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From Tap to Table: Consumer Values, Producer Attitudes, and Vermont Maple Syrup in a Dynamic Landscape

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FROM TAP TO TABLE: CONSUMER VALUES, PRODUCER ATTITUDES, AND VERMONT MAPLE SYRUP IN A DYNAMIC LANDSCAPE

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Abstract

Harvesting the sap of maple trees [*Acer saccharum*] for use in the production of syrups and sugars has a storied history stretching back to the pre-Columbian practices of North America's indigenous peoples. Since its adaptation by European settlers in the late seventeenth century and into the present day, the production of maple syrup has become especially integral to the livelihoods and cultural identities of farmers in Vermont. While oftentimes esteemed as a timeless agrarian tradition, market forces and environmental changes have led maple syrup producers (or *sugarmakers*) to adopt new production practices that scarcely resemble the taps, buckets, and draft animals which feature so prominently on promotional packaging material.

Adapting to challenges posed by climate change, competition in commodity markets, and a shifting regulatory environment is necessary for maple producers. However, maple enterprises differ in fundamental ways that can shape their perceptions of risks and their willingness – or ability – to adapt. Regional stakeholders – especially maple consumers – are also aware of the pressures bringing change to the industry and concerned about what the consequences entail for producers, communities, and rural landscapes.

This thesis uses data collected from surveys of Vermont residents and maple sugarmakers to explore consumers' purchasing behavior and how producers prioritize different threats to their enterprise. I first examine how the ways consumers define local products and perceive threats to the regional maple industry affect their willingness to pay for "Made in Vermont" maple syrup. Then I show how concerns expressed by maple producers to different social-ecological threats relate to specific enterprise characteristics, production practices, and types of maple enterprises. Findings seek to better understand the concerns expressed by Vermont maple producers and consumers – and what implications these attitudes may have for the industry.

Dedication

For A. P., J. B., & R. O. McCracken.

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"Onward!"

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Chapter 1: Introduction

Producing and consuming maple syrup is a foundational part of Vermont's heritage and place in American popular culture. The proportion of the state's forestland employed in harvesting maple sap for syrup is unmatched anywhere else in the United States: with over 1.94 million gallons produced in 2018 alone (nearly 50% of the national total) (Farrell & Chabot, 2012; USDA-NASS, 2018). Though the absolute volume of syrup produced in Vermont has receded from its peak nearly two centuries ago, the economic effects of this quintessential regional industry are still valued in the hundreds of millions of dollars (Becot, Kolodinsky, & Conner, 2015; Vermont Agency of Natural Resources, 2017).

These assessments encompass more than just the financial value of the maple syrup produced in-state, but also account for the industry's multifunctional impact on the region's economy (Hodbod, Barreteau, Allen, & Magda, 2016). Maple producers and their enterprises are invaluable components of the Northeast's agricultural and culinary heritage (Center for an Agricultural Economy, 2012). Moreover, the practice of maple syrup production (or *sugarmaking*) itself is foundational to the distinctive cultural identity of Vermonters (Hinrichs, 1998; Lange, 2017) and their relationship with the landscape (Morse, 2005; Morse, 2018).

While often romanticized as a timeless agrarian tradition, sugarmaking sits at a nexus of forces bringing change to the industry. Responding to dramatic increases in global demand (FAOSTAT, 2018) and shifting ecological conditions within New England hardwood forests (Oswald et al., 2018; Rapp et al., 2019), Vermont maple

producers have adapted a widening range of enterprise scales and practices to meet the challenges of a dynamic agricultural market (Heiligmann, Koelling, & Perkins, 2006; Cannella, 2018).

Since 1961, the global demand for maple syrup has grown from $11 million to over $800 million – mostly in the United States and Canada (FAOSTAT, 2019). This has occurred alongside a sea change in consumer preferences favoring local foods (Adams & Salois, 2010). This is especially the case in Vermont, where rates of local food consumption and regional food system engagement are exceptionally strong (Timmons, Wang, & Lass, 2008; Vermont Sustainable Jobs Fund, 2013). Given their deep embeddedness within this system and their indelible place in the state's history, maple producers are recognized as purveyors of cultural services and crucial links between communities and ecosystems (Mathews, 2012; Trubek, 2011).

Despite the established role of Vermont consumers as cultural stakeholders and a critical source of demand for the maple syrup produced in-state (Lange, 2017; Becot, Kolodinsky, & Conner, 2015), their attitudes towards locally marketed products and issues affecting the regional maple industry have gone largely unstudied. Likewise, while existing research highlights diversity among Vermont maple enterprises, existing research accounts mostly for variation in attitudes regarding climate change and other social-ecological risks in terms of scale rather than across a broader range of production practices.

1.1 Research Questions

To address these gaps, this thesis is guided by the following research questions:

RQ1: How do Vermont consumers' perception of risks facing the maple industry affect their willingness to pay for "Made in Vermont" maple syrup?

RQ2: How do Vermont maple producers vary in their own perceptions of the risks facing their enterprises?

Chapter 2: Comprehensive Literature Review

2.1 The Historical and Cultural Context of Maple

2.1.1 The Early History of Maple Sugarmaking

According to the lore of the Chippewa and Ottawa people, the ancient god Ne-naw-Bo-zhoo ("the most remarkable, wonderful, and supernatural being [to] ever trod upon the earth") was so struck by the taste of the sap issued forth from the sugar maple that he diluted its sweetness as a means of hiding it away to assure its value amongst humans through the labor of extraction and processing (Nearing & Nearing, 1970; p. 16-17). The art of this labor was first passed between First Nations peoples who taught one another the painstaking work of gashing the surface of sugar maples with stone implements, collecting sap in wooden vessels, and boiling it down to sugar by carefully using the ends of deer antlers to deposit fire-heated rocks into the containers (Morse, 2005). Alongside honey, maple sugar was the primary source of sweetener for indigenous North Americans – incorporated into candies, distilled into alcohols, and soured into vinegars (Nesom, 2006). Not long after arriving in the "New World," European settlers, too, began a centuries-long relationship with sugar maple and its culinary potential.

First encountered by Jesuit missionaries in 1670s New France, maple sugar was received at first as an exotic delicacy exported to European courts for its taste and presumptive medicinal properties: though in nowhere near the same volume as the cane sugar imported from the West Indies (Whitney & Upmeyer, 2004). It was not until the British blockade of the St. Lawrence River in the early 1700s that maple sugar production

– capable of supplanting reliance on imported cane sugars – began in earnest to satisfy the demand for sweeteners amongst Quebécois settlers excluded from the flows of colonial trade. In Anglophonic North America the consumption of maple sugar and "sugaring" as an agricultural practice was adopted more gradually, only becoming commonplace on Northeastern farmsteads around the middle of the eighteenth century (Whitney & Upmeyer, 2004). Following the American War of Independence, maple sugaring garnered national attention as a means of supplanting domestic reliance on sugar imports from the English Caribbean: both corroborating the Jeffersonian ideal of agrarian self-sufficiency and providing for the *Anti-saccharite* movement a way to counter the economic hegemony of the plantation slavery system (Sturges, 2019).

Early-American politicians, civic organizations (namely *The Society for Promoting The Manufacture of Sugar from the Sugar Maple Tree*), and international business interests (like the French-based *Castorland Company* and Dutch *Holland Land Company*) sought to supplant cane sugar with maple. However new landholders in Vermont had other plans, largely foregoing the production of maple sugar in large enough quantities to make this possible (Donchez, 2017). Combined with a sequence of poor-yielding sugaring seasons and the preference for clearing forestland for agricultural use and potash production, maple sugaring fell largely to the wayside on Vermonter farmsteads until the mid-eighteenth century. Though the commercial outlook on the viability of a substantially larger commodity maple sugar market subsided, the practice of maple sugaring itself remained – albeit, as a somewhat marginal component of the livelihood practices of Vermont farmsteads (Butterfield, 1958).

The degree of national self-sufficiency envisioned by Thomas Jefferson and the American abolitionists in domestic sugar production was informed by the gradual introduction of new collection and processing techniques. In place of the hulled out segments of logs, earthenware pots, and birch bark bowls traditionally utilized by First Nations' sugarers in collecting maple sap in keeping with their gash-drip method, Europeans utilized handled wooden buckets hung from spouts made of hollowed sumac and elder stems inserted into tap holes bore into maple trees with metal augers (Heiligmann, Koelling, & Perkins, 2006). The boiling procedure – once fueled through transferring stones from fires into basic wooden vessels – also improved with the use of conductive metal capable of heating sap directly over open flame. These relative advances in sugaring technology were themselves supplanted over time by the introduction of tin, which replaced foraged wooden devices with taps and buckets constructed from this lighter and more durable material (Lawrence & Martin, 1993). Multiuse cauldrons and kettles would fall into disuse following the patent of the first flat-bottomed evaporating pan in 1858 – a device which soon became a fixture in increasingly modern sugarhouses (Lawrence & Martin, 1993; Donchez, 2017).

During the American Civil War, maple sugaring would again enter the public's consciousness as a statement of national pride in opposition to the tyranny of slavery – this time not abroad in far-flung Caribbean plantations, but instead in the Southern Confederacy. Northern consumers who once forewent the purchase of cane sugar due to its association with chattel plantation slavery were now, upon the initiation of open conflict, left with no other option than to go without (Vermont Historical Society, 2006).

2.1.2 Commercializing Maple Sugars

By the 1850s, maple sugaring had become a vital element within the livelihood portfolios of farming families in upper New England and French Canada. Due to the steep price of imported "customary sugar," household production was a mainstay on early-nineteenth century Vermont farmsteads: with as many as two-thirds of all households producing maple sugar for in-home use and for limited sale in local markets (Schuette & Schuette, 1935). By 1860, statewide maple production totaled nearly 10 million pounds, great enough to – in theory – afford the citizens of Wilmington, Vt. with 140lbs of maple sugar each sourced entirely from their township alone (Department of Agriculture, 1862). In his dispatch penned for the U.S. Department of Agriculture's 1862 installment of the *Report of the Commissioner of Agriculture,* C. T. Alvord relayed his view on the immense potential of maple production, stating:

> The maple sugar crop…is one of the most profitable crops made, and there is probably no branch of the farmer's business that affords as much income and clear profit according to the amount of capital invested and labor expended (Department of Agriculture, 1862; p. 396).

His pronouncement was put to the test in the wake of the Union victory at the close of the Civil War. Following improvements in cane sugar production techniques and advances in transportation technology, increased demand for cane sugar amongst urban residents led to a considerable reduction in the use of maple sugar nationally (Heiligmann

et al., 2006). As a result, maple sugarmakers relied on more specialized market channels for the sale of their product, turning towards marketing liquid maple syrup as a topping for pancakes and waffles. Especially integral to the continued economic viability of sugarmaking towards the beginning of the 1900s was the inclusion of maple as an additive in tobacco products – a particularly lucrative value-added channel made possible through the growing prominence of wholesale maple purchasers (Whitney & Upmeyer, 2004).

Chief amongst them was George C. Carey of the Carey Maple Sugar Company: an ex-wholesale grocer turned maple magnate whose St. Johnsbury-based operation at its peak accounted for nearly 50% of all syrup purchased in the State of Vermont (Thomas, 2018). Apart from connecting disparate rural maple producers in the state with the tobacco industry, Carey also served as a member of the board of the Towle Maple Product Company – which itself would maintain an industrial presence in the town of St. Johnsbury until the death of company president P.J. Towle in 1915: providing regional producers with a crucial link with the national commercial table syrup market.

While the large-scale sale of maple products into specialty syrup markets helped the regional industry rebound following a substantial dip in demand between 1890-1900, bulk commodification introduced a new slate of challenges to maple producers – namely product purity concerns (Lockhart, 2008). The increasing importance of packers in the industry magnified this problem in scale and scope. So great was the presumptive threat to the regional maple industry that in 1903, Redfield Proctor – then a Vermont state senator – lobbied the federal government to act. Against the backdrop of more pervasive

agri-food quality concerns, these efforts culminated in the passage of the 1906 *Pure Food and Drug Act* (Fifty-Ninth Congress of the United States, 1906).

2.1.3 The Craft of Maple Syrup

The distinctive taste of and for Vermont maple syrup evidences the cultural narratives and values it is thought to embody – and as a product maple syrup links both place, production, and practice (Deselnicu, Constanigro, Souza-Monteiro, & McFadden, 2013; Garavaglia & Marcoz, 2014). In this sense, a popular taste for Vermont maple products first emerged in early American history as corroborative of Jeffersonian ideals of agrarian self-sufficiency (Whitney & Upmeyer, 2004). Maple sugar was imbued as a loadstone for the virtues of the yeoman farmer pitted against cane sugar: the production of which was entirely contingent upon the institution of chattel slavery (Donchez, 2017; Sturges, 2019). While unable to supplant the domestic reliance on imported sugars as envisioned by early-American leaders, the cultural significance of maple syrup retains at its core an emphasis on the small family farm (Heiligmann et al., 2006).

The persistence of small, independent producers within the regional maple industry structurally informs the aesthetic framing invoked in discussing maples' eclectic yet distinctive *terroir* composition (Paxson, 2010; Trubek, 2011). Given its fundamental character as a wild product and the susceptibility of its flavor profile to the agronomic particularities of each sugarbush (Tyminski, 2011), maple syrup has developed a distinctive taste regime defined to frame the nuances of origin. Lighter syrup (formerly *Grade A*/*Fancy*), which exhibits a taste profile more akin to vanilla than the

overwhelming "maple" taste of darker syrups, by reputation allows the consumer a "more…local, connoisseur type flavor'" – both showcasing the producer's "knowledge of good sugaring" and providing an experiential inroad toward the composition of the sugarbush itself at a distance (Lange, 2017, 47). This melding together of practice and place by experienced maple sugarmakers is the *sine qua non* of maple syrup as a craft good.

For Vermonters, the patronage of "good sugarmakers" provides more than just the right syrup from the right producer: it also serves as a kind of investment into preserving the state's agrarian heritage and the working landscape that sugarmakers rely on (Hinrichs, 1998; Morse, 2018). By exercising a distinct preference for "local" foods, consumers engage in practically supporting both small farmers and their region's rural economy (Adams & Salois, 2010; National Institute of Food and Agriculture, 2016).

2.2 Maple Production as a Social-Ecological System

2.2.1 Social-Ecological Systems and Resilience

Recognition of the dense interconnectedness of human systems with ecological dynamics emerging within "natural" ones is by no means a peculiarity of the maple industry. A broad cross-section of academic disciplines – from ecology (Gunderson & Holing, 2002), to philosophy (Latour, 2014), and economics (Daly, 1973) – have sought to dismantle the distinction between "natural" and "social" systems and reintegrate each domain into a holistic view of how each is contingent upon the other. Bruno Latour, a

prolific sociologist of scientific method and process, describes this project with a pressing sense of urgency in his address to the Holberg Memorial Price Symposium:

> …[T]he Earth has now taken back all the characteristics of a full-fledged *actor*. Indeed…it has become once again an *agent of history*, or rather, an agent…of our common *geostory*. The problem becomes for all of us in philosophy, science, or literature, how do we tell such a story (Latour, 2014; p. 3).

From a social-ecological perspective, the story is told through situating human action at its commensurate scale within the hierarchy of ecological processes and interpreting from there the residual impact of our activity above and below the system in-focus (Gunderson & Holing, 2002; p. 64-68). This narrative of social-ecological change is defined through interlaying levels of complexity which describe the cascading impact of interactions and effects – an *adaptive cycle* which links localized events with larger- and smaller-scale changes. Change in these systems comes irregularly, as gradual shifts in different parts of a global system lead to widespread, rapid change and subsequent reorganization – giving way to alternative states characterized by their own stabilizing pulls and unique thresholds of instability.

As a matter of practice, insights from this integrated *geostory* describing local-to-global interactions across scales reflects upon scientific approaches to the management of social-ecological systems (SESs) (Resilience Alliance, 2015). Walker, Holing, Carpenter & Kinzig (2004) conceptualize adaptive regime dynamics as *stability landscapes* –

themselves defined by varying *basins of attraction* which heuristically exert a pull upon natural and socioeconomic components towards alternative, self-perpetuating relational dynamics. Through an interdisciplinary approach to evaluating their constituent elements, they assert the possibility of meaningfully interpreting the *resilience* of systems in the face of change: by gauging their ability to withstand change without collapse, resistance to the pull of alternative regime states, proximity to transformational reorganization, and the effects of systems above and below the one in focus on maintaining an optimal state.

2.2.2 Transitional Pathways at the Enterprise Level

At the level of individual maple syrup enterprises, the environmental conditions impacting forest stand health and productivity are among the most imminent concerns of sugarmakers. Given the considerable degree of variability in inter-seasonal temperature regimes even within the same region, detecting poor shoulder season conditions is imperative to mitigating their effect on yield and *Acer* health (Duchesne & Houle, 2014). Yield in a given sap flow period is largely driven by prevailing climactic conditions in the previous year. Warmer and drier conditions during the previous growing season coincide with higher yields – while healthy radial growth rates coincide with warmer summer temperatures. Low competition pressures on productive maple stand have also been found to coincide with higher sugar concentration, which in turn enhances per tap productivity. Seed production and masting events in sugar maple populations diminish the productivity of commercial *Acer* stands by reducing sap sugar content (Rapp & Crone, 2015). While many discrete thresholds can demarcate the transition between a

commercially viable versus non-viable maple sugarmaking season, previous yearly temperature conditions and seed masting instances are especially important local indicators of forest stand health and productivity.

Apart from proactively monitoring biophysical indicators of maple stand, enterprise operators can also exercise adaptive capacity though expanding the scale of their operation or securing access to more lucrative market channels. Amidst declining bulk and retail prices, extension services have emphasized the importance of "right-sizing" enterprises to match both scale, capital investment, and time commitment with operators' overall livelihood portfolio (Cannella, 2018). An especially important strategy for smaller-scale maple producers is establishing niche market channels to fetch higher prices for the syrup they produce compared to traditional bulk sales channels (Cannella, 2017). Adapting new sugarmaking technologies like reverse osmosis machines and smart sap line monitoring tools are also encouraged as a way of increasing yield (Heiligmann et al., 2006; Kuehn, Chase, & Sharkey, 2017). Though sound in theory, practically encouraging farm innovation and adaptation depends on the unique connections between farmers, their broader support networks, and expert services (Cofré-Bravo, Klerkx, & Engler, 2019). Transitional pathways and threshold points for management, scale, and commercial adaptations must then be assessed at the enterprise level as a function of its stock of natural, financial, and social capital.

The aggregate effect of enterprise management decisions is apparent at the level of the landscape itself – where land use decisions are conditioned by the financial viability of a given maple sugarmaking operation. In modeling land use transition in

Vermont's Missisquoi River watershed, Tsai et al. (2015) find that deforestation occurs alongside specific socioeconomic development patterns – with sufficient economic returns from agricultural livelihoods leading to forest clearing for expanded crop production. Findings suggest that a similar dynamic would occur amongst maple producers choosing to retain their productive forest stand as a result of successful enterprise outcomes. The physical composition of working landscapes in Vermont have historically transformed alongside prevailing rural livelihood strategies, as seen in the clearcutting of the state's forests by European settlers amidst heightened demand for sheep's wool, coal and potash in the eighteenth and nineteenth centuries (Rolando, 1991; Wulf, 2017). Ultimately, transformations in forest land use and composition may be largely determined through environmental transitions in sugarmaking conditions occurring at higher system scales (Oswald et al., 2018; Reinmann, Susser, Demaria, & Templer, 2019).

2.2.3 Transitional Pathways at the Industry Level

The eventual migration of optimal sugarmaking conditions from southern Canada and New England northward as a result of climate change is the principal, long-term environmental issue facing producers. Though evidence suggests that the duration of sap flow seasons will remain almost the same (Skinner, DeGaetano, & Chabot, 2010), projections accounting for the effect of temperature variability on sugar content and actual sap flow volume suggest more favorable conditions to the North while total syrup yield per tap declines across Vermont through the twenty-first century (Rapp et al.,

2019). Adverse temperatures in shoulder seasons and diminishing volumes of insulating snowpack during the most extreme winter conditions are projected to erode the resilience of maple stand to environmental stressors within this same timeframe (Oswald et al., 2018; Reinmann et al., 2019). These adverse seasonal temperature regimes are principal drivers of the biophysiological transition toward less robust hardwood forest and less productive maple stand across the state (Matthews & Iverson, 2017).

Outside the strict confines of the biophysical domain, diminished retail and bulk prices for maple syrup in Vermont are significant drivers of the economic transitions altering producer, purchaser and consumer relations within the industry. While sugarmakers have traditionally relied upon the bulk purchases made by packers to channel the syrup they produce into more lucrative out-of-state markets (Thomas, 2018), the returns paid through these commodity channels are persistently insufficient for smaller scale producers. This is due in part to heightened domestic production and the outsize influence of Quebecois maple sugarmakers on the international maple syrup market (Gagné, 2008; Gregg, 2018; *PPAQ*, 2019). Becot et al. (2015) find significant variation in market channel access according to tap scale: with producers operating less than 3,000 relying mostly on direct-to-consumer sales and 5,000+ tap operations selling most of their syrup on average through bulk channels.

