alternatives are found from the DCE. Data from the DCE are analyzed following random utility theory (McFadden 1973), which assumes that consumer *n*'s utility derived from choosing alternative j is:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \text{ for all j } \ldots\ldots \text{ (i)}$$

where ε_{nj} is the random error term. The systematic component V_{nj} for our experiment is

$$V_{nj} = \alpha_{nj} + \beta_{price} * PRICE_{nj} + \beta_{localness} * LOCALNESS_{nj} \ldots\ldots \text{ (ii)}$$

Here α is an alternative-specific constant (ASC) that demonstrates utility for an alternative relative to the no-buy option (which is normalized to zero), β_{price} is marginal utility of price and $PRICE_{nj}$ is price of alternative j that is seen by participant *n*. $\beta_{localness}$ and $LOCALNESS_{nj}$ are read similarly. From this baseline, we empirically estimate a random parameter logit (RPL) model to account for

random taste variation across consumers. We assume a normal distribution for the ASC as preference for any option in the model can be either positive or negative (Hensher and Greene, 2003). A more complete introduction to DCE modeling is found in Bylund and Malone (2022).

Cider can be consumed on- or off-premises so respondents are divided into two groups within the online survey. Half of the panel are directed to, "Imagine you'd like to order a 12 oz pour of such beverages at a bar or restaurant (locally/non-locally made)", and the other half are directed to, "Imagine you'd like to purchase a 12 oz can/bottle of such beverages (locally/non-locally made) at a grocery store." This effectively creates a between-subjects design, eliminating bias towards either of the certain scenarios in the panel. The within-subject design in the survey involves both groups of respondents repeatedly choosing from among the five alcoholic beverage alternatives plus a no-buy option.

As our experimental design includes five choice alternatives with three price levels (not counting status quo/no-buy option) and two 'localness' levels, a full factorial design would require $(3^{5 \times 2} \times 2^{5 \times 2}) = 60{,}466{,}176$ unique choice questions. This is reduced to 36 choice tasks by applying a simultaneous orthogonal fractional factorial design that is apt for labeled designs (Louviere, Hensher and Swait 2000). These 36 questions are divided into three blocks of 12 questions each. Each participant faces any of the three blocks, and the order in which they see the questions is randomized. This means they choose products 12 times at varying prices and localness levels of the options. In addition to completing choice tasks, respondents fill out a set of demographic questions.

INPUT-OUTPUT ANALYSIS

We use Input-Output Modeling to trace out inter-industry linkages between the hard cider industry and the Michigan economy. Widely used at the local, regional, national and international

levels (Miller and Blair 2009), the Input-Output analysis method is a popular tool to conduct economic analysis. As the industry grows, initial changes in hard cider expenditures (Direct Effect), secondary changes in expenditure across industries connected with hard cider (Indirect Effect), and tertiary changes from income generated by employees of the businesses in the hard cider supply chain (Induced Effect) reflect the total economic contribution associated with hard cider production and sales.

$$\text{Total Effect} = \text{Direct Effect} + \text{Indirect Effect} + \text{Induced Effect} \quad \text{(iii)}$$

Given the nature of the Input-Output model, the total effect is a multiple of the direct effect. Accordingly, the multiplier, k, is derived as:

$$k = \text{Total Effect}/\text{Direct Effect} \quad \text{(iv)}$$

If k = 1, the total impact of changes in the hard cider industry on the Michigan economy is just the direct monetary contribution of its output. But because of transaction among businesses within the state and new employment creation along the hard cider supply chain, the secondary and tertiary ripple effects are expected to exceed the direct expenditure effects such that k will be greater than one.

In this paper, we develop two scenarios using Input-Output Modeling. **Scenario 1** is the baseline economic contribution of Michigan's hard cider industry to the state economy including the direct and all secondary/tertiary effects. **Scenario 2** assumes that total production in Scenario 1 is doubled due to industry stimulus, like a focused marketing effort to increase consumer

awareness. As any increase in sales of hard cider implies substitution from other craft beverage purchases, Scenario 2 nets out the estimated substitution effects found in the DCE. That is, Scenario 1 measures the gross economic impact of current sales while Scenario 2 shows the expected net economic effect of doubling that base.

