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Animal Welfare and Treatment Label Claims in U.S. Table Eggs: Trends in Retail Premiums and Policy Impacts, 2008–18

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Abstract

Animal welfare and treatment label claims are increasingly prevalent for U.S. retail table eggs. A wide inventory of claims addressing housing (e.g., cage-free, free-range, pasture-raised), exogenous substance use and feeds (e.g., no added antibiotics or hormones, vegetarian-fed), and third-party humane or comprehensive certifications (e.g., organic, United Egg Producers certified, Certified Humane, and American Humane Certified) are available to U.S. table egg consumers. Retail premiums for products bearing specialty claims are the market incentives for producers to adopt alternative production practices to meet consumer demands. Stability or consistency of premiums is essential to supporting markets for alternative production. This report examines the retail premiums, or discounts, for animal welfare and treatment claims in U.S. table eggs and assesses the dynamics of those premiums from 2008 to 2018. The report also investigates the impacts of the 2014–15 highly pathogenic avian influenza (HPAI) outbreak and the passage of several State-level policies addressing the treatment of laying hens and the sale of eggs on the average retail premiums for animal welfare and treatment claims on table eggs sold between 2008 and 2018.

Keywords: eggs, specialty claims, animal welfare, retail price premiums, hedonic pricing model

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What Is the Issue?

In the U.S. table egg industry, a range of production practices have been under scrutiny, from the housing where animals are kept, to the use of exogenous substances like antibiotics and hormones, to the types of feed the animals receive. A common assumption has been that consumer demand for animal welfare and treatment practices accompanies a willingness to pay market premiums for the resulting products. Market premiums are a common justification or incentive for producers shifting production away from conventional standards. However, increased costs of alternative production methods can mean the sustainability of a specialty operation depends on the size and consistency of premiums. In addition to classical market drivers, shocks like State policy passage and disease outbreaks may increase the uncertainty of premiums. In the 2008–18 period, the U.S. table egg industry experienced both types of shocks in the form of: (1) a highly pathogenic avian influenza (HPAI) outbreak in 2014–15; and (2) the passage of a series of State policies restricting the housing practices allowed in laying-hen production or restrictions on the sale of eggs from hens housed under certain conditions. This report provides a full accounting of common animal welfare and treatment claims in the U.S. retail table egg market from 2008 to 2018 and investigates dynamics of price premiums for those claims.

What Did the Study Find?

Clear trends have emerged in the proliferation of animal welfare and treatment claims in the retail U.S. table egg market. Since 2008, products bearing the claims evaluated in this report have captured substantial shares of U.S. consumer table egg expenditures. For example, although absent from the market in 2008, eggs bearing pasture-raised claims captured 5 percent of total U.S. consumer egg expenditures by the end of 2018. The trend has been corroborated by the general decline in the share, by value, of U.S. table eggs sold with no animal welfare, treatment, or production claims from 41 percent at the beginning of 2008 to 27 percent at the end of 2018.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

Most of the animal welfare and treatment claims evaluated commanded a premium, on average, at a national level, though discounts were also observed.

- Across 2008–18, the estimated average monthly premiums were:
  - 9.9 percent for no added antibiotics claims,
  - 13.8 percent for cage-free claims,
  - 18.7 percent for free-range claims,
  - 40.9 percent for organic claims
  - 8.8 percent for third-party, humane certified claims, and
  - 46.5 percent for pasture-raised claims.
- Over the same period, on average, the United Egg Producers Certified claim was associated with a 6.9 percent discount.

The study identified significant trends in premiums for several claims, but the direction of the trend depended on the claim, with most premiums increasing over time but some decreasing. Overall, price differentials for animal welfare and treatment claims compared with conventional U.S. table egg average prices exhibited significant change over the 2008–18 period.

The magnitude of premiums for some animal welfare and treatment claims was significantly affected by major market shocks, including widespread HPAI disease outbreaks and the passage of State policies addressing production of laying hens or retail sale of table eggs.

- The HPAI outbreak of 2014–15 had a mainly negative influence on premiums for several claims, reducing all but one evaluated premium by between 1 and 31 percentage points.
- Passage of a production policy reduced premiums for claims for cage-free (–7 percentage points), organic (–16 percentage points), vegetarian-fed (–7 percentage points), no added hormones (–2 percentage points), free-range (–10 percentage points), and United Egg Producers Certified (–1 percentage point).
- The passage of a sales policy had a net negative effect on all evaluated premiums except those of claims for organic (increased 7 percentage points), vegetarian-fed (4 percentage points), and no added hormones (3 percentage points).

How Was the Study Conducted?

For this study, the author compiled an inventory of common animal welfare and treatment claims for U.S. retail eggs, including official USDA, Agricultural Marketing Service definitions for common terms. Using retail food scanner data from Circana (previously Information Resources, Inc. (IRI)), merged with package label data from Label Insight, the study characterizes the market for U.S. table eggs bearing common animal welfare and treatment claims by calculating monthly market expenditure shares and average monthly prices from 2008–18. The author estimated a set of semi-log hedonic pricing models to assess the magnitude and dynamics of retail market premiums, or discounts, for the traits of interest over the sample period. Additionally, the author estimated a comprehensive hedonic pricing model across the full sample period to assess the impacts of the 2014–15 HPAI outbreak and the passage of State laying-hen welfare production and retail egg sales policies on specialty egg premiums.

Animal Welfare and Treatment Label Claims in U.S. Table Eggs: Trends in Retail Premiums and Policy Impacts, 2008–18

Introduction

Animal welfare and treatment in livestock and poultry production have received considerable attention in recent years, with an increasing proliferation of policies, industry pledges, and product offerings. The scrutiny of U.S. livestock industries and novel policies addressing animal product production has even reached the U.S. Supreme Court, with a May 2023 ruling on California's Proposition 12 demonstrating the growing importance of U.S. production standards to a range of stakeholders across the market spectrum.[1] This attention covers a range of production practices, from the housing or enclosures in which animals are kept, to the use of exogenous substances (e.g., antibiotics and hormones), to the type of feed the animals receive. The U.S. consumer table egg industry has demonstrated this clearly, with product labels covering a wide breadth of claims for specialty production practices employed in raising and keeping laying hens.

Generally, consumer demand for traits like specialty animal welfare or treatment practices gives rise to a premium for those products, creating an incentive for producers to meet those demands (Carlson et al., 2023). Premiums reflect increased value to consumers of a production practice above the conventional norm or industry standard, while also alleviating the additional cost pressures producers incur in using alternative production methods that may reduce overall production efficiency. Consumer willingness to pay premiums for specialty egg traits like organic and cage-free has been well documented in the economic literature (Heng et al., 2013; Norwood & Lusk, 2011; Ochs et al., 2019b), as has the observation of premiums for specialty labeled eggs at the retail level in market data (Badruddoza et al., 2021; Chang et al., 2010; Loke et al., 2016). Market premiums thus are a common justification for shifting production away from the conventional standard. However, consistency in market premiums for specialty food production traits is not necessarily guaranteed (Badruddoza et al., 2021; Carlson & Jaenicke, 2016), especially as consumer preferences for animal welfare may not be well defined, consistent, or stable (Ochs et al., 2019a). Although net premiums may be impacted by increasing production costs, retail-level shifts in prices may also impact the size of premiums for specialty production traits.

When policies pass that impact production or retail sales options, it is unclear how premiums are affected—particularly for claims that are indirectly related to the practices a policy may address. Additionally, major shocks to production, such as disease outbreaks, can have unknown effects on the prices of specialty-differentiated products. The U.S. retail table egg industry offers an excellent opportunity to explore premium dynamics through the potential impacts of both policy and disease shocks. Since 2008, several U.S. States have passed policies regulating the way laying hens can be housed or restricting the sale of table eggs from

[1] In May 2023, the U.S. Supreme Court ruled on a case challenging the implementation of California's Proposition 12 law, which requires, among other things, that any covered pork product sold within the State of California be raised in a manner compliant with the State's production standards for hogs (specifically, that hogs be given a minimum amount of space per animal; for more information, see Ufer (2022)). Though the legal basis for the case centered on the constitutionality of a State imposing market requirements that might affect out-of-State producers, the case itself drew attention to the issues of animal welfare and treatment in U.S. animal agriculture and the nature of current U.S. industrial standards of production.

hens housed in spaces or structures not in compliance with State standards (Ufer, 2022). Although these policies often had delayed implementation dates, the attention their passage drew to the industry and its standard practices may have influenced consumer preferences and market behavior. Consequently, market prices and premiums for traits may have been affected, directly or indirectly, due to provisions of the pending policies.

Although the effects of animal welfare policy passage on some aspects of the hog market and pork industry have been investigated (Blemings et al., 2023), the influence of policy passage on market premiums for animal welfare and treatment claims in U.S. table eggs remains largely unexplored. Between 2008 and 2018, the U.S. table egg industry also experienced a major disease shock during the 2014–15 highly pathogenic avian influenza (HPAI) outbreak. This outbreak significantly reduced the U.S. laying hen population and consequently exerted heavy impacts on the price of eggs, though the relative impacts of the prices of specialty eggs compared with conventional eggs is unclear.

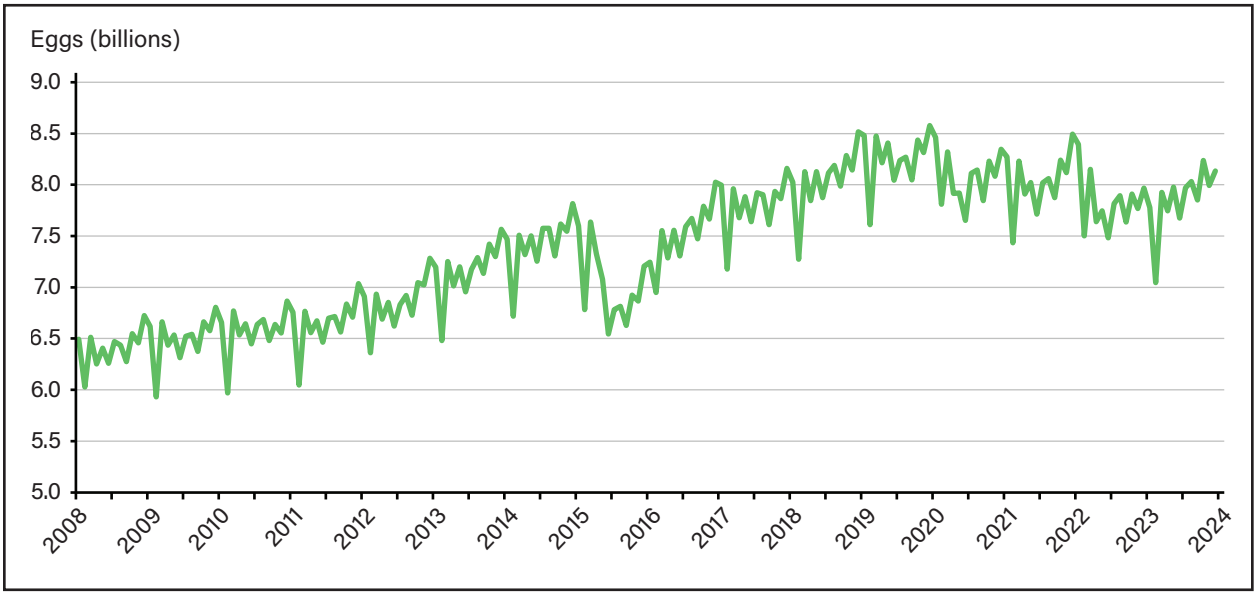
The goal of this report is to provide a full accounting of common animal welfare and treatment claims in the U.S. retail table egg market from 2008 to 2018 and to investigate premium dynamics for those claims on specialty eggs. The first question we addressed was how market offerings for animal welfare and treatment claims in table eggs have evolved over time. The author characterized the U.S. table egg market and the most common animal welfare and treatment claims, as well as the market's dynamics, by assessing changes in value-based market shares and prices for offerings bearing those claims over the 11-year period. Second, the author investigated the consistency of premiums, or discounts, for individual egg claims on a national level by plotting the movement of premiums and discounts and estimating trends in that movement. Third, the author examined whether major disease outbreaks and the passage of State policies addressing the production or sale of eggs under specific housing conditions impacted average market premiums for common animal welfare and treatment claims.

Overview of U.S. Table Egg Production and Demand

The United States is among the top global egg producers (Food and Agriculture Organization Statistics (FAOSTAT), 2023). The United States' annual table egg production has been approximately 88 billion eggs (7.3 billion dozen), on average, since 2008 (figure 1). The U.S. inventory of table egg laying hens has followed similar trends over time, with the national flock averaging around 307 million birds since 2008, reaching a 15-year high of 343.8 million birds in April 2019 (figure 2). While the laying-hen inventory has generally trended upwards since 2008, the U.S. poultry industry has faced several challenges with regard to biosecurity and disease mitigation, particularly during the 2014–15, and more recently the 2022–24, HPAI outbreaks. Both outbreaks resulted in substantial losses to the national flock, with an estimated 12-percent decrease in table egg laying hens during the 2014–15 outbreak and record-high retail prices for eggs (Ramos et al., 2017). Although there have been occasional market shocks like the HPAI outbreaks, U.S. per capita egg consumption has generally trended upwards since 2008 (figure 3). Annual per capita disappearance was just under 250 eggs in 2008 but increased to nearly 280 eggs in 2022 after peaking in 2019 at 292 eggs per capita.[2] While these figures represent the disappearance of all eggs and egg products and, thus, are an upper-bound estimate of consumption, they are indicative of strong and growing demand for eggs in the United States consumer market.