The imperative to "right-size" operation scales for the intermediate producers (Cannella, 2017) suggests a transition point between either a regional industry composed mostly of smaller enterprises marketing craft goods at retail prices or larger-scale maple sugarmakers expanding their production to achieve the economies of scale necessary to

abide by bulk and commodity prices. Business considerations around harvesting, processing, and marketing also pose unique, value-laden questions to maple producers – especially in treating syrup as a homogenous commodity rather than as a craft product imbued with the characteristics of individual sugarmakers and their working landscapes (Lange, 2017; Paxson, 2010).

To incentivize specific environmental stewardship goals, civil society organizations, including the Northeast Organic Farming Association (2014) and the Audubon Society (Saha, 2017), leverage value-added potential of consumer demand for specialty foods (Darby, Batte, Ernst, & Roe, 2008; Garavaglia & Marcoz, 2014; Loureiro & Hine, 2002) by authorizing product certifications to operations abiding by attendant forest management practices and input controls – effectively exercising a degree of power within the value chain (Bolwig, Ponte, Du Toit, Riisgaard, & Halberg, 2010). State actors both within Vermont and at the national level have also begun to exert heightened oversight of the maple industry. Producers selling more than half of their maple syrup through bulk channels are subject to commercial food safety standards by the FDA (Gregg, 2019), compelling decisionmakers to balance their willingness and ability to navigate bureaucratic oversight with a whole range of other management considerations. The Vermont State Legislature itself has levied another layer of oversight upon larger scale producers through the passage of *House Bill 631* (General Assembly of the State of Vermont, 2018), which seeks to inventory the extent of forestland used by large-scale maple production operations, assess their environmental impact, and establish a longer term regulatory framework.

2.2.4 Higher Scale Transitional Pathways

Encapsulating the entire social-ecological system which supports the livelihood practice of maple sugarmaking in Vermont is the imminent procession of global climate change. The depth of yield declines, increases in forest stand stress exposure, and – in turn – the viability of maple syrup production itself as an economic activity is largely determined to the extent that substantial reductions in worldwide carbon emissions can be achieved. Multilateral governance and enforcement protocols, global in scope and reach, present the only feasible means of guiding the planetary system toward a low emissions scenario (Intergovernmental Panel on Climate Change, 2000). Unfortunately for Vermont maple producers, even if such a regime were to materialize, substantially higher climate-driven sugar maple decline is projected under even the most charitably feasible emission scenarios (Oswald et al., 2018).

An accumulating body of evidence suggests that sugar maple in the hardwood forests of Canada and the northeastern United States exhibits an increased susceptibility and exposure to biotic and abiotic environmental stress pressures. In their multiyear study of forest stand in central-New Hampshire, Reinmann, Susser, Demaria and Templer (2019) find decreased annual basal growth rates in sugar maples as a result of reductions in insulating snowpack. Soil freezing depth and duration projections are incorporated into a variable infiltration capacity model of change in insulating snowpack depth across the American Northeast, finding a substantial decline in the likelihood of insulating midwinter snowpack in Vermont through 2099.

In assessing the impact of various climate conditions on sugar maple crown health in Vermont, Oswald et al., (2018) project widespread deterioration in favorable environmental conditions across the state, increasing the susceptibility of maple stand to secondary stress agents like pests and pathogens through the year 2099. This projection is based upon a novel Forest Stress Index accounting for the effect of seasonal temperature variation on spring budbreak, delayed foliar senescence, and increased foliar respiration. While their conclusion anticipates an aggregate reduction in favorable inter-seasonal temperature regimes across the state, acute forest stand stress varies considerably across Vermont. Models predictions suggest a tendency toward higher climate-driven stress pressures in the Northeast Kingdom, lower pressure in the Champlain Valley, and relatively favorable conditions in the southeast of the state.

Apart from the discrete effects of climate change on the specified resilience of *Acer* stands to environmental stress conditions, the viability of maple syrup production as a livelihood activity is likewise dependent on temperature conditions which inform the sugaring season's duration and productivity. Skinner et al. (2010), expanding upon what was then a nascent body of literature, provide a series of longitudinal sap flow day projections based upon potential worldwide carbon emission scenarios as detailed in the Intergovernmental Panel on Climate Change's *Special Report on Emission Scenarios* (2000). Findings suggest a notable decrease in sap flow days and start dates across the entire American Northeast beginning in 2030 – with the starkest declines in the southernmost extent of the *Acer saccharum* range included within the study area (State College, Pennsylvania).When adjusting for earlier start dates, Skinner et al. (2010)

predict only minor changes in the number of sap flow days in northern New England and Vermont.

Subsequent research anticipating the effects of climate change on regional syrup yield has incorporated a wider range of biophysical factors and updated climatological projections into more comprehensive models of maple stand productivity. Encompassing a spatial extent from southern Virginia to Quebec, Rapp et al. (2019) assess tapping season timing, sap volume, and sap sugar content data to predict geographic variation in optimal maple syrup production conditions across North America. Projections regarding the earlier (yet comparable) duration of the maple sugaring season across the *Acer saccharum* range remain consistent with prior findings (Skinner et al., 2010). However, when accounting for changes in the sugar content and volume of sap flow, optimal maple sugarmaking conditions are projected to migrate northward to Canada and northern Maine – while the productivity of gravity fed maple operations in Vermont is anticipated to decrease through 2100.

These emergent conditions, while illustrative of slowly occurring pressures in the climatological regime governing biophysical systems at the base of the regional maple industry, coincide with other shorter-term pulse events. As inter-seasonal temperature volatility becomes more common as a result of global climate change, temperatures in the spring and fall shoulder seasons between sap flow periods may mark the onset of a more immediate pressure on enterprise productivity (Duchesne & Houle, 2014). Models of precipitation and temperature impacts on maple syrup yield suggests that variability at the regional scale results from complex interactions with localized climatological and

shoulder season conditions. Declining crown conditions, reduced snowpack, and secular trends toward increased stress pressures in northern hardwood forest make maple stand more susceptible to rapidly occurring stress events (Oswald et al., 2018; Reinmann et al., 2019). In their predictive models of sugar maple mortality, Pitel & Yanai (2014) establish that a threshold of >70% crown dieback coincides with a significantly lower year-to-year survival probability – attributing it mostly to soil composition, pest species exposure, and duration since prior masting events.

Nevertheless, as global demand for maple syrup continues increasing, so too may the speculative interests of *haute finance* in the industry (Nickerson, 2016). Vermont is now home to some of the largest, corporate-financed maple enterprises on the planet – one of which consists of more than 450,000 taps: making it the largest single-source maple operation in the world (Egan & Pollack, 2018). Considering the substantial growth projections in both the market for maple syrup itself (Farrell, 2013) and value-added maple products (Arthur, 2017), pressures incubating the continued incursion of high finance into the production of commodity maple products are set to continue – and with indefinite effect for other producers within the industry (Lange, 2017).

2.3 Adaptive Taste: Linking Resilience with Consumer Preference

As the structural processes that maple syrup production relies on changes, so too will its signification. This symbolic transition entails feedback effects upon both consumer demand and the linkage between maple sugarmakers and Vermont's cultural economy. The contribution to the Vermont maple industry to the distinctive identity of

the state itself cannot be understated, and less yet given its impressive economic contribution to the wider region (Becot et al., 2015).

Willingness to pay among consumers (WTP) for "Made in Vermont" maple syrup encompasses more than support for the product and its producers – but also an entire suite of ecological, sociocultural, and livelihood services which the practice of craft itself functions through and maintains (Mathews, 2012). Given the historic susceptibility of working landscapes in Vermont to the ebb and flow of livelihood strategies (Rolando, 1991; Wulf, 2017), patronizing the state's maple producers supports the scenic beauty and environmental benefits derived from an ecological regime sustained by the maintenance of productive forestland.

Recognition of this indelible link between product and place has gradually begun to figure more prominently in literature on consumer food preferences. Adams & Salois (2010) attribute the growing preference for local foods amongst consumers to a commensurate increase in disaffection with organic certification regimes. Instead, consumers have turned toward more salient features like geographic origin to assess the virtues of a particular product and inform their consumption decisions (Saitone & Sexton, 2010). While geographic indications provide a means of asserting products' embeddedness within a set of cultural, civic and aesthetic institutions, they are effective only insofar as they valorize a taste regime which empowers vulnerable natural and human actors as inseparable from a good's authenticity (Bowen, 2010). This sort of placemaking is central to the discursive construction of maple syrup's *terroir* in Vermont. The valorization of light flavor profiles specifically places front and center the

contingency of sensory experience on the particularities of agronomy and process (Lange, 2017; Trubek, 2011).

While specific notions of "good taste" can enhance the resilience of craft food producers by valorizing practice and place as inseparable from the *terroir* of a final good (Bowen, 2010; Kral, 2018), their effectiveness is oftentimes diminished by a preoccupation with tradition and a tendency to prioritize imagining the past over constructing the future (Trubek, 2011). To enhance the adaptive capacity of Vermont sugarmakers in the face of climate change, consumers themselves must adopt a sensibility of good taste that strikes a balance between emphasizing certain parts of maple syrup's heritage while embracing the open-endedness of change within the sector.

Chapter 3: Vermonters' Attitudes and Willingness to Pay for "Made in Vermont" Maple Syrup

Abstract

Increasing demand for "local" foods provides small- and medium-scale farmers a crucial means of generating higher pay prices amidst thinning returns in commodity markets. This is especially true in Vermont, where per capita rates of local food expenditure outpace those of any other US state. Drawing conceptually from previous research into consumer preferences for locally sourced food, this article uses novel survey data to explore Vermont residents' definition of and willingness to pay for locally sourced maple syrup. We focus on how perceived threats affecting the maple syrup industry relate to consumers' willingness to pay for "Made in Vermont" maple products. Findings suggest that while household income plays a significant role in predicting willingness to pay for maple syrup, the perception of threats to the industry (and especially to its family farms) figure prominently as predictors of reported willingness to pay for Vermont-made maple syrup.

3.1 Introduction

Across the United States' agricultural economy, small farms face mounting economic pressures from low farmgate prices (MacDonald, Hoppe, & Newton, 2018). The United States Department of Agriculture finds that farms with sales totaling less than $10,000 (roughly 50% of all farms in the country) have, on average, seen negative returns from agricultural activities since 2016 (USDA, 2018). Despite high rates of local food

consumption within the state (Timmons et al., 2008), farmers in Vermont are no exception to this broader trend: with low commodity market prices having led to the loss of almost 40% of the state's dairies since 2008 (University of Vermont Extension and Vermont Housing & Conservation Board [UVM Extension & VH&CB], 2018; Walsh, 2018).

Comparable conditions are seen in the movement of commodity prices in the Vermont maple syrup industry. Through 2008, appreciation in the per pound retail value of maple syrup accompanied expansion in global demand, peaking at an average price of $3.70 nationally and $3.56 in Vermont (USDA-NASS, 2019). U.S. domestic maple prices have since fallen, with per pound bulk and retail values exhibiting especially severe declines in Vermont. This is an especially poignant stress for the smaller scale operations which have traditionally been the backbone of the regional maple industry (Hinrichs, 1998; Cannella, 2018). This has forced maple producers to reconsider time-worn marketing and production practices (Cannella, 2018; Matalon, 2018).

In response, small- and medium-scale producers are compelled to seek out specialty marketing opportunities outside of traditional bulk purchasing arrangements (Bouttes, Darnhofer, & Martin, 2019; Cannella, 2017). Over the last few decades, consumers have themselves increasingly sought out specialty foods based on how and where they are produced (Saitone & Sexton, 2010). The rate of growth in consumer demand for certified-organic products has, for instance, vastly outstripped that of the US food market as a whole (Willer & Lernoud, 2017). This indicates robust expansion in a niche market channel that is associated with higher average rates of profitability for

farmers when compared to conventional modes of food production (Organic Trade Association, 2018).

Increasingly common among American consumers is a preference for local food products (Adams & Salois, 2010). Such preferences are informed by an assumption that how and where a food is produced contributes to its distinctiveness and authenticity – otherwise stated as the product's *terroir* (Van Leeuwen & Seguin, 2006). Aesthetic qualities are only one piece of *terroir*, however, as the valorization of a particular mode of production or place of origin engages with larger issues related to the civic and cultural values reflected in the consumptive choices made by consumers (Trubek, 2011b).

For so-called "locavore" consumers, engaging in the local food system by patronizing nearby farmers helps sustain modes of agriculture that directly benefit the immediate community (Adams & Salois, 2010; 5). This view of the impact-potential of local consumption is shared by the National Institute of Food and Agriculture (NIFA), who emphasize that sustaining small farms is integral to increasing the accessibility of nutritious foods, regional food security, and revitalizing rural economies (National Institute of Food and Agriculture, 2016). For producers, these local marketing channels are a lucrative and at-hand way of accessing consumers with a higher willingness to pay (WTP) for their products.

While prior work has focused on the appeal of local foods to consumers (Fernández-Ferrín, Calvo-Turrientes, Bande, Artaraz-Miñón, & Galán-Ladero, 2018; Lockeretz, 1986), there is only a limited set of literature on preferences and attitudes toward locally-sourced food in Vermont – and even less on consumer attitudes toward a

product as culturally significant as maple syrup. Moreover, the literature that does exist stops short of engaging hypotheses related to what drives Vermont consumers' WTP for local foods in the first place.

To help fill this gap, the proceeding literature review details prior research on why producers emphasize the origin of their products. We also consider how the distinct historical and cultural relationship between Vermonters and maple syrup – and their attitudes towards local foods in general – could reflect in their purchasing behavior regarding this specialty local food. Also provided is an overview of prior work documenting patterns in the attitudes and demographic characteristics of consumers with their WTP for specialty food attributes.

Next, an analysis of data from a state representative survey where participants indicate their preference for a variety of specialty maple syrups, qualify their attitudes about specific "Made in Vermont" products, express concerns related to the state's maple industry, and quantify their willingness to pay (WTP) for "Made in Vermont" products is presented. This analysis specifically examines variation in respondents' maple syrup preferences, how strict their definitions are of what qualifies as a genuinely "Made in Vermont" product, and the maple industry-related concerns they express. Finally, we use multivariate analyses to draw inferences regarding how WTP for Vermont-produced maple syrup is affected by the ways Vermonters define a locally made products and the industry-specific concerns they express.

3.2 Literature Review

3.2.1 The "Taste of Place" in Vermont

Associating a specific geographic origin with the quality of an agricultural product itself allows producers to establish niche market channels and fetch higher pay prices for their goods (Bowen, 2010; Renting, Marsden, & Banks, 2003). This is especially true for commodity producers who use these marketing techniques to shift away from price taking roles in undifferentiated product markets towards specialty craft production (Adjemian, Brorsen, Hahn, Saitone, & Sexton, 2016; Saitone et al., 2010). Demarcating specialty attributes also provides consumers with meaningful criteria for assessing otherwise unapparent product qualities: whether related to taste, the positive impact of their purchasing decisions, or something as imperceptible as a product's "authenticity" (Garavaglia & Marcoz, 2014).

Geographic indications specifically have been adopted across the world in response to intensified price competition in globalized commodity chains (Bowen, 2010). Origin standards that strongly emphasize the social and environmental particularity of products and traditional agricultural practices are especially effective in enhancing the competitiveness of smaller-scale producers within a competitive global market. This emphasis on *terroir* valorizes the environmental resources and cultural practices upon which specialty goods rely – connecting consumer demands with social and ecological stewardship goals (Deselnicu et al., 2013).

Maple syrup is well-positioned to emphasize ecological and cultural characteristics when marketing towards Vermont consumers. This is especially true given

the product's ubiquity within the state and its deep embeddedness in Vermont's agrarian heritage (Lange, 2017; Trubek, 2011). Like in vineyards, maple syrup can exhibit a wide range of colors, smells, and flavors depending on how and when it is produced (Tyminski, 2011). Syrup produced towards the end of the sugaring season tends, for instance, toward a more robust and distinct flavor whereas lighter syrup – sometimes considered a hallmark of especially fine craftsmanship – is produced towards the beginning of the season, allowing for a more nuanced taste profile reflective of the landscape itself (Farrell, 2013). Maple producers have incorporated these phenomena into a grading scale and other marketing tactics which invoke the their product's *terroir* characteristics (Ramsingh, 2018; Lange, 2012; Trubek, 2011a).

Though the specified taste regime surrounding the consumption and appreciation of maple syrup is partially a function of its cultural and historic value (Center for an Agricultural Economy, 2012; Lange, 2017; Morse, 2005), appreciation for locally-sourced foods in Vermont extends well beyond its maple sector. Per capita demand for the agricultural products grown in-state exceeds anywhere else in the US (Timmons et al., 2008): accounting for $52 million annually – or about 2.5% of the $2 billion spent each year on food by Vermonters (Conner et al., 2013). Many statewide initiatives, like the Farm to Plate Investment and Local Food In Your Community Programs, specifically aim to support further agriculture sector growth through increasing local consumption of Vermont-produced foods in both retail venues and institutional settings like schools, prisons, and hospitals (Vermont Agency of Agriculture Food and Markets, 2020; Vermont Sustainable Jobs Fund, 2020). Vermonters already engage within their regional

food system through community-supported agriculture (CSA): with at least eighty such arrangements spread across the state (NOFA-VT, 2020).

3.2.2 Local Preference and Willingness to Pay

Adams & Salois (2010) link increasing demand for local food in the United States to strains within the organic movement emphasizing sustainability and community-embeddedness as an alternative to industrial agriculture. This reflects other widespread concerns regarding consolidation within the agricultural sector, the loss of family farms, and the damaging effects of these developments on rural economies (Wachenheim & Rathge, 2000).

According to a meta-analysis of willingness to pay studies focusing on fresh fruits and vegetables, “local” foods are associated with enhanced experiential attributes (like taste, aroma, and nutritional quality) and the socio-environmentally beneficial effects of their production and consumers’ purchasing decisions (Moser, Raffaelli, & Thilmany-McFadden, 2011). While the benefits of buying locally-sourced products feature prominently in academic literature and policy rhetoric (Tropp, 2014), Bond, Thilmany, & Bond's (2008) analysis of willingness to pay WTP for local products from national survey data finds a greater interest amongst consumers in qualities like cost and taste rather than the beneficial implications of their production and consumers’ purchasing decisions.

Surveyed beef consumers in Nevada also demonstrate a higher WTP based on experiential product qualities rather than presumptions of the beneficial impact of consumer purchasing decisions (Curtis, 2014). A separate meta-analysis of WTP

premiums for livestock products also shows that higher pay prices tend to coincide more with experiential and directly-consumable product qualities when compared with geographic indications of origin (such as “local”) (Yang & Renwick, 2019).

Carpio & Isengildina-Massa (2009), however, find support for local farmers and the local economy to be the primary motivation for choosing in-state grown products rather than an alternative food. State-wide geographic differentiation is especially effective in capturing price premiums for agricultural commodities in short food supply chains where product-specific branding approaches are impractical (Deselnicu et al., 2013). For products marketed according to a defined geographic origin, Marchesini, Huliyeti, & Regazzi (2007) find that shorter distances between the producers and consumers of a regionally-distinctive food coincides with higher price premiums – though demand for these goods increases at greater distances from their place of origin. More restrictive product definitions are also known to coincide with increased WTP for foods marketed according to their place of origin (Burnett et al., 2011).

In a survey of Indiana residents, Jekanowski, Williams, & Schick (2000) identify household income, in-state residence duration, education level, and gender as significant sociodemographic predictors of WTP for local products. Their findings specifically underscore the importance of collective state promotion programs in providing local producers a means of differentiating their products at points of sale. This is especially true for consumers reticent to incur the search and time costs associated with purchasing such products directly from farms and farmers’ markets. The importance of linking certifiable claims of product quality with origin at the state-level is further established in

a conjoint analysis of Maryland grocery store shoppers and buying club members (Adalja, Hanson, Towe, & Tselepidakis, 2015).

In the case of South Carolina, both older consumers and women were found to accept a higher price for state-sourced products – though these effects vary across producer and product types (Carpio & Isengildina-Massa, 2009). Political ideology has also been shown to effectively predict purchasing intent and pay price acceptance for foods marketed according to their origin and other specialty attributes (Conner, Campbell-Arvai, & Hamm, 2008; Onyango, Hallman, & Bellows, 2007; Witzling & Shaw, 2019). In multivariate analyses, we introduce an interaction term to control for established patterns regarding age and political beliefs (Glamser, 1974; Van Hiel & Brebels, 2011). The presence and number of children in a household have also been accounted for in prior analyses – though without a clear consensus to its effect on purchasing behavior (Adalja et al., 2015; Conner et al., 2008; Lyford et al., 2010).

