Optimal Quality Standards for Credence Goods: An Application to Organic Strawberries and the Commercial Availability Loophole

Samuel Raburn, University of California - Davis, sraburn@ucdavis.edu

Selected Paper prepared for presentation at the 2024 Agricultural & Applied Economics Association Annual Meeting, New Orleans, LA; July 28-30, 2024

Optimal Quality Standards for Credence Goods: An Application to Organic Strawberries and the Commercial Availability Loophole

Samuel Raburn
Department of Agricultural and Resource Economics
University of California, Davis

May 15, 2024

1 Introduction

There exists a plethora of food product labels for credence attributes (e.g., organic, cruelty-free, local) with associated standards. Two relevant economics literatures for evaluating the impact of labels and standards are the credence goods and policy design literatures. However, within these literatures, there exists a largely unexamined question: to what extent are the underlying production standards optimal? For example, in the United States, land must be treated organically for three years before crops can be considered for organic certification. In California, Proposition 12 mandates that certain pigs be afforded at least 24 square feet of floor space. Why do policymakers not require land be treated for only 35 months or why not require at least 25 square feet of floor space? This essay aims to address this gap in the literature.

I outline a theoretical model that combines a classic Mussa-Rosen market structure with a Cobb-Douglas benefit function to study the optimality of credence good production standards. In addition to outlining a general model, I provide an application to California's organic strawberry industry with respect to the use of organic strawberry seedlings. While the National Organic Standards (NOS) mandates the use of organic seedlings, a loophole called the 'Commercial Availability Clause' (CAC) allows for organic strawberry acres to be planted with non-organic seedlings; roughly 85 percent of California's organic strawberry acres utilize this loophole. The use of non-organic seedlings in organic strawberry production means that consumers may not get what they *think* they are purchasing – even if it is the industry standard.

Assuming organic strawberry seedlings have a cost premium of \$0.195 per plant (4.5 percent of retail organic strawberry price per pound in 2021) and consumers are largely unaware if policy changes, demand for organic strawberries is estimated to shrink by 13 percent; industry production costs are also estimated to increase by \$20.1 million per year if the loophole is closed. Since many consumers operate under misperceptions of what exactly 'organic' entails, it may also be that consumers do not sufficiently value the use of organic seedlings, leading to lower-than-expected willingness to pay for the credence variety. Compounded with the imperfect diffusion of information, closing the CAC loophole is almost always a welfare-reducing proposition, even when accounting for the environmental benefit from organic production, relative to conventional.

I make three primary contributions in this paper. First, I contribute to the credence good literature by constructing a theoretical framework to study the optimality of credence good production standards. Second, I contribute to the policy design and legal loopholes literatures by analyzing the welfare implications of closing the CAC loophole on California's strawberry industry. Lastly, I provide potential implications for the future of the industry, given a shift in federal policy.

The remainder of this essay is organized as follows. Section 2 provides a review of relevant literature. Section 3 outlines the core economic model used in this essay and its methodology.

Section 4 provides an application of the model to the organic strawberry industry. Section 5 describes the data used to calibrate my model. Section 6 offers results and a sensitivity analysis. Section 7 concludes.

2 Literature Review

In this section, I review literatures pertinent to the study of credence goods and my subsequent application to a federal policy loophole; the first subsection covers credence goods and production optimality, the second covers motives for purchasing organic products, and the third covers legal loopholes.

2.1 Credence Goods

Credence goods have unobservable qualities that often make it difficult to assess the utility gained from consumption (Akerlof, 1970; Darby and Karni, 1973; Caswell and Mojduszka, 1996; Emons, 1997). This asymmetric information can be resolved through an increase in homogeneity across consumers (Dulleck and Kerschbamer, 2006), an increase in competition across firms (Baksi, Bose, and Xiang, 2012), or third-party verification (Caswell and Padberg, 1992). Government enforcement of regulation (Bonroy and Constantatos, 2008; Cuffaro and Di Giacinto, 2015), third-party enforcement (McCluskey, 2000; Giannakas, 2002), and consumers' perception of the efficacy of enforcement efforts (Cuffaro, Liu et al., 2008; Sheldon, 2017) are critical to the continued existence of high quality credence goods. Moreover, the degree to which consumers believe organic products are high-quality affects the industry's viability (Holland, 2016).

Most credence goods are promoted by some stakeholders because they produce, or are *believed* to produce, a positive externality relative to the conventional product. General motivations include altruism (Andreoni, 1990) and social norms (Vermeir and Verbeke, 2006; Sexton and Sexton, 2014); there are also attribute-specific motivations. For example, proponents of organic goods claim that organics preserve the environment (CCOF, 2022), are more nutritious (Schuldt and Schwarz, 2010), and are more flavorful than conventional foods (Lee et al., 2013); and proponents of non-GMOs claim that non-GM foods are healthier than conventional GMOs and protect the environment (NonGMO Project, 2022). For consumers and stakeholders of these credence varieties, the externalities associated with consumption are salient. However, the validity of this marketing often contradicts reality. Organic goods are likely no more nutritious than conventional (UC Davis Health, 2019), and non-GM varieties are no healthier (FDA, 2022) nor any more environmentally friendly than GM counterparts (Food Insight, 2020). While the purpose of this essay is not to comment on these claims or their accuracy, I present these dialogues to show the ongoing debates surrounding agricultural credence attributes.

Farm animal welfare, or non-intensive farming, is a particularly popular debate in agriculture, with many papers researching the welfare implications of confined farm animal housing practices (Bennett, 1997; Frewer et al., 2005; Owen and Videras, 2006; Krystallis et al., 2009; Mullally and Lusk, 2018). In addition to increasing farm animal living standards, proponents of farm animal welfare claim that non-intensive farming uses fewer resources than conventional farming and creates more jobs (World Animal Protection, 2022). An example of policy intended to improve animal welfare is California's Proposition 12 (Lee, Sexton, and Sumner, 2021). Despite 63 percent of California voters approving the ballot measure (Ballotpedia., 2018), research suggests that consumers do not perceive animal welfare as having positive externalities (Carlsson, Frykblom, and Lagerkvist, 2007; Tonsor, Olynk, and Wolf, 2009; Lusk and Norwood, 2011). This all contributes to the possibility that Proposition 12's level of stringency is not optimal.

With pushes for increased credence good production, there must be some external benefit from consuming credence goods that enters the decision making process. Without a positive externality, policymakers would simply balance private marginal cost and marginal benefit such that policies promoting credence goods would not occur. While the optimality of credence attribute regulation is under-studied, the environmental economics literature has extensively studied the optimality of carbon emission regulations (Helfand, 1991; Holland, Hughes, and Knittel, 2009; Rajagopal, Hochman, and Zilberman, 2011; Chen et al., 2014; Holland et al., 2015). This literature, in particular, influenced the way I consider the externalities associated with credence good production.

