Why Did Food Retailers Voluntarily Pledge to Go Cage-free with Eggs?

Xiao Dong*
Federal Trade Commission

Abstract

Recent studies show a significant portion of consumers prefer non–cage-free eggs, which raises the question of why many food retailers voluntarily pledged to only offer cage-free eggs instead of providing both. I develop a model of provision competition among food retailers to examine the economic rationale behind these pledges. I show that profit maximizing retailers facing competition will incur fixed costs to offer both cage-free and non–cage-free eggs to poach consumers or to prevent rivals from poaching consumers, and competition leads to a prisoners' dilemma equilibrium where all retailers will provide both types of eggs. In a dynamic setting, retailers can potentially sustain an equilibrium where collectively withholding non–cage-free eggs leads to higher profits. My model allows the discount rate threshold needed to sustain this outcome to be a function of supply costs and consumer trends. I show that changing supply conditions and consumer trends around cage-free eggs could result in a cage-free eggs only equilibrium with pledges acting as a signal of retailers' intentions and commitment to facilitate tacit coordination.

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Keywords: Food Retail Competition; Cage-free Eggs; Animal Welfare; Tacit Coordination

EL Codes: C70; D21; L81; Q18

*. E-mail: xdong@ftc.gov. Corresponding Author.

Introduction

In 2016, many food retailers of grocery products made voluntary pledges to only provide eggs from cage-free sources by 2026 or earlier (Graber and Keller 2020).[1] These pledges to go cage-free in eggs came amongst the trend of increasing public interest in the ban of battery cages for egg laying hens, and 10 States in the U.S. ultimately either banned the production and/or sale of "caged" eggs (Ufer 2022). The implications for consumers and egg producers of the transition to cage-free eggs have been well studied in the economics and agricultural economics literature (Allender and Richards 2011; Malone and Lusk 2016; Mullally and Lusk 2018; Lusk 2019; Kotschedoff and Pachali 2020; Carter, Schaefer and Scheitrum 2021; Oh and Vukina 2022; Caputo et al. 2023; Xie and Lusk 2023). However, the question of ***why*** food retailers voluntarily decided to only provide cage-free eggs has not been thoroughly explored.

Food retailers compete for consumers with prices, assortments, and other store amenities (Fox et al. 2004; Briesch et al. 2009; Bonnano and Lopez 2009; Hamilton and Richards 2009). Eggs are an important product category to draw in grocery shopping consumers, and retailers typically offer multiple variants of eggs to cater to consumers with heterogenous preferences for different egg attributes. Recent work by Allender and Richards (2010), Lusk (2019), Oh and Vukina (2021), Caputo et al (2023b), and Cao et al. (2021) show that a significant segment of consumers still prefer non–cage-free eggs, and Caputo et al (2023b) show that 56% of consumers are unaware that their preferred retailer made such a pledge in a survey. These studies raise the

[1] Almost all of the major national food retailers (including Walmart, Target, Kroger, Albertsons, Aldi, Whole Foods, Costco, etc) and regional food retailers (Meijer, Publix, Giant Eagle, Hy-Vee, etc) made a variation of this pledge.

question of why retailers facing competitive pressure would voluntarily risk losing a large portion of consumers by withholding an egg variety favored by many.

In this article, I propose that retailers made pledges of only providing cage-free eggs to soften competition on within category assortment and save on fixed costs associated with providing non–cage-free eggs. Specifically, retailers will often offer a variety of attractive products to compete for basket shopping consumers. However, providing many different "luring" products can be costly to the retailer. I develop a theoretical model of strategic retailer interaction that captures the provision strategies used by retailers where retailers can provide non–cage-free eggs at a cost to poach basket shopping consumers that favor non–cage-free eggs from a rival store. I show the equilibrium is a classic "prisoners' dilemma" scenario where retailers provide both cage-free and non–cage-free eggs even though a cooperative equilibrium where retailers only provide cage-free eggs is more profitable for all retailers.[2]

As the States bans will shift the supply landscape and cost structure of egg production, the incentives for retailers' provision decisions can also change. My model shows that increasing sourcing and production cost of non–cage-free eggs for retailers will increase the incentives for retailers to result in an outcome to only provide cage-free eggs under a dynamic game setting. Similar to price announcements under a pattern of price leadership, these nonbinding "cheap talk" cage-free pledges can serve as a signal and coordination device to other retailers on their intentions and commitments in terms of egg provision choices.