Variation in respondents' level of education – though analyzed consistently in studies on willingness to pay for agricultural products and services – has itself varied in significance and effect across studies (Curtis, 2014; Díaz, Pleite, Paz, & García, 2012; Mathews, 2012). More well-established in the food systems and food marketing literature are differences in the purchasing behavior of urban and rural consumers (Darby et al., 2008; Lockeretz, 1986). Findings in their segmentation of fresh produce consumers from national survey data lead Bond et al. (2008) to consider high-income urban professionals an especially lucrative market for specialty foods – given their heightened demand and WTP for specialty quality products.

Despite growing interest in maple products as a natural sweetener (Arthur, 2017; Vermont Agency of Agriculture Food and Markets, 2019), few studies have looked specifically at WTP for maple syrup. In their analysis of the consumer market potential for Kentucky-grown pure maple syrup, Deng, Sahaian and Woods (2012) find a heightened willingness to pay amongst both higher income respondents and those with smaller household sizes. Giraud, Bond, & Bond, (2005), in a regional survey of consumers in northern New England, emphasize the potential benefit to producers from state labeling programs for specialty food products like maple syrup. Vermonters are familiar with finding and purchasing local products – and willing to accept a price premium for luxury foods typically sold at higher price points (Giraud, Bond & Bond, 2005).

This study examines how attitudes towards local foods, perceptions of various threats facing producers, and individual- and household-level characteristics effect demand for a culturally significant food like maple syrup. Our analysis focuses on Vermonters' preferences for specialty maple syrup products, how stringently they define "Made in Vermont" products, and what issues they see affecting the region's maple industry. These analyses seek to gauge how both the rigidity of consumers' definition of "local" and their perception of risks facing the state's maple industry ultimately affects WTP for "Made in Vermont" maple syrup. We conclude by considering how these findings reflect wider attitudes guiding Vermonters' willingness to engage in their regional food system by purchasing local foods.

3.3 Data & Methods

3.3.1 Survey Data

This survey draws on data from a statewide telephone survey of Vermont residents in 2019. Calling was conducted between the hours of 4:30 PM and 8:30 PM beginning on February 19, 2019 and ending February 28, 2019 using computer-assisted telephone interviewing (CATI). A random sample for the poll was drawn from a list of Vermont landline and cellular telephone numbers. Only Vermont residents over the age of eighteen were interviewed. The analysis focuses on evaluating responses to a series of questions regarding participant responses to "Made in Vermont" product certification questions. Specific questions regarding willingness to pay for "Made in Vermont" maple syrup were also included in the survey instrument, alongside an extended series of questions regarding certification preferences for maple syrup, attitudes towards hypothetical "Made in Vermont" product labeling scenarios, and perceived threats facing the state's maple industry.

When compared with the State of Vermont as a whole, survey respondents are wealthier – with a median income bracket of $75,000 - $100,000 relative to the statewide median household income of $57,808 – and older – with an average age of 58.8 compared with a statewide median age of 42.8 – than Vermonters in general (U.S. Census Bureau, 2018). Female participants were overly represented in the sample, accounting for 63.5% of all respondents compared to 50.6% of the state's total population. Respondents also report higher levels of educational attainment relative to statewide estimates, with nearly 97% of respondents over the age of 25 holding a High

School Diploma or its equivalent – relative to only 92.3% of Vermonters on average. Of those over the age of 25, 53.4% of respondents indicate holding either a bachelor's or post-graduate degree as their highest level of education compared to a Census-estimated 36.8% statewide. Average household size (2.48) and racial composition (96.58% White or Caucasian) largely reflect the estimated persons per household (2.32) and Race and Hispanic Origin (94.2% White alone) for Vermont as a whole. Over three-quarters of respondents (77.55%) indicate living in a household without anyone under the age of eighteen present – with a cumulative 63.58% indicating living in a household of one or two people.

Table 1.

Summary statistics for respondent demographics

Variable	Obs	Mean	Std. Dev.	Min	Max
Individual Characteristics					
Gender	628	0.64	0.48	0	1
Age	628	58.76	16.90	18	96
Bachelor's degree	626	0.52	0.50	0	1
Republican	596	0.16	0.37	0	1
Household Characteristics					
Yearly household income[1]	544	3.27	1.39	1	5
Yearly household income over $75,000	544	0.44	0.50	0	1
Rent home	628	0.17	0.38	0	1
Household size	628	2.48	1.28	1	10
Number of children in household	628	0.38	0.80	0	4

Reside in Chittenden County (Urban)	628	0.27	0.45	0	1

[1] 1 = Less than $25,000, 2 = $25,000 - $50,000, 3 = $50,000 - $75,000, 4 = $75,000 - $100,000, 5 = More than $100,000.

Sociodemographic characteristics taken into consideration reflect information captured at the individual and household levels (See *Table 1*). For multivariate analyses, certain individual characteristics are recoded into binary variables. Gender is reported as either (0) for male or (1) for female participants. To account for education level, respondents are coded as either holding a bachelor's degree (1) or not (0). Conservative political beliefs are reflected in a binary variable indicating whether respondents identify as a Republican (1) or not (0). At the household level, while we retain the initial income scale for bivariate analyses, a new binary income variable for respondents reporting a household income level either below (0) or above (1) $75,000 a year. Residence-related questions reflect whether a respondent lives in a rented (1) or owned home (0), the number of people in their household, whether they have children, or reside either inside (1) or outside (0) Chittenden County – the most urban area of the state.

3.3.2. Maple Syrup Quality Preferences

Over 78% of respondents reporting to consume maple syrup in the month prior to participating in the survey indicated a willingness to pay extra for "Vermont-produced" maple syrup (*Figure 1*). When asked about other product qualities, almost three-quarters of these respondents were also willing to pay extra for "Family-farmed" maple syrup

(72.3%): followed in turn by all-natural (49.6%), organic (37.3%), wood-fired (33.6%), bird friendly (31.4%), and kosher (11.4%) maple syrups.

Since respondents are asked specifically for which maple syrup product qualities they are willing to pay, responses are treated as ordinal dependent variables in preliminary bivariate statistical tests with individual and household characteristics. Relationships between remunerative product preferences with gender, Republican political beliefs, renter-status, and urban residence are considered using Wilcoxon-Mann-Whitney tests. Yearly household income level, household size, and number of children in the household are likewise considered using Kruskal Wallis tests. Respondents' age is assessed using a one-way analysis of variance (ANOVA).

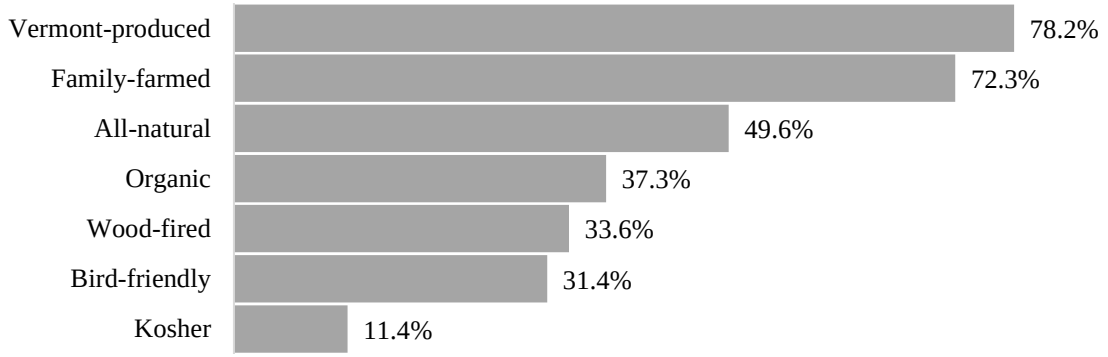

Figure 1. Maple syrup product qualities for which Vermont maple consumers are willing to pay. N = 567.

3.3.3. Attitudes Toward "Made in Vermont" Products

Elaborating on attitudes toward "Vermont-produced" products specifically, respondents assessed a range of hypothetical products and stated whether they agree or disagree with their being labeled "Made in Vermont" under given production scenarios

(*Table 3*). Aside from questions regarding the appropriateness of marketing maple syrup sourced from trees in either New York or Canada and bottled in Vermont as a "Made in Vermont" product, other products also include sausages processed in-state from Ohio-sourced pork; cheese processed in New York by a Vermont-owned company; alcohol produced in-state from imported grains; and handicraft baskets woven in Vermont using Chinese materials.

Table 2.

Summary statistics for responses to whether products are appropriately labeled as "Made in Vermont."

Variable	Obs	% Disagree	Std. Dev.	Min	Max
Maple syrup from trees in Canada that is bottled in Vermont	578	0.92	0.27	0	1
Maple syrup from trees in New York that is bottled in Vermont	578	0.88	0.33	0	1
Cheese that is produced in New York by a Vermont-based company	578	0.87	0.34	0	1
Pork from Ohio that is processed into sausage in Vermont	566	0.80	0.40	0	1
Baskets woven in Vermont using materials from China	563	0.53	0.49	0	1
Alcohol produced in Vermont using grains grown outside Vermont	556	0.39	0.49	0	1
Variable	Obs	Mean	Std. Dev.	Min	Max
Number of "Made in Vermont"-labeled products rejected	600	4.18	1.57	0	6

Respondents expressed their most stringent attitudes towards using the "Made in Vermont" label on maple syrup sourced from Canada (92% disagreement) and New York (88% disagreement) bottled in-state. Comparably strict "Made in Vermont" labeling attitudes were also expressed towards cheese produced in New York by a Vermont-based company (87% disagreement) and pork from Ohio processed into sausage in-state (80%). Respondents did, however, seem to hold less-exacting standards for non-food products: specifically, labeling baskets woven from in-state out of imported Chinese materials (53% agreement) and alcohol distilled in-state from out-of-state grains (39% disagreement) as "Made in Vermont."

Based on responses to these product labeling questions, a new indicator variable is compiled to reflect how strict respondents' overall definition is of "Made in Vermont" products. This is done by summing all negative responses together: where answers indicating disagreement with a product scenario (e.g., disagreeing that maple syrup from Canada bottled in Vermont should qualify for a "Made in Vermont" label) are treated as one, and agreement with a given labeling scenario is treated as zero. When summed, higher values indicate more stringent local product standards while lower values indicate more relaxed attitudes towards what qualifies as a "Made in Vermont" product.

Adapting an approach similar to the one used in bivariate analyses of remunerative maple syrup quality preferences, responses to the product labeling questions outlined in *Table 2* are treated as ordinal variables indicating either a *more* or *less* stringent attitude towards a specific product. Preliminary bivariate statistics are tabulated accordingly (e.g. Wilcoxon-Mann-Whitney tests with dichotomous categorical

dependent variables, Kruskall Wallis tests with interval/ordinal dependent variables, and one-way ANOVA for the continuous age variable).

3.3.4. Industry Concerns

The survey instrument also included a battery of questions regarding specific concerns facing the Vermont maple industry (*Table 3*): covering a range of topics from product quality to environmental concerns, market competition and input costs. While as seen in *Figure 1* the percentage of respondents indicating concern about the loss of family farms (71%) is relatively consistent with the percentage reportedly willing to pay extra for "Family-farmed" maple syrup (72.3%), concern surrounding out-of-state competition (51%) is less prevalent than reported willingness to pay for "Vermont-produced" maple syrup (78.2%). Concern regarding the risk posed by climate change is also prevalent among respondents (69%), as are those related to the cost of inputs (equipment: 53%; fuel: 49%). Quality concerns (32%) and animal habitat loss-related (34%) concerns were the least common among survey participants. These responses were compiled into an indicator variable reflecting the number of concerns indicated by a respondent.

Table 3.

Summary statistics for maple industry concerns indicated by respondents.

Variable	Obs	Mean	Std. Dev.	Min	Max
Low quality	628	0.32	0.47	0	1

Animal habitat loss	628	0.34	0.48	0	1
Fuel costs	628	0.48	0.50	0	1
Out-of-state competition	628	0.51	0.50	0	1
Equipment costs	628	0.53	0.50	0	1
Climate change	628	0.69	0.46	0	1
Loss of family farms	628	0.71	0.45	0	1
Number of indicated concerns	628	3.59	1.98	0	7

Apart from adopting the same approach taken in bivariate analyses of willingness to pay for maple syrup qualities and attitudes towards the labeling of "Made in Vermont" products to assess the relationship between industry concerns, individual, and household characteristics, a series of Chi-squared tests are also conducted to assess the relationship between each maple industry concern and WTP for specific syrup qualities. A Cramer's V statistic is also calculated to determine the strength in association between what syrup qualities participants are willing to pay for and the concerns they express regarding the Vermont maple industry.

3.3.5. Willingness to Pay for "Made in Vermont" Maple Syrup

Respondents' demographic characteristics, attitudes toward "Made in Vermont" products, and indicated maple industry concerns are incorporated into analyses of their reported willingness to pay (WTP) for "Made in Vermont" maple syrup. Beginning at a base price of $8, those reporting to consume maple syrup in the last month were asked through a sequence of questions if they would pay and additional dollar for eight ounces

of Vermont-produced maple syrup (e.g. “Would you pay $9...?”, Would you pay $10…?”, etc.) until an indeterminate upper bound of more than eleven dollars was reached (numerically coded as 12; shown in *Table 4*). Respondents were assumed to only accept the base price of $8 for eight ounces of Vermont-produced maple syrup unless otherwise stated.

Table 4.
Summary statistics of WTP for “Made in Vermont” maple syrup.

Variable	Obs.	Mean	Std. Dev.	Min	Max
WTP for eight ounces of “Made in Vermont” maple syrup	628	9.04	1.28	8	12

WTP for “Made in Vermont” maple syrup is assessed using a series of multivariate models and comparisons. Given the indeterminate upper bound of the dependent variable, ordered logistic regressions are used to consider the effects of demographics, “Made in Vermont” product attitudes, and perceived risks facing the regional maple industry on reported WTP (Kennedy, 2008). Results from these analyses are reported as odds-ratio.

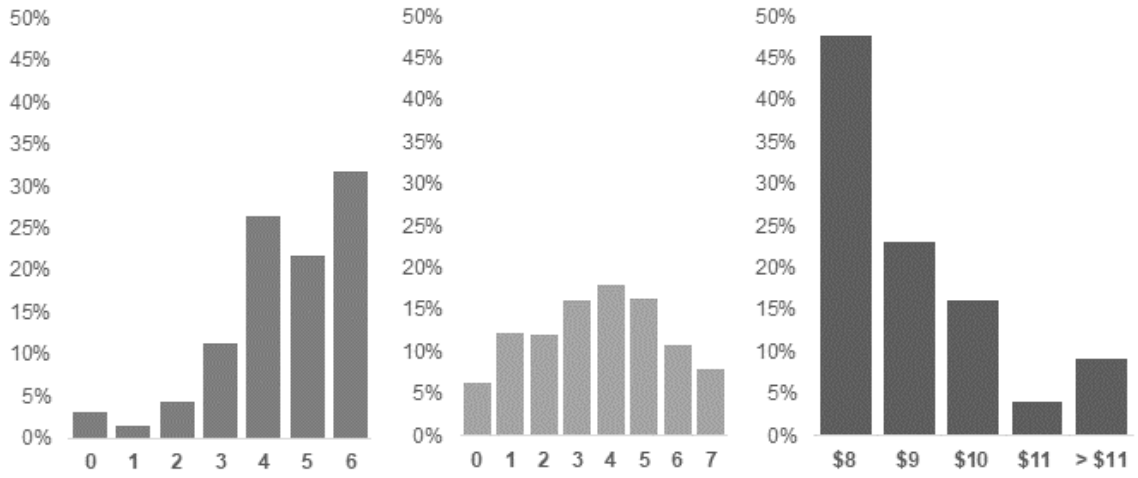

Figure 2. *Number of rejected "Made in Vermont" products (Left, N = 600), number of indicated maple industry concerns (Center, N = 628), WTP for eight ounces of "Made in Vermont" maple syrup (Right, N = 628).*

Our first set of ordered logistic regressions estimate the effect of individual and household characteristics (described in *Table 1*) on WTP for Vermont-produced maple syrup. Next, we iterate into this base demographic model encoded responses to "Made in Vermont" product labeling questions and the indicator variable for how many labeled products a respondent is willing to accept (outlined in *Table 2*). Our final multivariate analysis sequentially introduces indicated maple industry concerns and the number of indicated concerns variable alongside the base demographic model of WTP for Vermont-produced maple syrup.

As a final robustness check, we run similar regressions for reported WTP for one pound of "Made in Vermont" sausage. This secondary dependent variable was compiled from a sequence of questions similar to those used to determine accepted maple syrup prices, covering a range from $4 to "More than $7." These checks serve as a comparison

case to assess how demographic and attitudinal effects on WTP for local products vary between a regional specialty good and a less culturally significant food.

3.4 Results

3.4.1 Quality Preferences

In preliminary bivariate analyses of WTP for specific maple syrup qualities, we find a tendency among renters ($Z = -1.75$, $p < 0.1$) and larger households ($\chi^2 = 20.91$, $p < 0.01$) to accept a higher pay price for Vermont-produced maple syrup – though this tends to fall in households with more children ($\chi^2 = 11.52$, $p < 0.05$). While popular among all respondents, women are especially likely to accept a higher price in exchange for "family-farmed" maple syrup ($Z = -1.93$, $p < 0.1$). A remunerative preference for "all-natural" ($Z = 3.06$, $p < 0.1$) organic ($Z = -2.04$, $p < 0.05$) and wood-fired maple syrup ($Z = -2.36$, $p < 0.05$) is notably less common among homeowners – who instead tend to express WTP for bird-friendly maple syrup more often than other respondents ($Z = 1.92$, $p < 0.1$).

College-educated respondents are also more likely to express a preference for bird-friendly ($\chi^2 = 9.99$, $p < 0.01$) and forego paying more for wood-fired syrup ($\chi^2 = 3.66$, $p < 0.1$). Urban residents are also less likely to pay an additional amount for wood-fired maple syrup products ($Z = 2.32$, $p < 0.05$). Those expressing their political affiliation with the Republican Party are significantly less likely to express WTP for either bird-friendly ($Z = 2.40$, $p < 0.05$) or Vermont-produced ($Z = 1.75$, $p < 0.1$) maple syrup products.

3.4.2. Attitudes Towards "Made in Vermont" Products

Relatively stringent attitudes towards marketing imported maple syrup bottled in-state as "Made in Vermont" seems, in the case of New York-sourced syrup, especially pronounced among higher-income ($\chi^2 = 16.01$, $p < 0.01$) and urban respondents ($Z = 1.94$, $p < 0.1$). With respect to maple syrup sourced from Canada, however, larger households are found to generally exercise less stringent labeling standards ($\chi^2 = 15.56$, $p < 0.01$). Urban residents' relatively strict product labeling standards seems to hold with other food products as well – seen in their lower acceptance of sausage made from Ohio-raised pork as a genuine "Made in Vermont" product ($Z = 1.70$, $p < 0.1$).

Wealthier participants exercise significantly less stringent attitudes regarding non-food products, namely towards the use of imported grains in alcohol ($\chi^2 = 10.40$, $p < 0.05$) and baskets produced out of materials sourced from China ($\chi^2 = 12.83$, $p < 0.05$). Homeowners also tend to exhbit more stringent "Made in Vermont" labeling attitudes on food products like cheese ($Z = -3.22$, $p < 0.01$) – though again a general tendency towards more relaxed attitudes seems to emerge in households with more people ($\chi^2 = 12.77$, $p < 0.05$) and with more children specifically ($\chi^2 = 9.94$, $p < 0.05$). Overall, women ($Z = 2.30$, $p < 0.05$) and households with more children ($\chi^2 = 8.88$, $p < 0.1$) tend to have the least stringent local product standards.

3.4.3. Maple Industry Concerns

While it is the most commonly expressed concern among all survey respondents, women are exceptionally likely to indicate concern regarding the loss of family farms (Z

= -3.55, $p < 0.01$). Women also tend to more often express concern about the cost of fuel oil ($Z = -1.95$, $p < 0.1$) – while men are significantly more likely report concerns regarding low-quality maple syrup ($Z = 2.94$, $p < 0.01$).

Concerns regarding climate change are especially common among college degree holders ($\chi^2 = 18.93$, $p < 0.01$), urban residents ($Z = -3.80$, $p < 0.01$) and wealthier respondents ($\chi^2 = 12.49$, $p < 0.05$) – while remarkably less prevalent among Republicans ($Z = 8.29$, $p < 0.01$). Those expressing conservative political beliefs are, in fact, less likely to express concerns in general: including with regard to syrup quality ($Z = 2.81$, $p < 0.01$), market competition from outside of Vermont ($Z = 2.71$, $p < 0.01$), the cost of fuel oil ($Z = 1.65$, $p < 0.1$), and the loss of wild animal habitat ($Z = 1.95$, $p < 0.1$).