2.2 Organic Purchasing Motives

Much research has discussed the determinants of organic food consumption decisions. While there remain considerable gaps between consumer values and actual purchases (Young et al., 2010), consideration for one's health is the leading stated motive for purchasing organic products, above concern for the environment (Magnusson et al., 2001; Chen, 2009; Smed, 2012; Bryła, 2016; Yadav, 2016). Similarly, Padel and Foster (2005) find that consumers foremost associate organic products with a healthy diet, and Wier et al. (2008) find that organic food purchase decisions are primarily motivated by 'private good' attributes such as taste and healthiness. Although the health benefits of organic diets are difficult to prove (Jespersen et al., 2017), this "egoistic" motive is a stronger predictor of organic purchasing habits than "altruistic" motives such as care for the environment (Magnusson et al., 2003).

Whereas governments and supranational bodies continue to pass policies expanding organic farming to improve agricultural sustainability (Rousset et al., 2015; H.R.2 – 115th Congress, 2018; European Commission, 2021), with over 70 studies corroborating this result (Hole et al., 2005), consumers prioritize personal health. It is common knowledge that multi-targeted and indirect policies are largely inefficient (Tinbergen, 1956). However, environmental concern remains a factor in consumers' decision-making (Yoon et al., 2019), so expanding organic production may still be the best tool for policymakers to improve agricultural sustainability (Schader et al., 2014).

2.3 Loopholes

Studying loopholes is a standard of economic research dating back to Averch and Johnson (1962), and covers a sweeping variety of subjects including pharmaceutical prices (Kyle, 2007), mine maintenance (Pepper, Hughes, and Haigh, 2021), corporate taxes (Desai and Hines Jr, 2002), state expenditures (Benker, 1986), banned substances (Boesen, 2020), farm labor (Canny, 2005; Donovan and Shimabukuro, 2016; Marin, 2019), farm labor in organic farming (Getz, Brown, and Shreck, 2008), and even outer space liability (Kehrer, 2019). Despite the plethora of papers studying loopholes, little work outside of farm labor has been done on the agricultural industry.

A subset of the loophole literature aims to estimate the economic impact of closing federal loopholes. Closing loopholes usually results in either increased government revenue (Persaud, 2015) or decreased government expenditure (Spatig-Amerikaner, 2012), but the impact of closing the CAC is more ambiguous. In the specific case I examine, eliminating the CAC loophole and mandating the use of organic strawberry seedlings would result in higher producer costs and lead to welfare losses. The push by organic stakeholders to close this loophole (USDA, 2022), along with other gaps in the NOS (Strengthening Organic Enforcement Act, 2023), may have multiple motivations beyond legal uniformity (e.g., decreasing environmental impact, reducing competition).

3 Model

My model considers the perceived external benefit associated with increasing the stringency of credence good production. In organic strawberries, this increase of stringency is represented by closing the CAC loophole. To illustrate the main theoretical effects, I consider a market with two products with differing costs and associated levels of externality – one product being a conventional good and the other being a credence good. In Stage 1, a policymaker sets the stringency of the requirements for the credence good, K_c, to optimize total social welfare – with K_c being communicated to both producers and consumers. In Stage 2, assuming perfect enforcement, quantities and prices are determined given the optimal level of quality requirement, K_c^*.

3.1 Consumers

As with many papers analyzing vertically differentiated products, I use a Mussa and Rosen (1978) model with a continuum of consumers distributed continuously and uniformly according to a taste parameter $\theta \in [0, 1]$. Define a consumer's indirect utility from consuming one unit of variety v as

$$V(P_v, K_v; \theta) = (M - P_v) + K_v\theta, \quad v = \{c, n\} \tag{1}$$

where $v = \{c, n\}$ denotes the variety of product, credence or non-credence (henceforth conventional), M denotes a consumer's income, P_v is the retail price for one unit of variety v, and $K_v \geq 1$ measures "quality". Let $K_n = 1$ such that $K_c > 1$ measures the relative quality advantage perceived by all consumers relative to the conventional good.

Define the marginal consumer who is indifferent between consuming the credence or conventional variety as having taste parameter $\tilde{\theta} = \frac{P_c - P_n}{K_c - 1}$ and define by $\hat{\theta} = P_n$ the consumer indifferent between consuming the conventional variety and not consuming any product at all. Normalizing the total mass of consumers to be $M = 1$, the respective quantities demanded for each variety are:

$$Q_n^D(P_v, K_v) = \tilde{\theta} - \hat{\theta} = \frac{P_c - P_n}{K_c - 1} - P_n \tag{2}$$

$$Q_c^D(P_v, K_v) = 1 - \tilde{\theta} = 1 - \frac{P_c - P_n}{K_c - 1} \tag{3}$$

Inverting the above system of equations gives us the indirect demand functions:

$$P_n^D(Q_v) = 1 - Q_c^D - Q_n^D \tag{4}$$

$$P_c^D(Q_v, K_v) = K_c(1 - Q_c^D) - Q_n^D \tag{5}$$

3.2 Production

Assume there exists a mass of producers $N \in (0, 1)$ in which each producer chooses to produce 1 unit of the conventional good (Q_n) or 1 unit of the credence good (Q_c). Further assume that the credence good is not produced in the absence of government intervention, because credence varieties do not survive in market equilibrium without proper product protection. After a policy change, some producers will opt to shift production to the credence variety, given K_c and a distribution of conversion costs ϕ. Because the number of producers is fixed, I assume producers incur no variable production costs, but are heterogeneous in one-time conversion costs. Define producer profit as:

$$\Pi_v = P_v Q_v - X^2, \qquad X = \begin{cases} 0, & \text{if } v = n \\ K_c, & \text{if } v = c \end{cases} \tag{6}$$

where $\phi_j \sim U(\underline{\phi}, \bar{\phi})$ is producer j's fixed cost incurred when transitioning from conventional to credence production. Producer j will choose to transition to producing the credence variety if producing the credence variety yields higher profit than producing the conventional variety. That is, producer j switches if

$$P_c - K_c^2 \phi_j > P_n \tag{7}$$

Only producers with sufficiently low values of ϕ will opt to transition. Rearranging equation (7) gives the relationship that must hold for a farmer to transition to producing the credence variety:

$$\frac{P_c - P_n}{K_c^2} > \phi^j \tag{8}$$

with the marginal producer who is indifferent between producing conventional and switching to producing the credence variety having transition costs $\tilde{\phi} = \frac{P_c - P_n}{K_c}$. Because ϕ is distributed uniformly, the cumulative distribution function for ϕ is $F(\phi) = \frac{\phi - \underline{\phi}}{\bar{\phi} - \underline{\phi}}$ with probability density function $f(\phi) = \frac{1}{\bar{\phi} - \underline{\phi}}$. Total supply of conventional and credence varieties, respectively, are

$$Q_n^S = N \int_{\tilde{\phi}}^{\bar{\phi}} f(\phi) d\phi = N(\bar{\phi} - \frac{P_c - P_n}{K_c^2}) \tag{9}$$

$$Q_c^S = N \int_{\underline{\phi}}^{\tilde{\phi}} f(\phi) d\phi = N(\frac{P_c - P_n}{K_c^2} - \underline{\phi}) \tag{10}$$

Setting $Q_n^S + Q_c^S = N$ results in the equality $\bar{\phi} = 1 + \underline{\phi}$, which provides structure to the bounds of ϕ.