[2] Cooperative equilibrium/outcome does not necessarily mean that the stores/firms are actively cooperating with each other but the outcome is one for which the firms would reach if they were one firm/active cooperating with contractual arrangements. Reaching the cooperative equilibrium can be a result of tacit strategies.

Although theoretical, I hope this article can provide some insights into a seeming puzzle of why profit maximizing firms will voluntarily lose a nontrivial amount of consumers and potentially reduce profits with regards to these cage-free egg pledges. These results contribute to the broader literature on food retail competition by modeling and highlighting how retailers can engage in product provision competition. Moreover, evidence of price leadership and follow the leader pricing, where public price announcements can facilitate tacit price coordination, has been empirically established in many retail settings such as supermarkets, gasoline, and beer (Clark and Houde 2013; Seaton and Waterson, 2013; Byrne and de Roos, 2019; Miller et al. 2021). I show the possibility of tacit coordination in retail competition in terms of variety competition.

I also contribute to the public policy literature on voluntary industry pledges, which are common in the food industry with example such as pledges to reduce sodium, calories, sugar, marketing to children, and increasing voluntary food safety standards (Sharma et al. 2011; Hawkes and Harris. 2011; Philipsborn et al. 2018; Minor et al. 2019). In particular, Mozaffarian (2014) raise the question of "why would for-profit, highly competitive corporate giants such as General Mills, Kellogg, Unilever, Kraft, Nestle, PepsiCo, and Coca-Cola actively aim to reduce sales?". I highlight an alternative motive behind why firms will voluntarily engage in decisions that seemingly indict self-harm by providing a profit maximizing theory behind these pledges.

I further contribute to the literature on the cage-free egg transition, animal welfare and the supply dimensions of transitioning to animal friendly products as consumers have growing interest in animal welfare along the food supply chain and retailer decisions have a lot of ramifications both downstream to consumers and upstream to producers. From a welfare perspective, I show that only providing cage-free eggs is beneficial for retailers but inflict welfare loss on consumers.

The rest of the paper proceeds as follows. Section 2 provides background information on retail competition and the transition to cage-free eggs. Section 3 set ups the model and determines the Nash equilibrium under a one-shot game and the subgame perfect Nash equilibrium (SPNE) under a dynamic game setting. Section 4 examines comparative statics to see how supply factors and consumer trends can change the threshold at which a cooperative equilibrium is possible and sustainable. Section 5 looks at the associated welfare changes. Section 6 concludes and discusses the policy implications.

2. Background and Literature Review

There is growing consumer interest and concern regarding food safety, health attributes, local sourcing, and animal welfare among common consumer products including food products, and this interest is permeating back upstream into the supply chain as consumers are becoming more interested in where and how their food products are sourced (Lagerkvist and Hess, 2011; Clark et al. 2017; Britwum and Yiannaka 2019; Ortega and Wolf 2018; Dong et al. 2023). In particular, the humane treatment of egg producing hens has generated a lot of consumer interests. As such, 10 U.S. States passed bills and/or referendums to require the production of eggs within the State to be cage-free, and 8 of those States also require the sale of eggs to be from cage-free sources (Ufer 2022). Cage-free hens, which are allowed to roam during the laying cycle, has become a growing share of the U.S. egg-laying flock (USDA-ERS 2023).

The end egg products that reach consumers come to market through retail, food service, or as an input ingredient in other food products. The food retail store is where the majority of eggs for consumers end up as 56.6% of U.S. produced eggs were distributed to retail and 29.3% were further processed into manufacturing or other channels in 2022 (Caputo et al. 2023). Unlike eggs used in food service, manufacturing, or restaurants, eggs products purchased at retail stores are

often unprocessed shell eggs, and these unprocessed eggs are processed by consumers themselves via cooking, baking, coloring, and other methods.