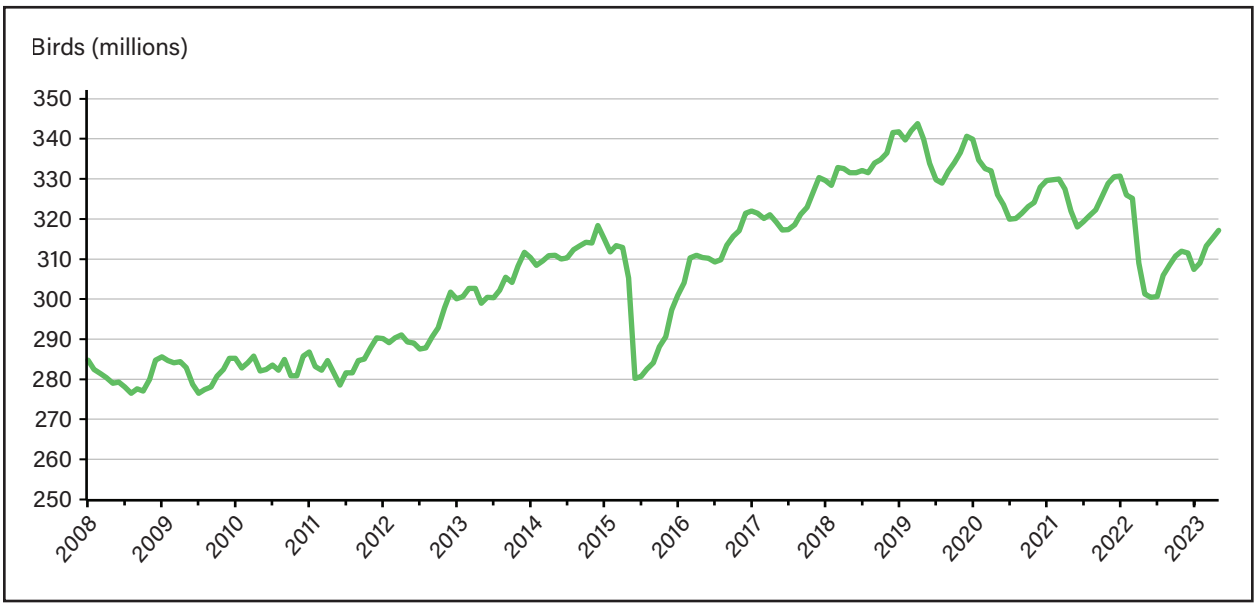
[2] Disappearance is reported as a proxy, albeit an imperfect one, for consumption. Disappearance is calculated as a measure of total supply per capita (i.e., supply minus exports and ending stocks). It is an imperfect proxy for consumption as it does not account for demand-side losses, such as food waste and nonfood uses, nor does it necessarily account for timing discrepancies caused by stocks in transit or holding by retailers and foodservice firms (Jones et al., 2018).

Figure 1
U.S. monthly table egg production, 2008–23



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Quick Stats data.

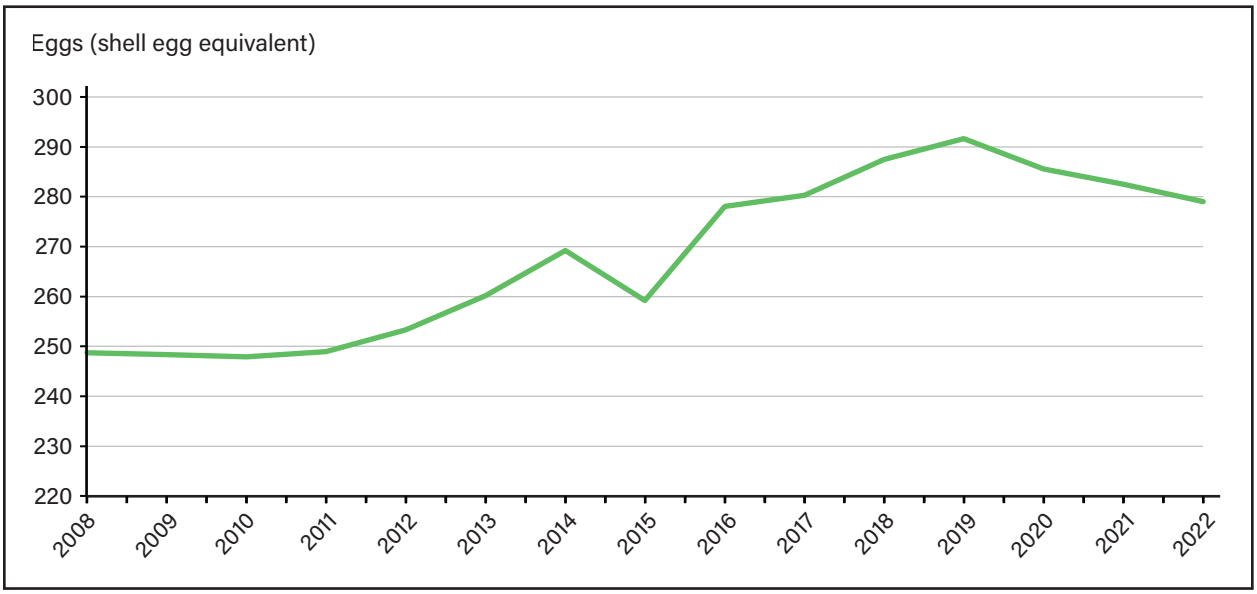
Figure 2
U.S. monthly table egg laying hen inventory, 2008–23



Note: Values are representative of the national inventory as of the 1st of each month.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Quick Stats data.

Figure 3
U.S. per capita egg disappearance (shell egg equivalent), 2008–22



Note: Disappearance is reported in shell egg equivalents.

Source: USDA, Economic Research Service, Meat Supply and Disappearance Tables data.

U.S. egg production has evolved gradually over time. Through the early 1900s, egg production occurred predominantly in backyard or small flocks. From the 1940s to the 1960s, developments in indoor housing systems for laying hens provided improved sanitation and bird health as well as more controlled production, which led to an industry shift toward caged production (Mench et al., 2011). By the early 2000s, the vast majority of U.S. egg production occurred in large-scale cage operations, with less than 5 percent of output coming from hens in alternative housing systems by 2010 (American Egg Board, 2023; Mench et al., 2011; United Egg Producers (UEP), 2023). Economies of scale in production have led to substantial consolidation of the industry (table 1). In 2008, according to WATT Poultry, the top five egg producing companies in the United States accounted for approximately 24.1 percent of all laying hens in the country (WATT Poultry, 2008). By the start of 2018, the top five companies' share had grown to nearly 29 percent (King, 2018) and continued growing, reaching 32.2 percent in 2023 (WATT Poultry, 2023). Although egg production in the United States primarily takes place in large-scale facilities, increasing consumer interest in specialty or alternative production methods, such as cage-free or organic production, has led to a growing trend in egg farm transition or alternative practice adoption to meet novel demands (American Egg Board, 2023; UEP, 2023).

Table 1
Top five U.S. egg producing companies and share of U.S. egg production, 2008, 2018, and 2023

2008 rank	2018 rank	2023 rank	Company	Number of hens (millions) 2008	Number of hens (millions) 2018	Number of hens (millions) 2023
1	1	1	Cal-Maine Foods	22.8	40.1	44.0
2	2	2	Rose Acre Farms	22.6	26.9	25.1
3	7	10	Michael Foods	14.0	12.2	9.8
4	*	*	Moark, LLC	12.0	*	*
4	15	25	Sparboe Summit Farms	12.0	6.1	3.6
20	3	3	Hillandale Farms	3.9	16.7	17.8
NA	4	4	Versova Holdings LLP	NA	16.4	17.0
7	5	4	Daybreak Foods	7.9	12.8	17.0
			Largest five companies	83.4	112.9	120.9
			All U.S. egg production	345.7	390.3	375.4
			Largest five companies' share of U.S. production	24.1 percent	28.9 percent	32.2 percent

NA = Not available. The data for these years are not available because Versova Holdings LLP was formed in 2016 and, thus, does not have data for 2008.

Asterisk (*) = Moark, LLC was sold to Hillandale Farms in 2015. All U.S. production values are the USDA, National Agricultural Statistics Service reported values for U.S. Inventory of Layers, January 1 of 2008, 2018, or 2023.

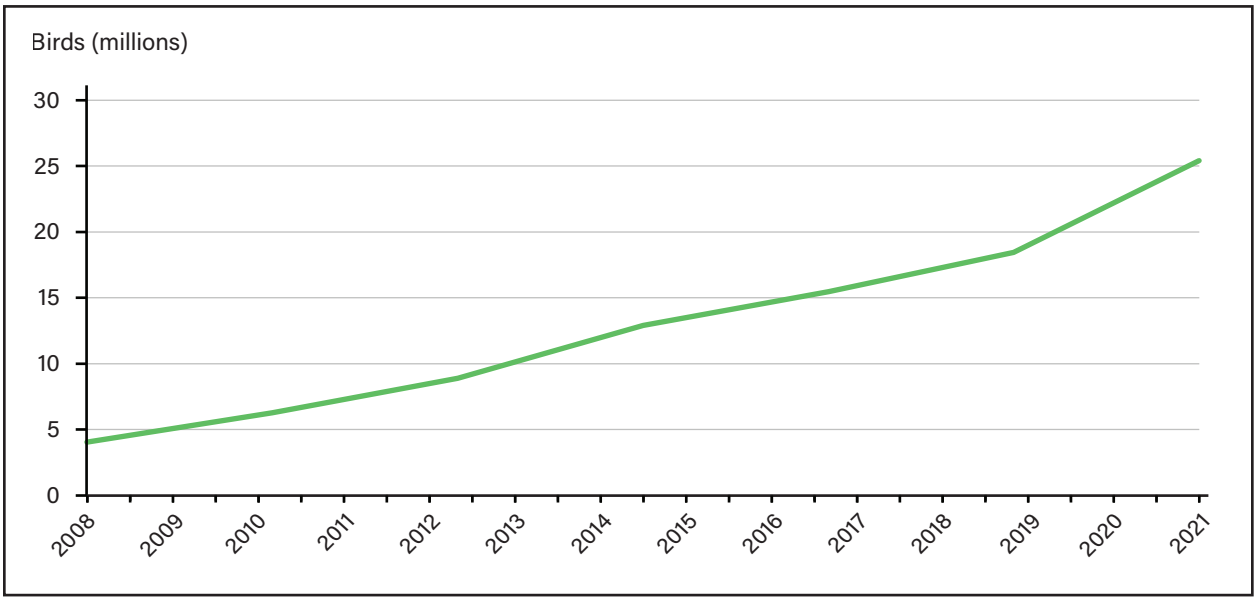
Sources: USDA, Economic Research Service using WATT Poultry, January 2008, February 2018, and January 2023 data; and from USDA, National Agricultural Statistics Service data.

Specialty Egg Production and Common Animal Welfare and Treatment Label Claims

Specialty egg production generally encompasses any practices that depart from the industry norm or conventional production practices.[3] In many cases, these practices specifically pertain to the welfare or treatment of the laying hens that produce the eggs. Several studies have found animal welfare to be a top concern for U.S. consumers when it comes to table eggs (Ellison et al., 2017; Powers et al., 2020), even surpassing environmental concerns of production (Heng et al., 2013). Shifting consumer preferences towards production practices relevant to animal welfare and treatment are evident from the growing number of State-level regulations and industry pledges to eliminate some production practices (Ufer, 2022). The rising interest in specialty eggs, in particular, is also demonstrated by the shifting composition of the national laying hen flock. For example, from 2008 to 2021, the number of organic laying hens in the national inventory grew more than sixfold from 4.1 million to 25.4 million (figure 4). By comparison, the total national inventory grew by only 16 percent, or 45.8 million birds total, during the same time.

[3] Conventional U.S. laying hen production has been characterized by the use of battery cage production in barns with no outdoor access. Typical U.S. laying hen production also employs antibiotics, a wide variety of feedstuffs, which can include genetically modified crops, and can include practices such as induced molting and beak trimming. Specialty production with attention to animal welfare and treatment deviates from conventional production in at least one of these typical elements.

Figure 4
U.S. organic laying hen inventory, 2008–21



Note: Inventory values represent census values reported for end of December in the stated year.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Quick Stats data.

Growing consumer concern for livestock and poultry production practices in other industries also provides insights into the increasing demand for nonconventional products. For example, consumer demand for chicken products from broilers raised without antibiotics supported sustained growth in those products' market shares, on a total expenditure basis, from 2012 to 2017 (Page et al., 2021). While a wide array of claims has adorned table egg packages in the last 15 years, this study's analysis was limited to the most common and well-defined claims relevant to animal welfare and treatment. These included cage-free, pasture-raised, USDA organic, no added antibiotics or hormones, free-range, vegetarian fed, United Egg Producers Certified (UEPC), and third-party humane certified (largely consisting of Certified Humane Raised and Handled® or American Humane Certified) eggs. Though consumer interpretations of labels may vary (see box "Product Labels, Claim Veracity, and Consumer Perceptions"), this report details the official or widely accepted definitions of the terms or claims examined in the study.

Cage-Free, Free-Range, and Pasture-Raised

Most of the U.S. egg industry, until the early 2000s, relied on battery cages, which confine large groups of laying hens in a small space and are stacked multiple layers deep within a barn for laying hen housing. Since then, cage-free, free-range and pasture-raised claims have increased, denoting eggs from birds not kept in conventional housing systems.[4] The USDA, Agricultural Marketing Service (AMS) has defined cage-free eggs as being laid by hens able to roam vertically and horizontally in indoor houses, with access to fresh food and water. Additionally, the hens must be allowed to exhibit natural behaviors and include enrichments like scratch areas, perches, and nests (USDA, Agricultural Marketing Service (AMS), 2015). The USDA,

[4] Additional alternative housing practices exist beyond these, most notably "enriched colony" or "furnished cage" housing, which maintains a cage-based production system but allows more space per bird and includes animal enrichment features permitting natural behaviors, such as scratch pads, dust baths, perches, and nesting boxes. While enriched-colony housing represents several animal welfare-oriented practices, table egg products bearing claims of enriched colony production are relatively rare and thus were excluded from the analysis.

AMS free-range definition has been nearly identical to the cage-free definition with the exception that free-range production also requires that hens must have continuous access to the outdoors during their laying cycle while remaining protected from predators (USDA, AMS, 2015). Although official USDA definitions for pasture-raised claims are largely indistinguishable from free-range, requiring continuous access to the outdoors, these claims often bear a connotation of hens raised outdoors with access to housing for roosting space and protection from predators and inclement weather (Certified Humane, 2014). That is, pasture-raised claims typically imply the hens are kept outdoors with indoor access, while free-range claims are inverted, indicating hens are kept indoors with access to the outdoors.

Housing claims have received a great deal of attention in the economic literature on animal welfare demand for table eggs, with researchers typically finding consumers willing to pay significant premiums for cage-free, free-range, and pasture-raised claims (Heng et al., 2013; Lusk, 2019; Norwood & Lusk, 2011; Ochs et al., 2019b). Additionally, Widmar et al. (2020) found housing systems for egg production to be the main focus of online discussions about egg laying hens, indicating significant consumer attention to these traits.