Larger household are more likely to express concern regarding the cost of maple equipment ($\chi^2 = 10.89$, $p < 0.1$) and the threat posed by market competition from outside of Vermont ($\chi^2 = 13.80$, $p < 0.05$), though less inclined to state concern related to low syrup quality ($\chi^2 = 14.52$, $p < 0.05$). Concerns regarding out of state market competition are also significantly more common among college degree holders ($\chi^2 = 2.77$, $p < 0.1$) and urban residents ($Z = 1.67$, $p < 0.1$). Older respondents tend to forego expressing either quality ($F = 1.39$, $p < 0.05$) or fuel oil cost ($F = 1.31$, $p < 0.05$) concerns.

In tests of association between WTP for specific product qualities and industry concerns (*Table 5*), remunerative preferences for Vermont-made maple syrup coincides most strongly with concerns related to input costs (e.g. cost of maple equipment; $V = 0.18$, $p < 0.01$) and the effects of climate change ($V = 0.18$, $p < 0.01$). While most strongly correlated with concerns related to the loss of family farms ($V = 0.28$, $p < 0.01$),

WTP for family-farmed maple syrup also exhibits a relatively strong correlation with the perceived threats posed by equipment costs ($V = 0.20$, $p < 0.01$). Perceived concerns related to the loss of wild animal habitat, though help by only 34% of respondents in our sample, exhibits the strongest degree of association with stated WTP for all-natural, organic, wood-fired, and bird-friendly maple syrup when compared to all other industry concerns considered.

Table 5.

Cramer's V measures of association between WTP for product qualities and maple industry concerns.

	Low Quality	Cost of equipment	Cost of fuel oil	Climate change	Loss of habitat	Loss of family farms	Market Competition
VT-produced	0.13***	0.18**	0.13***	0.18***	0.12***	0.11***	0.16***
Family-farmed	0.15***	0.20***	0.15***	0.14***	0.19***	0.28***	0.18***
All-Natural	0.12***	0.15***	0.17***	0.08*	0.21***	0.12***	0.07
Organic	0.08*	0.16***	0.10**	0.15***	0.18***	0.12***	0.04
Wood-fired	0.13***	0.16***	0.10 **	0.09**	0.17***	0.16***	0.06
Bird-friendly	0.12***	0.13***	0.19***	0.21***	0.28***	0.18***	0.13***

Note. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Shading indicates which product quality is most strongly associated with each specific concern.

3.4.3. Willingness to Pay

In the demographic base model comparison, WTP for "Made in Vermont" maple syrup is predicted less effectively by individual and household characteristics than WTP for Vermont-produced sausage (*Table 6*; *Appendix I*). While the latter exhibits statistically significant effects for age, college education, and renting a home, none of these appear as significant in predicting accepted price for locally produced maple syrup. Income-related effects do coincide with WTP for Vermont syrup: as households reporting income over $75,000 are more likely to accept a higher price for "Made in Vermont"

syrup (OR = 2.21, $p < 0.05$). There does, however, appear to be a remarkably *lower* WTP among higher-income, college-educated urban residents for both maple syrup (OR = 0.12, $p < 0.01$) and locally produced sausage (OR = 0.15, $p < 0.01$).

Table 6.

Ordered logistic regression results of WTP for "Made in Vermont" maple syrup, controlling for individual and household characteristics.

Individual Characteristics	Odds Ratio	
Gender	1.14	
Age	1.00	
Bachelor's Degree	1.11	
Republican	3.54	
Household Characteristics		
Household income ≥ $75,000	2.21	**
Rent	1.25	
Household Size	0.97	
Number of children in household	0.97	
Reside in Urban County	1.36	
Interaction Effects		
Republican x Age	0.98	
≥$75,000 x bachelor's degree	1.14	
≥ $75,000 x Urban	2.26	
Bachelor's Degree x Urban	1.93	
≥$75,000 x bachelor's degree x Urban	0.12	***
LR χ^2	41.21	
Prob > χ^2	0.000	
Psuedo R^2	0.030	
N	517	

Note. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

When accounting for attitudes toward "Made in Vermont"-labeled products, there is some indication that more stringent definitions of certified local products coincide with higher reported WTP for Vermont maple syrup (*Table 7*). Respondents opposed to

labeling cheese produced in New York by a Vermont-based company (OR = 1.80, $p < 0.05$), pork from Ohio processed into sausage in Vermont (OR = 1.48, $p < 0.1$) , and baskets woven in-state from Chinese materials (OR = 1.51, $p < 0.05$) as “Made in Vermont” are more likely to express a higher WTP for “Made in Vermont” maple syrup. This tendency appears to exist as well among respondents with more restrictive attitudes towards the using the “Made in Vermont” label (OR = 1.08, $p < 0.1$).

Compared to findings from the base model, incorporating product labeling attitudes into predicting WTP tends to reduce explanatory power overall. However, this is not the case when accounting for the effect of labeling attitudes towards cheese made in New York ($R^2 = 0.03$), baskets woven from imported materials ($R^2 = 0.033$), and the production of alcohol from out-of-state grains ($R^2 = 0.030$) – which either exceed or are nearly equal to the effectiveness of base model predictions.

Table 7.

Ordered logistic regression results of WTP for "Made in Vermont" maple syrup, controlling for demographic effects and product labeling attitudes.

Individual Characteristics														
Gender	1.07		1.05		1.13		1.11		1.03		1.11		1.05	
Age	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Bachelor's Degree	1.14		1.11		1.07		1.16		1.42		1.16		1.12	
Republican	2.96		2.96		2.95		4.30		2.51		3.12		2.78	
Household Characteristics														
Household income ≥ $75,000	2.12	**	2.29	**	2.51	***	2.02	**	2.74	***	2.46	***	2.29	**
Rent	1.28		1.25		1.32		1.23		1.27		1.38		1.24	
Household Size	0.97		0.97		0.97		1.00		0.99		0.96		0.99	

Number of children in household	0.98		0.99		1.01		0.97		0.89		0.96		0.96	
Reside in Urban County	1.38		1.41		1.32		1.36		1.00		1.04		1.35	
Interaction Effects														
Republican x Age	0.98		0.98		0.98		0.98		0.98		0.98		0.98	
≥$75,000 x bachelor's degree	1.02		1.02		1.00		1.13		0.79		1.02		1.06	
≥ $75,000 x Urban	1.90		1.90		1.61		1.94		2.33		2.15		1.79	
Bachelor's Degree x Urban	1.74		1.74		2.03		1.56		1.89		2.41		1.81	
≥$75,000 x bachelor's degree x Urban	0.17	**	0.17	**	0.17	**	0.19	**	0.17	**	0.13	**	0.17	**
"Made in Vermont" Product Labeling Attitudes														
Maple syrup from Canada bottled in VT	1.23													
Maple Syrup from New York bottled in VT			1.13											
Cheese produced by VT company in New York					1.80	**								
Pork from Ohio processed in VT							1.48	*						

Baskets woven in VT with Chinese materials					1.51 **		
Alcohol produced in VT from imported grains						0.88	
Number of labeled products accepted							1.08 *
LR χ^2	31.95	32.18	39.23	35.63	41.16	37.23	37.46
Prob > χ^2	0.007	0.006	0.001	0.002	0.000	0.001	0.001
Psuedo R^2	0.024	0.025	0.030	0.028	0.033	0.030	0.028
N	480	480	477	465	461	456	493

Note. Reported as odds ratios; * p < 0.1, ** p < 0.05, *** p < 0.01.

Variation in the fit of the models shown in *Table 7* – especially the relatively poor performance when incorporating the number of labeled products accepted indicator variable – suggests that the association between uses of the "Made in Vermont" designation and WTP for maple syrup is more a function of individual scenarios themselves than a relatively more or less strict attitudes about what qualifies as a "local" product in general. Though their effects are moderated when accounting for different product attitudes, household income continues as a strong predictor of WTP. As under based model conditions, high-income, college educated respondents living in an urban area generally have a lower WTP for "Made in Vermont" maple syrup when controlling for specific product labeling attitudes.

Controlling for maple industry concerns individually and together are more indicative of WTP than either models accounting for "Made in Vermont" labelling attitudes or just individual and household characteristics alone (*Table 8*). While higher household income levels and the high income-college-educated-urban residence interaction term continue to demonstrate significance in predicting WTP, they are generally outperformed by both specific industry concerns and overall level of concern.

Concerns related to the loss of family farms (OR = 2.21, $R^2 = 0.042$) and cost of maple equipment (OR = 2.05, $R^2 = 0.042$) are especially indicative of higher WTP for "Made in Vermont" maple syrup. These are followed in order of association strength by concerns regarding the cost of fuel oil (OR = 1.95, $R^2 = 0.041$), clim ate change (OR = 1.77, $R^2 = 0.035$), low syrup quality (OR = 1.64, $R^2 = 0.035$), the loss of wild animal habitat (OR = 1.59, $R^2 = 0.035$) and finally market competition from outside Vermont (OR = 1.44, $R^2 = 0.033$).

Unlike the labeling attitude models included within *Table 7*, each specific industry concern is highly associated with WTP for "Made in Vermont" maple syrup. Notable is the way in which the cumulative number of indicated concerns strongly outperforms its analog in the local product labeling model series – suggesting an underlying relationship between industry concerns in general with a heightened WTP among respondents for Vermont-produced maple syrup.

Table 8.

Ordered logistic regression results of WTP for "Made in Vermont" maple syrup, controlling for demographic effects and maple industry concerns.

Individidual Characteristics								
Gender	1.21	1.11	1.06	1.11	1.09	1.12	0.99	1.04
Age	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bachelor's Degree	1.15	1.12	1.17	1.10	1.21	1.03	1.21	1.19
Republican	4.34	3.49	4.37	3.70	3.80	3.68	3.17	4.32
Household Characteristics								
Household income ≥ $75,000	2.39***	2.19**	2.18**	2.20**	2.12**	2.18**	2.30**	2.26**
Rent	1.22	1.23	1.26	1.25	1.22	1.25	1.24	1.22
Household Size	0.97	0.96	0.96	0.95	0.97	0.96	0.97	0.95
Number of children in household	0.95	0.99	0.97	0.99	0.96	0.99	0.94	0.95
Reside in Urban County	1.53	1.43	1.41	1.39	1.49	1.33	1.47	1.59
Interaction Effects								
Republican x Age	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
≥$75,000 x Bachelor's Degree	1.08	1.16	1.13	1.19	1.22	1.13	1.06	1.14
≥ $75,000 x Urban Residence	1.83	2.10	2.06	2.22	2.33	1.97	2.10	1.71
Bachelor's Degree x Reside in Urban County	1.62	1.79	1.77	1.78	1.82	1.90	1.60	1.44
≥$75,000 x Bachelor's Degree x Reside in Urban County	0.16***	0.13***	0.14**	0.12***	0.11***	0.14**	0.14**	0.16**
Maple Industry Concerns								
Low maple syrup quality	1.64***							
Loss of wild animal habitat		1.59***						
Costs of fuel oil			1.95***					
Market competition from outside VT				1.44**				
Cost of maple equipment					2.05***			
Climate change						1.77***		
Loss of family farms							2.21***	
Number of indicated concerns								1.28***
LR χ^2	48.95	48.46	57.08	45.71	58.69	49.29	57.87	71.81
Prob > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Psuedo R2	0.035	0.035	0.041	0.033	0.042	0.035	0.042	0.052
N	517	517	517	517	517	517	517	517

Note . Displayed as odds ratios; * p < 0.1, ** p < 0.05, *** p < 0.01.

3.5. Discussion

This study was conducted to see how Vermont consumers' WTP for locally made maple syrup coincides both with how strict they are in accepting the use of the "Made in Vermont" label and with what risks they perceive to affect the regional maple industry. Our results demonstrate that while attitudes toward the use of the "Made in Vermont" label on certain products is significantly associated with the price respondents report accepting for locally branded maple syrup, the kind and number of threats perceived to affect the maple industry are more effective in predicting WTP.

In preliminary bivariate analyses of product quality preferences, willingness to accept a price premium for "Made in Vermont" syrup is notably lower among conservatives before accounting for the effects of other demographic factors. While there is a higher reported willingness to accept cost premiums for Vermont-produced syrup in larger households, this tends to diminish in homes with more children. Significant variation in other product quality preferences also appears across demographic groups. Homeowners, urban residents, and higher income earners are, for instance, less likely to express a remunerative preference for either organic or wood-fired syrup varieties. While the same is also true for college-educated participants, these respondents are also more likely to express interest in a relatively niche product certification like bird-friendly.

Individual and household characteristics are also found to coincide significantly with how "Made in Vermont" products are defined and what industry concerns respondents express. Urban residents and homeowners generally hold more stringent qualifications for what constitutes as locally made – while larger households – and

especially those with more children – hold less exacting standards for "Made in Vermont" products. High income households, while reticent to accept the made-in-state labeling of imported maple syrups, have less restrictive attitudes towards other food products like cheese produced out-of-state. Conservative respondents are significantly less likely to express specific industry concerns overall. Urban residents have a general tendency to express heightened concern around the effects of climate change and out-of-state market competition. In general: women are by far more likely to express concerns about the loss of family farms and express more stringent "Made in Vermont" labeling standards.

Tests of association between specific concerns and quality preferences find that, while the loss of wild animal habitat is not an especially widespread concern, it is the category of risk most highly associated with a price premium acceptance for organic, bird-friendly, and wood-fired syrup varieties. Another interesting result found in threat-quality associations is how relatively weak the relationship is between concern about out-of-state competition and any remunerative quality preference whatsoever – despite the emphasis placed on the threat posed by Canadian competition in both the popular press and academic literature (Matalon, 2018; Whitney & Upmeyer, 2004).

An interesting pattern which emerges from multivariate models of WTP is the significantly lower WTP among urban residents with a college education and yearly household income above $75,000 for "Made in Vermont" maple syrup. This is especially striking given that income level appears, overall, to be the most reliable demographic indicator of heightened WTP (see *Figure 3*).

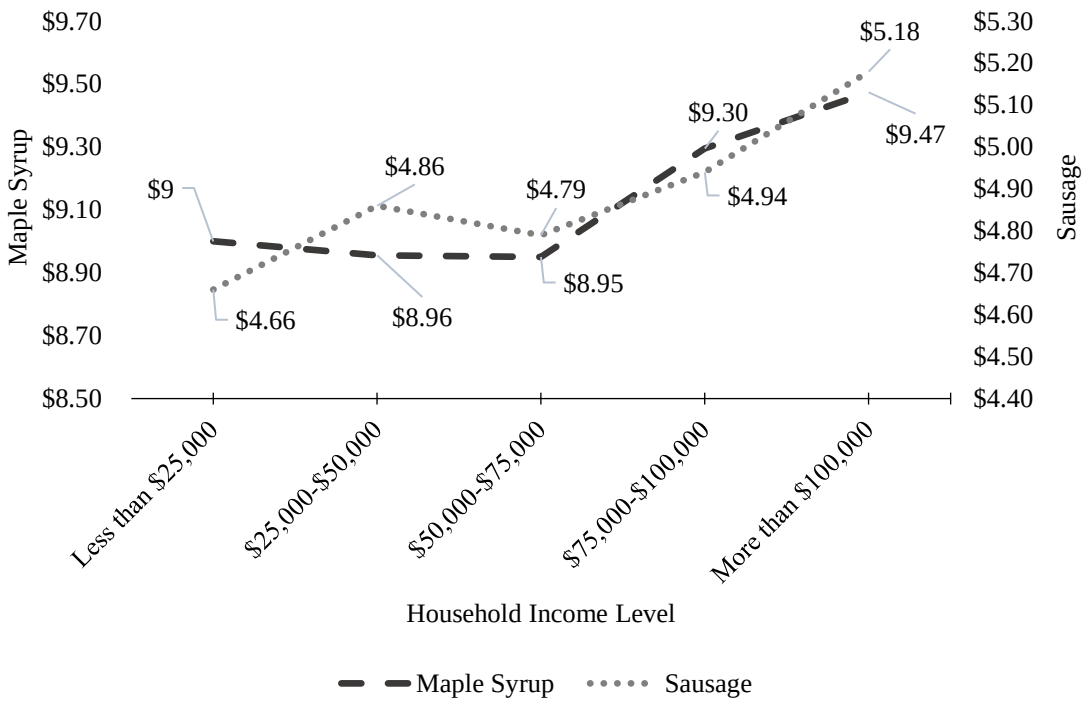

Figure 3. Mean price for "Made in Vermont" products by household income level.

Relatively stringent attitudes towards the labeling of "Made in Vermont" products – when considered against the demographic effects mentioned previously – are a weak indicator of WTP overall. Due to widespread rejection of the hypothetical maple syrup products considered (e.g. labeling New York or Canadian syrup bottled in-state as "Made in Vermont"), neither register as significant in this regard. Attitudes towards the production of cheese out-of-state by a Vermont-owned firm and the production of handicrafts from imported materials do, however, appear indicative of WTP. When compiled together, the number of "Made in Vermont"-labeled products respondents reject (e.g. how strict they are in defining locally-made products) is a relatively weak – though nevertheless significant – indicator of WTP.

Concerns related to the maple industry are, on the other hand, strongly associated with WTP and constitute in every instance a net-improvement over the base demographic model. Especially potent predictors of WTP seem to be related to costs faced by farmers (e.g. the costs of fuel oil and maple equipment) and the loss of family farms. Unlike the model accounting for the effect of stringent "Made in Vermont" product labeling attitudes, the number of indicated concerns expressed exhibits an unambiguously strong and significant relationship with WTP. The relatively weak performance of label-use attitudes and comparatively strong predictive power of risk perceptions are also seen in robustness checks on reported WTP for "Made in Vermont" sausage (*Appendix I, II & III*) – even though the threats considered in this paper explicitly dealt with the maple industry.

3.6 Conclusion

Overall, these findings support the conclusion that WTP for "Made in Vermont" maple syrup is driven both by how strict consumers are in their definition of local products and – to a larger extent – by specific and general concerns about the maple industry. This is especially true regarding the loss of family farms and the perceived risks posed to producers by high input costs. As would be expected, higher WTP also coincides strongly with respondents' actual ability to pay, as seen in the persistently significant effect of household income level on accepted pay price. However, one subset of high-income respondents, specifically college degree-holders in urban areas, are

significantly *less* likely to pay more for the "Made in Vermont" products considered in this study.

A definite limitation of these findings is their basis on reported WTP and not actual purchasing behavior in either an experimental or retail setting. During a telephone survey, respondents may feel inclined to express socially desirable purchasing intentions which they may never realistically follow-through on. Future research on the WTP of Vermonters for specific qualities of maple syrup would benefit from adopting either an indirect approach to assessing how consumers valuate attributes like "localness" using methods like contingent valuation (Giraud et al., 2005), the direct observation of purchasing behaviors, or through other experimental designs (Adalja et al., 2015)

While room exists for methodological adjustments, findings from this analysis seem to coincide with prior work documenting the value placed by Vermonters on the production of maple syrup, agriculturally productive forestland, and maple sugarmakers themselves (Lange, 2017; Lovell, Mendez, Erickson, Nathan, & DeSantis, 2010). While it is somewhat surprising to find that perceived threats to the maple industry are statistically significant predictors of WTP for both "Made in Vermont" maple syrup and sausage, Vermont consumers' situational awareness of regional food system issues has materialized in the past as increased financial support for the state's food producers (Chriest & Niles, 2018; Farm Aid, 2011).

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Chapter 4: Environmental, Economic, and Social Risk Perceptions among Vermont Maple Producers

Abstract

Sitting at a confluence of human and environmental processes, the production of maple syrup in Vermont is a complex social-ecological system integral to the livelihood of producers and the wider regional cultural economy. Enterprises engaged in the production of maple syrup are subsequently exposed to a variety of stress pressures including secular decline in the health of Northern hardwood forests, forces in a globalized commodity market, and the exercise of regulatory governance within the industry. This study uses survey data from Vermont maple syrup producers to assess risk perceptions relating to a broad range of challenges by identifying specific subgroups of producers and evaluating their attitudes towards climate change and other social-ecological concerns. Findings suggest that while maple enterprise attributes like scale and marketing channels coincide strongly with the expression of different social, economic, and environmental concerns, the beliefs and characteristics of producers themselves are especially influential in the way such risks are prioritized.

4.1 Introduction

As a cultural and livelihood activity, maple sugaring (the cultivation of sap from sugar maple [*Acer saccharum*] for use in making maple syrup and sugar) in the Northeastern United States is a storied practice stretching back to pre-Columbian origins. Among First Nations peoples, the sap of sugar maples first came into use as a culinary

ingredient in the preparation of food, fermented alcohols, candies, and vinegars (Nesom, 2006). Following European colonization of North America, maple sugaring soon became an integral livelihood activity for settlers in the region (Whitney & Upmeyer, 2004) – continuing through to this day as an essential component within the livelihood portfolio of many Vermont households (Hinrichs, 1998).