Food retailers such as Walmart and Kroger are multiproduct firms, and they offer multiple similar versions of a food product for many food categories such as different types of cereal, many flavors of ice cream, and numerous varieties of apples. As such, retail stores can easily offer and market differentiated varieties of eggs to consumers depending on their preferences, which include eggs that are organic, local, cage-free, brown, contains omega-3, etc. Some eggs feature multiple attributes such as eggs that are both organic and cage-free. Oh and Vukina (2022) provides excellent summary statistics on the breakdown of retail shares of different egg varieties.

For consumer purchase decisions with regards to the cage-free attribute, economic theory suggests consumers with valuation for the cage-free attribute above the additional price premium will purchase cage-free eggs and consumers with little to no valuation for the cage-free attribute will purchase the cheaper non–cage-free egg. Allender and Richards (2010), Lusk (2019) and Oh and Vukina (2022) show mandated ban on sales of non–cage-free eggs will reduce consumer welfare as consumers with revealed preference for non–cage-free eggs will have to substitute to different eggs or no longer purchase eggs.[3]

As some consumers have high valuation for the cage-free attribute and some consumers have low valuation for cage-free attribute, the "private market solution" of providing both types of differentiated eggs is the likely outcome compared to only providing one type of egg as competitive pressure pushes retailers to provide multiple egg variants to attract consumers with

[3] These studies and this article take a human centric view of welfare ignoring any externalities and/or ethical concerns with regards to animal welfare (see Lusk and Norwood 2011 and Kuruc and McFadden 2023).

varying preferences for cage-free eggs, who can purchase their preferred eggs (Ufer 2022). Even for a monopolist, under many theoretical models, the profits from offering both types of eggs are also typically higher for the retailer. If retailers are assumed to profit maximizing on eggs alone, a price discriminating monopolist retailer can extract more rent by using the cage-free attribute to quality price discriminate consumers of varying preference for cage-free eggs (Mussa and Rosen 1979; Tirole 1988; Dong 2023).[4]

These studies assume consumers and more importantly retailers make pricing and provision decisions on eggs as a category independent of other products sold within the store. Modern food retailers are multiproduct firms that offer anywhere from 10,000 to 150,000 products (measured in stock keeping units or SKUs) across many product categories and departments. Consumers typically make store choice decisions on based purchasing a bundle of grocery goods (Bliss 1988; Lal and Matutes 1994; Chevalier et al. 2003; DeGraba 2006; Hamilton et al. 2020) along with other store characteristics. Correspondingly, retailers will engage in competition on price, varieties, services and other amenities (Richards and Hamilton 2006; Bonanno and Lopez 2009) to attract consumers.

As multiproduct firms, recent studies have shown that retailers compete across product categories and utilize the consumer complementarity between products to profit maximize (Lal and Matudes 1994; Richards et al. 2018; Thomassen et al. 2017; Hamilton et al. 2020). Intuitively, consumers purchase a bundle or basket of products at one store to save on travel costs associated with shopping at many stores. Thomassen et al. (2017) shows that actual retail margins are consistent with retailers pricing based on one trip shoppers' demand

[4] There is a point where it is better for the monopolist to only offer the high quality good (see Tirole 1988).

complementarity compared to pricing categories independently. In addition, consumers will often make unplanned purchases once in store as some studies show that 60% of purchase are unplanned (see Kollat and Willett 1967; Park, Iyer, and Smith 1989; Heilman, Nakamoto, and Rao 2002; Johnson 2017).

Correspondingly, a key strategy for retailers is to draw in consumers by offering better assortment. One trip shoppers will often shift where they purchase their basket of goods based the prices and offering of some key products and other amenities of retailers (Lal and Matudes 1994). Messinger and Narasimhan (1997) show that the key reason that retailers offer more products is to attract one trip shoppers.

Eggs are a key product category that draws in consumers as 94% of U.S. households purchase eggs (O'Keefe 2020), eggs comprise roughly 1.5% of consumer food-at-home expenditures (BLS 2022) and consumers also purchase eggs very frequently due to the perishable nature of eggs. With the heighted awareness and interest among consumers for eggs, the price and availability of different eggs can be significant factors on consumers' store choice. The availability of non–cage-free eggs (or lowering the price of eggs) means possibly "stealing" some consumers that prefer non–cage-free eggs from a rival store. Most food retailers currently offer multiple varieties of eggs to drawn in all consumers with varying preferences for the cage-free attitude to purchase the type of eggs that they like best. The pledges to only provide cage-free eggs could mean the loss of some consumers and the profit on the additional products they purchase, which leads to the question of the economic rationale behind the decisions.