No Added Antibiotics and No Added Hormones

Antibiotics are commonly used in livestock and poultry production, either for therapeutic purposes (i.e., the direct treatment of a diagnosed disease) or subtherapeutic purposes (i.e., where antibiotics are administered to prevent disease or bring about other production benefits, such as increased efficiency) (Key & McBride, 2014; Kumar et al., 2018). USDA, Food Safety and Inspection Service (FSIS) has defined claims such as "no added antibiotics" or "raised antibiotic-free" for meat and poultry products as meaning the producing animals were not administered antibiotics at any point in the production process (USDA, Food Safety and Inspection Service (FSIS), 2021).[5] Although antibiotic use has been more restricted in laying-hen production than in broiler production (Singer, 2023), increasing market shares by value, and availability of poultry products with "raised without antibiotics" claims, demonstrate growing consumer interest in reduced antibiotic use in agriculture (Page et al., 2021).

The use of exogenous or added hormones is prohibited in U.S. poultry production (USDA, FSIS, 2019), which has rendered the no added hormones claim effectively meaningless for practically differentiating eggs. Nevertheless, claims of no added hormones on poultry and egg products in the United States have remained permitted so long as an additional statement noting that Federal regulations prohibit the use of hormones is included as well. Research on consumer willingness to pay for no added hormones claims on products where the claim does not indicate a practical differentiation from unlabeled products (e.g., U.S. eggs and, historically, pork) has supported the expectation of a premium for the claim (Heng et al., 2016; Ufer et al., 2022; Yang et al., 2020).

Organic

Organic egg production has followed the standards laid out by USDA's National Organic Program (NOP). NOP has detailed requirements across a variety of agricultural commodities and products, but some core principles are upheld generally for organic production. These have included prohibitions of synthetic pesticides, herbicides, and fertilizers in crop production and genetic engineering in both plants and animals. Specific crop rotation and soil conservation practices are required also. These principles for organic crop production follow through to organic livestock and poultry production, for which only organic feed, pasture, forage, and plant-based bedding may be used. In addition, NOP has prohibited the use of antibiotics and

[5] USDA, FSIS is responsible for the oversight of claims on egg products (e.g., liquid egg white products, dried egg products, etc.) but does not oversee claims on table eggs. Instead, table eggs are overseen by the U.S. Food and Drug Administration.

growth hormones and required that natural nutritional and behavioral requirements be met (Carlson et al., 2023). In the case of laying hens, this has included prohibiting the use of cages in production. Organic claims have been among the best-studied specialty claims in the food economics literature, with several studies identifying existing market premiums or positive consumer willingness to pay a premium for retail table eggs bearing organic claims (Badruddoza et al., 2021; Carlson & Jaenicke, 2016; Chang et al., 2010; Heng et al., 2013; Loke et al., 2016; Oberholtzer et al., 2006).

National Organic Program standards for laying hen production, particularly those relevant to animal welfare, housing and treatment, have evolved over the past two decades. Initially, NOP requirements for laying hen production included "access to the outdoors, shade, shelter, exercise areas, fresh air and direct sunlight," with consideration for stage of production, climate, and environment. These early requirements had left a lot of room for interpretation, which resulted in variations in the definition of compliance across certifying agents. As the definition of organic egg production could vary from operation to operation, depending on the certifying agent, the risk of consumer misinterpretation or misunderstanding of the provisions of the organic label was high under the original rules and led to calls for revision. The top concerns in NOP included the use of porches for laying hens (i.e., screened, elevated patio structures) by some organic producers to meet the requirement for outdoor access. An estimated 70 percent of USDA organic laying hens only had porch access rather than outdoor access to soil and pasture (Federal Register FR 2023–23726). In January 2017, USDA's NOP published a proposed revision to the rules that included minimum indoor and outdoor space requirements and eliminated the eligibility of porch structures as qualifying outdoor access, but the rule never went into effect as it was withdrawn in March 2018. USDA published a new final rule[6] in November 2023, which aimed to standardize animal welfare requirements with greater clarity and consistency for enforcement across certifying agents. The new rule included a minimum requirement of 75 percent of outdoor areas to include soil, with vegetation to the degree possible and establishes minimum indoor and outdoor space requirements per bird and stocking density limitations. The new rule also included additional animal welfare requirements or restrictions relevant to preventive health care actions and physical alterations (USDA, 2023).[7]

Third-party Humane Certification and United Egg Producers Certified (UEPC)

Although most animal welfare and treatment claims made for table eggs have focused on a singular aspect of production, one subclass of claims that has aimed to comprehensively address animal welfare or humane treatment is third-party humane certifications. Though several certifications have existed in the retail market, two of the most common for U.S. table eggs are the Certified Humane Raised and Handled (or simply referred to as Certified Humane) and the American Humane Certified labels. Additionally, the United Egg Producers (UEP), an agricultural cooperative supporting its member farmers, has administered its own certification for production standards addressing hen well-being since 2002 (i.e., United Egg Producers Certified (UEPC)). Third-party standards are determined independently by the organizations that oversee the certifications and cover any aspects of production the certifier has deemed relevant to animal welfare. In the case of laying hens, these typically include housing facilities; feed standards; health and sanitation standards including administration procedures for antibiotics; access to the outdoors and other environmental considerations; acceptability of routine practices like beak trimming or induced molting; and handling, transport, and slaughter (Humane Farm Animal Care, 2023).

[6] Although the USDA rulemaking process can occur multiple times for a program and the possibility of future new rules is ever present, each iteration of the rulemaking process culminates in a final rule. The discussion in this section relates to the final rule published in November 2023.

[7] While the 2017 revision of USDA's NOP rules had overlapped with the sample period of this study, the officially enforced NOP standards remained the same throughout the sample period. This means that no alterations were made in the enforcement of the NOP rules during the study period, but the variations in interpretation by certifying agents and, consequently, by consumers were probable during this time.

Both types of certifications, third party and UEPC, have some distinctions in their standards depending on production type. For third-party humane certifiers, these distinctions tend to come between cage-free versus pasture-raised or free-range systems, and for UEPC the distinctions are between caged versus cage-free systems. Additionally, previous research has indicated variations in the credibility consumers impart to different certifications, and thus the premiums or possible discounts assigned to them. For example, according to a study by Powers et al. (2020), UEPC may not be regarded as having as high credibility with consumers as Certified Humane. We treated third-party humane certification and UEPC certification separately, as the goals of the different organizations overseeing these two types of certifications are very different and the third-party humane certification standards tended to deviate from conventional production standards more substantially than the UEPC programs.

Vegetarian Fed

Laying hens are naturally omnivorous animals and poultry production in the United States commonly involves various feeds, both animal and vegetable. Animal-based feeds can include byproducts of other livestock production, including meat, bone, or blood meal (Applegate & Fowler, 2021). According to USDA, FSIS, diet claims for meat and poultry products refer to what animals are fed prior to harvest and processing, which means that the animal only ate the claimed diet for the entirety of its lifetime. Vegetarian fed claims, or similarly worded claims that indicate a vegetarian diet, have indicated operators only used vegetable feeds during production and excluded all animal products (USDA, FSIS, 2019). Though vegetarian fed claims have received little attention in the literature on specialty claims in table eggs, the available evidence has indicated the claim may be associated with a slight discount rather than a premium (Heng et al., 2013).

Product Label Oversight, Claim Veracity, and Consumer Perceptions

The U.S. egg industry is overseen by multiple government agencies, including USDA, Agricultural Marketing Service, USDA, Food Safety and Inspection Service (FSIS), and the U.S. Food and Drug Administration (FDA). USDA, FSIS only oversees labeling of egg products (e.g., liquid egg white products, etc.) and not table eggs, requiring that applicants provide supporting documentation to prove the veracity of any animal welfare or treatment claims they intend to make on their packaging. This includes labels bearing animal-raising claims (e.g., no added antibiotics, no hormones added, vegetarian fed), cage-free, free-range, and humanely raised. In contrast, U.S. table eggs are regulated by the FDA and are not subject to the same documentation requirements as egg products overseen by USDA, FSIS.

Where external verification is involved, such as for the USDA National Organic Program, United Egg Producers Certified (UEPC), or third-party humane certifiers, regular farm audits may be conducted to ensure program standards are met. Thus, whether by government oversight or a third-party audit, the claims made on U.S. retail food products generally have represented a standard of product reliability and trustworthiness.

Despite both public and private oversight infrastructure aimed at ensuring accuracy and consistency of egg labels, it is important to acknowledge the potential difference of what a label means and what consumers may interpret a label to mean. Consumers may lack knowledge about specific food label standards, and consumers may depend on visual and/or verbal cues from the physical labels to construct an interpretation of the label's production specifications (e.g., some consumers perceive the organic claim to mean the product came from a small farm even though there are no farm size limitations in USDA organic standards) (Powers et al., 2020; Ufer & Ortega, 2023). Consumer values for specialty label claims have historically included interpretations that are inconsistent with the actual label provisions or value for labels that provide no meaningful or useful information (Heng et al., 2016; Kuchler et al., 2023; Lim & Page, 2022; Scholl-Grissemann, 2018). Additionally, as is evident from some of the claims discussed in this report, product marketing strategies may utilize consumers' ignorance of standard production practices. An example of this is the no added hormones claim used on some U.S. table eggs despite the already-existing law against added hormone use in all U.S. egg production. This study can be helpful for understanding market premiums for animal welfare and treatment claims, but users should not necessarily interpret this to mean the market has perfect information and consumers fully understand the production practices that the claims represent.

Data and Methodology

Data

To assess the market shares, average prices, and average retail market premiums for various animal welfare and animal treatment claims on table egg labels, the author analyzed proprietary retail point of sale data from Circana (previously Information Resources, Inc. (IRI)) for the 2008–18 period. Although public data sources for table egg sales values and volumes are available, including series and reports from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) and USDA, Agricultural Marketing Service (AMS), the use of scanner data offers some advantages for this study. Scanner data provides a real-time representation of total revenues and volumes directly reported by participating retailers. By comparison, some public sources have, in part, relied on promotional or advertised pricing, which can present a downward bias in reported prices.

The scope and detail of scanner data—specifically the breakdown of products by individual Universal Product Code (UPC)—allowed the author to cross reference scanner data with other data sources to identify a broader range of product traits.

The point of sale, store-based scanner data, or OmniMarket Core Outlets (formerly InfoScan) data, are collected and reported as weekly sales (i.e., revenue and volume) by Circana from various retail establishments, including grocery stores, drug stores, convenience stores, mass merchandiser stores, club stores, and dollar stores across the United States.[8] For our purposes, the relevant data from each Circana record for an individual store for a given week consists of a product's UPC, the total value of sales for that product, and the total number of units sold. Circana product dictionaries provide additional detail for products at the UPC level, including package size, count or weight, brand or company name, a product description, and a limited selection of product traits including organic, natural, non-genetically modified, and no added antibiotics, depending on the year of the record.

Although Circana's product dictionaries and product descriptions can be used to identify some animal welfare or treatment traits of interest, several claims on product labels are omitted. Following a similar procedure to that used in Page et al. (2021), we merged the Circana data with a second data source, Label Insight, to identify additional relevant animal welfare label claims. Label Insight is a proprietary database of product labels that includes full listings of any text contained on a product's packaging, images of representative labels, and dates of label activity, all associated with UPC identifiers. Data for all shell or table egg products in the Label Insight database were compiled and merged with all fresh egg product UPCs in the Circana data for the 2008–18 period. Approximately 27.5 percent of the Circana fresh egg UPCs across all years in the study sample, which accounted for 67.5 percent of the fresh table egg records in the Circana store retail scanner data, could be matched to a corresponding Label Insight product entry. A total of 1,112 unique UPCs were matched between the Circana and Label Insight databases. Circana identified similar traits, such as organic, vegetarian fed, and nongenetically modified, which were used to check the accuracy of the Label Insight variables. A summary of the data is presented in appendix A, including total observations across the entire sample period, total observations in each year, and the percent of observations within the full sample bearing each animal welfare and treatment claim of interest.

The author identified and coded the animal welfare and treatment claims for eggs as dummy variables for each record in the merged sample. These claims included cage-free, organic, pasture-raised, free-range, raised without antibiotics, no added hormones, third-party humane certified, vegetarian fed, and United Egg Producers Certified (UEPC). Specialty labeled eggs tended to have nonwhite shells more often. Estimates of premiums for animal welfare claims on eggs have been found to be influenced by the color of the eggshell, so a portion of a claim's estimated premium may actually be due to values consumers derive from beliefs related to shell color rather than the value of the claim itself (e.g. consumers may perceive eggs with brown shell color to be healthier or higher quality) (Chang et al., 2010). As a result, to avoid omitted variable bias the author included a dummy variable identifying brown eggs. Additional claims variables with arguably less relevance to animal welfare or treatment were also included in the analysis as control variables, such as natural and nongenetically modified claims. Records were also coded to identify the outlet type in which the product was sold (e.g., grocery store, convenience store, dollar store, mass merchandise store, or other store type); the carton size (e.g. half dozen, dozen, 18 count, or other); the size of the eggs (e.g., medium, large, extra-large, or jumbo); and the State in which the store was located (including Washington, DC). In addition, dummy variables indicating store or retail chain, brand, and whether the product was sold under a private label were included to further reduce the risks of omitted variable bias.

[8] OmniMarket Core Outlet data include two types of store aggregation levels: (1) individual stores, and (2) retailer marketing area (RMA) (Muth et al., 2016). Although RMA data provide useful market insights, in the context of this study the wider geographic variation and ambiguity of the RMA-level data limit their usefulness in assessing market effects across U.S. States. Thus, the study analysis was limited to store-level observations.

Methods

The author conducted a descriptive analysis of the data to determine the market shares by value and the average prices of products bearing each of the animal welfare traits of interest. We calculated national-level monthly market shares on the basis of total reported expenditures. We also calculated the average monthly prices at the national level, although the calculation was limited to products sold in 1-dozen-egg size packages. A more detailed explanation of how market shares and national average prices were calculated is available in appendix B.