The scenarios are analyzed closely following methods from a recently conducted economic impact study for the Michigan craft beer industry (Miller et al., 2019). This involves identifying channels of hard cider consumption at different levels of the value chain, allocating proper proportions of sales to those levels, and using the IMPLAN software to carry out the final contribution and economic analyses.

To estimate the baseline direct effects, we turn to Michigan's excise tax records. Cider producing entities in Michigan file taxes in the same category as beermakers. This is a volume tax rather than *ad valorem* tax, and is levied at the rate of $6.30 per barrel (Michigan Liquor Control Commission 2020). Total cider sales volume data, therefore, was obtained by isolating the cider producer sales from 2020 Beer Tax Collection Report provided by the Licensing and Regulatory Affairs (LARA) of Michigan's Financial Division (Michigan.gov 2020). To do this we match reporting facilities on the 2020 Beer Tax Collection Report to known Michigan cider producers. Tax revenues of those with matches as being hard cider producers are then attributed to hard cider production.

Channels of cider consumption include direct on-premise sales at cideries, bars and restaurants, and off-premise sales stemming down from producers via wholesale through retail. Wholesale and retail are estimated to count for 81.5% of the total cider sales in the country while the rest are on-site sales and exports (Lombardo 2020). We assume the same 81.5% share in our analysis for off-premise (wholesale and retail) sales, while the remaining 18.5% is the share of on-

premise sales. This allocation excludes export sales out of Michigan, which appears to make up a small overall portion of Michigan hard cider production. Thus, total volume of cider sold in Michigan is allocated to on- and off-premise channels using these proportions.

Consistent with the discrete choice experiment setup, on-premise sales are assumed to be in 12 oz pours/glasses while off-premise sales were in 6-packs of 12 oz cans/bottles. Price of a 12 oz glass of cider on-premise is assumed to be $6.00 on average based on menu prices posted on over one hundred Michigan cidery websites. Using this price, converting the on-premise sales volume to a sales value is straightforward. On the other hand, average price of for off-premise consumption 6-packs is assumed to be $10.00 based on typical Michigan grocery store price listings. Volume of production is based on excise tax collected at production. Moving down the value chain, we allocate 100% in-state purchases of retailers from wholesales and of wholesaler from producers and model each leg from production to retail sales for final consumption individually. Profit margins at the wholesale and retail levels are obtained from Annual Trade Surveys (United States Census Bureau 2022; United States Census Bureau 2021) to identify prices paid per unit at those levels based on a final price of $10.00 for a six-pack of 12 oz cans/bottles. These on- and off-premise sales values are directly plugged into the software IMPLAN pro 3.1 at each leg of the supply chain (producer, wholesaler and retailer for off-premise and producer only for on-premise sales) for our analysis. While the IMPLAN software contains significant industry and commodity detail, it does not provide a category for hard cider production. This means hard cider is not included as a separate industry. But transactions of the cider industry are included with Wineries (IMPLAN commodity 30107). We choose this as hard cider production processes closely mirror wine production and under Michigan regulations, cideries are registered as small wineries.

SECTION 6: RESULTS

DISCRETE CHOICE ANALYSIS

Results of estimated Multinomial Logit model and Random Parameter Logit model are presented in Table 2. The latter model is preferred by both a likelihood ratio test ($\chi 2 = 8336.6$, $\alpha = 0.05$, $P < 0.001$) and Akaike Information Criteria as a better fit for our data. The parameters show expected signs. The own-price coefficient is negative while the localness parameter is positive. 'Made in Michigan' drinks increase indirect utility 0.242 units compared to drinks not made in Michigan. A $1 increase in prices, on the other hand, decreases utility 0.198 units.