The official pledges of these retailers often cite alignment of their practices with consumer preferences and expectations on animal welfare as the rationale behind the cage-free

commitments.[5] Under the context of multiproduct firms, the studies that show a significant share of consumers have low value for cage-free eggs still raise the intuitive question of why retailers voluntarily risk losing a large portion of consumers as providing multiple type of eggs is critical for drawing the entire spectrum of consumers to stores.

While some States also banned the sales of non–cage-free eggs in the recent cage-free bills, it is unlikely these bills destroyed the ability and incentives of these retailers to provide non–cage-free eggs. The total population of States with sales ban comprises less than 25% of the total U.S. population (Ufer 2022), and some retail chains that made pledges such as Giant Eagle and Hy-Vee have almost no presence in any of the States with the sales bans. In terms of provision, the bans in production of non–cage-free eggs represent about 13% of the total egg laying flock (Ufer 2022). Although the bans likely resulted in higher sourcing cost, they did not eliminate the availability of non–cage-free eggs.

One possible answer is that providing additional products is costly. While large retailers do enjoy economies of scope (MacDonald et al. 2023), there is a fixed cost to provide another slightly differentiated version of the same product. In the case of case of eggs, Oh and Vukina (2022) notes that "Personal interviews with egg industry participants and extension specialists produced an opaque picture of fragmented and idiosyncratic market, complicated by the presence of various intermediaries (brokers and dealers) and the absence of centralized procurement schemes among large retailer banners", which indicates continued sourcing/shoe leather costs with searching, finding, and negotiating for egg suppliers.

[5] For example, Kroger states: "As our customer base has been moving to cage-free at an increasing rate, Kroger's goal is to transition to a 100% cage-free egg supply chain by 2025." Walmart states: "Our customers and members count on Walmart and Sam's Club to deliver affordable products in a way that is sustainable for people and for the planet."

Most retailers are also constrained by selling space (a store only has so much selling area before major renovations), and to provide non–cage-free eggs is at the opportunity cost of more profitable high margin items such as processed liquid eggs or ready to eat eggs. Moreover, reducing the number of products within a category could mean more refrigerator space for other more high margin categories such as high-end cheeses and deli meats.

While retailers would like to save on costs associated with provision, food retailers also face competition with the potential for rivals to incur the costs, provide both type of eggs, and lure away some consumers. The best response for a retailer is likely to follow suit and provide non–cage-free eggs with the zero-sum equilibrium of every retailer providing non–cage-free eggs. Ellickson (2006), Ellickson (2007), and Ellickson (2013) model quality attributes in terms of store size, which proxies the number of the products along with endogenous fixed costs needed to increase store size. These studies show that product varieties are strategic complements in retail competition where one firm incurring costs to provide more products leads other firms to follow. Hamilton and Richards (2009) also show that retailers increase the assortment depth (number of different varieties) within a product category if competition increases. However, if all retailers tacitly withhold quality improvements by only providing cage-free eggs, consumers are not stolen away by competition, and retailers can save on provisional costs.

While it is possible for all retailers to only provide cage-free eggs to soften variety competition and reduce provision costs, the incentives to sustain tacitly not engaging in provision competition depends on the tradeoffs between gains from stealing and the provision cost savings. A non-competitive or cooperative outcome among competitive rivals is difficult to sustain in cases where there are incentives to “cheat” and intentions are unclear. One way to sustain cooperative outcome is information sharing for credible monitoring and enforcement. Even in stances where

the talk is “cheap” and lack credibility, even communication can facilitate and sustaining a cooperative outcome (Fonseca and Normann 2012; Awaya and Krishna 2016).

Pledges are a great way to announce and signal intentions and commitments publicly. Miller et al. (2021) provide evidence of “supermarkups” and extra profits under a price leadership game in the beer industry where one brewer makes public price announcements as a signal and coordination device with other brewers closely following the announced price. Similarly, the cage-free pledges came from almost every major retailer in the country, and most modern food retailer stores are also often part of a large regional or national chain.[6] The window in which all retailers made the voluntary pledge was also very narrow (most retailers made the pledge within the 6 month between end of 2015 to June of 2016) and highlights the likelihood of these pledges serving as coordination devices and signals.