Dynamic analysis of premiums for specialty food claims and qualities have used various methods (Badruddoza et al., 2021; Çakır et al., 2022; Faye & Le Fur, 2019; Wang et al., 2023). To model the premiums for various animal welfare and treatment claims, the author employed a hedonic pricing model approach based on the work of Rosen (1974). The hedonic pricing model takes a linear functional form and defines price (or a transformation of price) as a function of product attributes. The resulting coefficient estimates can then be used to calculate the implicit price, or average premium, for the individual attributes in the model (Costanigro & McCluskey, 2011).[9] Hedonic pricing models offer several advantages and have been widely employed in agricultural studies and food product studies (for example, Bimbo et al. (2016), Bonanno (2016), Botta et al. (2023), Carlson and Jaenicke (2016), and Szathvary and Trestini (2014)), including fresh eggs (Badruddoza et al., 2021; Chang et al., 2010; Loke et al., 2016) to identify price premiums for product attributes. Hedonic pricing models allow for the isolation of price premiums associated with specific product traits or attributes, such as individual claims associated with a product, while controlling for such traits as variations in packaging size, geographic location of sale, and store outlet type (Carlson & Jaenicke, 2016; Costanigro & McCluskey, 2011).

Though hedonic pricing models have been useful in characterizing the price environment of products and product attributes within a market, it is important to note that these models are not immune to bias. Implicit prices may be overestimated or underestimated if the model is inaccurately specified, whether by omitting essential explanatory variables or by misidentifying attributes of interest with inaccurate dummy variables. Additionally, market forces cannot always be fully accounted for in a hedonic pricing model including general price fluctuations, volatility, and market constraints or effects of imperfect competition. For example, a hedonic pricing model does not capture the impacts of supply controls or quotas, in which specialty products are shifted into conventional marketing channels to maintain a minimum price level for the specialty product. Instead, the hedonic pricing model assumes a perfectly competitive market (Costanigro & McCluskey, 2011), an assumption that may not necessarily hold in practice for the U.S. table egg industry. Despite the limitations of the hedonic pricing model, when applied with due caution it is still a valuable tool for offering insights into the structure of prices across a market.

To investigate the dynamics of retail price premiums, the author estimated a series of hedonic pricing models on a monthly basis across the 11-year sample. Marginal effect estimates were stored and compiled into a time series of estimated premiums across the 132 months in the sample. The author then ran simple linear regressions on each series of premiums for animal welfare and treatment claims to identify any significant trends in premium dynamics. As the data for some series showed evidence of seasonality in prices, the author included controls for seasonal variation in premiums in months with major holidays. Additionally, a dummy variable was included for the months of January 2008 through July 2009 to control for any price effects from the

[9] In interpreting the implicit prices of the attributes or traits included in a hedonic pricing model, one caution offered by Costanigro and McCluskey (2011) is to avoid confusing implicit prices as measuring consumer willingness to pay for or value for the trait. Instead, implicit prices more closely represent an equilibrium market price, accounting for both consumer preferences and potentially greater costs of production. Consequently, a greater implicit price for one trait over another does not necessarily imply that consumers value that trait more highly than the trait with the lower implicit price.

Great Recession[10] in the study sample. A dummy variable was also included for the months from December 2014 to September 2015 to control for possible effects from the 2014–15 HPAI outbreak (December 2014–June 2015), as well as for the 3-month, post-outbreak period to account for delayed impacts of HPAI discovery and depopulation effects on egg prices and premiums (Ramos et al., 2017).

In addition to an exploration of regular premium dynamics, the author investigated the impacts of market shocks on average price premiums relative to the entire period of 2008–18. The study focused on two types of shocks including widespread disease outbreaks and the passing of State-level animal welfare policies. In the case of disease outbreaks, the author focused on the effects of the 2014–15 HPAI outbreak on the average price premiums for animal welfare and treatment claims. The analysis also examined whether the passing of animal welfare policies that address U.S. laying-hen industry practices affected retail premiums for animal welfare and treatment label claims at the State level. Several State-level policies have restricted the confinement of laying hens by requiring a minimum amount of space per bird or State-level policies have restricted the in-State sale of products produced in noncompliant hen housing passed by ballot measure or legislative action during the study (Ufer, 2022). In total, from 2008 to 2018, seven States passed restrictions for in-State laying hen housing, and three States passed further policies restricting the in-State sale of eggs produced by hens kept in noncompliant housing (table 2).

Table 2
State laying hen welfare production and retail sales policy initial passage dates, 2008–18

Policy type	State	First policy passed[1]
Confined[2] hen or battery-caged egg production	California	Nov. 2008
	Massachusetts	Nov. 2016
	Michigan	Oct. 2009
	Ohio	Nov. 2010
	Oregon	Jun. 2011
	Rhode Island	Jul. 2018
	Washington	Apr. 2011
Sales of eggs from confined[2] or battery-caged hens	California	Jul. 2010
	Massachusetts	Nov. 2016
	Michigan	Oct. 2009

[1] Following the initial passage of a policy, several of the listed States later passed policies that addressed production or retail sales standards and imposed more stringent restrictions. Only the first policies passed in each State during the 2008–18 period are reported here. A more detailed reporting of State animal welfare policies can be found in Ufer (2022).

[2] Confined means animals raised in spaces smaller than the required minimum of a State's legislation.

Source: USDA, Economic Research Service using Ufer, D. (2022). *State policies for farm animal welfare in production practices of U.S. livestock and poultry industries: An overview* (Report No. EIB-245). U.S. Department of Agriculture, Economic Research Service.

Although newly passed policies with delayed implementation may not directly affect product availability or production, other reports' findings have suggested that the promotional media and attention to the issue occurring at the time surrounding the policy passage can significantly alter consumer purchasing behavior (Francisco et al., 2015) and exert real effects on the market and retail sales of eggs (Lusk, 2010). Previous work has explored the effect of similar policies' passage for breeding-hog housing on the U.S. pork supply

[10] The USDA, National Agricultural Library Thesaurus defines a recession as the contraction phase of the business cycle lasting for a few months to several years. A recession is generally viewed as an economic downturn that is less severe than an economic depression. The Great Recession (December 2007 to June 2009) was the longest economic recession in the United States since World War II and was characterized, in part, by high unemployment, increased economic uncertainty, and reduced consumer spending. Although the U.S. agricultural sector did not experience the more severe effects of the Great Recession that other sectors did, it was not immune to the economic impacts of the broader global economic slowdown (Sundell & Shane, 2012).

(Blemings et al., 2023) or the implementation of California's retail egg sales policy on egg prices (Mullally & Lusk, 2018). Research on these policy effects has typically focused on consumer welfare losses (Allender & Richards, 2010; Malone & Lusk 2016), industry productivity and structure (Mullally & Lusk, 2018), or egg prices in general (Carter et al., 2021; Malone & Lusk, 2016; Mullally & Lusk, 2018) rather than the effect on implicit prices for retail specialty egg claims.

To investigate the effects of the 2014–15 HPAI outbreak and the passing of the 10 State animal welfare production and retail sales policies on average animal welfare and treatment premiums for fresh eggs during 2008–18, the author estimated a single, comprehensive model across the entire 11-year sample. The author defined retail table egg price as a function of the following:

- brand or private label;
- outlet type (grocery store, convenience store, dollar store, etc.);
- store where the product was sold;
- carton size;
- State where the product was sold;
- whether the product was sold during the 2014–15 HPAI outbreak;
- whether the product was sold in a State in which an animal welfare policy had been passed; and
- the most common animal welfare, treatment, and production claims.

The model also included a series of interaction terms between several of these attributes to account for concurrent claims on a product and to identify the effects of the various price shocks on specialty-trait premiums. Following the model's estimation, the author estimated the average marginal effects of each trait of interest under the different market shocks (i.e., disease outbreak or policy passage) and compared the estimated price premiums to determine the average effects of the shocks. Appendix C explains both the monthly and comprehensive hedonic model functional forms, distributional assumptions, and marginal effects calculations in greater detail.

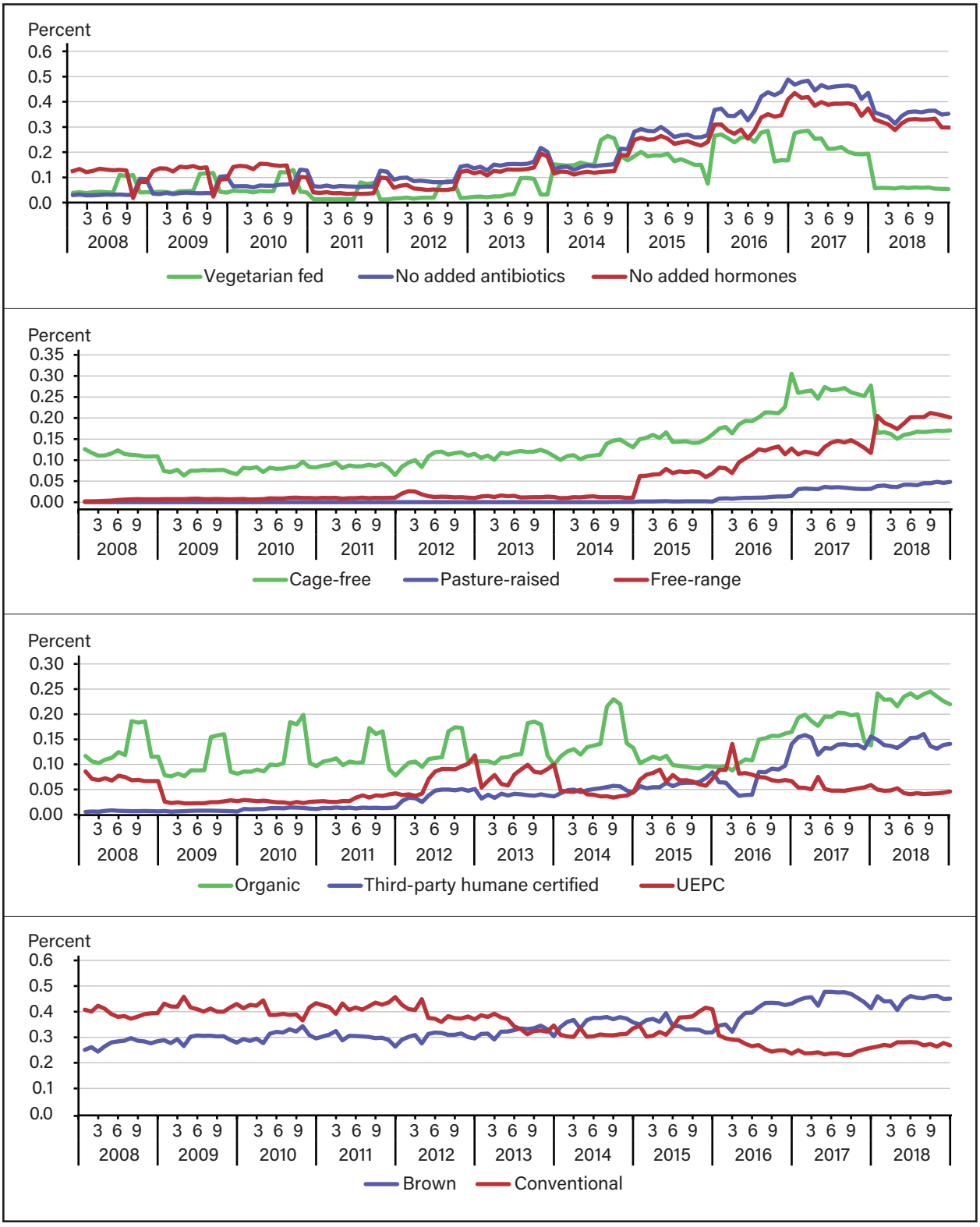
Market Shares and Prices

Monthly Average Market Shares

Monthly market shares, on a total expenditure basis, for individual animal welfare and treatment claims varied from 0 percent to as high as 49 percent (for no added antibiotics eggs in December 2016). Organic egg sales accounted for between 7 and 25 percent of U.S. table egg expenditures between 2008 and 2018, while the cage-free eggs market shares ranged from 6 to 31 percent. By contrast, conventional white shelled eggs bearing no animal welfare treatment, or production claims accounted for between 22 and 46 percent of U.S. egg expenditures in any given month during the sample period. Figure 5 depicts the average monthly marketing shares, by value, for eggs with animal welfare or treatment traits of interest, and table 3 reports the full descriptive statistics of the monthly shares of animal welfare and treatment claim types.

Figure 5

Monthly animal welfare and treatment claim shares of total U.S. table egg expenditures, 2008–18



UEPC = United Egg Producers Certified.

Note: Market shares are calculated in terms of value as the share of national expenditures on table eggs bearing the noted claim or trait.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

Table 3

Summary statistics of monthly animal welfare and treatment claim shares of total U.S. table egg expenditures, 2008–18

Egg claim or trait	Mean	Standard deviation	Minimum	Median	Maximum
			Percent		
Vegetarian fed	10.60	8.42	1.21	6.70	28.49
Organic	13.82	4.78	7.63	11.64	24.51
No added antibiotics	19.33	14.56	2.84	14.27	48.85
No added hormones	18.33	11.36	1.77	13.63	43.50
Cage-free	13.47	5.69	6.34	11.69	30.52
Pasture-raised	0.81	1.45	0.00	0.01	4.85
Free-range	5.23	6.33	0.19	1.22	21.23
Third-party humane certified	5.36	4.82	0.56	4.09	16.06
UEPC	5.48	2.42	2.23	4.98	14.10
Brown shell	34.68	6.28	24.42	32.34	47.77
White shell conventional	34.84	6.60	22.96	37.26	45.83

UEPC = United Egg Producers Certified.

Note: Summary statistics are calculated with respect to 132 monthly share observations. Market shares are calculated in terms of value as the share of national expenditures on table eggs bearing the noted claim or trait.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

A general trend of growth has emerged from many of the specialty traits' value-based market shares since 2008. From 2008 to approximately 2014, market shares for vegetarian fed eggs, no added antibiotics eggs, no added hormones eggs, third-party humane certified eggs, free-range eggs, and cage-free eggs all remained relatively stable and low with value-based market share increases occurring most substantially in the last 4 to 5 years of the sample period. In contrast, the market share of expenditures for white shelled conventional eggs bearing no animal welfare, treatment, or production claims, underwent a general decline from 2008 to 2017, though it recovered somewhat in 2018. These trends together indicate a growing prevalence of products that make claims about animal welfare and treatment as well as an increasing share of U.S. consumer expenditures spent on retail eggs going to eggs produced with some claim of specialty production methods. By comparison, the market shares on an expenditure basis exceeded market shares calculated on a volume basis (appendix D), although the same increasing trends were generally observed across both calculations. This difference emerged as a result of the higher prices for specialty eggs, which allowed these eggs a disproportionately greater capture of the total U.S. table egg market.