Table 2: Discrete choice modeling results (pooled for whole sample)

	Standard Multinomial Logit	**Random Parameters Logit**
		Random parameters
Cider	1.874*** (0.065)	1.946*** (0.111)
Beer	2.265*** (0.064)	2.244*** (0.107)
Wine	1.918*** (0.064)	1.534*** (0.122)
Seltzer	1.137*** (0.072)	0.031 (0.179)
Mixed Drink	2.467*** (0.062)	2.765*** (0.115)
		Nonrandom parameters
Price	-0.198*** (0.008)	-0.349*** (0.011)
Localness	0.242*** (0.019)	0.491*** (0.030)
		Standard Deviations of Distribution
Cider		2.073*** (0.105)
Beer		2.148*** (0.087)
Wine		2.538*** (0.108)
Seltzer		3.095*** (0.050)
Mixed Drink		2.679*** (0.103)
Model Fit Statistics		
Log likelihood function	-14252.5	-10084.2
Akaike Information Criterion	28528.9	20192.5
Number of observations	8,748	8,748
Number of respondents	729	729

Notes: Number of participants = 729. Number of choices observed = 8,748. Asterisks (***) designates statistical significance at the 1% level. Numbers in parentheses are standard errors.

The non-random slope coefficients 'Cider', 'Beer', 'Wine', 'Seltzer' and 'Mixed Drinks' in Table 2 represent alternative specific constants for each of the choices. They capture indirect utility acquired by the respondents that is not explained by prices and localness from consuming each beverage compared to consuming nothing. From the Random Parameter Logit model, consumers receive about 1.946 units more utility from choosing cider compared to having nothing, holding all other considerations constant. Similar interpretations for all the other parameters indicate all choices are preferred to the 'none' option and among the beverages, consumers experience the most utility by consuming mixed drinks (2.765 units more compared to consuming nothing). The Random Parameter Logit estimation also indicates that consumer preferences are indeed heterogenous. For example, when preferences are assumed to be normally distributed, 99.7% of the consumers have a preference that is within 2.073 units of the mean indirect utility from cider compared to no-buy, or in the utility range of 1.946 ± 2.073 = [-0.127, 4.019].

Willingness to pay for 'local' beverages is found by dividing the localness parameter with the negative of the price parameter. In the Random Parameter Logit model, we see that consumers are willing to pay $\frac{0.491}{(-1)\times -0.349}$ = \$1.41 more for beverages that are made in Michigan compared to those that are not. Estimated average willingness to pay is calculated for any product j in our model using the formula:

$$WTP_j = \left(\frac{\alpha_j + \beta_{localness} * LOCALNESS_j}{-\beta_{price}}\right) \qquad \text{(v)}$$

Using this, we find that average willingness to pay for a 12 oz pour of cider to be \$6.98. The discrete choice analysis also facilitates calculation of cross-price elasticities for the alternatives. The row matrix in Table 3 shows cross-price elasticities of demand for other beverages with respect to hard cider.

Table 3: Cross-price elasticities of demand for other beverages with respect to hard cider

Cross-price Elasticities	Beer	Wine	Hard Seltzer	Mixed Drink
Hard Cider	0.1720	0.1612	0.1550	0.1383

While survey participants were instructed to consider their decision in the context of purchase for on-premise consumption or off-premise consumption, the results in this section are based on data from both treatments pooled together. The consequence, especially for the WTP calculations is that they represent a value averaged out between on- and off-premise beverage purchase scenarios. Additional Multinomial Logit and Randoms Parameters Logit analyses were run, and WTP calculations were done for two treatments separately. The results can be found in the Appendix.

INPUT-OUTPUT ANALYSIS

Total cider sales in Michigan were broken out into on and off-premise channels for the analysis. Table 4 shows the sales points and revenues.

Table 4: Revenues at points of sale with no exports

	On-premise	Off-premise
Number of 6-packs sold		2,048,890
Number of 12 oz pours/glasses sold	2,790,512	
Cider producer sales	$16,743,074.33	$13,932,450
Wholesale to retailers		$16,007,975
Retail sales to consumers		$20,488,897

SCENARIO 1

The economic contribution of Michigan's hard cider industry is presented at two levels of the value chain in Tables 5 and 6. Table 5 shows contribution estimates generated by cider production activities and Table 6 shows the same for combined wholesale and retail trade activities based on modified IMPLAN purchase coefficients. Dollar values are rounded up to the nearest thousand.