3.3 Production Externality

Define the positive externality that one unit of good v provides by $E(K_v, Q_v)$, where $E(\cdot)$ is the monetized value of benefit. The benefit of producing the credence variety is relative to producing the conventional one, so it follows that $E(K_n, Q_n) = 0$ and $E(K_c, Q_c) > 0$. For the externality function to be increasing in K_c and Q_c at a decreasing rate, it must be that both first derivatives be positive while the second derivatives be negative (e.g., $\frac{\partial E}{\partial K_c} > 0$, $\frac{\partial^2 E}{\partial^2 K_c} < 0$). Presumably, there is also some degree of trade-off between stringency and the level of adoption. To fit these characteristics, I specify the externality function as Cobb-Douglas:

$$E(K_c, Q_c) = K_c^{\alpha_1} Q_c^{\alpha_2} \tag{11}$$

where $\alpha_1 + \alpha_2 < 1$ to ensure concavity. The structure of Cobb-Douglas is consistent with many papers in the environmental literature that use the power function $F(b) = \alpha b^{\beta}$ to estimate the economic value of environmental benefit, where b is the amount of externality-producing good (e.g. biodiversity), $\alpha > 0$, and $\beta \in (0, 1)$ is a scaling coefficient that ensures positive-concavity (Cardinale et al., 2007, 2011; Reich et al., 2012; O'Connor et al., 2017; Paul et al., 2020). In my case, $K_c^{\alpha_1}$ is congruent with α in the power function, and $Q_c^{\alpha_2}$ congruent with b^β.

Assuming policymakers have perfect information regarding market mechanisms, they can set K_c to maximize total social welfare, defined as the sum of consumer surplus, producer profit, and positive externality: $W = CS + \Pi + E$. Substituting equation (1) for CS, equation (6) for Π, and equation (11) for E, the policymaker's optimization problem becomes

$$\max_{K_c} W = \sum_v [\, M - P_v + \int_\theta K_v\theta + P_v Q_v] - \int_\phi K_c^2\phi + K_c^{\alpha_1} Q_c^{\alpha_2} \tag{12}$$

Noting that the revenue that producers receive is what consumers pay, the above expression simplifies to

$$\max_{K_c} W = \int_{\tilde{\theta}}^{\bar{\theta}} K_c\theta + \int_{\hat{\theta}}^{\tilde{\theta}} \theta - M - \int_{\underline{\phi}}^{\tilde{\phi}} K_c^2\phi + K_c^{\alpha_1} Q_c^{\alpha_2} \tag{13}$$

which further simplifies to

$$\max_{K_c} W = Q_c(K_c - 1) - P_c + K_c^{\alpha_1} Q_c^{\alpha_2} \tag{14}$$

3.4 Equilibrium

The set of equations that characterize this equilibrium is:

$$\begin{aligned} Q_n^* = Q_n^{D^*} = Q_n^{S^*}; \quad P_n^* = P_n^{D^*} = P_n^{S^*} \\ Q_c^* = Q_c^{D^*} = Q_c^{S^*}; \quad P_c^* = P_c^{D^*} = P_c^{S^*} \end{aligned} \tag{15}$$

where asterisks denote equilibrium values. The two-stage model is solved recursively. In Stage 2, prices and quantities for the conventional and credence goods are determined, given an arbitrary level of K_c. Then, in Stage 1, K_c is chosen to maximize social welfare. Setting equations (2) and (9) equal and equations (3) and (10) equal gives the following relationships, respectively:

$$Q_n = \frac{P_c - P_n}{K_c - 1} - P_n = N(\bar{\phi} + \frac{P_n - P_c}{K_c^2}) \tag{16}$$

$$Q_c = 1 - \frac{P_c - P_n}{K_c - 1} = N(\frac{P_c - P_n}{K_c^2} - \underline{\phi}) \tag{17}$$

Solving the system of equations above gives us equilibrium prices $P_n^* = 1 - N > 0$ and

$$P_c^* = \frac{K_c^3 + K_c N + N^2 - K_c^2 N - K_c N^2 - N}{K_c^2 + K_c N - N} > P_n^* \tag{18}$$

Assuming there exists at least one producer that can transition to producing credence variety at no cost, such that $\underline{\phi} = 0$, and substituting the equilibrium prices into equation (13), Stage 1 policymakers solve the following problem to maximize social welfare:

$$\max_{K_c} W = \frac{2K_c^2 N + K_c N^2 + 2N - K_c^3 - 3NK_c - N^2}{K_c^2 + K_c N - N} + K_c^{\alpha_1} [\frac{N(K_c - 1)}{K_c^2 + K_c N - N}]^{\alpha_2} \tag{19}$$

While equation (19) has no closed-form solution without additional assumptions on α_1 and α_2, comparative statics can still be done to confirm the intuition behind the parameters. Both $\frac{\partial W^2}{\partial K_c \partial N}$ and $\frac{\partial W^2}{\partial K_c \partial \alpha_1}$ are signed as positive while $\frac{\partial W^2}{\partial K_c \partial \alpha_2}$ is signed as negative. This follows economic intuition, as an increase in the number of consumers N or an increase in α_1 strengthens the social value of credence production standards K_c. Since $Q_c < 1$, an increase in α_2 acts as a *decrease* in social value of expanding credence production, leading to a decrease in K_c^*.

Since these derivatives tell us how the slope of K_c changes along the orthogonal axes, we can interpret an increase in N or α_1 as having a positive effect on K_c^* while an increase in α_2 has a negative impact on K_c^*. This aligns with economic intuition, as an increase in N increases the size of the positive externality and an increase in α_1 increases the policy emphasis on credence quality over quantity. In contrast, an increase in α_2 leads to a decrease in K_c^* because the policy places a larger value on the quantity of credence good consumed rather than the quality of the credence good.

4 Application to the Organic Strawberry Industry

In this section, I outline an application of my model to California's organic strawberry industry. Strawberries are eaten by 94 percent of Americans (University of Illinois Extension, 2023) and 11.7 percent of average household fruit expenditure is spent on strawberries (Ferrier, Zhen, and Bovay, 2018). Strawberries represent a significant industry for California, where 90 percent of all U.S. strawberries were produced in 2021. Of this, 13 percent of harvested strawberries acres, or 9 percent of total volume, was organic (CDFA, 2022).

4.1 Background

Relative to many fruits, strawberries have many characteristics that complicate production, including chilling hours and crop rotations.[1] Organic strawberry growing practices are omitted from this section for sake of brevity, but can be found in Appendix A. In addition to being very susceptible to pests and disease like all strawberries, organic strawberries cannot be sprayed with conventional chemicals – furthering their susceptibility. Strawberry seedlings, also referred to as transplants or crowns, are a necessary input for both conventional and organic operations as they reduce the time to harvest relative to growing from seeds.[2] In California, nearly all strawberry seedlings are grown in Siskiyou County, which is ideal for young strawberry plants due to its relatively higher number of chilling hours.

---

[1] The traditional definition of a chilling hour is any hour under 45°F.

[2] Botanically, strawberry 'seedlings' are clones. However, 'seedlings' is the term used by the industry.