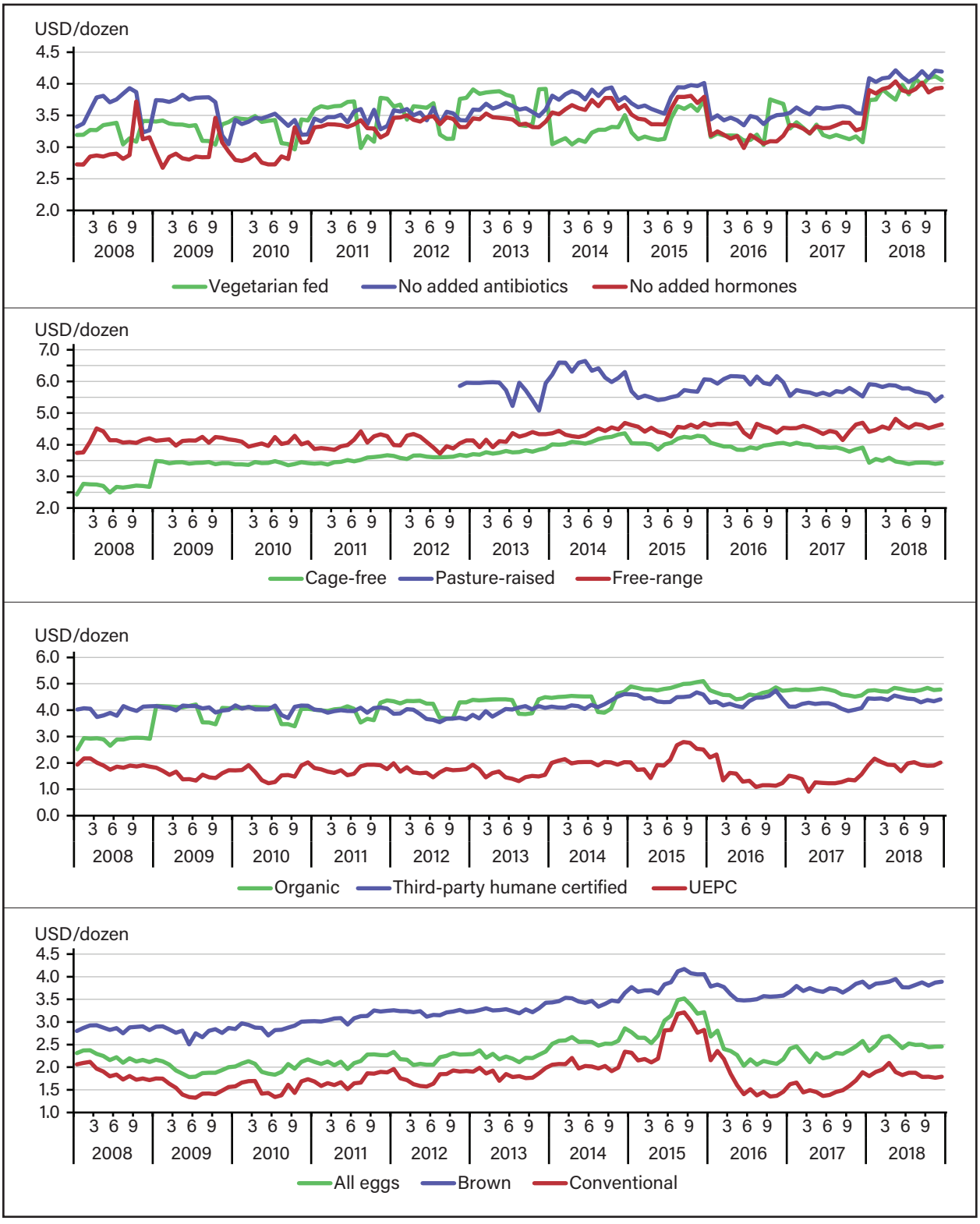
Monthly Average Prices

Figure 6 illustrates the mean monthly prices for one dozen eggs bearing an animal welfare or treatment claim or a brown shell color, as well as for conventional (white shelled with no claims), and all eggs in aggregate. Table 4 reports the summary statistics.[11] For eggs that had an animal welfare or treatment claim, price activity was relatively consistent across the sample 2008–18 period. The trait with the highest average monthly prices was pasture-raised eggs, with average prices ranging from $5.08 to $6.64 per dozen, and an overall average price of $5.85 across the sample period for which pasture-raised data were available (eggs bearing pasture-raised claims only began to consistently appear in the data from November 2012 onward). The lowest average price eggs were UEPC-labeled eggs, with a lower price than even conventional eggs bearing no specialty animal welfare, treatment, or production claims. Average prices for UEPC eggs ranged from $0.91 to $2.79 per dozen. By comparison, average prices for white shelled conventional eggs ranged from $1.32 to $3.21 per dozen, though the maximum price in the range roughly coincided with the recovery of the industry from the 2014–15 HPAI outbreak period and was not typical of conventional egg prices.

[11] Data for average monthly egg prices in this study align very closely with those of the U.S. Department of Labor, Bureau of Labor Statistics (BLS) Average Price: Eggs, Grade A, Large (cost per dozen) in the U.S. City Average [APU0000708111] series. The U.S. Department of Labor, BLS' average is a composite of all large white eggs, including organic, nonorganic, cage-free, free-range, and traditional. Compared with a similarly constructed average monthly price from the study's Label Insight and Circana merged dataset, the average discrepancy between the study data and U.S. Department of Labor, BLS values is approximately 3 cents per dozen. So the average prices and value-based market shares reported here could be considered to represent upper bound estimates, but are largely consistent with U.S. Department of Labor, BLS national averages. Similarly, comparisons to USDA, Agricultural Marketing Service's weekly retail egg price reports for the average prices of cage-free, organic, and vegetarian fed eggs have indicated that the Label Insight and Circana merged data were sufficiently representative of prices for eggs bearing animal welfare and treatment claims, despite some variations likely due to discrepancies in data collection methods.

Figure 6

Average monthly prices (U.S. dollars per dozen eggs) for 12-count U.S. table eggs with animal welfare and treatment claims, 2008–18



USD/dozen = U.S. dollars per dozen eggs. UEPC = United Egg Producers Certified.

Note: Pasture-raised estimates are only available for November 2012 onward, as products bearing that trait are not available in the data before that time.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

Table 4
Summary statistics of monthly animal welfare and treatment claim prices, 2008–18

Trait or claim	Mean of monthly prices	Standard deviation	Minimum price	Median price	Maximum price
			U.S. dollars per dozen eggs		
Vegetarian fed	3.43	0.29	2.96	3.37	4.12
Organic	4.23	0.58	2.51	4.37	5.10
No added antibiotics	3.64	0.24	3.05	3.60	4.21
No added hormones	3.32	0.34	2.67	3.35	4.04
Cage-free	3.64	0.41	2.43	3.64	4.36
Pasture-raised	5.85	0.32	5.08	5.86	6.64
Free-range	4.29	0.25	3.72	4.29	4.82
Third-party humane certified	4.14	0.24	3.54	4.12	4.74
UEPC	1.73	0.34	0.91	1.73	2.79
Brown shell	3.33	0.40	2.50	3.27	4.17
White shell conventional	1.82	0.36	1.32	1.78	3.21
All eggs	2.31	0.33	1.78	2.26	3.52

UEPC = United Egg Producers Certified.

Note: Summary statistics are calculated with respect to 132 average monthly price observations. Average monthly prices are calculated in terms of total national expenditures on 12-count table eggs bearing the noted claim or trait divided by the total number of corresponding units of eggs sold. Pasture-raised price data are not available prior to November 2012 due to market absence so pasture-raised summary statistics are calculated with respect to 74 average monthly price observations.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

The overall mean monthly price for cage-free eggs was $3.64 per dozen, less than the mean price for eggs bearing other housing claims like pasture-raised ($5.85) and free-range ($4.29). However, the overall mean monthly price for cage-free eggs was equal to or slightly higher than the average prices for claims relevant to other aspects of animal treatment including no added antibiotics ($3.64), no added hormones ($3.32), and vegetarian fed ($3.43). Overall, this indicated that retail prices for animal welfare and treatment claims were highest for claims related to animal housing or environment. Consistent with the findings of Chang et al. (2010), shell color has continued to have a strong relationship with price, likely due to correlation with animal welfare, treatment, or other production traits, with the mean monthly price of brown eggs (with or without additional claims) of $3.33 per dozen compared with white shelled conventional eggs at $1.82 per dozen.

Average monthly prices for many of the animal welfare or treatment claims (e.g., third-party humane certification, no added antibiotics, and cage-free claims) maintained relative consistency across the study period, with organic, free-range, no added hormones, and brown shell demonstrating a clearer, although slight, upward trend across the 2008–18 study period. The evident differences in the average conventional egg price movement compared with average prices for eggs bearing claims across the sample period indicated that retail market premiums for animal welfare and treatment traits have been likely to exhibit significant volatility over time.

Seasonality appears to be present in the average monthly prices and the value-based market shares of some, but not all, of the examined claims—most notably in vegetarian fed and organic, and, to a lesser extent, in no added antibiotics or hormones. The apparent seasonal price spikes for some traits corresponded to drops in total egg production, and, consequently, to the constrained supply observed around the same time (figure 1). This may also be explained by table eggs historically serving as a loss leader product—especially around holiday periods—in which retailers strategically offer seasonal discounted pricing on eggs to encourage

greater shopping time and store contact with consumers to increase sales of higher margin products (Walters & MacKenzie, 1988). Although loss leader promotion behavior has been better documented for all table eggs or for conventionally produced eggs, the apparent trends depicted in figures 5 and 6 provide tentative evidence that some specialty egg products may similarly experience this phenomenon.[12]

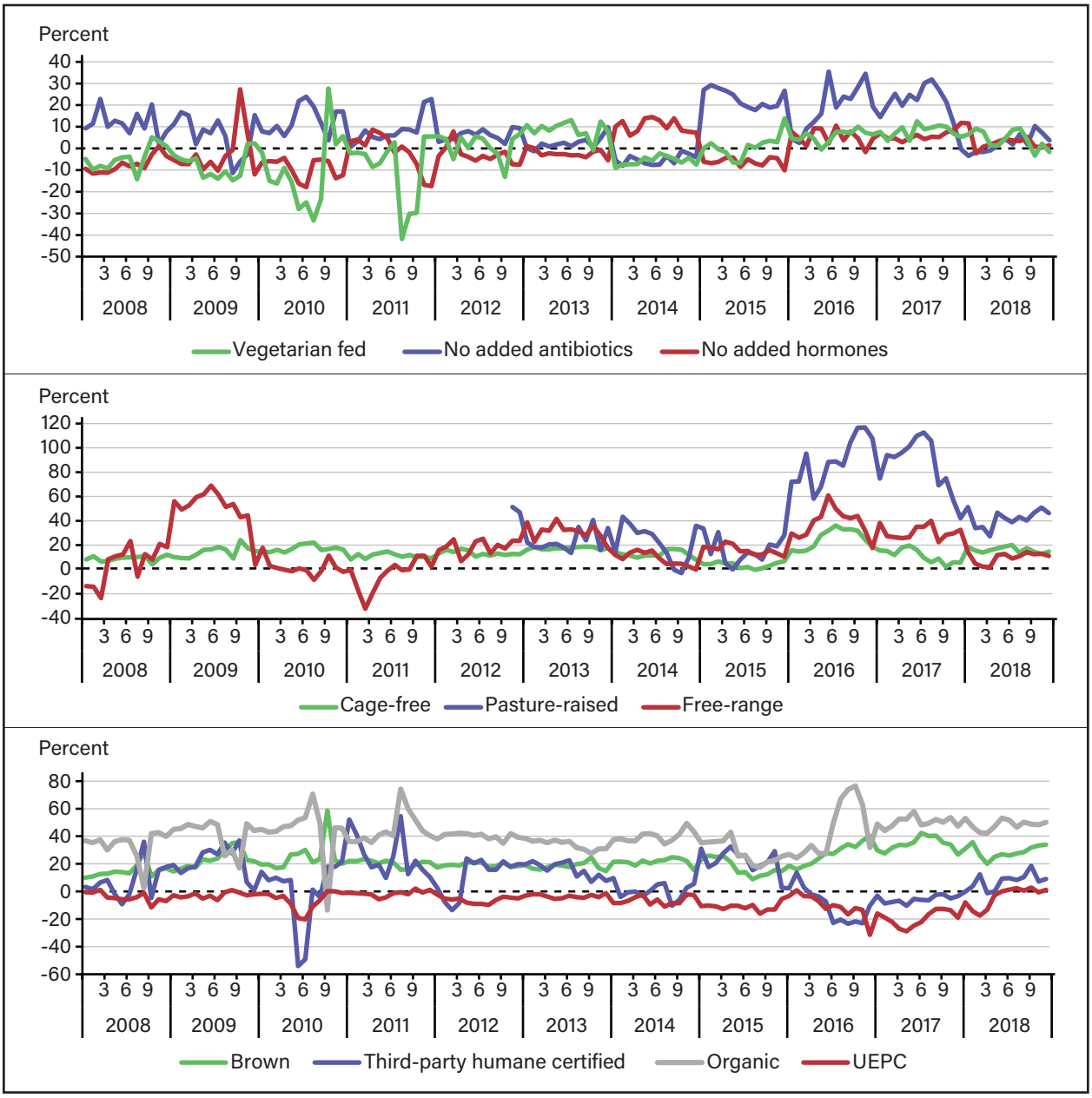
Premiums and Discounts Over Time

In this study, the premiums were derived from monthly national-level hedonic pricing models. The hedonic pricing model is superior to the approach of taking the simple difference between eggs bearing a given welfare and/or treatment claim and eggs bearing no claim. The benefit of this approach is that it better accounts for the phenomenon of simultaneous labeling, which helps to better identify the premium for the individualized trait. Monthly premium (or discount) estimates for the nine animal welfare and treatment claims and brown shell color are illustrated in figure 7.

[12] Although the presence of apparent seasonality in only a subset of the traits evaluated lends support to the possibility that trends are driven at least in part by seasonal or loss leading phenomena, it is possible that the apparent seasonality is occurring as an artifact of the data collection and merging process.

Figure 7

Estimated monthly premiums for animal welfare and treatment claims on U.S. table eggs, 2008–18



UEPC = United Egg Producers Certified.