Recall that the model assumes that producers sell hard cider directly to consumers at establishments they own and indirectly through wholesalers for off-premise consumption. Their producing activities include transactions with all the input producing industries as well as service providers. The aggregate contribution from such activities is seen in Table 5. Direct sales of hard cider are estimated to be $30.7 million. This generates about 314 direct jobs with annual payroll of around $9.16 million. Once accounting for all secondary effects, hard cider production generates around 472 jobs in the state with annual earnings of around $18 million dollars. Collectively, we can assert that hard cider production contributes about $27.7 million to annual Gross State Product, as measured by the Total Effect on in-state Value Added.

Table 5: Economic contribution of cider producing activities

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	314	$9,156,000	$13,491,000	$30,676,000
Indirect Effect	76	$4,689,000	$6,999,000	$13,215,000
Induced Effect	82	$4,140,000	$7,196,000	$12,799,000
Total Effect	472	$17,985,000	$27,687,000	$56,689,000

The estimated economic contributions of trade activities around hard cider are shown in Table 6. Such activities are valued at about $6.5 million, directly creating around 72 new jobs with average annual earnings of about $39,000. Other business-to-business purchases stemming from these activities and value arising from the expenditure of the direct job earnings support about 42 additional jobs and create $6.7 million more in output value. In total, hard cider trade activities are estimated to add a total of about $7.4 million to Michigan's Gross State Product.

Table 6: Economic contribution of cider wholesale and retail activities

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	72	$2,819,000	$3,841,000	$6,556,000
Indirect Effect	19	$1,078,000	$1,605,000	$3,153,000
Induced Effect	23	$1,167,000	$2,027,000	$3,606,000
Total Effect	113	$5,064,000	$7,473,000	$13,315,000

Due to the nature of the analysis framework, all associations are modeled as linear relationships through the supply chain where each input, including labor, enter the production process in fixed proportions. Because of this, the aggregate or gross economic impact of the hard cider value chain in Michigan is found by simply summing the marginal contributions at every level. The results are presented in Table 7. Direct transactions from the cider value chain give rise to about $37.2 million in output, helping create 386 jobs directly. When secondary and tertiary effects are taken into account, a total of about 586 new jobs are traced back to the cider value chain, with an associated total income of $23.0 million. Most of these jobs are related to making, selling, and serving cider. In total, we assert the cider value chain transactions are worth about $70.0 million, adding $35.1 million to the Gross State Product (Value Added) of Michigan.

Table 7: **Gross economic impact of Michigan's cider value chain**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	386	$11,975,000	$17,332,000	$37,232,000
Indirect Effect	95	$5,766,000	$8,604,000	$16,368,000
Induced Effect	106	$5,307,000	$9,224,000	$16,405,000
Total Effect	586	$23,049,000	$35,160,000	$70,005,000

SCENARIO 2

This scenario posits a concerted marketing effort that increases the in-state demand for hard cider. More specifically, we assume hard cider demand in Michigan doubles because of focused marketing efforts. This increase in hard cider sales comes at the expense of reduced sales of other substitute beverages, namely: beer, wine, hard seltzer, and mixed drinks. The proportion of such reduction can be found by referring to Table 3- this is where our unique methodology comes into play. We assume that the relative prices of cider substitutes remain constant, so any change in their sales is caused by reduced consumption. Table 3 shows that a $1 increase in the sales of hard cider results in decreases worth $0.17, $0.16, $0.16 and $0.14 in beer, wine, hard seltzer and mixed

drink sales respectively. This means for every dollar increase in cider sales, ($0.17 + $0.16 + $0.16+ $0.14) = $0.63 is lost from sales of the other alcoholic beverages. That is, availability of hard cider has an estimated net effect of increasing total expenditures for alcoholic beverages by $0.37 for every dollar spent, where the reduction in sales in other beverages reflects their relative cross-price elasticities with respect to hard cider. Incorporating this proportion into our contribution and modeling the net contributions along all legs of the supply chain provides the estimates in Table 8.