While the production of maple syrup is often romanticized as largely unchanged from its pre-modern origins (Heiligmann, Koelling, & Perkins, 2006; Lange, 2017), the contemporary Vermont maple industry is host to a wide range of producers and production practices reflecting the myriad of unique ways enterprises have adapted to new environmental, economic, and social realities. Climatic transitions at the global level require new silvicultural and production practices to meet challenging conditions within forest stands (Oswald et al., 2018; Perkins, Isselhardt, & Van Den Berg, 2015; Rapp et al., 2019). Exactly how producers choose to adapt to these conditions is also a function of concurrent changes in an increasingly globalized market for maple syrup – which entails its own unique set of business considerations (Cannella, 2017; Snyder, Kilgore, Emery, & Schmitz, 2019). Meanwhile, interventions by both civil society and governments aimed at protecting natural resources and exercising oversight of the commercial maple sector are an additional layer of complexity for producers to manage (Gregg, 2019; Gribkoff, 2018).

As producers adapt their maple operations in line with changing social-ecological conditions (Burke & Emerick, 2016), how they prioritize and consider the threats posed by such changes is as varied as enterprises are themselves (Lane et al., 2019). While previous research on different facets of the Vermont maple industry have focused on the

factors motivating and inhibiting adaptation to climate change (Kuehn et al., 2017), these studies focus on specific production practices rather than on producers' perceptions of a wider range of risks. And though some literature remarking on the complex social-ecological risks affecting the maple industry does exist (Snyder, Kilgore, Emery, & Schmitz, 2019), Vermont enterprises – which account for nearly 50% of the maple syrup produced in the United States (USDA-NASS, 2019) – have yet to receive such focus.

Drawing from a statewide survey of Vermont maple producers, we seek to fill this gap by evaluating how attitudes towards climate change and other environmental, economic, and social risks vary across maple producers and enterprises. Beginning with a preliminary literature review guided by the Social-Ecological Systems (SES) framework (Resillience Alliance, 2015), we consider a variety of environmental and socioeconomic concerns affecting the decision processes of Vermont maple producers. Using a *kmeans* clustering procedure, we identify distinct types of maple enterprises based on scale, processing efficiency, years of operation, financing decisions, and specific production practices. We then examine how producer attitudes towards climate change and other social-ecological threats vary across respondent demographics, enterprise characteristics and identified cluster groups. Then, using multinomial logistic regression models controlling for select demographic and enterprise performance measures, we assess how attitudes regarding climate change and other social, economic, and environmental risks vary across enterprise cluster groups.

4.2 Literature Review

4.2.1 Environmental Conditions

Environmental conditions impacting forest stand health and productivity are among some of the most imminent concerns for maple producers in Vermont. As new climatic conditions have led to considerable variability in inter-seasonal temperature regimes, poor shoulder season conditions have become especially deleterious to yield and sugar maple health (Duchesne & Houle, 2014). Duchesne & Houle (2014) find that yield in a given sap flow period is largely driven by prevailing climactic conditions in the previous year. Warmer and drier conditions during the previous growing season coincide with higher yields – while healthy radial growth rates coincide with warmer summer temperatures. Lowering competition pressures in productive maple forest stand between sugar maple and other species is also found to enhance the per tap productivity of sugaring operations. Seed production and dispersal events in sugar maple populations also diminish sap sugar content, in turn decreasing production efficiency (Rapp & Crone, 2015).

Apart from agronomic conditions unique to each productive stand, larger-scale climate conditions and environmental trends constitute their own set of concerns for the regional maple industry. The migration of optimal sugarmaking conditions from southern Canada and New England northward as a result of dynamic climate shifts is the principal environmental transition effecting the Vermont maple industry. When accounting for the effects of climatological variation and temperature conditions on the sugar content and volume of sap flow itself, more advantageous seasonal conditions will occur with greater

frequency at more northerly latitudes while total syrup yield per tap declines across Vermont through the end of this century (Rapp et al., 2019). Increasing average winter temperatures are projected to diminish the volume of insulating snowpack between growing seasons – eroding the resilience of Vermont maple stand to environmental stress pressures and their commercial productivity (Oswald et al., 2018; Reinmann et al., 2019).

4.2.2 Economic Conditions

In 2018, global demand for maple syrup reached an all-time high of $1.24 billion dollars – of which $141 million worth was produced in the United States, with almost half of that accounted for by producers in Vermont (Vermont Agency of Agriculture Food and Markets, 2019). Crucial to this market expansion has been an oversupply of syrup and declining bulk prices – a potent mix which, as of January 2020, seems likely to continue given high levels of production in Quebec and appreciation in the USD-CAD exchange rate (Gregg, 2020; *PPAQ*, 2019). As prices in the commodity marketing channels traditionally used by Vermont sugarmakers continue to remain low, producers must adapt their enterprises to either enhance production efficiency or generate more revenue by other means.

To enhance enterprise efficiency, many producers have turned towards new, technologically intensive production practices. These include reverse osmosis, vacuum tubing, and smart monitoring systems which boost yield as a means of enhancing enterprise profitability (Heiligmann et al., 2006; Kuehn et al., 2017). Making these adaptations, however, is dependent upon the linkages between farmers with extension

services and other sources of expertise (Cofré-Bravo, Klerkx, & Engler, 2019) – and an enterprises' ability to finance capital-intensive investments (Kuehn et al., 2017; McConnell & Graham, 2016). Recognizing this, extension agents encourage producers to think carefully about right-sizing maple operations in-line with the rest of their livelihood activities (Cannella, 2017). This is true not only in terms of purchasing new technologies – but also the implicit business costs associated with labor, fuel, transportation, and storage expenses (Farrell, 2014).

Apart from investments into new equipment and technologies, right-sizing can also entail adapting which commercial opportunities and sales channels producers access. Though sugarmakers have traditionally relied upon bulk purchases by maple syrup packers to sell in more lucrative out-of-state markets (Thomas, 2018), the returns paid through these commodity channels are especially insufficient for small-scale operations (Cannella, 2017; Matalon, 2018). For enterprises less suited to compete in high-volume markets, fetching higher pay prices through direct sales instead of traditional bulk channels is especially important (Cannella, 2017). To this end Becot et al., (2015) find significant variation in market channel access according to tap scale: with producers operating less than 3,000 taps relying mostly on direct-to-consumer sales while 5,000+ tap operations sell most of their syrup through bulk channels. Selling maple syrup to local consumers is an essential component of smaller-scale operations – especially given the relatively higher willingness to pay of Vermont consumers for this regionally-distinctive food (Giraud et al., 2005; Lange, 2017). Moreover, consumers in general are exhibiting a higher demand and willingness to pay for specialty foods and specific product qualities (Adams & Salois, 2010; Moser et al., 2011; Tropp, 2014).

4.2.3 Social Conditions

Leveraging the value-added potential of consumer demand for specialty products (Bolwig et al., 2010; Yang & Renwick, 2019), organizations like the Northeast Organic Farming Association [NOFA] (NOFA-VT, 2014), the Audubon Society (Saha, 2017), and the Forest Stewardship Council (2016) provide producers with specialty certifications in exchange for foregoing certain silviculture and production practices. While these specialty requirements constrain maple enterprises from fully pursuing yield-optimizing management practices, comporting operations to oversight regimens allows producers to secure higher pay-prices based on verified quality attributes (Murphy, Chretien, & Brown, 2012).

For sugarmakers of all production scales and practices, Food and Drug Administration [FDA] regulations have been an especially potent source of concern: well encapsulated in the widespread condemnation of a proposed measure to require all maple syrup to be labeled as containing added sugars (despite its fundamental constitution as a single-source, wild product) (Gribkoff, 2018). For enterprises making less than fifty percent of their income from direct retail sales, production and processing sites (known colloquially as “sugar houses”) are subject to the full complement of FDA safety standards and practices: including production site health inspections and environmental

guidelines concerning the disposal of "gray water" produced by reverse osmosis purification systems[1] (Gregg, 2019).

The State of Vermont itself has also begun to level more scrutiny on larger maple enterprises with the passage of *House Bill 631*, which establishes an oversight process for maple operations with more than 100,000 taps to assess their potential impact on the regions forestland (General Assembly of the State of Vermont, 2018). In response, the Vermont Maple Sugar Makers' Association [VMSMA] – a professional organization representing Vermont maple producers, packers, and equipment suppliers – expressed concern with the State's rationale for focusing on larger enterprises: suggesting that the explicit concerns related to production scale are largely irrelevant to the environmental issues the legislature purports to justify enhanced oversight (Gordon, 2018).

Apart from regulation, changes in the fundamental composition the Vermont maple industry forces a confrontation with more existentially fraught questions around regional identity and tradition. Maple syrup is a culturally potent food that connects producers and consumers alike with the state's agrarian heritage. Both are especially conscientious of the connection between practice, product, and the multifunctional implications of each on rural spaces and traditional livelihood (Mathews, 2012).

Social-ecological change has inspired a diverse mix of producers within a state once almost entirely comprised of family enterprises: ranging from hyper-scale enterprises drawing sap off hundreds of thousands of trees spread across 20,000 acres of

[1] In processing maple syrup, reverse osmosis systems are used to reduce the water content of maple sap and increase its sugar content – improving production efficiency by increasing processing speed and reducing fuel consumption (Heiligmann et al., 2006).

forestland (Egan & Pollack, 2018; Nickerson, 2016), to centuries-old intergenerational businesses (Morse, 2005), and backyard hobbyists (Lovell et al., 2010). As the composition and practices of producers within the industry continue to change, questions surrounding the cultural meanings of maple will become even more pressing for regional stakeholders (Lange, 2017; Trubek, 2011).

4.2.4 Risk Considerations Across Agricultural Enterprises

Previous research in the maple sector shows that the complex range of problems facing agricultural producers reflects in the kinds of concerns operations express. Maple enterprise operators are already known to range in their ability to adapt to climate-related challenges across varying scales of production (Kuehn et al., 2017). Likewise, insights from literature on innovation adoption underlines an array of mechanisms influencing the diffusion of new practices and technologies within industries and the selection into adaptation made by individual businesses (van Oorschot, Hofman, & Halman, 2018). And though long-term concerns related to climate change are commonly expressed amongst agricultural producers in the American Northeast, more immediate concerns like profitability, market conditions, and regulation oftentimes take precedent (Lane et al., 2019).

While many factors are known to influence the risk perceptions of maple producers regarding climate change and their ability to preemptively adapt their enterprises to its effects (Kuehn et al., 2017; *Figure 4*), research has yet to extend this lens across a broader scope of social-ecological issues confronting maple enterprises in the State of Vermont. In a survey of maple producers in Minnesota, Wisconsin, and

Michigan, Snyder, Kilgore, Emery, & Schmitz (2019) find that participants are, on average, more concerned with factors such profitability and the impact of regulatory oversight then climate-induced natural events affecting the industry as a whole. They also find that larger producers are especially concerned by the effects of both regulation and competition on their maple businesses.

To build upon previous research, we analyze a novel set of producer data collected through a series of surveys conducted from Spring 2019 to Winter 2020 and present findings on how producers' perception of climate change and other social-ecological risks vary across different kinds of enterprises. This entails first identifying meaningful subgroups of producers based on enterprise characteristics. We then present a summary of respondent attitudes towards climate change and specific risks across enterprise clusters, producer demographics, and enterprise characteristics. Multivariate analyses are then employed to determine whether attitudes towards climate change and risk perceptions vary significantly across enterprise clusters.

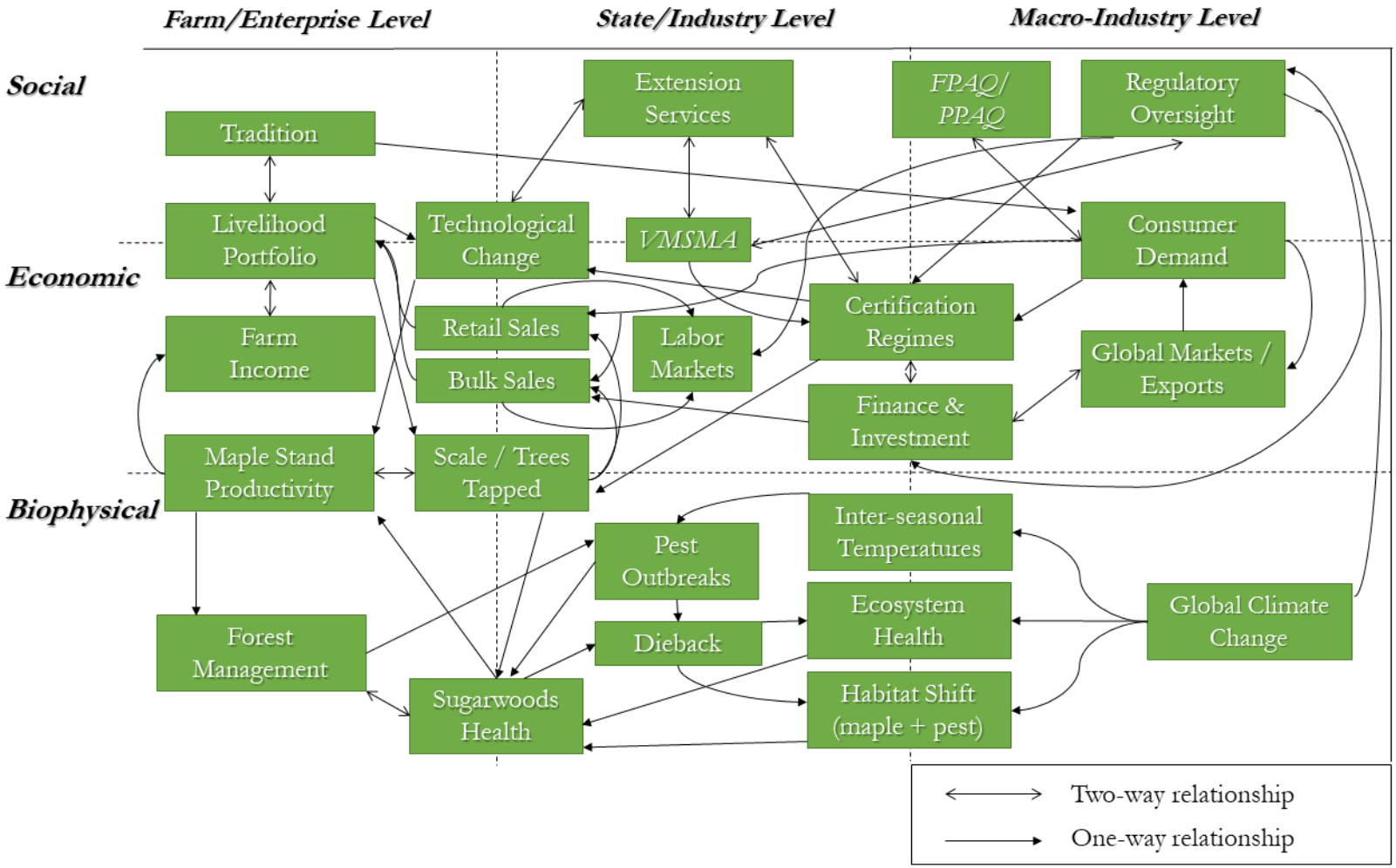

Figure 4. *An inter-scale diagram of interrelated social, economic, and environmental factors affecting the Vermont maple syrup production system. Adapted from Resillience Alliance, 2015.*

4.3 Data & Methods

4.3.1 Study Procedures

This research uses data collected over the course of the *2019 Vermont Maple Producers Study*, a survey of maple producers in Vermont. Respondent contact information for both telephone and online surveys were compiled from a variety of publicly-available, online sources including the Vermont Food System Atlas (Vermont Sustainable Jobs Fund, 2020), The Northeastern Organic Farming Association of Vermont's (2019) list of certified organic producers, and the Vermont Maple Sugar Makers' Association (2020) directory of member operations. Hard copies of the survey were also disseminated at two meetings of the Vermont Maple Conference (The University of Vermont Extension, 2019). Telephone and online data collection began September 23, 2019 in collaboration with the University of Vermont's *Center for Rural Studies* – a non-profit, fee-for-service research center (Center For Rural Studies, 2020). In-person survey dissemination and collection occurred on January 18, 2020 in Brattleboro, VT and January 25, 2020 in Hyde Park, VT.

The survey included a series of questions gauging producers' attitudes and perceptions of climate change as they relate to the regional maple industry (see *Table 9*) and their own maple enterprises – recorded on a seven-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." Topics ranged from general beliefs ("The projected impacts of climate change are exaggerated") to perceived effects ("The impacts of climate change are already noticeable in my region," "I have observed maple dieback caused by climate change," "Climate change has led to variability in the start date of the

season," The beginning of the tapping season is happening earlier") and perceptions of their own enterprises' adaptability ("The impacts of climate change are happening slowly enough to allow my enterprise to adapt," "Climate change poses a threat to my maple sugaring operation").

Producers also rated the level of concern posed by the natural events, social and economic risks facing their maple enterprise. These were again recorded on a Likert scale – though this time with a five-point range for concern. Social risks include the burden of regulatory compliance, maple substitutes, low syrup quality, and the loss of family farms. Economic risks given consideration include competition from Canadian, US, and other Vermont producers; low syrup prices; and labor, fuel and equipment costs. Respondents were then asked to select from a list of natural events, social risks, and economic risks which risk qualified as the greatest concern affecting their enterprise.

Table 9. *Summary statistics for demographic characteristics, enterprise characteristics, climate change attitudes, and risk perceptions.*

	Variable	Obs	Mean	Std. Dev.	Min	Max
Demographics	Respondent age	164	60.39	12.84	24	87
	Gender [A]	170	0.18	0.39	0	1
	Education level [B]	171	3.23	0.94	1	4
	Household income level [C]	139	4.44	1.26	1	6
	Conservative political beliefs [D]	176	0.23	0.42	0	1
Enterprise Characteristics	ln(# Trees, 2019)	176	7.82	1.43	2.64	12.25
	Gallons per tree, 2019	176	0.36	0.17	0	1
	Years enterprise in production [E]	176	4.14	1.66	1	6
	Secure loan/credit for enterprise [D]	176	0.49	0.50	0	1

	Hold a certification [D]	176	0.36	0.48	0	1
	Use vacuum tubing (20HG+)[D]	176	0.62	0.49	0	1
	Use wood fuel [D]	176	0.65	0.48	0	1
	Use reverse osmosis [D]	176	0.76	0.43	0	1
	Use hired labor [D]	176	0.34	0.48	0	1
Performance Measures	More profitable (Last ten years) [D]	138	0.46	0.50	0	1
	Higher yield (Last ten years) [D]	143	0.45	0.50	0	1
	% Sold at bulk prices	137	64.67	30.55	0	100
Climate Change [F]	Poses a threat to maple sugaring operation.	172	4.58	1.86	1	7
	Impacts are already noticeable in region.	170	4.93	1.67	1	7
	Observed maple dieback caused be climate change.	163	3.21	1.35	1	7
	The beginning of the season is happening earlier.	171	4.71	1.66	1	7
	Impacts are happening slowly enough to allow enterprise to adapt.	169	4.68	1.49	1	7
	The projected impacts of climate change are exaggerated.	169	3.49	1.83	1	7
	Has led to variability in the start date of the season.	171	4.93	1.68	1	7
	It's now easy to determine the best moment to tap.	168	3.33	1.72	1	7
Social Risks [G]	Regulation	170	3.61	1.33	1	5
	Maple substitutes	168	3.32	1.50	1	5
	Low quality	166	2.87	1.58	1	5
	Loss of family farms	169	3.56	1.37	1	5
Economics Risks [G]	Canadian competition	169	2.99	1.39	1	5
	US competition	170	2.46	1.31	1	5
	Vermont competition	171	2.70	1.43	1	5
	Low prices	169	3.72	1.31	1	5
	Labor costs	167	2.62	1.45	1	5

Fuel costs	166	2.52	1.32	1	5
Equipment costs	168	3.52	1.26	1	5
Natural events [G]	168	3.71	1.16	1	5

Note. [A] 0 = Male, 1 = Female; [B] 1 = Less than high school graduate, 2 = High School Grad. or Equivalent, 3 = Some college, no degree, 4 = College degree or equivalent; [C] 1 = $10,000 >, 2 = $10k - $25k, 3 = $25k - $50k, 4 = $50k - $75k, 5 = $75k - $100k, 6 = $100k+; [D] 0 = No, 1 = Yes; [E] 1 = Less than five years, 2 = Between five and ten years, 3 = …10-20 years, 4 = …20-30 years, 5 = …30-40 years, 6 = More than 40 years; [F] 1 = Strongly Disagree, 2 = Disagree, 3 = Partially Disagree, 4 = Unsure, 5 = Partially Agree, 6 = Agree, 7 = Strongly Agree; [G] 1 = Not at all concerning, 2 = Of little concern, 3 = Unsure, 4 = Concerning, 5 = Very concerning.