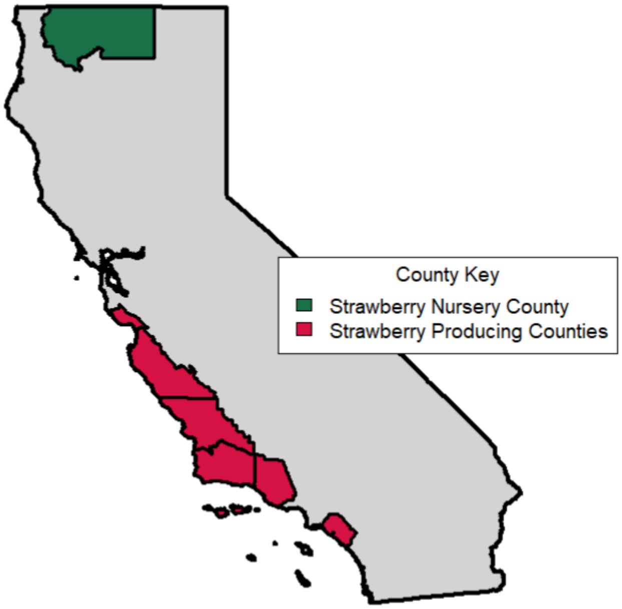

Figure 1: Counties with Strawberry or Strawberry Nursery as a Top-10 Commodity in 2021

Despite the NOS mandating that organic production use organic seedlings, approximately 85 percent of organic strawberry acres are planted with conventional seedlings due to the CAC loophole in the organic guidelines. The CAC states:

> “The producer must use organically grown seeds, annual seedlings, and planting stock: Except, that, nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available.”[3]

Put simply, in the event that a farmer can prove that their desired seedling is not offered organically, or is not offered in the desired quantity, they can use nonorganic plants. Notably, a higher price of organic seedlings cannot be used as a reason to purchase conventional ones. While the cost of organic seedlings is not a formally valid reason for an exemption, it can nonetheless be a reason farmers may seek out an exemption; organic seedlings are often 2-to-3.5 times the cost of conventional seedlings.

---

[3] USDA Standards Manual §205.204

Growers can qualify for the exemption if they contact three nurseries for organic seedlings and provide documentation to their certifier that the desired organic seedling is not available. The interesting complication for the organic strawberry industry is that growers need not contact Innovative Organic Nursery (ION), the United States' only organic strawberry nursery, to fulfill this requirement. While the CAC applies to all crops, I exclusively focus on strawberries in this paper.

4.2 Application

Under the CAC, strawberry producers of variety v can choose to use seedlings of either variety v, effectively. Organic strawberry growers can use conventional seedlings due to the CAC and conventional strawberry growers can, by default, always use the more expensive organic seedlings. Consequently, organic strawberry seedlings remain a niche product, since their production quality exceeds policy requirements. It is only after a policy change which increases organic production requirements, and eliminates the CAC, that organic seedlings grow beyond a niche.

Suppose that policymakers close the CAC, subject to delayed enforcement, requiring organic growers to use organic seedlings regardless of social welfare implications. This hypothetical comes as the NOS are being redrafted, and proponents have discussed tightening the CAC to increase production uniformity. Despite stakeholders' best intentions to improve environmental stringency, closing the CAC may damage the organic strawberry industry with little improvement to the "cleanliness" of producing organically. Even large industry players face challenges achieving 20 percent organic seedling production.

5 Data

I have collected a number of data sets to calibrate my model to the organic strawberry industry, including quantities, prices, and production costs for conventional and organic strawberries (FRED, 2022a,b; USDA AMS, 2022). No organization or governmental body records data on strawberry seedlings, so I parameterize input prices using numbers I collected from industry members and University of California researchers.[4] Additionally, I have access to proprietary organic strawberry production data and production costs, which I use to estimate market share and production costs. A summary of the data I use in my calibrations are found in the table below.

Table 1: Descriptive Summary of Data Sets

Data	First Year	Frequency	Observations	Source
Strawberry Production	2000	Month	252	USDA AMS
Organic Strawberry Production	2008	Month	166	USDA AMS
Proprietary Strawberry Production	2005	Month	182	Proprietary
Strawberry Farm Price*	2000	Month	252	FRED
Strawberry Retail Price*	2000	Month	252	USDA AMS

*First year of dataset predates 2000 but is limited to begin in 2000 for consistency.

A few companies are testing proprietary varieties, and even fewer use them extensively. The share of organic strawberries produced with proprietary varieties is estimated to oscillate around 50 percent but I calculate monthly market share using production data. I also have proprietary information on organic seedling production, which is largely the reason I can precisely estimate industry impacts. Previously, all proprietary organic strawberry production was assumed to use organic seedlings, but the breakdown is closer to 30 percent organic seedlings, 70 percent conventional seedlings. Thus, the proprietary sector would also be impacted by a policy change.

To calibrate my model, recall that the mass of strawberry producers is given by $N \in (0, 1)$. Since each consumer and producer consumes and produces one unit of strawberry, respectively, it follows that the mass of consumers is equal to the mass of producers. Since

---

[4] Conventional seedlings cost in the range of \$165-\$185 per 1000 seedlings, and organic seedlings cost in the range of \$295-\$349 per 1000.

94 percent of consumers each consume one unit of strawberries, the mass of producers is also equal to 94 percent, or 0.94. Letting $N = 0.94$, prices become

$$P_n^* = 0.06; \quad P_c^* = \frac{1.06K_c^3 - K_c^2 - 0.06(K_c - 1)}{1.06K_c^2 + K_c - 1} \tag{20}$$

and quantities become

$$Q_n = \frac{0.94K_c^2 - 0.06(K_c - 1)}{K_c^2 + 0.94(K_c - 1)}; \quad Q_c = \frac{0.94(K_c - 1)}{K_c^2 + 0.94(K_c - 1)} \tag{21}$$

Substituting these into the welfare function gives us

$$\max_{K_c} W = \frac{0.94(K_c - 1)^2}{K_c^2 + 0.94(K_c - 1)} - \frac{1.06K_c^3 - K_c^2 - 0.06(K_c - 1)}{1.06K_c^2 + K_c - 1} + K_c^{\alpha_1}(\frac{0.94(K_c - 1)}{K_c^2 + 0.94(K_c - 1)})^{\alpha_2} \tag{22}$$

where $K_c^*(\alpha)$ uniquely solves the equality $\frac{\partial W}{\partial K_c} = 0$. As detailed in Section 3, without further assumptions on α, this proves difficult to do. However, we can back out some details through the production and price data. By calibrating the model with either price or quantity per month, one can back out the level of quality K_c that would produce said data.[5] Using production shares, I find that the empirical K_c averages 1.15 over the sample period. For this to be welfare-maximizing, the values of α_1 and α_2 would both need to be approximately 0.2. Meaning, a large emphasis is placed on expanding organic production, rather than increasing organic production standards. This aligns with the history of organic regulation, as organic production standards have largely remained unchanged since 1990, but government programs to subsidize the production of organics continue to garner support.