Table 8: **Net economic impact of Michigan's cider value chain if cider demand doubles**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	331	$10,046,000	$14,685,000	$32,946,000
Indirect Effect	83	$5,148,000	$7,647,000	$14,408,000
Induced Effect	90	$4,544,000	$7,898,000	$14,047,000
Total Effect	505	$19,738,000	$30,230,000	$61,401,000

In this hypothetical scenario, direct cider sales in the state are valued at $32.9 million which is estimated to support 331 jobs. Accounting secondary effects, we assert that a total of about 505 new jobs are created in Michigan, with average annual income of about $39,000 for employees. In total, the hard cider value chain in this scenario facilitates transactions worth $61.4 million and contributes about $30.2 million to the state economy. Comparing the numbers in Tables 7 and 8, it is obvious that even though cider demand is twofold, taking substitution effects into account resulted in more modest estimates than simply doubling the findings in Table 7.

It is interesting to note that a doubling of hard cider production and sales is expected to lead to less than a doubling of estimated baseline economic contributions. The baseline anticipates $70 million in new transactions in total (Table 7), while doubling output will only increase total transactions by another $61.4 million. The difference is related to two considerations. First, every new dollar in hard cider sales results in a decrease in other beverage sales by $0.63. That would

suggest a smaller net effect than what is suggested in Table 7. However, because hard cider is by assumption made in state, much of the lost sales are revenues leaked by imports of more mass-market oriented products imported from other states. Hence, those lost sales are not as impactful to the state economy as the new sales of hard cider. The net effect is that a disproportionately large economic effect is realized for every consumer dollar spent on hard cider.

SECTION 7: DISCUSSION

According to Nielsen (2019), the hard cider industry looks primed for more expansion. That, taken together with Michigan residents' appreciation for this beverage (as evidenced by the 150+ operations selling craft cider in the state) puts Michigan in a promising position to reap benefits from this industry. In this paper, we review the current scenario of the cider industry in Michigan and detail our discussion with two separate modeling approaches. A discrete choice analysis based on data collected directly from Michigan consumers reveals the average willingness to pay for a 12 oz unit of cider to be $6.98. Further insight comes in the form of consumers' willingness to pay an additional $1.41 for a 'local' element ('Made in Michigan') in craft beverages. The hard cider value chain for Michigan is constructed, and calculations tracking sales dollars from producers to consumers through two different channels (on- and off-premise) facilitate eventual economic contribution analyses. We estimate that in its current state, the hard cider industry in Michigan creates about 586 jobs in with a total income of about $23.0 million for the employers. We assert it adds $35.1 million to Michigan's annual Gross State Product. These numbers represent gross economic impact of the Michigan cider value chain. Finally, we analyze the net economic impact of a hypothetical scenario where cider demand doubles via increased consumer interest. This scenario includes the simultaneous increase in cider sales and reduction in substitute beverage sales. Estimations reveal the net impact of such a scenario on Michigan's Gross State Product to be an additional $30.2 million.

Making use of our choice experiment data to get cross-price elasticity results and connecting those with the economic impact simulations allowed us to predict the net economic impacts cider sales in Michigan. Hence, the economic effects of reduced consumption of substitute

beverages were deducted from the economic effects of increases cider sales in the region avoiding overestimation of the economic contribution of a locally produced product or market channel.

Even with substitution effects considered, a possible doubling of hard cider demand has a considerable effect on the state's economy. This is because we assume the hard cider value chain to be completely contained in-state. Because hard cider production is usually geared toward local markets, increases in hard cider sales generally posits an import substitution proposition. This has implications for policy making, suggesting that encouraging craft beverage industry development will create net economic gains. Understanding how regional hard cider production contributes to economic growth and development can open new discussions at the state administration level and facilitate policy recommendations for growing regional cider value chains. It can also support considerations of future investments in or promotions of the industry. Besides informing Michigan policymakers on the potential contribution of this budding industry, this study seeks to be a point of reference for researchers attempting to understand the inner workings of hard cider markets in other regions. The overall industry discussion and value chain assessment should be useful for local stakeholders, and likely hold similar effects for the craft hard seltzer market.