Similar to the theoretical papers of Bourquard and Wu (2020), Winfree and Watson (2021), Nuño-Ledesma et al. (2022), I develop my hypothesis into a formal model where I combine a model of horizontal product differentiation in food retailing with the availability of different egg types as a vertical quality attribute of the store. The assumptions and mechanisms of the model are well supported by empirical evidence and studies on the cage-free egg transition and retail competition. The implications of the model will hopefully shed light on the underlying economic incentives and decision-making process of retailers surrounding the cage-free transition.

[6] Cho and Volpe (2015) find independent grocery stores, as defined as food retail establishments whose owners operate fewer than four outlets simultaneously, was 11 percent of all U.S. grocery sales in 2015.

3. Model

3.1 Model Setup

I start the model with two horizontally differentiated and symmetric food retail stores, and the differentiation is modeled through the linear Hotelling line (see Hotelling 1929; Merel and Sexton 2011; McClusky and Winfree 2021). I assume food retail stores at fixed in terms of location and are located at the end points of a line with a length of 1. Store 1 is located at $x = 0$, and store 2 is located at $x = 1$.

Next, I assume consumers have linear utility U, and the utility is comprised of utility from purchasing a basket of grocery goods at a store where r represents the utility the consumer has for a basket of grocery goods sans eggs. For store 1, $l_1 = 0$. For store 2, $l_2 = 1$. x represents where the consumer is along the line, and $|l_i - x|$ is the distance to store i from the vantage point of a consumer. Finally, t is travel cost/differentiation preference, and the total disutility from travelling to store i is $t|l_i - x|$.

Consumers have utility for the basic egg, e and receive utility of $(e - p_{iNCF})$ if the consumer decides to buy non–cage-free eggs at store i, $HNCF_i$ = 1. If consumers purchase cage-free eggs at store i, HCF_i = 1, they receive $(\theta_c + e - p_{iCF})$, where θ_c is consumer valuation for the additional cage-free attribute of eggs and the value of θ_c depends on the type of consumer, c. I assume consumers have unit demand for eggs, and consumers only buy one type of eggs or no eggs with the choice set as either [$HNCF_i$ = 0, HCF_i = 1], [$HNCF_i$ = 1, HCF_i = 0], or [$HNCF_i$ = 0, HCF_i = 0] and the constraint becomes $HNCF_i + HCF_i \leq 1$.

Among the consumers, I assume there are three types of consumers that currently purchase eggs, $c \in [l, s, h]$, where consumer types are classified by their preference for the cage-free attribute.

Consumers that have low preference are indexed as l, consumers with "switching preference" are indexed as s, and consumers with high preference are indexed h. These consumers only differ in their valuation for the cage-free attribute of eggs.

The terms c_{NCF} and c_{CF} are the marginal cost of non–cage-free and cage-free eggs respectively. I note that the marginal cost of cage-free eggs is higher than non–cage-free eggs as show by the inequality $c_{CF} > c_{NCF}$, which has been empirical established based on recent studies that show the marginal cost for cage-free eggs is higher due to additional production costs (Caputo et al. 2023).

For all consumers, I assume $c_{CF} > e > c_{NCF}$. For consumers with high preference, I assume that $\theta_h > c_{CF} - c_{NCF}$. For consumers with switching preference, I assume that $c_{CF} - c_{NCF} > \theta_s > c_{CF} - e$. Finally, for consumers with low preference, I assume that $\theta_l = 0$. I assume the share of s consumers is λ, share of l consumers is σ, and share of h consumers is $1 - \lambda - \sigma$. I assume each type of consumers is evenly distributed along the line.

The consumer utility maximization equation is written below:

$$\max_{i, HNCF_i, HCF_i} U_c = r - t|l_i - x| + (\theta_c + e - p_{iCF})HCF_i + (e - p_{iNCF})HNCF_i$$

$$s.t.$$

$$HNCF_i + HCF_i \leq 1$$

Stores make total profit π_i based on the total profit of eggs and other goods. For eggs, stores make a profit based on quantity demanded of non–cage-free eggs, Q_{iNCF}, and cage-free eggs, Q_{iCF} multiplied by their markups $(p_{iNCF} - c_{NFC})$ and $(p_{iCF} - c_{CF})$ respectively. The store incurs fixed costs of F_{NCF}, F_{CF} for providing non–cage-free eggs and cage-free eggs respectively.