For seedling costs, I assume conventional seedling costs \$200/1000 (University of California Cooperative Extension, 2022) and organic seedling costs \$395/1000, post-policy – a premium of \$195/1000. To convert this real cost to a parameter within the model, one of

---

[5] Since this model is a perfect competition setting, empirical K_c depends on which data set is chosen.

two methods can be used:

$$\begin{aligned} &Method\ 1 : P_n^* * (\frac{P_{seed}}{P_{c,farm}})(\frac{P_{c,AMS}}{P_{n,AMS}} - 1) \\ &Method\ 2 : P_n^* * (\frac{P_{seed}}{P_{c,AMS}})(\frac{P_{c,farm}}{P_{n,farm}} - 1) \end{aligned} \tag{23}$$

where $P_{seed} \equiv \$0.395 - \$0.2 = \$0.195$ is the premium for an organic seedling, $P_{v,farm}$ is the farm-gate price per pound for variety v, and $P_{v,AMS}$ is the retail price per pound. While both methods achieve the desired standardization, I use Method 2 as it produces a more conservative estimate of costs.

Assuming there exists a subset of consumers that are aware of the positive quality change, the change in quantity demanded due to an increase of K_c can be modeled as

$$\Delta Q_c(\gamma) \equiv \frac{P_c - P_n}{K_c - 1} - \frac{P_c' - P_n}{\gamma K_c' + (1-\gamma)K_c - 1}, \qquad \gamma \in [0,1] \tag{24}$$

where γ is the portion of aware consumers. If we instead assume all consumers are unaware of the increase in quality due to mandating organic seedlings, such that the perceived $\Delta K_c = 0$, the change in demand simplifies to

$$\Delta Q_c \equiv 1 - \frac{P_c' - P_n}{K_c - 1} - \{1 - \frac{P_c - P_n}{K_c - 1}\} = \frac{P_c - P_c'}{K_c - 1} \tag{25}$$

Since $|\Delta Q_c| \geq |\Delta Q_c(\gamma)|$, information acts as a buffer to own-price elasticity. Meaning, the more informed a consumer base is, the less reactive to a quality-based shift in price they may be.

6 Results

For the baseline results, I assume the price of a pound of organic strawberries rises by the same $P_{seed} \equiv \$0.195$ as Section 5 and I assume uniformed consumers ($\gamma = 0$). However, I provide sensitivity analyses to illustrate scenarios that differ from this. Table 2 provides the estimated shift in demand, given a price increase of P_{seed} and a percentage of informed consumers γ. Under base assumptions, demand is estimated to decrease by 8.1 percent, assuming consumers are unaware of the quality change (effectively, a standard price increase). If all consumers are made aware of a quality-based price increase (i.e., $\gamma = 1$), every value of P_{seed} would increase demand.

Table 2: Estimated Percent Change in Demand for Organic Strawberries

P_{seed}, γ	0	0.2	0.4	0.6	0.8	1
0.1	-4.1%	-3.2%	-2.3%	-1.4%	-0.6%	+0.3%
0.195	-8.1%	-6.4%	-4.6%	-2.9%	-1.1%	+0.6%
0.25	-10.2%	-7.9%	-5.8%	-3.6%	-1.4%	+0.8%
0.3	-12.2%	-9.5%	-6.9%	-4.3%	-1.7%	+0.9%
0.35	-14.2%	-11.1%	-8.0%	-5.0%	-1.9%	+1.1%
0.4	-16.2%	-12.7%	-9.2%	-5.7%	-2.2%	+1.2%

From the base results, the own-price elasticity of organic strawberries can be calculated as approximately -1.80, which falls within the range of elasticities found in papers that use Nielsen Scanner Data. If the CAC were closed, approximately 5,000 acres of organic strawberries would be affected – totaling around 109.2 million seedlings.[6] Additionally, due to increased production costs and lower consumer demand, an estimated 475 acres of organic strawberries would exit production – stemming from the nonproprietary sector.

Assuming $P_{seed} = \$0.195$, seedling costs would increase by $2,214 per acre, an increase in cultural costs of 8.4 percent. Seedling costs state-wide would increase by approximately $20.1 million per year, if the demand for organic seedlings could be met. This represents a

---

[6] Affected Acreage is calculated as: Total Acres - (Proprietary Acres)x(% Organic Seedlings) - (Non-Proprietary Acres)x(ION's Market Share) = 5,871 - (2,321) x (0.315) - (5,871 - 2,321) x (0.05) = 4,962 acres; and Total Seedlings = Affected Acres x Average Seedlings/Acre = 4,962 x 22,000 = 109.2 million seedlings.

Table 3: Estimated Own-Price Elasticities for Organic Strawberries

Article	**min**	**max**	**Data Source**
Raburn *(forthcoming)*	-1.80	-1.80	USDA AMS, CSC
Nelson et al. (2017), conditional	-0.34	-1.90	Nielsen Scanner Data
Nelson et al. (2017), unconditional	-0.77	-7.33	Nielsen Scanner Data
Yoon and McFadden (2018)	-1.74	-2.36	Nielsen Scanner Data

decline in net grower returns by 8.6 percent but, due to the difficult nature of ramping up organic strawberry seedling production, real costs may be higher.

Table 4: Increase in Commercial Industry Costs

P_{seed}, γ	0	0.2	0.4	0.6	0.8	1
0.1	\$10,472,983	\$10,568,833	\$10,664,503	\$10,759,994	\$10,855,306	\$10,950,441
0.195	\$20,058,978	\$20,443,800	\$20,827,182	\$21,209,134	\$21,589,664	\$21,968,779
0.25	\$24,519,412	\$25,121,778	\$25,721,332	\$26,318,092	\$26,912,080	\$27,503,313
0.3	\$28,758,114	\$29,627,082	\$30,491,185	\$31,350,464	\$32,204,959	\$33,054,710
0.35	\$32,775,090	\$33,959,974	\$35,137,125	\$36,306,619	\$37,468,531	\$38,622,933
0.4	\$36,570,328	\$38,120,704	\$39,659,526	\$41,186,923	\$42,703,021	\$44,207,946

With higher costs and a stricter production process, the closure of the CAC is largely a welfare-reducing change. Since there is no clear methodology to calculate the true values of α, I allow for two scenarios. In Scenario 1, I calibrate the model using ($\alpha_1 = \alpha_2 = 0.2$) to demonstrate a world where any increase in K_c beyond the empirical average is welfare-reducing. This is a world that greatly prefers expanding organic production over increasing organic production standards, similar to reality. In Scenario 2, I calibrate the model using ($\alpha_1 = \alpha_2 = 0.5$) to demonstrate a world in which an increase in K_c could be welfare-improving. This is a world that equally values expanding organic production and increasing organic production standards. Since the NOS have remained largely unchanged since 1990, this second scenario is less likely, but it allows me to highlight conditions under which welfare change can be positive.