Note: Pasture-raised estimates are only available for November 2012 onward, as products bearing that trait are not available in the data before that time.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

On average, only brown color eggs commanded a positive premium in all months. However, organic and cage-free claims each had premiums in all months, except for 1 month wherein they each had a statistically significant discount. The finding of premiums for organic eggs is consistent with other studies (Badruddoza et al., 2021; Carlson & Jaenicke, 2016; Chang et al., 2010; Loke et al., 2016). In general, free-range, pasture-raised, third-party humane certified, and no added antibiotics also on average received a premium, though in some months these traits were discounted. Consistent with the mean prices for eggs bearing each trait, the pasture-raised claim had the highest overall average premium at 46.5 percent higher than the average price

of eggs. Organic eggs also had a high average premium of 40.9 percent. The discount, on average, for eggs bearing a UEPC label, was 6.9 percent. However, the largest single estimated discount was for third-party humane certified eggs, with an estimated 54.0 percent discount in June 2010.

Eggs bearing UEPC, vegetarian fed, or no added hormones labels, on average, received a discount. Although, in the case of both vegetarian fed and no added hormones claims, the overall mean implicit price was not statistically different from zero, which indicates neither a premium nor a discount existed for those claims on average. Since both traits seemingly represent little additional effort from producers and have little-to-no corresponding increase in cost of production, the lack of a significant average premium or discount for the vegetarian fed and no added hormones label claims was not surprising. The no added hormones claim is valid for all U.S. table eggs under Federal production regulations, though not all egg labels explicitly make the claim. Therefore, the claim did not represent any production value added over unlabeled eggs. Although consumers are not always aware of Federal production standards relative to no added hormones claims and may ascribe value to the label and associated trait (Heng et al., 2016; Ufer et al., 2022; Yang et al., 2020), these results indicated that in the long run, the market does not reward the effectively meaningless claim. The average monthly premiums mean across the 2008–18 sample period for each claim or trait is reported in table 5, along with other summary statistics.

Table 5
Summary statistics of monthly premiums for animal welfare and treatment claims on U.S. table eggs, 2008–18

Trait or claim	Mean premium or discount (percent)	St dev	Minimum premium (maximum discount) (percent)	Median (percent)	Maximum premium (minimum discount) (percent)	Trend 2008–18
Vegetarian fed	-0.85	10.33	-41.81	1.39	27.64	Increasing
Organic	40.90***	12.23	-13.62	41.48	76.58	Increasing
No added antibiotics	9.86***	10.36	-11.35	8.17	35.48	Increasing
No added hormones	-0.64	7.65	-17.82	-1.85	27.27	Increasing
Cage-free	13.79***	6.39	-0.38	13.88	36.09	Uncertain
Pasture-raised	46.52***	33.19	-3.04	38.25	116.77	Increasing
Free-range	18.74***	18.71	-32.31	15.91	68.98	Increasing
Third-party humane certified	8.75***	16.38	-54.02	9.48	54.49	Decreasing
UEPC	-6.90***	6.73	-31.50	-5.08	2.81	Decreasing
Brown	22.84***	7.76	8.96	21.29	58.60	Increasing

UEPC = United Egg Producers Certified. St dev = Standard deviation.

Note:*** indicates the mean premium is significantly different from zero at the 1-percent significance level. Pasture-raised estimates are only available for November 2012 onward, as products bearing that trait are not available in the data before that time. Trends are reported as increasing if a significant, positive coefficient is estimated on the trend variable in the linear trend model for the corresponding trait or claim, decreasing for a significant, negative coefficient, and uncertain if the coefficient estimate on the trend variable was not statistically different from zero.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

The results in table 5 indicate the general trends in premium dynamics at the national level across the sample period and provide insights as to whether premiums (or discounts) were growing or shrinking or remaining relatively constant. The results suggest that significant positive trends exist for the premiums of all evaluated claims with the exceptions of UEPC and third-party humane certified eggs, which had significant negative trends, and cage-free eggs, which had no significant trend in any direction. Overall, the results from

the linear trends models indicate that the relative value for most animal welfare and treatment traits may be increasing over time. As UEPC and third-party humane certified eggs were the exception to this result, their significant average monthly decreases in a premium (or increases in discount) indicate that the value for comprehensive animal treatment certifications may be reducing over time. As there is no reason to suspect these decreases were driven by a coinciding reduction in production costs, this result may be in part driven by consumer preference for singular, compact animal welfare and treatment claims over broader, more comprehensive claims (Ellison et al., 2017). Additionally, the frequent coincidence of third-party humane certification claims with other animal welfare and treatment claims may explain a shrinking premium, as the primary driver of value for concurrently labeled eggs may be claims other than the third-party certification. The decreasing premiums may then indicate that the third-party certification claims impart decreasing additional value at the retail level over already present, and increasingly economically valuable, specialty claims.

Effects of Disease Shocks and the Passing of State Animal Welfare Policies on Animal Welfare and Treatment Claim Premiums

Market shocks can exert varying impacts on prices with respect to both direction and magnitude. For example, shocks can occur on the supply side, affecting production and supply chain elements, as well as on the demand side, through consumer behavior and end market constraints. The U.S. retail table egg market has experienced a variety of market shocks since 2008, with disease outbreaks and changes to the policy environment among the most prominent. Disease outbreaks represent a significant supply-side shock. The 2014–15 highly pathogenic avian influenza (HPAI) outbreak[13] affected the U.S. egg industry nationwide and reduced the laying hen population by an estimated 12 percent. This population reduction was due to both a direct result of the disease or by active depopulation to stop the spread, which led to a contraction of the U.S. egg supply and subsequent market impacts (Ramos et al., 2017). Increased hen mortality represents an increase in production costs for eggs, although whether this increase was uniformly distributed across all U.S. egg producers, including specialty producers, or if the effects were more concentrated in conventional operations remains unknown. The author of this study investigated this phenomenon using the results from a comprehensive, national, hedonic pricing model across the entire 2008–18 study period, which identified variations in 2014–15 HPAI outbreak effects on eggs bearing animal welfare and treatment claims as well as the outbreak's overall effect on average egg prices.

In addition to disease shocks, another type of shock that can influence premiums for animal welfare and treatment claims is the passing or implementation of a policy. Over the past two decades, several State-level policies have been passed to restrict the production practices that may be used on in-State operations or the sale of products produced using prohibited practices (Ufer, 2022). During the 2008–18 study period, a total of seven States passed a production policy and three States passed a retail sales policy (table 2). For the egg industry, these policies address laying hens' housing, either requiring minimum floor space per bird or outlawing the use of cages in egg production. In many cases, State animal welfare policies are passed with a lagged implementation date to allow in-State industries time to convert operations to compliant structures, so the markets are unlikely to be immediately impacted by a supply shock. However, as these policies are passed, consumer expectations of conventional egg production may adjust to the new standards, either through contact with media that raises consumer awareness and concern over production practices or as a natural consequence for those consumers who supported or voted the legislation into place. Consequently, new State

[13] Although the U.S. egg industry has faced multiple large outbreaks of HPAI, this study only covers the 2014–2015 outbreak. The 2022–2024 HPAI outbreak falls outside the scope of the study period.

regulations may reflect changed consumer expectations, influencing the economic value consumers place on eggs bearing animal welfare or treatment claims.

Using the same comprehensive hedonic pricing model of retail 2008–18 egg sales, this study assessed whether the passage of a production or retail sales policy in a State significantly impacted the premiums (or discounts) observed at the retail level for eggs with various claims. It is important to emphasize that this is an investigation of retail market response to a policy being passed, but not necessarily enforced. This study also assessed the impact of the 2014–15 HPAI outbreak on premiums and discounts for eggs bearing animal welfare and treatment claims.

Before examining the effects of major market shocks, including widespread disease outbreak and animal welfare policy passage on the premiums and discounts for animal welfare and treatment claims, it is important to first understand the average effects of those shocks on table egg prices in general. These average effects are presented in table 6 in two forms: (1) as the isolated effect of the shock alone in the absence of any other market shocks or animal welfare, treatment, and production claims; and (2) as the average marginal effect of the shock when all other covariates (including other shocks and all evaluated claims) are held at their means. Since sales policies in the sample were exclusively passed in States that had also passed a production policy, this study calculated the marginal effects for when a sales policy had passed at the conditional means of all covariates (i.e., conditional on a production policy having passed). As expected, and consistent with past research (Ramos et al., 2017), the 2014–15 HPAI outbreak raised the average price of eggs. When controlling for the presence of various animal welfare, treatment, and production claims and other market shocks, the HPAI outbreak resulted in an average 14.4-percent price increase, though this shock was as high as 26.5 percent for unlabeled eggs unaffected by other market shocks.

Table 6
Average price impacts of major U.S. retail table egg market shocks, 2008–18

Market shock	Isolated effect (transformed model coefficient[1])	Marginal effect[2]
	Percent change	Percent (average egg price change if shock has occurred)
2014–15 HPAI outbreak	26.50***	14.38***
Production policy passed	-5.61***	-2.98***
Sales policy passed	0.43***	-1.54***[3]

HPAI = Highly pathogenic avian influenza.

Note: *** indicates the mean premium is significantly different from zero at the 1-percent significance level.

[1] The isolated effect of a shock is reported here as the coefficient for the single variable from the comprehensive model (in its transformed form (e^{β}-1) × 100 rather than β itself, where β is the estimated coefficient), and represents the relative effect, in percentage terms, of the associated market shock on the average price of eggs when no animal welfare or treatment claims or other shocks are present.

[2] Marginal effects represent the average effect in percentage terms of the associated market shock on the price of eggs when all animal welfare or treatment claims, market shocks, and other covariates are held at their means.

[3] Since sales policies in the sample are exclusively passed in States in which a production policy has also passed, marginal effects for when a sales policy has passed are calculated at the conditional means of all covariates, conditional on a production policy having passed (ProdPass=1).

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

When viewed in isolation, passing a production policy reduced the average price of eggs by 5.6 percent, and the passing of a retail sales policy slightly increased the price by 0.4 percent. These results were unsurprising as the original justification for the first retail sales policy (i.e., California's AB1437) was to protect in-State producers from inexpensive out-of-State imports that could outcompete the relatively more expensive eggs produced in State under the stricter production rules. If this reasoning holds, given most production policies were passed in States with small in-State industries (Ufer, 2022), we would expect to see the passage of a production policy reduce the average price of eggs, especially if producers begin to preemptively shift their production toward compliant practices prior to enforcement of the policy. Similarly, the egg price increase that occurred when a sales policy passed aligned with this study's expectations. The increase might first serve as a counterbalance to some of the production policy's price reductions since no retail sales policy has been passed in a State that does not also have a production policy. Additionally, as with the production policy passage, the increase in price may, in part, be due to producers' and retailers' preemptive actions in conforming to impending sales regulations before enforcement, which may limit the egg supply produced at lower costs and drive up the average egg cost following the sales policy's passage.

Though the isolated effects of either type of policy passing were as expected, the marginal effects demonstrate a more nuanced set of effects on average egg prices from policies' passage. For a production policy, the average marginal effect of policy passage on all eggs was a 3.0-percent price reduction with an additional 1.5-percent reduction if a sales policy was also passed.[14] This finding was contrary to what was generally expected for these policy effects. However, the finding does not take a policy's full enforcement into account so the market is not yet constrained by the policy's provisions, but rather by expectations of imminent constraints. Even so, as the effects include the impacts of passing each type of policy on eggs with animal welfare, treatment, and production claims, there is evidence that a policy's passage causes market distortion beyond simple supply and demand effects.

Effects of the 2014–15 HPAI Outbreak on Premiums

The difference in average marginal effects was calculated and reported as the absolute difference in percentage points in the average egg premiums or discounts. Largely, the 2014–15 HPAI outbreak significantly reduced premiums for animal welfare and treatment claims compared with non-outbreak premiums during the entire 2008–18 study period. Every animal welfare or treatment claim (excluding the no added hormones label) had lower average premiums during the 2014–15 HPAI outbreak and aftermath. The average organic premiums were 10.8 percentage points lower during the HPAI outbreak. Premiums for pasture-raised and free-range claims decreased the most, with 30.9-percentage-point and 20.4-percentage-point reductions, respectively. All other claims with reduced premiums had decreases ranging from 0.9 percentage points for third-party humane certified claims to 12.2 percentage points for vegetarian fed claims. Notably, no added hormone claims experienced a 0.5-percentage-point average premium increase. In addition, vegetarian fed claims had a notable 12.2-percentage point average premium reduction during the 2014–15 HPAI outbreak. Importantly, the reduction was large enough to result in an average discount for vegetarian fed claims during that time. Because these two claims demonstrated the greatest variation and most limited average premiums when estimated on a monthly basis, these results are consistent with the market not necessarily treating these claims as animal welfare or treatment claims of significant value. The average marginal egg price effects of the nine animal welfare and treatment claims, along with eggshell color, are reported in table 7 both during the

[14] Though not presented in table 6, a marginal effect for sales policy passage was also calculated conditional on a production policy not having passed. This represents a purely hypothetical scenario in which a State passes a restriction on the sale of eggs without necessarily imposing any corresponding regulatory constraints on its in-State industry. In such a scenario, the passing of a sales policy would result in an estimated 2.1 percent decrease in the average price of eggs.

2014–15 HPAI outbreak, including the 3-month recovery period following the official end of the outbreak, and for the rest of the sample period apart from the outbreak. How this report calculated the marginal effects is described in appendix C.

Table 7
Average effects of 2014–15 highly pathogenic avian influenza (HPAI) outbreak on animal welfare and treatment claim premiums, 2008–18

Trait or claim	Average premium when HPAI=0	Average premium when HPAI=1	Effect of HPAI outbreak on premium
	Percent	Percent	Percentage point difference
Cage-free	19.70	12.97	-6.73
Organic	21.27	10.52	-10.75
Vegetarian fed	9.85	-2.36	-12.21
No added hormones	2.16	2.70	0.54
No added antibiotics	11.59	8.29	-3.30
Third-party humane certified	17.58	16.73	-0.85
Pasture-raised	97.29	66.43	-30.86
Free-range	22.78	2.35	-20.44
UEPC	-9.27	-14.65	-5.38
Brown shell	28.68	24.95	-3.73

UEPC = United Egg Producers Certified.