Our study is not without limitations. We include the 'price' and 'localness' attributes in our discrete choice analysis, but consumption of cider and alternative beverages are affected by other attributes as well. Input-output models have some limiting assumptions, and for our analysis we make certain additional assumptions (e.g. all cider sold in Michigan are locally produced). While these assumptions still allow for results that should be broadly valid, some finer details may be lost.

Further exciting research avenues remain to be explored in the hard cider industry. In our study, we do not discuss the role of local apples in cidermaking. Most U.S. hard cider is made

from apple juice concentrate imported from other countries, lower-cost fresh market fruit, or processing fruit (Miles et al. 2020). But past case studies at different states like Washington, New York and Virginia indicate that cider apple growing businesses might be profitable in the long term (Farris, Peck and Groover 2013; Galinato, Alexander and Miles 2016; Peck and Knickerbocker 2018). Michigan producers may hold a competitive advantage in cider production, as the 34,500 acres of apple orchards in the state make Michigan the 3rd largest apple producer in the United States (Michigan.gov 2021). The use of fruit that failed to meet market standards for aesthetic or flavor-related reasons to make cider can contribute to curbing waste at Michigan's expansive apple orchards. Furthermore, producers are increasingly interested in diversifying their product set via changes in body, flavor, and aroma. This can lead to increased demand for specialized cultivars (Gottschalk et al. 2017). The resulting opportunities have benefits for both the apple production supply chain and cider makers (Becot, Bradshaw and Conner 2016). Future studies may expand local cider value chain assessment by connecting cider apple production as an upstream leg, resulting in a more thorough contribution analysis. Additionally, a flourishing hard cider industry adds a new dimension to the tourism appeal of a state. Seeking new experiences, learning about local products, and inclination to support artisan businesses influence people to tour craft cideries (Smith and Lal 2017). Cideries also tailor the aesthetics and experience of customer tours to illustrate the rural idyll (Wright and Eaton 2018). Future research might focus on the economic potential of regional agritourism promotional campaigns such as "cider trails" or cider festivals. As the consumer sample and social accounts used in our study are both representative of Michigan, modification and expansion for other states is possible to get region-specific results.

APPENDIX

Table 9: Discrete choice modeling results (on vs off-premise treatments)

	Treatment: On-premise		Treatment: Off-premise	
	Standard Multinomial Logit	**Random Parameters Logit**	**Standard Multinomial Logit**	**Random Parameters Logit**
		Random parameters		**Random parameters**
Cider	2.006*** (0.095)	2.110*** (0.152)	1.757*** (0.090)	1.867*** (0.149)
Beer	2.423*** (0.094)	2.422*** (0.164)	2.122*** (0.088)	1.910*** (0.183)
Wine	1.930*** (0.095)	1.632*** (0.184)	1.903*** (0.088)	1.851*** (0.154)
Seltzer	1.334*** (0.104)	0.249 (0.262)	0.953*** (0.100)	0.234 (0.218)
Mixed Drink	2.667*** (0.090)	2.652*** (0.160)	2.279*** (0.085)	2.238*** (0.175)
		Non-random parameters		**Non-random parameters**
Price	-0.212*** (0.012)	-0.360*** (0.016)	-0.184*** (0.011)	-0.343*** (0.016)
Localness	0.256*** (0.026)	0.510*** (0.043)	0.226*** (0.027)	0.425*** (0.040)
		Standard Deviations of Distribution		**Standard Deviations of Distribution**
Cider		2.074*** (0.137)		1.808*** (0.119)
Beer		2.530*** (0.152)		2.117*** (0.140)
Wine		2.515*** (0.139)		2.432*** (0.153)
Seltzer		2.431*** (0.153)		3.125*** (0.247)
Mixed Drink		3.670*** (0.219)		2.439*** (0.172)
Log likelihood function	-6902.82	-5014.29	-7330.23	-4993.53
Akaike Information Criterion	13,819.64	10,052.06	14,674.46	10,011.06
Number of observations	4,284		4,464	
Number of respondents	357		372	
WTP for 'localness'	$1.42		$1.24	
WTP for cider	$7.27		$6.74	

Notes: Asterisks (***) designates statistical significance at the 1% level. Numbers in parentheses are standard errors.

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