A variety of demographic questions were also asked, including age, gender, level of educational attainment, household income level, and political beliefs. Also included in this survey instrument were a series of questions collecting data on the characteristics of respondents' maple enterprises and maple business performance. These characteristics include the years an enterprise has been in operation; whether a business loan or line of credit has been secured to support the enterprise; what specific technologies are used in the harvesting and processing of maple sap into syrup; and their use of hired labor. Performance metrics considered include ten-year changes in profitability and yield alongside the percentage of maple syrup produced by an enterprise sold at bulk prices.

4.3.2 Data Analysis

Statistical analyses are all performed in Stata 15.1. To identify discrete subgroups of maple operations, we use factor analysis of enterprise characteristics to identify meaningful, emergent clusters within the sample data. We follow the procedure described by Makles (2012) to construct a *k*-means partitional clustering algorithm. It suggests a

multi-criterion approach to selecting an optimal cluster number based on within sum of squares (WSS), log(WSS), the proportional reduction in WSS for each cluster solution compared with the total sum of squares (η^2), and the proportional reduction in error (PRE) between *k* and *k*-1 clusters. Using the *Kmeans* multivariate analysis function in Stata (stata.com, n.d.), clusters of $k = 1$ through $k = 20$ are generated and then analyzed using ANOVA calculations for all enterprise characteristic variables across all cluster sets *k*. WSS, log(WSS), η^2, and PRE values for each cluster set are retained and plotted for visual analysis to determine the optimum number of clusters.

To normalize certain data, the natural log of the number of trees reported to have been tapped in the year 2019 is reported and included in subsequent analyses. Gallons per tree is calculated in terms of overall production in 2019 by number of tapped trees reported. After determining a meaningful cluster set based on the above parameters, we conduct a series of bivariate tests across enterprise characteristics incorporated into the clustering algorithm to determine the significance of between-group differences including t-, Wilcoxon-Mann Whitney, and Chi-square tests. We also analyze these subgroups in terms enterprise performance: again, relying on Wilcoxon-Mann Whitney for percentage of maple syrup produced sold at bulk prices and Chi-square tests for reported increases in profitability and yield.

We first examine bivariate associations between risk measures and various cluster subgroups, enterprise and demographic characteristics. The effects of respondents' age, percentage of household income from sugaring, the natural log of the number of trees trapped, and gallons of syrup produced per tree on stated climate change and risk-concern

attitudes are assessed using a non-parametric Spearman correlation. For ordinal demographic and enterprise variables (education level, household income level, and reported years in operation), Kruskal-Wallis analyses of variance are performed on the same climate and risk-concern attitude metrics. For binary variables (gender; conservative political beliefs; and the range of enterprise characteristics encompassing certification, the use of high-vacuum tubing, wood fuel, reverse osmosis, and hired labor), we use a series of Wilcoxon-Mann Whitney tests. We also compare climate change attitudes across enterprise subgroup clusters using Wilcoxon-Mann Whitney tests.

To control for pertinent demographic and enterprise performance characteristics in our analysis of variations in attitudes toward both climate change and risk perceptions, a multinomial logit model is specified:

$$P(\, y_i = k \,) = \beta_{\text{Age}}\, x_{\text{Age}} + \beta_{\text{College}}\, x_{\text{College}} + \beta_{\text{BulkSales}}\, x_{\text{BulkSales}} + \beta_{\text{Attitude}}\, x_{\text{attitude}} + \sigma_i$$

where y_i is the probability that some producer *i* belongs to cluster *k*, the term x_{Age} is a continuous variable of respondents' age, x_{College} is a binary variable denoting whether a respondent has achieved a bachelor's degree, and $x_{\text{BulkSales}}$ is a continuous variable for the percentage of maple syrup produced by an enterprise that is sold at bulk prices. $X_{Attitude}$ is a binary response to either a climate change attitude or risk perception question. Climate change attitudes are coded to reflect a statement of agreement with a climate change proposition outlined in *Table 9* (e.g. "Partially agree," "Agree," or "Strongly agree"). Binary recoding of risk perception questions only accounts for responses indicating

heightened concern about a particular risk (e.g. “Very concerning”). β_{Age}, $\beta_{College}$, $\beta_{BulkSales}$ and $\beta_{Attitude}$ are estimated parameters – and σ_i the error term. To interpret the effect of each parameter on cluster outcomes for models including risk perceptions, we report results in our regression tables as average marginal effects (AMEs).

4.4 Results

4.4.1 Enterprise Subgroup Characteristics

Respondents were generally around 60 years old, male (82%), with some college education, and report an average annual household income between $50,000 to $75,000. Most respondents identify their political affiliation around both poles of the political center (with a cumulative 60.3% identifying as either Center Left, Center, or Center Right); self-described Independents make up the largest single category at 25.6% of collected responses. Sample enterprises cover a considerable range in terms of operation scale, from those with as few as fourteen trees to and enterprise with more than 200,000 trees producing 80,000 gallons of maple syrup over the 2019 season. Enterprises have on average been in operation for between twenty and thirty years – though the survey data itself reflects results from operations less than five years old to over 40 years in operation. Nearly half (48%) of respondents report taking out at least one business loan or line of credit to finance their maple sugaring enterprise.

Out of all maple operations surveyed, 35.8% report holding at least one certification: including organic (23.9%), bird-friendly (14.2%), or kosher (2.8%). High vacuum tubing with over 20HG of pressure is the most common harvesting method used by respondents (62%), followed by low vacuum tubing (24%), no vacuum tubing (16%),

or simple bucket/bag collection (14%) (some respondents reported more than one means of sap collection). Wood-fired evaporation is by far the most common means of processing sap (65%), with oil fueling another 33% of evaporators – with the few unaccounted-for operations relying on either propane or wood chips. Most enterprises surveyed incorporate reverse osmosis processing into their production practices (76%), and only 34% report currently using hired labor. Yield (n = 143) and profitability (n = 138) have remained largely the same over the last ten years – with less than half of enterprises surveyed reporting an increase in either measure. Consistent with statewide figures (NASS, 2019), syrup sold at bulk prices accounts for the largest proportion of sales among surveyed producers (64.7%).

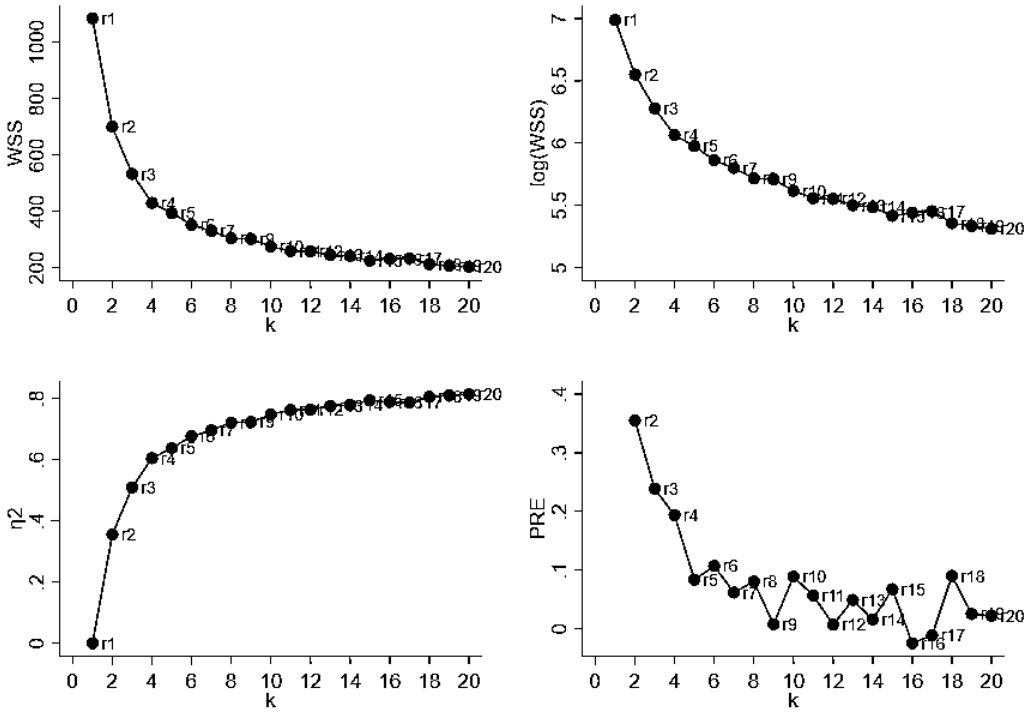

Figure 5. *WSS, log(WSS), η2, and proportional reduction in error across k enterprise clusters.*

In our enterprise subgroup clustering procedure, both WSS and log(WSS) noticeably taper at $k = 4$: the characteristic "kink point" in a scree plot indicating diminishingly meaningful within-group characteristics as more clusters are added (see *Figure 5*). Weighted in terms of total sum of squares, the graph of η^2 values also suggests a proportional reduction in the magnitude of WSS at $k > 4$. We also note a drop in PRE between $k = 4$ and $k = 5$ – again suggesting that a four-cluster *k* means analysis provides a sufficient number of enterprise categories while retaining meaningful distinctions between each group. Descriptive statistics for these clusters can be found in *Table 10*.

Table 10. *Descriptive statistics for maple enterprise cluster subgroups.*

	Cluster				
Variables	*1*	*2*	*3*	*4*	μ
Trees	871	965	9117	12538	6831
Gallons per tree	0.25	0.38	0.40	0.40	0.36
Years in production	5.11	2.00	3.04	5.76	4.13
Loan/credit for enterprise	18.4%	38.2%	65.3%	63.6%	49.4%
Hold a certification	13.2%	20.6%	57.1%	41.8%	35.8%
Use vacuum tubing (20HG+)	23.7%	58.8%	83.7%	71%	61.9%
Use wood fuel	81.6%	76.5%	44.9%	63.6%	64.8%
Use reverse osmosis	36.8%	61.8%	93.9%	94.5%	75.6%
Use hired labor	10.5%	8.8%	42.9%	58.2%	34.1%
n =	**38**	**34**	**49**	**55**	
More profitable (last ten years)	25.0%	30.8%	48.6%	61.1%	45.7%
Higher yield (last ten years)	29.0%	30.8%	48.6%	58.2%	45.5%
% sold at bulk prices	36.9%	40.5%	82.9%	68.6%	64.7%

Subsequent bivariate analyses show significant variation in most of the enterprise characteristics used in generating the four identified clusters. Based on the descriptive statistics provided in *Table 10*, we characterize these new subgroups as: *small-scale retail producers* (Cluster 1), *mixed commercial retail producers* (2), *specialized commercial producers* (3), and *legacy commercial producers* (4). *Small-scale retail producers* and *mixed commercial retail producers* manage enterprises of less than 1,000 trees producing mostly for sale in direct retail markets. They differ substantially in terms of technology use: with a higher proportion of *mixed commercial retail producers* incorporating reverse osmosis purification and high vacuum tubing into their production systems. *Specialized commercial producers* oversee drastically larger, primarily certified enterprises producing for sale in bulk commodity channels. These producers also utilize productivity-enhancing technologies and alternative fuel sources at higher rates than any other producer subgroup. *Legacy commercial producers* – the largest and oldest cohort of producers on average – rely extensively on hired labor and incorporate a mix of modern technologies and traditional practices into their maple enterprise. Despite their production scale, *legacy commercial producers* rely on retail sales for a substantial proportion of their enterprise income.

4.4.2 Attitudes Towards Climate Change

Identified cluster groups, producer demographics, and enterprise characteristics are now considered in relationship to climate change attitudes. Overall, roughly half of respondents consider that the effects of climate change pose a threat to their maple

sugaring operation (55%, N = 171; *Figure 6*) – with most agreeing that such impacts are already noticeable in their region (64.1%, N = 170). Though only 12.2% of respondents report observing maple dieback attributable to the effects of climate change, most agree that climate change itself has led to variability in (64.3%, N = 171) and earlier beginnings to the maple production season (60.8%, N = 171).

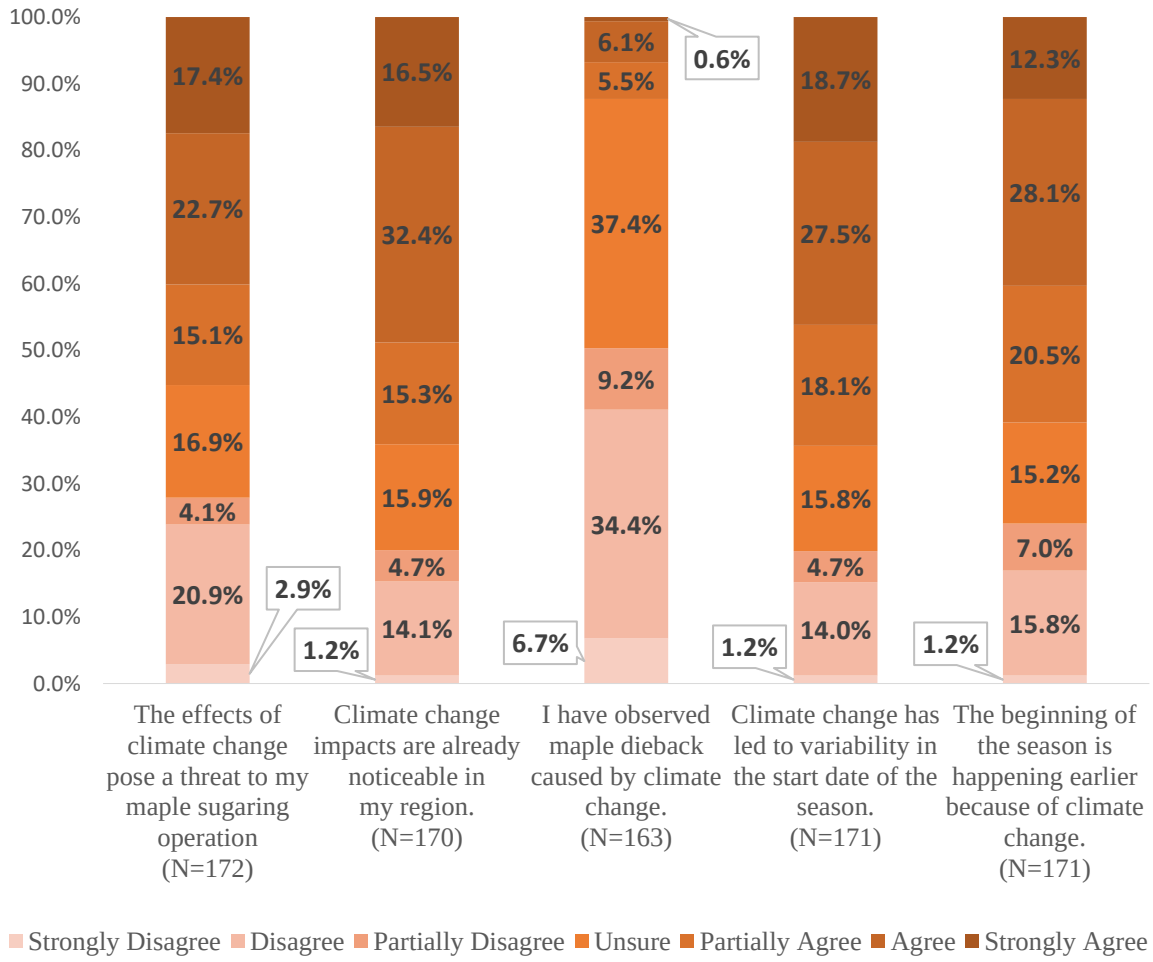

Figure 6. *Perceptions regarding the effects of climate change.*

Almost 22% of respondents report uncertainty regarding the veracity of the projected impacts of climate change – with an additional 31.4% agreeing that the impacts

are in some sense overstated (N = 169, *Figure 7*). Fifty percent of respondents disagree outright that, despite advances in meteorological forecasting and forest stand monitoring technology, it is easy to determine the best moment to tap their maple trees – while the other half either are unsure (16.1%) or believe this to be true to some extent (27.4%). Most agree that the impacts of climate change are emerging slowly enough to allow their enterprises to adapt as they occur (60.9%, N = 169) – with less than nineteen percent doubting their capacity to adapt.

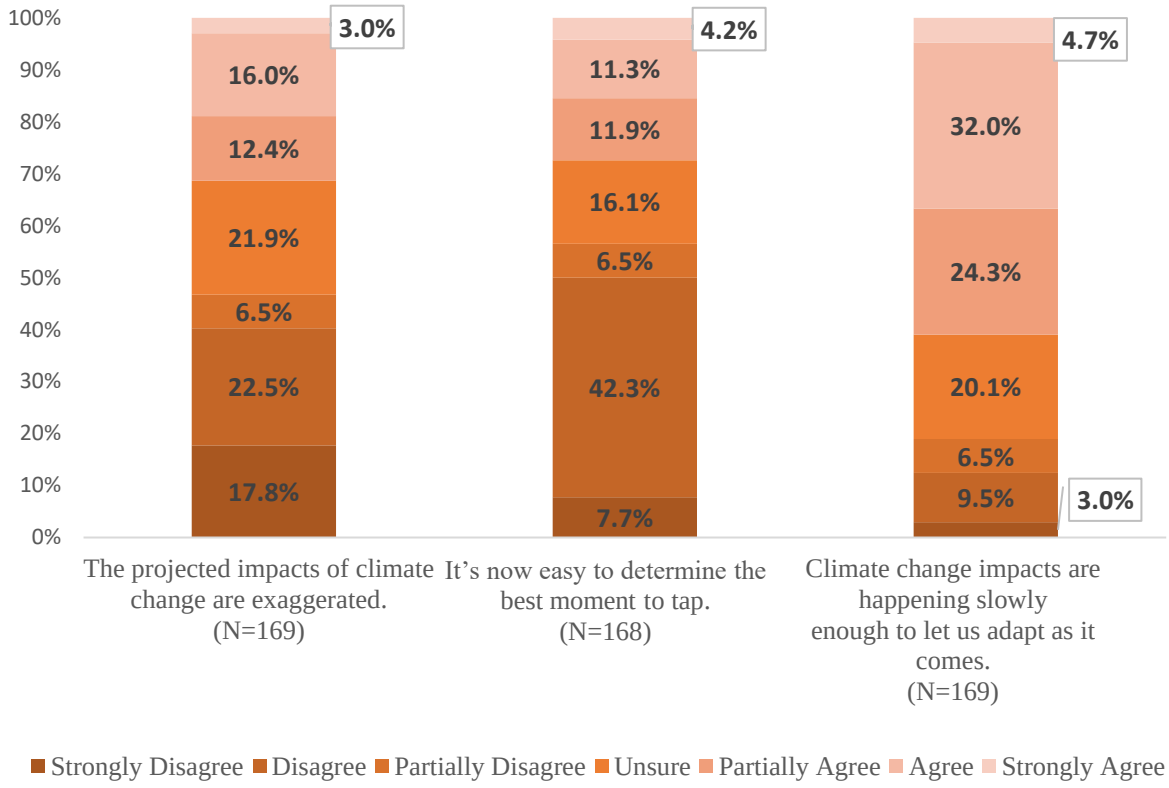

Figure 7. *Skeptical attitudes, tapping ease, and adaptability to climate change.*

Attitudes across enterprise clusters are largely consistent: especially regarding the threat climate change poses, the likelihood of its projected impacts, and the observation of direct effects like seasonal variability. *Mixed commercial retail producers* are less likely to both report noticing the impacts of climate change in their region ($Z = 1.83$, $p < 0.1$) and attribute these impacts for earlier seasonal start dates ($Z = 2.38$, $p < 0.05$). L*egacy commercial producers* are, on the other hand, significantly more likely to attribute earlier seasons to climate change ($Z = -2.179$, $p < 0.05$). Despite lower reported rates of experiencing direct effects, *mixed commercial retail producers* have significantly lower confidence than other cluster groups in their own ability to adapt to the onset of climate change ($Z = 2.04$, $p < 0.05$).

Larger operations in terms of trees tapped are more likely to report that climate change has led to variability in the start of the season ($Rho = -0.11$, $p < 0.1$) and are significantly more likely to report having an easier time determining optimal tapping conditions ($Rho = 0.18$, $p < 0.05$). Older enterprises tend to report noticing the effects of climate change in their region ($Chi2 = 9.31$, $p < 0.1$) while loan- and credit-financed enterprise tend to accept that seasonal variability is an effect of climate chance ($Z = -1.65$, $p < 0.1$) – and that their operations' are able to adapt ($Z = -2.69$, $p < 0.01$). Moreover, higher percentages of sales at bulk prices tends to coincide with an increased likelihood of perceiving climate change as an enterprise threat ($Rho = 0.16$, $p < 0.1$). Enterprises reporting increased profitability over the last ten year are statistically more certain about the impacts of climate change in their region ($Z = -2.48$, $p < 0.05$) – and are similarly more likely to attribute these impacts for earlier production seasons ($Z = -2.75$, $p < 0.01$).