Table 5: Welfare Change: Scenario 1 ($K_c^* = K_c = 1.15$; $\alpha_1 = \alpha_2 = 0.2$)

P_{seed}, γ	0	0.2	0.4	0.6	0.8	1
0.1	-1.38%	-1.10%	-0.82%	-0.55%	-0.27%	0%
0.195	-2.82%	-2.24%	-1.66%	-1.10%	-0.55%	0%
0.25	-3.55%	-2.81%	-2.09%	-1.38%	-0.68%	0%
0.3	-4.29%	-3.39%	-2.51%	-1.65%	-0.82%	0%
0.35	-5.05%	-3.98%	-2.94%	-1.93%	-0.95%	0%
0.4	-5.81%	-4.57%	-3.37%	-2.21%	-1.09%	0%

Table 6: Welfare Change: Scenario 2 ($K_c^* > K_c = 1.15$; $\alpha_1 = \alpha_2 = 0.5$)

P_{seed}, γ	0	0.2	0.4	0.6	0.8	1
0.1	-5.22%	-4.15%	-3.08%	-2.01%	-0.96%	+0.09%
0.195	-10.54%	-8.35%	-6.18%	-4.03%	-1.91%	+0.19%
0.25	-13.25%	-10.47%	-7.73%	-5.04%	-2.39%	+0.23%
0.3	-15.97%	-12.60%	-9.30%	-6.05%	-2.86%	+0.28%
0.35	-18.73%	-14.75%	-10.87%	-7.06%	-3.33%	+0.33%
0.4	-21.51%	-16.92%	-12.44%	-8.07%	-3.80%	+0.37%

Tables 5 and 6 present the change in welfare due to closing the CAC loophole, under two scenarios. Any increase in seedling price reduces social welfare, with the exception of perfect information in Scenario 2. Notably, the welfare losses in Table 6 are significantly higher than those in Table 5. Since the value placed on quality (α_1) is higher in Scenario 2, it follows that the marginal value of knowledge is higher under Scenario 2.

In both tables, welfare change is increasing in γ, as expected. Since credence goods can only survive in a market with explicit protection for credence attributes, an informed consumer base is similarly essential to the proper valuation of a credence product. Whether through marketing or initiative à la Prop 12, informed consumers are less likely to reject credence varieties if they are aware that the increase in price is due to an increase in quality.

7 Discussion

In this essay, I analyze the optimality of credence good production standards and the potential damages that can arise if policymakers close the CAC. This essay accomplishes many firsts. It is the first to study the optimality of credence production requirements, the first to investigate a loophole in organic agriculture outside of farm labor, and the first to record proprietary organic strawberry seedling production. California's organic strawberry industry is uniquely positioned to study this topic due to the industry-wide use of lower-quality, conventional seedlings without the revocation of organic certification.

As the National Organic Program is revising its standards to improve production consistency, organic proponents are calling for increased stringency. Although the CAC allows organic strawberry producers to exploit a legal grey area, contributing to production quality inconsistency, I argue that removing this language would almost certainly be welfare-reducing. Unless all consumers are fully aware of the quality increase *and* society values the strengthening of standards beyond historical indicators, removing the CAC is welfare-reducing.

The theoretical model I outline offers much outside of my application to California's organic strawberry industry, with credence attributes of agricultural products continuing to garner support from policymakers. This model can easily be used to study the optimality of Prop 12 or the optimality of local labels, just to name two examples. There is also scope to study how closing the CAC would impact other organic crops that heavily rely on seedlings (e.g., spinach, tomatoes). While strawberries are the largest seedling-reliant crop by value, the applicability of my model easily extends to the 17 other crops grown in California that rely on seedlings (UC Davis Department of Plant Sciences, 2019).

Given sufficient capital investment in the next decade, organic strawberry seedlings could become the majority for companies that produce their own proprietary seedlings – even if the expansion is costly. Since vertically-integrated companies have multiple revenue streams, expanding organic seedlings production could be a strategic investment, rather than an explicit source of profit. This differs from ION, whose revenue exclusively depends on selling organic seedlings, and expanding production without the proper demand would likely only lead to profit loss. Even if the closure of the CAC is not immediate, the temporal and monetary requirements to expand organic strawberry seedling production may harm nonproprietary organic strawberry production.

References

Akerlof, G. 1970. "The Market for "Lemons": Quality Uncertainty and the Market Mechanism." *The Quarterly Journal of Economics* 84:488–500.

Andreoni, J. 1990. "Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving." *The Economic Journal* 100:464–477.

Averch, H., and L. Johnson. 1962. "Behavior of the firm under regulatory constraint." *The American Economic Review* 52:1052–1069.

Baksi, S., P. Bose, and D. Xiang. 2012. "Credence Goods, Consumer Misinformation, and Quality." *Department of Eco*, 01, pp. .

Ballotpedia. 2018. "California Proposition 12, Farm Animal Confinement Initiative." https:// ballotpedia.org/California_Proposition_12,_Farm_Animal_Confinement_Initiative_(2018).

Benker, K.M. 1986. "Tax expenditure reporting: Closing the loophole in state budget oversight." *National Tax Journal* 39:403–417.

Bennett, R. 1997. "Farm Animal Welfare and Food Policy." *Food Policy* 22:281–288.

Boesen, U. 2020. "Cigarette Taxes and Cigarette Smuggling by State, 2018."

Bonroy, O., and C. Constantatos. 2008. "On the Use of Labels in Credence Goods Markets." *Journal of Regulatory Economics* 33:237–252.

Bryła, P. 2016. "Organic food consumption in Poland: Motives and barriers." *Appetite* 105:737–746.

Canny, A.L. 2005. "Lost in a Loophole: The Fair Labor Standards Act's Exemption of Agricultural Workers from Overtime Compensation Protection." *Drake J. Agric. L.* 10:355.

Cardinale, B.J., K.L. Matulich, D.U. Hooper, J.E. Byrnes, E. Duffy, L. Gamfeldt, P. Balvanera, M.I. O'connor, and A. Gonzalez. 2011. "The functional role of producer diversity in ecosystems." *American journal of botany* 98:572–592.

Cardinale, B.J., J.P. Wright, M.W. Cadotte, I.T. Carroll, A. Hector, D.S. Srivastava, M. Loreau, and J.J. Weis. 2007. "Impacts of plant diversity on biomass production increase through time because of species complementarity." *Proceedings of the national academy of sciences* 104:18123–18128.

Carlsson, F., P. Frykblom, and C. Lagerkvist. 2007. "Farm Animal Welfare—Testing for Market Failure." *Journal of Agricultural and Applied Economics* 39:61–73.

Caswell, J., and E. Mojduszka. 1996. "Using Informational Labeling to Influence the Market for Quality in Food Products." *American Journal of Agricultural Economics* 78:1248–1253.

Caswell, J., and D. Padberg. 1992. "Toward a More Comprehensive Theory of Food Labels." *American Journal of Agricultural Economics* 74:460–468.

CCOF. 2022. "Why Organic?" https://www.ccof.org/page/why-organic.

CDFA. 2022. "California Agricultural Organics Report 2021-2022."

Chen, M.F. 2009. “Attitude toward organic foods among Taiwanese as related to health consciousness, environmental attitudes, and the mediating effects of a healthy lifestyle.” *British food journal* 111:165–178.

Chen, X., H. Huang, M. Khanna, and H. Önal. 2014. “Alternative Transportation Fuel Standards: Welfare Effects and Climate Benefits.” *Journal of Environmental Economics and Management* 67(3):241–257.