Note: HPAI = 1 denotes if a product was sold during one of the ten months of the 2014–15 HPAI outbreak (December 2014 to June 2015) or the 3 subsequent months (July 2015 to September 2015). In addition, HPAI = 0 denotes if a product was sold in any other month during the 2008–18 study period. All average premium estimates are significantly different from zero at the 1-percent significance level.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

The premium decreases associated with the 2014–15 HPAI outbreak may have been a result of the May–September 2015 price increases for the average price of all eggs. These price increases would have effectively reduced the relative value of specialty egg claims, potentially indicating that specialty egg prices as a subset do not move at the same pace or time as all retail eggs. Although the majority of HPAI outbreak related effects on premiums were negative, the magnitude of these effects varied considerably. There was evidence of exceptions to the premium reducing effects of the outbreak. This may indicate that disease events can exert heterogeneous effects on market premiums, which can encourage researchers to be cautious when extrapolating these findings to other, even similar, disease outbreaks or market shocks. Nevertheless, these results overall indicate that disease related market shocks, or those that drastically affect total supply, can both affect retail prices on the whole and reduce the magnitude of premiums for animal welfare and treatment claims. As the size of the reduction varies relative to the claim or trait in question, such shocks may cause especially increased uncertainty or risk for specialty producers.

Effects of Passing a State Animal Welfare Policy on Egg Premiums

The author estimated the average premium for each claim associated with table egg products sold in a State in which no policy had been passed, a production policy only had been passed, and both production and sales policies had been passed.[15] The author calculated three effects for each trait and policy passage. First, the author calculated the effect of passing a production policy with no sales policy. This was calculated as the difference between the average premium for a trait in a State where only a production policy had passed and the average premium in a State where no animal welfare policy had passed. Second, the author calculated the combined effects of passing both a production policy and a sales policy. This was calculated as the difference between the average premium for a trait in a State where both policies had passed compared with a State where no policies had passed. Finally, the author calculated the net effect of a sales policy's passing as the difference between the average premiums in a State where both policy types had passed and a State where only a production policy had passed. The average implicit prices (or premiums) for eggs with the nine animal welfare, treatment claims, or eggshell color as affected by a production policy's passage (i.e., requiring minimum floor space per bird and/or outlawing battery-caged egg production) or a retail sales policy's passage (i.e., requiring all retail table eggs sold in-State to be produced in a manner compliant with the State's production standards) are presented in table 8.

Table 8
Average impacts of a passed State animal welfare production or retail sales policy on animal welfare and treatment claim premiums, 2008–18

Trait and claim	No policies passed	Production policy only passed	Both sales and production policies passed	Production policy only	Sales and production policies	Sales policy (net effect)
	Average premiums			Effects of policy passage on average premiums (percentage point difference)		
Cage-free	20.07	13.36	11.85	-6.71	-8.22	-1.51
Organic	21.68	5.35	12.82	-16.33	-8.86	7.47
Vegetarian fed	9.32	2.04	6.16	-7.28	-3.17	4.12
No added hormones	2.27	-0.22	2.38	-2.49	0.11	2.60
No added antibiotics	11.47	17.67	7.53	6.21	-3.94	-10.14
Third-party humane certified	16.68	31.53	21.52	14.86	4.84	-10.01
Pasture-raised	96.86	117.57	65.43	20.71	-31.43	-52.14
Free-range	22.29	12.21	11.34	-10.09	-10.95	-0.87
UEPC	-9.19	-10.46	-14.80	-1.27	-5.61	-4.34
Brown shell	27.53	40.25	33.33	12.73	5.80	-6.92

UPEC = United Egg Producers Certified.

Note: All average premium estimates are significantly different from zero at the 1-percent significance level.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

Passing a State-level animal welfare production policy had varied effects on the premiums for evaluated animal welfare or treatment traits. Production policy passage alone significantly reduced the average premiums for cage-free, organic, vegetarian fed, no added hormones, free-range, and UEPC-labeled eggs, whereas third-party humane certified, pasture-raised, no added antibiotics, and brown shell egg average

[15] Note that the reported values represent the transformed average marginal effects of each trait from the comprehensive hedonic pricing model. There are no cases in the sample period or in the United States in which a sales policy has been passed without a production policy also being passed in the State, so it is excluded from the analysis.

premiums increased. The average premium for cage-free eggs sold in a State with a production policy following passage of the policy was 6.7 percentage points lower than that of cage-free eggs sold in a State without a production policy during the 2008–18 study period. The results were similar for organic, vegetarian fed, no added hormones, free-range, and UEPC claims with decreases in premiums (or increases in discounts) that ranged from 1.3 percentage points for UEPC eggs to 16.3 percentage points for organic eggs. In contrast, for traits where a production policy's passage increased average premiums, the premiums increased between 6.2 percentage points (no added antibiotics claims) and 20.7 percentage points (pasture-raised claims).

In the event of a sales policy passing, which was always preceded by or concurrent with a production policy passing in the same State during the sample period, the study found more consistently negative impacts on most traits' average premiums. States where both a production and retail sales policy were passed experienced a decrease in relative premiums, on average, for most animal welfare and treatment claims, ranging from 3.2 percentage points for vegetarian fed eggs to 31.4 percentage points for pasture-raised eggs. The primary exceptions to reduced average premiums were third-party humane certified and brown shell color, which had increases in average premiums of 4.8 percentage points and 5.8 percentage points, respectively. Additionally, eggs with no added hormones claims also had a slight, but statistically significant, increase in the average premiums (0.1 percentage point).

The fact that most claims experienced an average-premium reduction when both policy types had been passed can be explained by the net effects of the sales policy's passage. The net effect of passing a sales policy can either offset the effects of a production policy by moving average premiums in the opposite direction or compound the impacts by moving in the same direction. Offsetting increased premiums and compounding decreased premiums were found to be the most common net effects of a sales policy's passing. For example, in the study, although the average pasture-raised egg premium increased by 20.7 percentage points if only a production policy passed, it decreased by 52.1 percentage points if a sales policy had also passed. This resulted in the premium's net decrease of 31.4 percentage points, on average, compared with a State where no policies were passed. In most cases, the net effect of passing a sales policy was negative, meaning passing a sales policy generally left premiums lower or discounts higher than if only a production policy had passed. For cage-free, no added antibiotics, pasture-raised, free-range, and UEPC labeled eggs, passing a sales policy either eliminated any premium gains and resulted in the average premium's net reduction or it compounded the average premium losses incurred when a production policy had passed. In contrast, for organic, vegetarian fed, and no added hormones, passing a sales policy better preserved the average premium that was observed when no animal welfare policy had passed. However, for all egg claims excluding the no added hormones and third-party humane certified claims, the average premium was still higher when no policies were passed than when both policy types were.

Overall, the study results indicate that passing State animal welfare policies generally lowered the premiums or increased the discounts for eggs with animal welfare or treatment claims—especially when both a production and sales policy have been passed. As the two policy types have increasingly been passed together, or the passage of a production policy alone has become rarer (Ufer, 2022), decreasing average premiums for specialty egg claims are likely to be the commonly observed outcome. However, the effect of animal welfare policy passage was found to be heterogeneous, exhibiting considerable variation in magnitude or direction across all specialty claims and dependence on whether a sales policy has been passed in conjunction with a production policy. The results in table 6 indicate the passage of a sales policy following the passage of a production policy may help to maintain higher prices for the average egg producer. However, when the policy effects are separated out by animal welfare or treatment claim, some practices may be penalized more once a sales policy has passed, whereas others receive some premium preservation benefits. It is unclear to what extent the

preservation of the price gap between eggs with a specialty claim and conventional eggs has been driven by the translation of increased production costs to retail prices. It is also unclear how shrinking price gaps may be influenced by post-passage changes in consumer preferences. Nevertheless, both drivers may play a role in premium dynamics related to animal welfare policy passage. The study results demonstrate the market shock potential of animal welfare policies, as these effects were evident even before the policy's requirements had necessarily become binding.

Discussion and Conclusion

Examining the U.S. retail table egg market from 2008 to 2018 revealed the increasing prevalence of animal welfare and treatment claims on eggs and the growing market shares of total table egg expenditures those products command. These claims cover multiple aspects of animal production, including housing and space provisions; the administration, or lack thereof, of antibiotics or exogenous hormones; the feed the animals receive; and/or a comprehensive suite of standards geared toward humane or organic production.

Although most of these animal welfare and treatment claims are associated with premium prices, some claims, like the UEPC (United Egg Producers Certified) label, are associated with eggs priced below the market average. Still other claims, such as vegetarian fed and no added hormones, may receive no significant price differentiation from unlabeled eggs, whether positive or negative, in the long run. Nevertheless, substantial premiums were generally observed for several of the animal welfare and treatment claims investigated in the study, which supports their status as specialty claims for which consumers might derive additional value beyond the conventional standards of production. The magnitude and even the nature of a claim's premium, as opposed to a discount, shows significant change across time.

Premiums for animal welfare and treatment claims seem to be significantly impacted by major market shocks, including widespread disease outbreaks and the passage of policies that require extensive industry conversion towards consumer-demanded production types. As expected, the 2014–15 HPAI outbreak raised the average price of eggs, but largely reduced the premiums received for retail eggs bearing animal welfare and/or treatment claims. This indicates that retail prices for conventional and specialty eggs do not necessarily move as a monolith but are subject to variation that may increase risk for specialty producers—especially if exposed to similar cost shocks as conventional producers. Our results also illustrate that price differentials for all evaluated claims are impacted by the passage of laying hen production or egg sales policies. Though these effects are subject to both the claim type and policy type, the study results largely show that when both are passed in a State, production and sales policies together can decrease the premiums (or increase the discounts) associated with animal welfare and treatment claims at the retail level. Nevertheless, there are some traits for which the passage of a production policy in particular results in an increased average premium. Consequently, the heterogeneity of the demonstrated policy effects indicates that these policies can increase uncertainty for specialty producers over retail market premiums for animal welfare and treatment claims, as it may not be clear whether the policy's passage will increase or decrease premiums. Moreover, although one of the stated goals of retail sales policies is to protect in-State producers and this objective is partially met for some traits evaluated and for eggs with no claims, findings of the study show that the passing of a sales policy may result in average premiums that are lower for some traits than those expected when only a production policy has passed. Overall, our results are largely consistent with other findings that the passage of animal welfare policies can be disruptive to typical table egg market behavior (Lusk, 2010).

This report provides insights on the market and premium dynamics for animal welfare and treatment claims in the U.S. retail table egg market, but there remains room for additional investigation. First, this report does not endeavor to empirically explain the drivers of retail premium dynamics, although recent work has begun to address such questions (Badruddoza et al., 2021). It excludes any discussion of how production costs, sales volumes, or distribution of consumer type may influence price differentiation between specialty and conventional eggs. Additionally, while the study's hedonic pricing model approach offers myriad benefits, there remains considerable potential for bias in estimation, driven by factors such as omitted variables, price volatility and fluctuation, and the accuracy of dummy variables in identifying singular traits across products. Moreover, the structure of the U.S. table egg industry may possess unique features that are not accounted for in this analysis, such as the use of supply controls and quotas on specialty egg marketing to maintain targeted price levels. Future employment of alternative methods to examine premiums, dynamics, market shocks, and the role of industry structure is warranted to assess the robustness of findings. Since this report is constrained by the timing of the data, future work might also engage in a greater exploration of the impacts of animal welfare and treatment policies, particularly looking at the effects of policy implementation as opposed to passage. Finally, though the U.S. table egg market served as an excellent case study for the purposes of this report, the high level of overlap in many of the claims of interest in eggs creates a complicated environment for identifying the value of individual traits. Future work would benefit from examining animal welfare and treatment claims on other animal products that experience less overlap in claims.

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Appendix A: Summary of Dataset Total Observations and Share of Records with Traits of Interest

Appendix Table A.1

Summary of Label Insights and Circana merged dataset

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	All years
Total observations	3,923,611	4,196,804	4,314,992	4,691,843	5,467,086	5,606,077	4,450,562	5,624,055	6,944,763	8,029,217	3,951,235	57,200,245
Claim:	Percent of records bearing claim in dataset											
Vegetarian fed	10.72	11.81	11.79	7.96	8.88	9.65	17.54	16.57	27.81	25.36	8.91	15.49
Organic	17.48	17.10	16.66	16.09	16.63	16.78	19.19	11.82	14.06	18.38	19.67	16.57
No added antibiotics	7.85	8.61	11.65	11.39	13.73	19.82	26.64	36.34	44.45	49.70	39.99	27.02
No added hormones	14.72	15.76	17.30	11.87	14.87	21.87	25.31	33.96	38.92	45.64	40.17	27.22
Cage-free	12.92	12.32	12.31	12.26	13.71	14.41	14.07	18.32	22.88	28.85	20.68	17.60
Pasture-raised	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.40	1.24	3.61	4.43	1.01
Free-range	1.00	1.21	1.25	1.38	1.92	1.65	1.51	7.39	9.83	12.21	18.01	5.71
Third-party humane certified	1.02	1.05	1.49	1.90	5.35	5.09	5.29	7.31	8.04	12.97	12.59	6.22
UEPC	4.68	3.97	4.73	6.15	10.19	11.24	4.05	9.71	10.84	7.91	10.80	7.99
Brown shell	40.53	39.97	39.55	39.49	40.72	40.63	44.92	40.88	42.93	48.10	46.94	42.53
White shell conventional (no claims)	29.16	29.98	28.84	27.71	25.20	23.62	17.38	25.45	22.55	19.66	21.87	24.23
All conventional (no claims)	36.51	36.82	35.69	34.39	31.38	29.89	24.63	33.95	26.14	23.42	24.62	30.06

UEPC = United Egg Producers Certified.

Note: Shares are the percent of records in the Label Insights and Circana merged dataset that correspond to an egg product with the listed trait. Shares are representative of the presence of sales records from individual stores in a given month of the noted year by Universal Product Code (UPC) but are not representative of market shares in terms of units sold or value of units sold.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

Appendix B: Descriptive Analysis

This study conducted a descriptive analysis of the data to determine the market shares, by value, and average prices of products bearing each of the animal welfare traits of interest. National market shares were calculated as the quotient of the sum of all expenditures or revenues on products with the trait of interest and the sum of all fresh egg expenditures or revenues in a given time period. That is, market shares were identified as:

(1) $$s_{jt} = {}^{e_{jt}}/_{E_t}$$

Where s_{jt} is the market share of products with claim j in time period t, e_{jt} is the total expenditure on products with claim j in period t, and E_t is the total expenditure on all fresh egg products in time t. National market shares were calculated on a monthly basis.