Production practices also predict climate change perceptions and attitudes. Certified enterprises are significantly more concerned by the effect of climatological transition ($Z = -2.67$, $p < 0.01$), perceptive of its effect on causing maple dieback ($Z = -2.29$, $p < 0.05$) and earlier sugaring seasons ($Z = -1.83$, $p < 0.1$); and confident in their own ability to adapt ($Z = -2.69$, $p < 0.01$). Enterprises using reverse osmosis technology, however, are statistically more likely to disbelieve the severity of projected climate change effects ($Z = -2.00$, $p < 0.01$) and report an easier time determining when is best to tap each season ($Z = -2.23$, $p < 0.05$).

Respondents reporting at least some college-level education believe more strongly in the severity of the projected impacts of climate change ($Chi2 = 7.21$, $p < 0.1$) and are generally more concerned about its effects on their enterprises ($Chi2 = 8.69$, $p < 0.05$). Conservatives are overall very skeptical about the effects of climate change: roundly less concerned about its impact on enterprises ($Z = 3.70$, $p < 0.01$) and less likely to report any apparent effects in the region ($Z = 4.48$, $p < 0.01$). Due perhaps in part to lower rates of perceiving phenomena like earlier ($Z = 4.10$, $p < 0.01$) and varying ($Z = 4.33$, $p < 0.01$) sugarmaking seasons as an effect of climate change, conservatives are also generally more confident in their ability to adapt their enterprises ($Z = -1.88$, $p < 0.1$).

4.4.3 Social-Ecological Risk Comparisons

In context with a broader set of risks (*Figure 8*), concerns about the impact of natural events on long-term enterprise viability are still the most pervasive category of concern amongst producers (with 76.8% ranking them as “Concerning” or “Very

concerning," N = 168). Low prices, however, are the most often cited as "Very concerning" (33.1%), and second only to the impact of natural events in terms of stated concern. Most respondents (70.4%, N = 169) consider the loss of family farms to be either "Concerning" or "Very concerning," followed by the perceived risk of regulatory burden (69.4%, N = 170), equipment costs (68.5%, N = 168), and maple substitutes (57.7%, N = 168). Only half of producers surveyed consider competition from Canadian maple sugarmakers a notable risk confronting their enterprise (50.3%, N = 169). Competition from other Vermont producers is an even less pressing risk – with only 39.8% considering it a "Concerning" or "Very concerning" risk (N = 171). Fuel costs (34.3%, N = 166) and competition from other U.S. producers (33.5%, N = 170) are the two lowest ranked risks in terms of any reported extent of concern.

Though consistent in terms of attitudes regarding the risk posed by natural events, enterprise subgroups vary considerably in their perception of different Economic Risks. *Small scale retail* (2.87, $p < 0.01$) and *mixed commercial retail producers* (2.88, $p < 0.01$) are significantly less likely to report concerns about labor cost while *specialized commercial* (-2.45, $p < 0.05$) and *legacy commercial producers* (-2.58, $p < 0.05$) are significantly more concerned. Similarly, *small-scale retail producers* are generally less concerned by the risk posed by low sale prices ($Z = 2.61$, $p < 0.01$) – especially when compared with *specialized commercial producers* ($Z = -1.75$, $p < 0.1$) who tend to be the most concerned by low maple prices.

Specialized commercial producers and *small-scale retail* producers are in turn both the most ($Z = 2.54$, $p < 0.05$) and least ($Z = -1.74$, $p < 0.01$) likely to report being

very concerned by low prices. *Small scale retail producers*, however, tend to be very concerned more often by regulatory burden than any other producer group ($Z = -.194$, $p < 0.1$) – while *specialized commercial producers* tend towards being very concerned more often by the threat posed by maple substitutes ($Z = -1.74$, $p < 0.1$). *Mixed commercial retail producers* are significantly more likely to report being very concerned by low-quality maple syrup ($Z = 2.57$, $p < 0.05$).

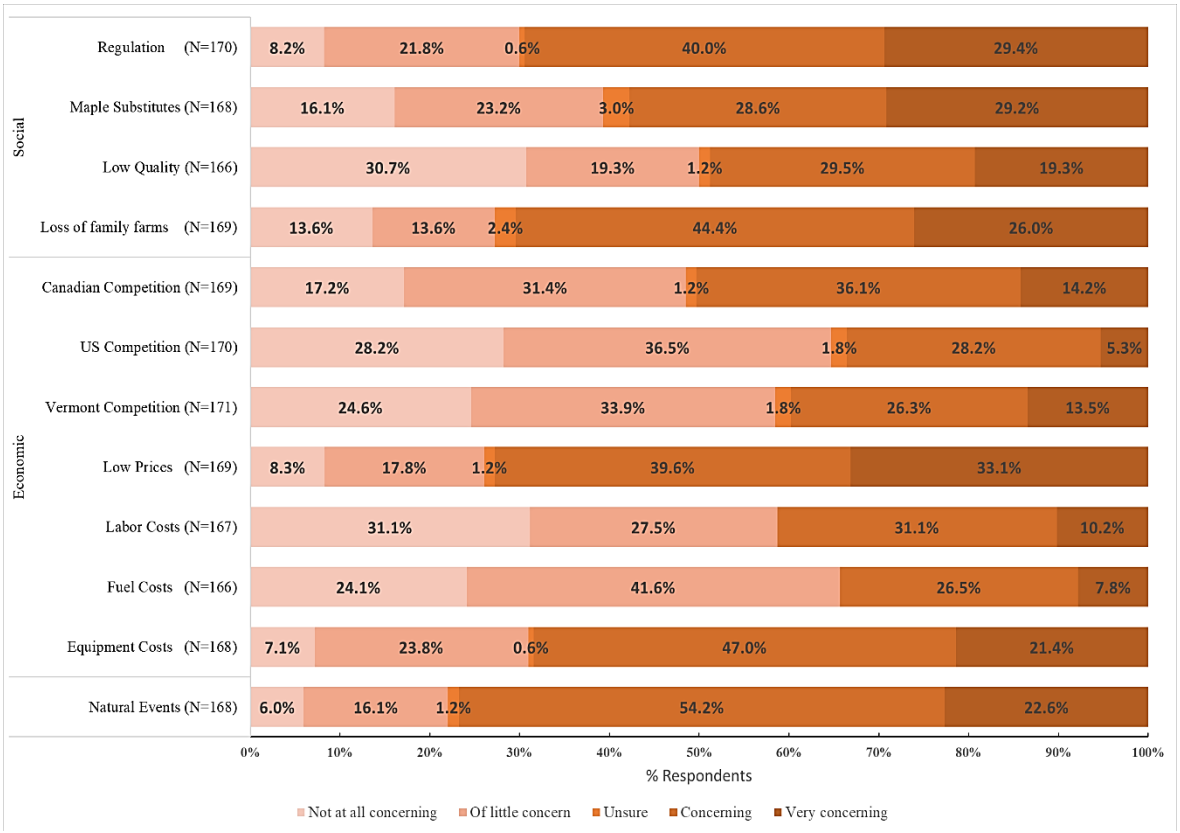

Figure 8. *Respondents' assessments of specific social, economic, and environmental risks.*

Heightened concern over the risk posed by natural events (e.g. “Very concerned”) is common among certified ($Z = -2.3$, $p < 0.05$) and – to a lesser extent – debt-financed enterprises ($Z = -1.71$, $p < 0.1$). Indicators of commercial scale, like higher numbers of tapped trees ($Rho = 0.44$, $p < 0.01$), per-tap yield ($Rho = 0.15$, $p < 0.1$), and the use of high-vacuum ($Z = -3.89$, $p < 0.01$) and reverse osmosis systems ($Z = 4.10$, $p < 0.01$) generally coincide with greater rates of concern about labor costs – and similarly for fuel expenses. Threats especially pertinent to commodity channel producers also coincide with more commercialized enterprises: as larger producers ($Rho = 2.10$, $p < 0.01$) using high-vacuum tubing ($Z = -3.12$, $p < 0.01$) and reverse osmosis purification ($Z = -2.58$, $p < 0.01$) tend to express the highest rates of concern about Canadian competition. Wood-fired enterprises, on the other hand, are generally less concerned about the input costs of fuel ($Z = 4.79$, $p < 0.01$) and labor ($Z = 2.37$, $p < 0.05$) – and low maple prices more generally ($Z = 2.31$, $p > 0.05$).

Increased enterprise profitability over the last ten years tends to coincide with significantly higher rates of concern regarding the risk posed by labor costs ($Z = -1.92$, $p < 0.1$), while those reporting higher yields over the same time frame are significantly more concerned about the effect of low maple prices ($Z = -2.04$, $p < 0.05$). Increased yield coincides with lower concern about competition from other US producers ($Z = 1.74$, $p < 0.1$) as does a higher proportion of sales made at bulk prices ($Rho = -0.15$, $p < 0.1$). Enterprises engaged more heavily in bulk sales are also remarkably less concerned by the threat posed by other Vermont producers ($Rho = -0.18$, $p < 0.05$).

Older respondents are significantly less concerned about the financial strain of both low maple prices (Rho = -0.2409, $p < 0.01$) and high labor costs (Rho = -0.197, $p < 0.05$). A higher household income level tends to coincide with a decreased likelihood of reporting concerns related to equipment costs (Chi2 = 9.90, $p < 0.1$). As suggested under previous analyses of climate change attitudes (Burke & Emerick, 2016), conservative respondents are concerned to a substantially lesser degree about the effect of natural events than other producers ($Z = 1.7$, $p < 0.1$).

4.4.4 Multivariate Analysis of Cluster Groups

Table 11.

Estimated AME for the base multinomial logistic producer cluster model

	Legacy retail	*Mixed commercial retail*	*Specialized commercial*	*Legacy commercial*
Age	0.010 ***	-0.008 ***	-0.009 ***	0.008 **
College Education	-0.135 ***	-0.025	0.034	0.126
% Syrup sold as bulk	-0.003 ***	-0.004 ***	0.006 ***	0.001 ***
Obs		126		
LR chi2		86.52		
Prob > Chi2		0.000		
Psuedo R^2		0.2660		

Note. ** $p < 0.05$ and *** $p < 0.01$.

In specifying the base multinomial model of enterprise and operator characteristics for evaluating variation in climate change attitudes social-ecological risks perceptions (*Table 11*), respondent age, education at the college level, and percentage of

syrup sold at bulk prices accounts for over 26% of the variation between cluster categories. While age is significantly associated with cluster assignment (with a *legacy* assignment marginally more likely as age increases), college education – or, more precisely, the lack thereof – is only significant in the case of *legacy retail* producers. The percentage of maple syrup produced by an enterprise sold at bulk prices is the strongest and most reliably significant predictor of cluster category.

As shown in *Figure 9*, rates of bulk sales between zero and 30% probabilistically coincide with a greater likelihood of falling into either the *legacy retail* or *mixed commercial-retail* producer category compared to larger-scale cluster groups. At bulk sales rates above and around 40%, we find that enterprises are most likely to classify as a *legacy commercial* producer. Enterprises selling 80% or more of the syrup at bulk prices are the most likely to classify as *specialized commercial* producers: meanwhile, the likelihood of a *legacy commercial* classification declines and *legacy retail* and *mixed commercial retail* probability approaches zero.

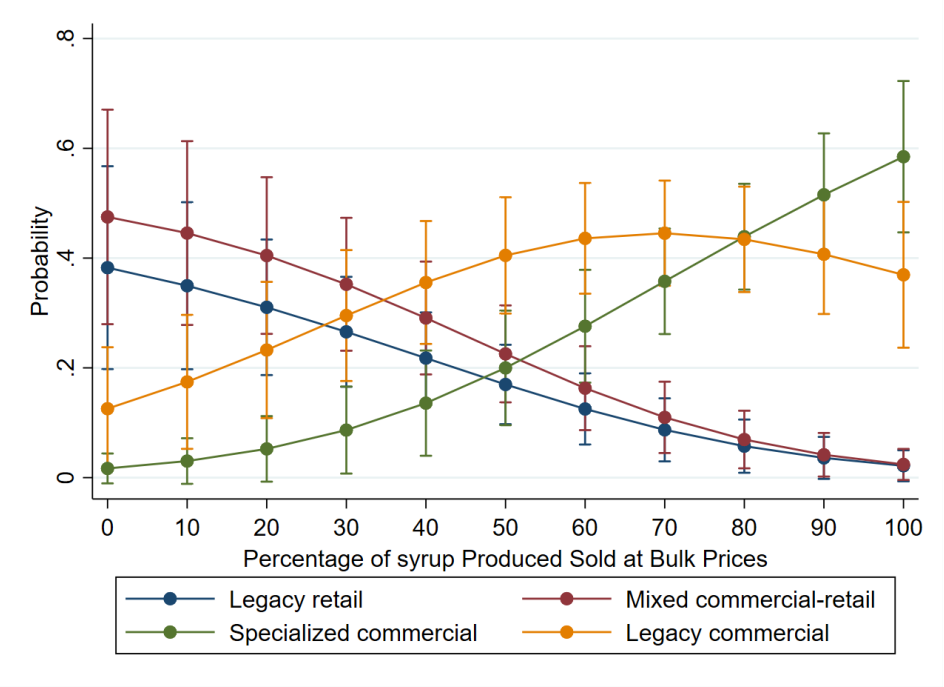

Figure 9. *Probability of cluster assignment by percentage of syrup produced sold at bulk prices.*

In multinomial analyses of cluster categories controlling for base model conditions described in *Appendix IV*, attitudes and beliefs regarding climate change are largely insignificant in predicting cluster membership. Respondents who report easily determining when is best to tap their maple trees are statistically *less* likely to categorize as a *legacy commercial* producer ($p < 0.1$). Similarly, respondents who attribute variability in the start date of the maple season to climate change are less likely to qualify as a *mixed commercial retail* producer ($p < 0.1$).

Average marginal effects determined from results of the multinomial analysis (shown in *Appendix V*) suggest for the most part that heightened concern regarding specific economic, social, and environmental risks are statistically consistent between enterprise clusters. When controlling for base model conditions, respondents reportedly

"very concerned" by the cost of fuel are almost 1% less likely to categorize as a *legacy retail* producer than those who are not (*AME* = -0.009; $p < 0.1$). On the other hand, those concerned to this extent about the cost of maple equipment are approximately 2.8% *more* likely to classify as a *legacy retail* producer (*AME* = 0.028, $p < 0.1$).

We find a lower likelihood of classifying respondents very concerned by labor costs as *mixed commercial-retail* producers (e.g. smaller enterprises using a mix of contemporary equipment and traditional production practices; *AME* = -1.384, $p < 0.1$). Though this is a comparatively large AME value, the effect is understandable given that only *one* respondent in the *mixed commercial-retail* producer cluster reported being "very concerned" by labor costs and that cluster assignment itself is heavily accounted for by age and percentage of syrup sold at bulk prices. This is also the case with the effect of low syrup quality concerns on *mixed commercial-retail* cluster assignment (which itself is determined as statistically insignificant).

Reporting heightened concern about the loss of family farms is the most statistically significant predictor of cluster assignment across all analyzed risk perceptions: entailing an approximately 13.3% higher likelihood of *legacy retail* classification when holding all other factors constant (*AME* = 0.133; $p < 0.01$). Those reportedly very concerned by the market presence of maple substitutes in the table syrup market are nearly 20% *less likely* to qualify as a *legacy commercial* producer when controlling for their age, education level, and percentage of bulk sales (*AME* = -0.196, $p < 0.05$). With respect to evaluations of risk posed by natural events, differences in the

likelihood of cluster assignment is found to be statistically insignificant across all producer categories.

4.5. Discussion

This study evaluates variation in attitudes towards climate change and other social-ecological risks across distinct types of maple operations, enterprise characteristics, and producer demographics. In support of insights from previous studies (Lane et al., 2019; Snyder et al., 2019), our results show evidence of significant variation in how risks are evaluated by different kinds of producers and enterprises. Findings especially emphasize that variation in the perception of risks is as reflective of differences between producers themselves as it is the technology or production practices they employ.

Larger, certified enterprises tend to believe more often in the effects and threat posed by the onset of climate change – as do those reporting higher yields and profitability over the last ten years. Enterprises more heavily engaged in bulk production practices (e.g. labor- or technologically- intensive production mostly for sale at bulk prices) also tend to take more seriously the threat posed by the effects of climate change – especially *legacy commercial producers* (the largest and oldest subgroup of enterprises on average). Specialized production practices tend to coincide with a stronger belief in an enterprise's ability to adapt in the face of climatologically induced threats: especially by certified producers and those using high-vacuum tubing and reverse osmosis purification systems.

Turning towards a broader range of issues, the impacts of natural events, low maple prices, and loss of family farms are the most pervasive sources of concern for producers. Concerns about competition are relatively less widespread but pronounced among larger, more commercialized enterprises. Competition from Canadian producers is especially concerning for larger enterprises – as are perceptions of the risk posed by rising labor and fuel costs. Concerns regarding the competition posed by other Vermont and US producers tends to fall as bulk market engagement and yield increases. Cost and price concerns are also more common amongst debt-financed enterprises and those using more technologically advanced production practices. Respondents using high-vacuum tubing, a yield-enhancing adaptation, are the only subgroup of enterprises statistically more concerned about competition from maple substitutes: an historical source of uncertainty in conventional bulk market channels (Thomas, 2018). Enterprises using more traditional production practices – especially firewood – tend to be less concerned about input and pay price related economic concerns.

Those most reliant on wood fuel – *small-scale retail* and *mixed commercial retail producers* – tend to emphasize concerns within the social domain over explicitly financial considerations. *Small scale retail producers* are more commonly concerned with regulations, for which a precedent clearly exists given the widespread uncertainty over the enforcement of FDA standards and regulations (Gregg, 2019). Amongst *specialized commercial producers*, a clearly heightened sense of concern exists around market competition from artificial maple substitutes. Given the documented history of competition between maple and cane sugar in the table syrup market (Ramsingh, 2018;

Thomas, 2018), bulk markets still seem to be a point of contention between maple producers and the suppliers of lower-cost sugars.

Interesting as well are the risks perceived by sugarmakers practicing certified production practices and those incorporating newer technologies into their enterprises. In the case of climate change, while producers incorporating either strategy tend to express confidence in their ability to adapt, more technologically inclined producers are significantly less concerned about any long-run impacts. This makes sense in line with previous findings of year-to-year yield increases on large and technologically advanced maple operations in Vermont despite disadvantageous environmental conditions (Perkins, Isselhardt & Van Den Berg, 2015). Though certified producers tend to feel acutely exposed to the threats posed by climate change, likely due in part to process-based standards constraining their use of yield-optimizing forest management practices (NOFA-VT, 2014; Saha, 2017; Forest Stewardship Council, 2016), they also express a greater situational awareness of climate change-related events like maple dieback and earlier sugaring seasons.

Under bivariate analyses, we find a significant relationship between higher levels of educational attainment with belief in climate change and the risk it poses to maple enterprises. As noted in previous research (Kuehn, Chase & Sharkey, 2017; Burke & Emerick, 2016), attitudes towards climate change tend to coincide strongly with political beliefs – especially in terms of expressing skepticism about its projected effects. Perhaps for that reason, we also find that conservative respondents have a significantly higher belief in their own ability to adapt their enterprises with the challenges it poses.

Various instances appear in our multinomial logistic regression analyses suggesting that climate change attitudes and risk perceptions meaningfully segment in terms of likely coinciding with different producer clusters. Under models controlling for age, college education level, and bulk sales, those who easily determine when best to tap their maple trees and attribute earlier production seasons to the effect of climate change are, *ceteris paribus*, significantly less likely to classify as either *legacy retail* or *mixed commercial retail* producer respectively. Respondents concerned by the cost of maple equipment are nearly 3% more likely than those who are not to fit the *legacy retail* classification – while those expressing concerns regarding fuel costs are nearly 1% less likely. As would be expected, participants classified as *mixed commercial retail* producers (who, according to *Table 10*, operate the least labor-intensive enterprises out of all cluster categories) are especially unlikely to express a heightened concern regarding labor costs.

Despite the historically contentious competition between maple producers and substitute sugars in commodity markets, participants expressing a high degree of concern about maple substitutes are – again, holding all else equal – almost 20% *less* likely to classify as a *legacy commercial* enterprise. The loss of family farms is the most significantly predictive out of all risks considered: with respondents stating a high level of concern regarding this issue over 13% more likely than those who do not to classify as a *legacy retail* producer. Together, these findings seem to imply a difference in the effectiveness of enterprise management strategies of *legacy* products. *Legacy commercial* producers relatively diverse range of marketing and production strategies may be partially responsible for their diminished concern about competition from maple

substitutes in bulk commodity channels. *Legacy retail* producers, on the other hand, are significantly more likely to express a fundamental concern regarding the very survival of enterprises like their own.

4.6 Conclusion

This study sought to compare and contrast concerns expressed by different groups of maple producers toward a range of social-ecological risks. Substantial variation is seen across enterprise groups in terms of specific attitudes towards climate changes and various other social, economic, and environmental threats. *Small scale retail producers* tend to reflect recently heightened concern about the enforcement of regulatory oversight on smaller scale maple enterprises (Gregg, 2019). Findings regarding this especially acute threat perception coincide with attitudes identified amongst relatively large syrup producers in Wisconsin and Michigan – who are also concerned by regulatory oversight and produce at scales roughly equivalent to that of a *small-scale retail producer* in Vermont (Snyder, Kilgore & Emery, 2019).