Cuffaro, N., and M. Di Giacinto. 2015. “Credence Goods, Consumers’ Trust in Regulation and High Quality Exports.” *Bio-based and Applied Economics* 4:179–197.

Cuffaro, N., P. Liu, et al. 2008. “Technical Regulations and Standards for Food Exports: Trust and the Credence Goods Problem.” *FAO* 2007:67.

Darby, M., and E. Karni. 1973. “Free Competition and the Optimal Amount of Fraud.” *The Journal of Law and Economics* 16:67–88.

Desai, M.A., and J.R. Hines Jr. 2002. “Expectations and expatriations: Tracing the causes and consequences of corporate inversions.” *National Tax Journal* 55:409–440.

Donovan, S.A., and J.O. Shimabukuro. 2016. “The Fair Labor Standards Act (FLSA) Child Labor Provisions.”

Dulleck, U., and R. Kerschbamer. 2006. “On Doctors, Mechanics, and Computer Specialists: The Economics of Credence Goods.” *Journal of Economic Literature* 44:5–42.

Emons, W. 1997. “Credence Goods and Graudulent Experts.” *The RAND Journal of Economics*, pp. 107–119.

European Commission. 2021. “On an Action Plan for the Development of Organic Production.”

FDA. 2022. “GMOs and Your Health.” https://www.fda.gov/media/135280/download.

Ferrier, P., C. Zhen, and J. Bovay. 2018. “Price and Welfare Effects of the Food Safety Modernization Act Produce Safety Rule.” Paper presented at IAAE annual meeting, Vancouver, July 28–2 August.

Food Insight. 2020. “GMO Crops: Safety, Regulation and Sustainability Insights.” https://foodinsight.org/gmo-crops-safety-regulation-and-sustainability-insights/.

FRED. 2022a. “Average Price: Strawberries, Dry Pint (Cost per 12 Ounces/340.2 Grams) in the West Census Region - Urban.” https://fred.stlouisfed.org/series/APU0400711415.

FRED. 2022b. “Producer Price Index by Commodity: Farm Products: Strawberries.” https://fred.stlouisfed.org/series/WPU01110222.

Frewer, L., A. Kole, S. Van de Kroon, and C. de Lauwere. 2005. “Consumer Attitudes Towards the Development of Animal-Friendly Husbandry Systems.” *Journal of Agricultural and Environmental Ethics* 18:345–367.

Getz, C., S. Brown, and A. Shreck. 2008. “Class politics and agricultural exceptionalism in California’s organic agriculture movement.” *Politics & Society* 36:478–507.

Giannakas, K. 2002. “Information Asymmetries and Consumption Decisions in Organic Food Product Markets.” *Canadian Journal of Agricultural Economics* 50:35–50.

Helfand, G. 1991. “Standards Versus Standards: The Effects of Different Pollution Restrictions.” *The American Economic Review* 81:622–634.

Hole, D.G., A. Perkins, J. Wilson, I. Alexander, P. Grice, and A.D. Evans. 2005. “Does organic farming benefit biodiversity?” *Biological conservation* 122:113–130.

Holland, S. 2016. “Lending Credence: Motivation, Trust, and Organic Certification.” *Agricultural and Food Economics* 4:14.

Holland, S., J. Hughes, and C. Knittel. 2009. “Greenhouse Gas Reductions Under Low Carbon Fuel Standards?” *American Economic Journal: Economic Policy* 1:106–146.

Holland, S., J. Hughes, C. Knittel, and N. Parker. 2015. “Unintended Consequences of Carbon Policies: Transportation Fuels, Land-Use, Emissions, and Innovation.” *The Energy Journal* 36.

H.R.2 – 115th Congress. 2018. “Agriculture Improvement Act of 2018.” https://www.congress.gov/bill/115th-congress/house-bill/2/text?s=2&r=19&q=%7B%22search%22%3A%22organic+agriculture%22%7D.

Jespersen, L.M., D.L. Baggesen, E. Fog, K. Halsnæs, J.E. Hermansen, L. Andreasen, B. Strandberg, J.T. Sørensen, and N. Halberg. 2017. “Contribution of organic farming to public goods in Denmark.” *Organic agriculture* 7:243–266.

Kehrer, T. 2019. “Closing the liability loophole: the liability convention and the future of conflict in space.” *Chi. J. Int’l L.* 20:178.

Krystallis, A., M. de Barcellos, J. Kügler, W. Verbeke, and K. Grunert. 2009. “Attitudes of European Citizens Towards Pig Production Systems.” *Livestock Science* 126:46–56.

Kyle, M.K. 2007. “Pharmaceutical price controls and entry strategies.” *The Review of Economics and Statistics* 89:88–99.

Lee, H., R.J. Sexton, and D. Sumner. 2021. “Economics of Mandates on Farm Practices: Lessons from California’s Proposition 12 Regulations on Pork Sold in California.” *Agricultural and Resource Economics Update* 24:5–8.

Lee, W., M. Shimizu, K. Kniffin, and B. Wansink. 2013. “You Taste What You See: Do Organic Labels Bias Taste Perceptions?” *Food Quality and Preference* 29:33–39.

Lusk, J., and B. Norwood. 2011. “Animal Welfare Economics.” *Applied Economic Perspectives and Policy* 33:463–483.

Magnusson, M.K., A. Arvola, U.K.K. Hursti, L. Åberg, and P.O. Sjödén. 2003. “Choice of organic foods is related to perceived consequences for human health and to environmentally friendly behaviour." *Appetite* 40:109–117.

Magnusson, M.K., A. Arvola, U.K. Koivisto Hursti, L. Åberg, and P.O. Sjödén. 2001. "Attitudes towards organic foods among Swedish consumers." *British food journal* 103:209–227.

Marin, J. 2019. "What Is" Agricultural" Anyway: A Closer Look at the H-2A and H-2B Loophole." *J. Corp. L.* 45:557.

McCluskey, J.J. 2000. "A game theoretic approach to organic foods: An analysis of asymmetric information and policy." *Agricultural and Resource Economics Review* 29:1–9.

Mullally, C., and J. Lusk. 2018. "The Impact of Farm Animal Housing Restrictions on Egg Prices, Consumer Welfare, and Production in California." *American Journal of Agricultural Economics* 100:649–669.

Mussa, M., and S. Rosen. 1978. "Monopoly and Product Quality." *Journal of Economic Theory* 18:301–317.

Nelson, E., J.M. Fitzgerald, N. Tefft, and J. Anderson. 2017. "US Household Demand for Organic Fruit."

NonGMO Project. 2022. "6 Benefits of Going Non-GMO." https://www.nongmoproject.org/blog/6-benefits-to-going-non-gmo/.

O'Connor, M.I., A. Gonzalez, J.E. Byrnes, B.J. Cardinale, J.E. Duffy, L. Gamfeldt, J.N. Griffin, D. Hooper, B.A. Hungate, A. Paquette, et al. 2017. "A general biodiversity–function relationship is mediated by trophic level." *Oikos* 126:18–31.