Average prices for products bearing animal welfare claims of interest were also calculated. Rather than take a simple mean of the prices across each record in the sample, we calculated average price as the sum of all expenditures on products bearing a given trait divided by the total number of units sold with that trait. That is, we calculated average price as:

(2) $$\bar{p}_{jt} = {}^{e_{jt}}/_{u_{jt}}$$

Where $\bar{p}_{jt}$ is the average price for eggs with trait j in period t, and u_{jt} is the total number of units with trait j sold in period t. This average price approach was used to prevent inadvertent weighting of products sold in greater or smaller volumes at individual stores. Although all other analyses included data for a variety of carton sizes, average prices were calculated using only 12-count products to prevent bias from premiums and discounts associated with alternative package sizes. Hence, all average prices reported were in dollars per dozen. Average prices were calculated both on a monthly basis and across the full 11-year sample. Note that the stores that opted in to participate in the Circana OmniMarket Core Outlets panel are not fully representative of all retail food stores across the United States, so caution is due in interpreting estimated average prices and market shares.

Appendix C: Hedonic Pricing Models

To investigate the dynamics of retail price premiums, a base linear hedonic pricing model was constructed and estimated on a monthly basis across the 11-year sample. We specified the base model as:

$$\ln(p_{ist}) = \alpha_t + \boldsymbol{\beta}_t \boldsymbol{X} + \boldsymbol{\gamma}_t \boldsymbol{Z} + \boldsymbol{\zeta}_t \boldsymbol{D} + \boldsymbol{\varphi}_t \boldsymbol{X}_j' \boldsymbol{X}_k + \boldsymbol{\pi}_t \boldsymbol{B} + \boldsymbol{\lambda}_t \boldsymbol{S} + \varepsilon_{ist} \quad (3)$$

Where p_{ist} is the average price (in dollars per unit) of a fresh egg product i sold in store s during month t, α_t is a time-varying constant to be estimated, $\boldsymbol{X}$ is a vector of dummy variables for animal welfare and treatment claims, and brown shell color, $\boldsymbol{Z}$ is a vector of control variables including carton size, egg size, private label status, production methods unrelated to animal welfare and treatment,[16] and outlet type; $\boldsymbol{D}$ is a vector of dummies denoting the State where the store s is located, $\boldsymbol{B}$ is a vector of brand fixed-effects dummies, and $\boldsymbol{S}$ is a vector of fixed effects for stores or retail chains.[17] $\boldsymbol{X}_j'\boldsymbol{X}_k$ represents a matrix of pairwise interaction terms for the primary animal welfare, treatment, and production claims of interest. $\boldsymbol{\beta}_t$, $\boldsymbol{\gamma}_t$, $\boldsymbol{\zeta}_t$, $\boldsymbol{\varphi}_t$, $\boldsymbol{\pi}_t$, and $\boldsymbol{\lambda}_t$ are vectors of coefficients to be estimated in each month, and ε_{ist} is a normally distributed error term. As the availability of some products varied across the monthly models (e.g., products bearing pasture-raised claims are not available in the data until November 2012), and some interaction terms exhibit collinearity in some months but not others, the number of variables in the model varied slightly from month to month.

For the comprehensive hedonic pricing model, the base model used in the monthly analysis was amended to the following:

$$\ln(p_{ist}) = \alpha + \boldsymbol{\beta}\boldsymbol{X} + \boldsymbol{\gamma}\boldsymbol{Z} + \boldsymbol{\zeta}\boldsymbol{D} + \theta HPAI + \rho ProdPass + \psi SalesPass + \boldsymbol{\xi}\, ProdPass \times \boldsymbol{X} + \boldsymbol{\eta} SalesPass \times \boldsymbol{X} + \boldsymbol{\delta} HPAI \times \boldsymbol{X} + \boldsymbol{\varphi}\boldsymbol{X}_j'\boldsymbol{X}_k + \boldsymbol{\pi}\boldsymbol{B} + \boldsymbol{\lambda}\boldsymbol{S} + \varepsilon_{ist} \quad (4)$$

The comprehensive model included several dummy variables for time periods corresponding either to market shocks (e.g., disease or periods during and after which an animal welfare policy has been passed) and other time-based control variables (e.g., seasonal dummies for holidays and a dummy for the months of the 2007–09 Great Recession included in the sample period). These variables were excluded from the monthly models due to high collinearity when applied on a monthly basis but were appropriate and necessary for the comprehensive model. Note that the t subscripts are absent from the parameter vectors in the comprehensive model as only a single estimate of each parameter was calculated across the entire 11-year sample. *HPAI* is a dummy variable taking the value of 1 if time t corresponds to 1 of the 10 months of the 2014–15 highly pathogenic avian influenza (HPAI) outbreak (December 2014–June 2015) or the 3 subsequent months to account for delayed impacts of HPAI discovery and depopulation effects on egg prices and premiums (July 2015–September 2015) (Ramos et al., 2017), and zero otherwise. Differences in premium dynamics were explored under two policy events: (1) passage of a production policy and (2) passage of a sales policy. Thus, *ProdPass* and *SalesPass* are dummy variables taking the value of 1 if a unit was sold in a State and in a month in which a production policy or retail sales policy, respectively, addressing laying-hen welfare or treatment had been passed (table 2), and zero otherwise. As with the monthly models, pairwise interaction terms were included for the primary animal welfare, treatment, and production claims of interest, but the comprehensive model also includes interactions between those claims and *ProdPass*, *SalesPass*, and *HPAI*.[18] α, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, $\boldsymbol{\zeta}$, θ, ρ, ψ, $\boldsymbol{\delta}$, $\boldsymbol{\xi}$, $\boldsymbol{\eta}$, $\boldsymbol{\varphi}$, $\boldsymbol{\pi}$, and $\boldsymbol{\lambda}$ are vectors of coefficients to be estimated, and ε_{ist} is a normally distributed error term. A

[16] These production claims included local, omega-3, nongenetically modified, and natural.

[17] To limit the estimation difficulties presented by excessively granular modeling, brand and store fixed effects dummies are limited to those brands with a minimum of 5,000 observations (a total of 71 brand dummies) and stores that represent approximately 0.02 percent of the sample or more (100,000 observations or more, a total of 65 store-level dummies).

[18] Interaction terms that did not identify any variables in the sample were excluded from the model.

total of 326 binary variables were included in the comprehensive hedonic pricing model. The semi-log functional form was chosen for two reasons. First, semi-log hedonic pricing models are well supported and widely used in the literature (for example, see Chang et al., 2010; Connolly & Klaiber, 2014; Loke et al., 2016), with stronger theoretical foundations and relatively less heteroskedastic errors than linear model errors (Diewert, 2003a; Diewert, 2003b; Chang et al., 2010). Second, the semi-log specification estimates premiums for traits on a relative, rather than absolute, basis, better allowing for comparisons across time periods. That is, a time series of coefficients derived from semi-log hedonic pricing models implicitly accounts for inflation and variations in the base price of eggs. Estimation of the hedonic pricing model was performed using White's heteroskedasticity-consistent (robust) standard errors.

Following the monthly models' estimation, the average marginal effects for each of the primary animal welfare, treatment, and production claims controlled for time, policy passage, simultaneous appearance on a product (i.e., interactions), and product technical specifications (i.e., egg and carton size), were calculated. The average marginal effect is equal to the derivative of the estimated model taken with respect to the variable of interest evaluated where all other variables are set equal to their means. Following estimation of the comprehensive hedonic pricing model, conditional marginal effects were calculated for each of the primary animal welfare and treatment claims of interest under varying market shock contexts. That is, marginal effects for each trait were calculated when *HPAI* = 0 (where, for example, all other covariates were set to their conditional means when *HPAI* = 0) and when *HPAI* = 1 for the disease shock. For the policy shocks, marginal effects for each trait were calculated when both *ProdPass* and *SalesPass* equaled 0 (with corresponding conditional means for all other covariates), when *ProdPass* equaled 1 and *SalesPass* equaled 0 (representing the effect of only a production policy being passed), and when both *ProdPass* and *SalesPass* were equal to 1 (representing the effect of when both policies have been passed).[19] Standard errors were calculated using the delta method, following the approach of Carlson and Jaenicke (2016), such that the variance is defined as:

$$s^2 = \left(\frac{\partial \gamma}{\partial \theta} \mid \hat{\theta}\right)\left(\hat{V}(\hat{\theta})\right)\left(\frac{\partial \gamma}{\partial \theta'} \mid \hat{\theta}\right) \tag{5}$$

Where γ is a function of all parameters, θ, and V is the covariance matrix of the parameters.

The estimated coefficients and marginal effects from the hedonic pricing model were converted from natural log form to relative premia or implicit price form, following Chang et al. (2010), so that:

$$\widehat{Premium}_j = \left(e^{\hat{\beta}_j} - 1\right) * 100 \tag{6}$$

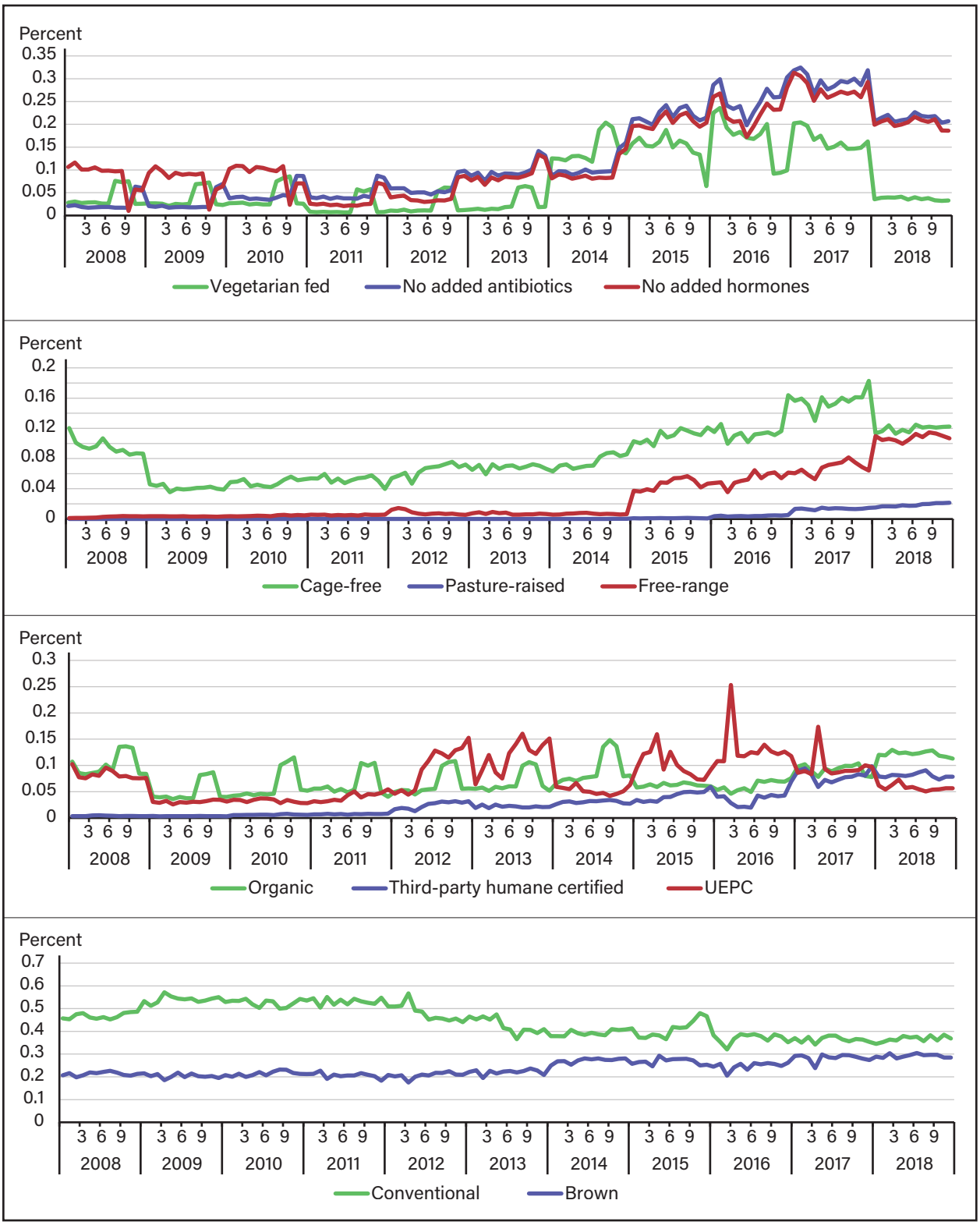
Where $\widehat{Premium}_j$ is the estimated relative premium, in percentage terms, for claim *j*, and $\hat{\beta}_j$ is the estimated coefficient or average marginal effect for trait *j*. The same conversion was applied to assess the average implicit price variations in animal welfare and treatment premia for fresh eggs when sold in a State following the passage of an animal welfare policy relevant to egg production and sales, or the impacts of the 2014–15 HPAI outbreak on relative price premia for animal welfare, treatment, or production claims.

[19] In no real world case is there an instance of a sales policy being passed without a production policy already having been passed or being passed simultaneously. Therefore, our data are unsuited to estimating effects under those circumstances. Even if the data were suitable, the effects would not be of any practical value if estimable.

Appendix D: Market Shares by Volume

Appendix figure D.1

Monthly animal welfare and treatment claim shares of total U.S. table egg volume, 2008–18



Note: Market shares are calculated in terms of volume as the share of total units sold nationally of table eggs bearing the noted claim or trait.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.

Appendix Table D.1

Summary statistics of monthly animal welfare and treatment claim shares of total U.S. table egg volume, 2008–18

Claim or trait	Mean	Standard deviation	Minimum	Median	Maximum
			Percent		
Vegetarian fed	7.74	6.64	0.69	4.71	23.61
Organic	7.66	2.84	3.58	6.94	14.83
No added antibiotics	12.70	9.77	1.66	9.29	32.48
No added hormones	13.01	8.18	1.01	9.83	31.32
Cage-free	8.63	3.57	3.55	7.42	18.28
Pasture-raised	0.34	0.62	0.00	0.00	2.15
Free-range	2.84	3.41	0.12	0.70	11.47
Third-party humane certified	3.07	2.75	0.31	2.42	9.83
UEPC	7.67	4.01	2.59	7.33	25.30
Brown shell	23.92	3.46	17.56	22.66	30.45
Conventional	44.34	6.95	32.03	44.69	57.17

UEPC = United Egg Producers Certified.

Note: Summary statistics are calculated with respect to 132 monthly share observations. Market shares are calculated in terms of volume as the share of total units sold nationally of table eggs bearing the noted claim or trait.

Source: USDA, Economic Research Service using Circana, 2008–18 OmniMarket Core Outlets data; and Label Insight data.