Mixed commercial retail producers are the most concerned about their enterprises' abilities to adapt in the face of climate change – and express the greatest levels of concern related to maple syrup quality. This set of risk perceptions coincides with the middle ground these producers seem to occupy between *retail*- and *commercial*-scale business practices: relying both on direct sales in roughly the same proportion as *small scale retail producers,* but with markedly higher rates of technology use and per-tap efficiency that are more comparable to those of *specialized* and *legacy retail*

producers. The threat perceptions of *specialized commercial producers* seem to best typify pressing concerns within conventional bulk markets channels: namely competition from maple substitutes and low prices. *Legacy commercial producers* are the same in this last respect – but, given their business model, also express relatively more concern about labor costs. These *legacy* producers constitute the most financially successful out of all enterprises surveyed – reporting significantly higher rates of ten-year profitability and yield growth than other producer clusters.

For those interested in encouraging enterprise adaptations amongst maple producers and enhancing the resilience of both the states' forestland and traditional livelihood practices to ecological and socioeconomic changes, these findings provide valuable insights in terms to guide how best to engage with different kinds of maple enterprises. As highlighted in previous work, personal beliefs and maple production's place in a broader set of livelihood practices plays an operative role in informing how producers interpret and prioritize threats within a complex and interrelated set of social-ecological risks.

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Chapter 5: Conclusion

5.1. Overview of Findings

As maple enterprises in Vermont continue facing new challenges, understanding the behavior of both producers and consumers is vital to navigating change within the industry. This research sought to evaluate risk perceptions among both groups: in terms of perceived risks' effects on consumers' WTP for "Made in Vermont" maple syrup and how perceived risks vary across maple enterprises.

In Chapter 3, results from an analysis of statewide survey data suggest that Vermont residents are motivated to pay extra for locally sourced maple products in part out of concern for the industry itself. This is especially true for those concerned by the loss of family farms: who on average are willing to pay around six percent more for eight ounces of "Made in Vermont" maple syrup. Increasing public awareness of the multifunctional benefits associated with purchasing Vermont maple syrup could help in securing higher pay prices for producers – which is especially important given prevailing trends in conventional bulk markets.

Chapter 4 shows that producers themselves vary in their perceptions of the risks they consider most threatening to their maple enterprises. While larger scale commercial producers are more likely to notice and take seriously the effects of climate change, specialized production practices and newer technologies coincide with higher levels of confidence in enterprises' ability to emerging, climate-induced threats. Moreover, this study presents compelling evidence that producers' perceptions of risks are informed by

both components of their enterprises (e.g. their size, production practices, and use of technology) as well as education level, overall household income, and political beliefs.

When asked to consider a broader range of social-ecological issues, larger producers tend to emphasize economic threats like input costs and low prices – while smaller-scale retail producers express higher levels of concern towards issues of regulatory compliance and product quality. Overall, however, perceptions related to both climate change and risks in general heavily coincide with producers' household income, education, and political beliefs. This work also yields four generalizable typologies related to production scale, enterprise duration, and specific production practices useful for both categorizing enterprises and analyzing different patterns of social and economic concern.

5.2. Limitations

Though the results of these analyses provide useful information regarding the perceptions of risks by Vermont maple consumers and producers, the methods adopted in approaching each research question present their own set of limitations. In the evaluation of consumer preferences and WTP, we relied on an implicit assumption that respondents were aware of the meaning of certain maple syrup-related quality and certification designations. In analyzing the collected survey data, respondent also reported acquiring maple syrup through a variety of ways that did not conform to answer options: including gift-exchange and at-home production. Omitting a more diverse range of options may perhaps have skewed our estimates of alternative supply channels lower as a result.

Another set of limitations is bias within the survey that tends to skew towards older, higher-income, and more highly educated participants. Given its importance in explaining WTP, accounting of the effect of household income through an ordinal variable limits a crucial source of data that is especially useful for optimizing estimates. Our measure of WTP also presents its own limitations as it was also captured on an ordinal scale with an indeterminate upper-bound (e.g. respondents were asked if they "would…pay more than $11 for eight ounces of 'Made in Vermont' maple syrup").

The presented analysis of producer risk perceptions must also be qualified within the boundaries of its limitations. First, contact information for participants in online and telephone surveys were drawn from industry databases: perhaps entailing selection bias which may limit the generalizability of these findings about Vermont maple enterprises. Elements of our data collection process also introduce specific limitations. Evaluations of enterprise performance in terms of increased yield and profitability relied solely on the self-reports of producers – not actual financial or agronomic data. Enterprise scale itself is captured in terms of the number of trees tapped rather than number of taps or acres of productive forestland, which in future efforts may prove to be more effective measures.

Measures of producer risk perceptions also present notable limitations. While respondents were asked about specific attitudes regarding the effects of climate change, "climate change" itself was not included in our categorical evaluation of risk alongside social, economic, and environmental factors. Moreover, attitudes towards environmental threats were captured entirely under a single "natural events" parameter – precluding an ability to make claims about what environmental dynamics maple producers consider to be most concerning to their enterprises.

An intrinsic limitation to the approaches adopted in both studies lies in their reliance on survey data and quantitative analyses to answer questions about a traditional livelihood practice that is rich with deeply seated cultural implications. While this, of course, does not invalidate statistical approaches to quantifying effects on WTP or enterprise concerns, there is certainly a sacrifice made in terms of qualitative depth. Fortunately, faculty members at UVM's Department of Community Development and Applied Economics (especially Dr. Sarah Heiss) have made inroads towards addressing this gap through qualitative research focusing on the interplay of gender roles in married households engaged in maple syrup production.

5.3. Future Research

Keeping in mind these limitations, the studies presented as part of this thesis project introduce considerations for future research into the Vermont maple industry. Findings from the analysis of Vermont consumers' WTP for maple syrup suggest that purchasing behavior is informed by respondents' desire to both support regional producers and maintain the multifunctional benefits derived from the practice of maple syrup production. From this insight, subsequent work can focus on ways consumer preference can be leveraged to pursue certain social and environmental stewardship goals. Given the role maple sugarmakers play as purveyors of cultural ecosystem services, use of contingent valuation measures would be an appropriate means of enumerating the different benefits the wider community derives from this traditional livelihood practice: whether through maintaining scenic forestland, providing a

connection with the state's agrarian heritage, or another set of uncompensated outcomes provided by producers.

Subsequent approaches quantifying consumer behaviors could aim towards a fuller inventory of Vermonters' WTP for other product attributes apart from just locally produced. This is especially important considering that results show heightened consumer demand for "all natural" maple syrup relative to rigorous and certified product quality claims. Defining what prices consumers are willing to accept for different product attributes would be crucial information for producers as they seek out production practices and marketing strategies to right size their enterprises in a changing marketplace. Again, contingent valuation analysis may be an appropriate approach to answering such questions.

As sugarmakers continue reckoning with the emerging effects of climate change, a growing global commodity market for maple syrup, and governance and regulation within the industry, the task of understanding producers' risk perceptions should be approached as a longitudinal question. For extension services and those otherwise engaged in helping maple enterprises adapt in an uncertain business environment, these findings hopefully underscore the importance of being attuned to the social and cultural dispositions of producers themselves.

The literature compiled as part of this thesis will hopefully provide future researchers with an overview of indicators relevant to other work approaching the Vermont maple industry as a complex social-ecological system. An especially engaging route for subsequent analysis lies in the application of geospatial data to analyzing

producers' perceptions of threats within the industry. Given that maple sugarmaking is fundamentally a relationship between human beings and the particularities of Northern hardwood forests, examining consumers and producers – at best – can only tell half of the story.

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Appendix

Appendix I.

Ordered logistic regression results of WTP for "Made in Vermont" sausage, controlling for individual and household characteristics.

Individual Characteristics	Odds Ratio	
Gender	0.87	
Age	0.99	*
Bachelor's Degree	1.81	**
Republican	1.04	
Household Characteristics		
Household income ≥ $75,000	1.64	
Rent	1.64	**
Household Size	1.17	
Number of children in household	0.72	**
Reside in Urban County	1.01	
Interaction Effects		
Republican x Age	1.00	
≥$75,000 x bachelor's degree	0.93	
≥ $75,000 x Urban	4.60	**
Bachelor's Degree x Urban	1.33	
≥$75,000 x bachelor's degree x Urban	0.15	**
LR χ^2	45.75	
Prob > χ^2	0.000	
Psuedo R^2	0.035	
N	517	

Note. * p < 0.1, ** p < 0.05, *** p < 0.01.

Appendix II.

WTP for "Made in Vermont" sausage, controlling for demographic effects and product labeling attitudes.

Indvididual Characteristics														
Gender	0.77		0.79		0.79		0.81		0.76		0.78		0.77	
Age	0.99		0.99		0.99		0.99		0.99		0.99		0.99	
Bachelor's Degree	2.00	**	2.02	**	1.84	**	1.94	**	2.06	**	2.08	**	1.88	**
Republican	0.98		1.06		1.01		1.56		0.83		1.17		0.91	
Household Characteristics														
Household income ≥ $75,000	1.87	*	1.78		1.66		1.63		1.76		1.96	*	1.69	
Rent	1.68	**	1.75	**	1.77	**	1.58	*	1.72	**	1.90	**	1.69	**
Household Size	1.16		1.19		1.21	*	1.23	*	1.22	*	1.17		1.22	*
Number of children in household	0.73	**	0.73	**	0.71	**	0.70	**	0.67	**	0.74	*	0.70	**
Reside in Urban County	0.94		0.94		0.89		0.90		0.83		0.88		0.87	
Interaction Effects														
Republican x Age	1.00		1.00		1.00		0.99		1.00		1.00		1.00	
≥$75,000 x bachelor's degree	0.66		0.70		0.89		0.80		0.85		0.75		0.86	
≥ $75,000 x Urban	3.54	*	3.75	**	4.00	**	3.94	**	4.57	**	3.53	*	4.07	**
Bachelor's Degree x Urban	1.22		1.22		1.45		1.38		1.35		1.39		1.41	
≥$75,000 x bachelor's degree x Urban	0.24	*	0.23	*	0.17	**	0.18	**	0.17	**	0.20	*	0.17	**
"Made in Vermont" Product Labeling Attitudes														
Maple syrup from Canada bottled in VT	0.87													

Maple Syrup from New York bottled in VT		1.19					
Cheese produced by VT company in New York			1.34				
Pork from Ohio processed in VT				1.27			
Baskets woven in VT with Chinese materials					1.55 **		
Alcohol produced in VT from imported grains						1.16	
Number of labeled products accepted							1.12 **
LR χ^2	41.33	41.14	43.77	40.63	47.9	40.85	47.36
Prob > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Psuedo R^2	0.034	0.034	0.036	0.339	0.040	0.035	0.038
N	480	480	477	465	461	456	493

Note. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix III.

WTP for "Made in Vermont" sausage, controlling for demographic effects and perceived maple industry concerns.

Indvididual Characteristics								
Gender	0.91	0.85	0.82	0.85	0.84	0.84	0.80	0.80
Age	0.99	0.99	0.99	0.99	0.99	0.99 *	0.99	0.99
Bachelor's Degree	1.87 **	1.84 **	1.93 **	1.81 **	1.95 **	1.73 *	1.98 **	2.01 **
Republican	1.1	1.00	1.22	1.06	1.05	0.93	0.91	1.09
Household Characteristics								
Household income ≥ $75,000	1.72	1.65	1.64	1.63	1.63	1.60	1.70	1.69
Rent	1.63 *	1.63 *	1.70 **	1.64 **	1.63 *	1.66 **	1.65 **	1.66 **
Household Size	1.17	1.16	1.17	1.16	1.18	1.16	1.18	1.16
Number of children in household	0.72 **	0.74 **	0.73 **	0.74 **	0.72 **	0.75 *	0.70 **	0.74 **
Reside in Urban County	1.10	1.05	1.07	1.05	1.09	0.99	1.08	1.20
Interaction Effects								
Republican x Age	1.00	1.00	1.00	1.63	1.00	1.01	1.00	
≥$75,000 x Bachelor's Degree	0.90	0.92	0.88	0.95	0.92	0.91	0.84	0.87
≥ $75,000 x Urban Residence	3.84 **	4.33 **	4.04 **	4.40 **	4.43 **	3.85 **	4.09 **	3.36 *
Bachelor's Degree x Reside in Urban County	1.14	1.22	1.15	1.18	1.20	1.24	1.10	0.91
≥$75,000 x Bachelor's Degree x Reside in Urban County	0.18 **	0.16 **	0.18 **	0.15 **	0.15 **	0.18 **	0.18 **	0.22 *
Maple Industry Concerns								
Low maple syrup quality	1.46 **							
Loss of wild animal habitat		1.36 *						
Costs of fuel oil			1.68 ***					
Market competition from outside VT				1.41 **				
Cost of maple equipment					1.60 ***			
Climate change						2.04 ***		
Loss of family farms							1.81 ***	
Number of indicated concerns								1.21 ***
LR χ^2	50.06	48.78	54.76	49.63	53.07	57.50	55.10	64.71
Prob > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Psuedo R2	0.038	0.037	0.420	0.038	0.041	0.044	0.042	0.050
N	517	517	517	517	517	517	517	517

Note . Displayed as odds ratios; * p < 0.1, ** p < 0.05, *** p < 0.01.

Appendix IV.

Multinomial logistic regression results for specific attitudes and beliefs regarding climate change among surveyed producers.

Legacy commercial producers	Intercept	-3.49	-3.88	-3.40	-3.29	-3.29	-2.70	-3.10	-1.022	-3.75
	Age	0.09 *	0.09 *	0.09 *	0.09 *	0.09 *	0.09 *	0.10 *	0.06	0.09 *
	College Education	-2.00 **	-1.97 **	-2.15 ***	-1.95 **	-2.01 **	-2.061 **	-2.074 ***	-2.309 ***	-1.90 **
	% Syrup sold as bulk	-0.05 ***	-0.05 ***	-0.05 ***	-0.05 ***	-0.05 ***	-0.05 ***	-0.048 ***	-0.047 ***	-0.05 ***
	Climate change poses a threat to maple operation		0.31							
	The projected impacts of climate change are exaggerated			-1.05						
	Climate change impacts are already noticable in my region				-0.64					
	Observe maple dieback caused by climate change					-0.45				
	Climate change has led to variability in start of season						-1.076			
	Earlier beginning of the season due to climate change							-1.174		
	Its now easy to determine the best moment to tap								-2.234 *	
	Climate change impacts are happening slowly enough to let us adapt									0.42
Mixed commercial-retail producers	Intercept	7.37 ***	6.99 ***	7.38 ***	8.08 ***	6.94 ***	8.30 ***	8.17 ***	7.00 ***	7.27 ***
	Age	-0.10 ***	-0.09 ***	-0.10 ***	-0.10 ***	-0.09 ***	-0.093 ***	-0.10 ***	-0.093 ***	-0.09 ***
	College Education	-0.74	-0.74	-0.74	-0.84	-0.81	-0.80	-0.90	-0.655	-0.69
	% Syrup sold as bulk	-0.04 ***	-0.04 ***	-0.04 ***	-0.04 ***	-0.04 ***	-0.046 ***	-0.042 ***	-0.04 ***	-0.04 ***
	Climate change poses a threat to maple operation		0.36							
	The projected impacts of climate change are exaggerated			0.22						
	Climate change impacts are already noticable in my region				-0.80					
	Observe maple dieback caused by climate change					-0.85				
	Climate change has led to variability in start of season						-1.283 *			
	Earlier beginning of the season due to climate change							-1.058		
	Its now easy to determine the best moment to tap								0.05	
	Climate change impacts are happening slowly enough to let us adapt									-0.17
Specialized commercial producers	Intercept	1.86	1.44	1.77	2.02	1.66	1.97	2.36	1.82	1.21
	Age	-0.06 ***	-0.06 ***	-0.06 ***	-0.06 ***	-0.06 ***	-0.062 ***	-0.068 ***	-0.062 ***	-0.07 ***
	College Education	-0.11	0.09	-0.13	-0.09	-0.04	-0.075	-0.20	-0.055	0.01
	% Syrup sold as bulk	0.02 **	0.03 **	0.02 **	0.02 **	0.02 **	0.02 **	0.02 **	0.02 **	0.03 ***
	Climate change poses a threat to maple operation		-0.42							
	The projected impacts of climate change are exaggerated			0.11						
	Climate change impacts are already noticable in my region				-0.23					
	Observe maple dieback caused by climate change					0.80				
	Climate change has led to variability in start of season						-0.341			
	Earlier beginning of the season due to climate change							-0.148		
	Its now easy to determine the best moment to tap								-0.092	
	Climate change impacts are happening slowly enough to let us adapt									0.52
	Base Cluster	LCP	LCP	LCP	LCP	LCP	LCP	LCP	LCP	LCP
	Obs.	126	123	125	124	118	125	125	123	123
	LR-Chi2	86.52	86.88	87.07	86.94	79.64	89.84	90.93	87.04	93.20
	Prob > Chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Psuedo R2	0.266	0.2705	0.2694	0.2722	0.2594	0.2779	0.2814	0.2742	0.2921

Note . * p < 0.1, ** p < 0.05, *** p < 0.01. "LCP" Legacy commercial producers. Estimates based on respondents' indication of either "Partially agreeing," "Agreeing," or "Strongly agreeing" with climate change-related statements.

Appendix V.

Estimated AMEs of the multinomial logistic regression model for specific economic, social and environmental risks among surveyed producers

Legacy retail producers	Respondent Age	0.010 ***	0.010 ***	0.008 ***	0.009 ***	0.010 ***	0.011 ***	0.009 ***	0.009 ***	0.009 ***	0.010 ***
	College education	-0.135 ***	-0.136 ***	-0.129 **	-0.125 **	-0.114 **	-0.059 **	-0.138 ***	-0.121 **	-0.095 *	-0.146 ***
	% Syrup sold as bulk	-0.003 ***	-0.003 ***	-0.003 ***	-0.003 ***	-0.003 ***	-0.002 ***	-0.003 ***	-0.003 ***	-0.003 ***	-0.003 ***
	Sales prices		-0.007								
	Cost of fuel			-0.009 *							
	Cost of equipment				0.028 *						
	Cost of labor					0.304					
	Loss of family farms						0.133 ***				
	Low syrup quality							0.299			
	Regulatory burden								0.059		
	Maple substitutes									0.065	
	Natural Events										-0.081
Mixed ommercial-retail producers	Respondent Age	-0.008 ***	-0.008 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.008 ***	-0.008 ***	-0.009 ***	-0.009 ***
	College education	-0.025	-0.022	0.000	-0.017	-0.060	-0.063	-0.054	-0.032	-0.032	-0.011
	% Syrup sold as bulk	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***
	Sales prices		0.067								
	Cost of fuel			0.080							
	Cost of equipment				0.015						
	Cost of labor					-1.384 *					
	Loss of family farms						-0.047				
	Low syrup quality							-1.304			
	Regulatory burden								-0.055		
	Maple substitutes									0.024	
	Natural Events										0.083
Specialized commercial producers	Respondent Age	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***	-0.008 ***	-0.009 ***	-0.008 ***
	College education	0.034	0.039	0.027	0.044	0.045	0.027	0.043	0.040	0.037	0.042
	% Syrup sold as bulk	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***	0.006 ***
	Sales prices		-0.028								
	Cost of fuel			-0.041							
	Cost of equipment				0.102						
	Cost of labor					0.533					
	Loss of family farms						-0.089				
	Low syrup quality							0.466			
	Regulatory burden								0.019		
	Maple substitutes									0.107	
	Natural Events										0.078
Legacy commercial producers	Respondent Age	0.008 **	0.007 **	0.010 ***	0.009 **	0.007 **	0.006 *	0.007 **	0.008 **	0.009 **	0.007 **
	College education	0.126	0.120	0.101	0.098	0.129	0.095	0.148 *	0.112	0.090	0.115
	% Syrup sold as bulk	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000
	Sales prices		-0.032								
	Cost of fuel			-0.030							
	Cost of equipment				-0.144						
	Cost of labor					0.547					
	Loss of family farms						0.003				
	Low syrup quality							0.539			
	Regulatory burden								-0.024		
	Maple substitutes									-0.196 **	
	Natural Events										-0.080
	Obs.	126	124	121	123	123	123	122	124	123	122
	LR-Chi2	86.52	85.54	87.4	88.15	86.27	88.88	90.80	85.93	86.85	85.93
	Prob > Chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Psuedo R2	0.266	0.2664	0.2792	0.2762	0.2720	0.2803	0.2879	0.2676	0.2739	0.2711

Note . * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates based on respondents' indicating that specific threats are "Very concerning."