Owen, A., and J. Videras. 2006. "Civic Cooperation, Pro-Environment Attitudes, and Behavioral Intentions." *Ecological Economics* 58:814–829.

Padel, S., and C. Foster. 2005. “Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food.” *British food journal* 107:606–625.

Paul, C., N. Hanley, S.T. Meyer, C. Fürst, W.W. Weisser, and T. Knoke. 2020. “On the functional relationship between biodiversity and economic value.” *Science Advances* 6:eaax7712.

Pepper, M., M. Hughes, and Y. Haigh. 2021. “Loophole or lifeline? The policy challenges of mines in care and maintenance.” *The Extractive Industries and Society* 8:100879.

Persaud, A. 2015. “Closing the Stamp Duty Loophole.”

Rajagopal, D., G. Hochman, and D. Zilberman. 2011. “Multi-Criteria Comparison of Fuel Policies: Renewable Fuel Standards, Clean Fuel Standards, and Fuel GHG Tax.” *Journal of Regulatory Economics* 18:217–233.

Reich, P.B., D. Tilman, F. Isbell, K. Mueller, S.E. Hobbie, D.F. Flynn, and N. Eisenhauer. 2012. “Impacts of biodiversity loss escalate through time as redundancy fades.” *Science* 336:589–592.

Rousset, S., K. Deconinck, H. Jeong, and M. Von Lampe. 2015. “Voluntary environmental and organic standards in agriculture: Policy implications.”

Schader, C., N. Lampkin, A. Muller, and M. Stolze. 2014. “The role of multi-target policy instruments in agri-environmental policy mixes.” *Journal of Environmental Management* 145:180–190.

Schuldt, J., and N. Schwarz. 2010. “The ‘Organic’ Path to Obesity? Organic Claims Influence Calorie Judgments and Exercise Recommendations.” *Judgment and Decision Making* 5:144–150.

Sexton, S., and A. Sexton. 2014. "Conspicuous Conservation: The Prius Halo and Willingness to Pay for Environmental Bona Fides." *Journal of Environmental Economics and Management* 67(3):303–317.

Sheldon, I. 2017. "Certification Mechanisms for Credence Attributes of Foods: Does it Matter Who Provides Diagnosis?" *Annual Review of Resource Economics* 9:33–51.

Smed, S. 2012. "Information and consumer perception of the "organic" attribute in fresh fruits and vegetables." *Agricultural economics* 43:33–48.

Spatig-Amerikaner, A. 2012. "Unequal Education: Federal Loophole Enables Lower Spending on Students of Color."

Strengthening Organic Enforcement Act. 2023. "National Organic Program (NOP); Strengthening Organic Enforcement." https://www.federalregister.gov/documents/2023/01/19/2023-00702/national-organic-program-nop-strengthening-organic-enforcement.

Tinbergen, J. 1956. "Economic policy: principles and design."

Tonsor, G., N. Olynk, and C. Wolf. 2009. "Consumer Preferences for Animal Welfare Attributes: The Case of Gestation Crates." *Journal of Agricultural and Applied Economics* 41:713–730.

UC Davis Department of Plant Sciences. 2019. "Vegetable Transplants: Their Use in the Vegetable Industry." https://www.plantsciences.ucdavis.edu/news/vegetable-transplants-their-prevalence-vegetable-industry-video.

UC Davis Health. 2019. "Are organic foods really healthier? Two pediatricians break it down." https://health.ucdavis.edu/blog/good-food/are-organic-foods-really-healthier-two-pediatricians-break-it-down/2019/04.

University of California Cooperative Extension. 2022. “Sample Costs to Produce and Harvest Organic Strawberries.”

University of Illinois Extension. 2023. “Strawberries and More.” https://web.extension.illinois.edu/strawberries/facts.cfm.

USDA. 2022. “Meetings: National Organic Program.” https://www.regulations.gov/document/AMS-NOP-21-0085-0001.

USDA AMS. 2022. “Strawberries Report Results.” https://www.marketnews.usda.gov/mnp/fv-report-top-filters?locName=&commAbr=STRBY&commName=STRAWBERRIES&className=FRUITS&rowDisplayMax=25&startIndex=1&navClass=FRUITS&navType=byComm&repType=termPriceDaily&type=termPrice.

Vermeir, I., and W. Verbeke. 2006. “Sustainable Food Consumption: Exploring the Consumer ‘Attitude-Behavioral Intention’ Gap.” *Journal of Agricultural and Environmental Ethics* 19:169–194.

Wier, M., K.O. Jensen, L.M. Anderson, and K. Millock. 2008. “The character of demand in mature organic food markets: Great Britain and Denmark compared.” *Food Policy* 33:406–421.

World Animal Protection. 2022. “Farm Animal Welfare.” https://www.worldanimalprotection.org/our-work/animals-farming.

Yadav, R. 2016. “Altruistic or egoistic: Which value promotes organic food consumption among young consumers? A study in the context of a developing nation.” *Journal of Retailing and Consumer services* 33:92–97.

Yoon, S., L. House, Z. Gao, K. Grogan, and C. Mullally. 2019. “Is Environmental Consciousness Associated with Organic Consumption? - A Revealed Preference Approach.”

Yoon, S., and B. McFadden. 2018. “Demand Elasticity of Organic Fruits and Vegetables by Income.”

Young, W., K. Hwang, S. McDonald, and C.J. Oates. 2010. “Sustainable consumption: green consumer behaviour when purchasing products.” *Sustainable development* 18:20–31.

Appendix A Organic Strawberry Growing Practices

All commercial strawberry plants – whether organic or conventional – are transplants. Strawberries are primarily grown in three areas within California: Salinas-Watsonville, Santa Maria, and Oxnard. The average cropping cycle for organic strawberries varies by variety but typically follows preparing fields early September through mid-October, transplanting crowns between mid-October and late November, and harvesting from mid-February to late July (Gaskell, 2017). There is also a second, less common, cropping cycle for strawberries which begins with preparing fields in early November. Californian strawberries prefer slightly acidic soil and are typically grown in either two-row or four-row raised beds using drip irrigation, which reduces the incidence of moisture-related disease and fungus (OSU, 2014; Guerena, 2021).

Mitigating disease and managing soil health are essential to organic operations. Because most conventional chemicals are banned in organic production, solarization (Katan, 1981; Katan, 1984; Linke, 1994), steam (Hoffman et al., 2016; Fennimore and Goodhue, 2016), and anaerobic soil disinfection (Shennan et al., 2018, Hewavitharana et al., 2021) play a vital role in managing soil-borne disease, nematodes, and weeds. Due to the significant benefits of crop rotation on soil health, it is a codified requirement for organic growers; most organic growers rotate strawberries in a four-crop cycle including alfalfa, broccoli, and cover crops. Planting cover crops is also mandated by the NOS, and provides both green manure and can lower risk of soil-borne disease. Similarly, rotating strawberry with broccoli lowers verticillium wilt incidence on strawberries (Njoroge and Kabir, 2009; Michuda et al., 2018; Shennan et al., 2020; Zavatta et al., 2021), however, growing low-value broccoli may be economically infeasible in high land rent areas such as Monterey County (Michuda et al., 2019).