The store makes additional profit based on non-egg products that consumers purchase once in store, where Q_{ib} is the total non-egg products per trip demanded. I assume B is the per trip profit and the total profit on non-egg products is the total quantity demanded, Q_{ib}, multiplied by the per trip profit. Quantity demanded, Q_{ib}, Q_{iCF}, and Q_{iNCF} are functions of egg prices in own store and rival store, $p_{iCF}, p_{-iCF}, p_{iNCF}, p_{-iNCF}$, the availability of eggs, NCF_i, CF_i, consumer choices $HNCF_i, HCF_i$, and consumer preferences and distribution parameters $\theta_c, t, \lambda, \sigma$.[7]

$$\pi_i = Q_{ib}B + (p_{iCF} - c_{CF})Q_{iCF} + (p_{iNCF} - c_{NCF})Q_{iNCF} - F_{CF} - F_{NCF}$$

where

$$Q_{ib}(p_{iCF}, p_{-iCF}, p_{iNCF}, p_{-iNCF}, NCF_i, CF_i, HNCF_i, HCF_i, \theta_c, t, \lambda, \sigma)$$

$$Q_{iCF}(p_{iCF}, p_{-iCF}, p_{iNCF}, p_{-iNCF}, NCF_i, CF_i, HNCF_i, HCF_i, \theta_c, t, \lambda, \sigma)$$

$$Q_{iNCF}(p_{iCF}, p_{-iCF}, p_{iNCF}, p_{-iNCF}, NCF_i, CF_i, HNCF_i, HCF_i, \theta_c, t, \lambda, \sigma)$$

3.2 Game and Strategies

I examine the non-cooperative game where retailers can offer only cage-free eggs or both cage-free and non–cage-free eggs.[8] I assume both stores will always offer cage-free eggs, which reduces the choice of the store to simply be provide or not provide non–cage-free eggs and leads to the 4 possible strategies for each store. The strategies for store 1 are $[NCF_1 = 1\ if\ NCF_2 = 1]$, $[NCF_1 = 1\ if\ NCF_2 = 0]$, $[NCF_1 = 0\ if\ NCF_2 = 1]$, $[NCF_1 = 0\ if\ NCF_2 = 0]$, and the strategies for store 2 are $[NCF_2 = 1\ if\ NCF_1 = 1]$, $[NCF_2 = 1\ if\ NCF_1 = 0]$, $[NCF_2 = 0\ if\ NCF_1 = 1]$, $[NCF_2 = 0\ if\ NCF_1 = 0]$. Table 1 presents the normal form of the game with

[7] I note that $HNCF_i$ indexes consumer choice of non–cage-free eggs at store i, and c_{NCF} indexes if store i offers non–cage-free eggs.
[8] I ignore the possibility of stores not providing cage-free eggs as the question at hand is the pledge to only offer cage-free eggs.

the strategy profiles of store 1 and store 2 and the associated outcomes. Table 1 is also the payoff matrix and shows the profit for both store 1 and store 2 in each of the 4 possible outcomes.

Table 1. Normal Form of the Game

	$NCF_2 = 0$	$NCF_2 = 1$
$NCF_1 = 0$	Outcome A. Neither store 1 nor store 2 provide non–cage-free eggs. Profit π_1^A, π_2^A	Outcome C. Only store 2 provides non–cage-free eggs. Profit π_1^C, π_2^C
$NCF_1 = 1$	Outcome B. Only store 1 provides non–cage-free eggs. Profit π_1^B, π_2^B	Outcome D. Both store 1 and store 2 provide non–cage-free eggs. Profit π_1^D, π_2^D

3.3 Solution

Next, I solve for the profits in the two-by-two game in Table 1. To reduce the complexity of the analysis and to make the model tractable, I make two assumptions based on real world practices of retailers.

3.3.1 Assumptions

Simplifying Assumption 1: Consumers only make one trip for shopping, or I assume the travel cost $t > e - c_{NCF}$. In other words, the value of eggs is not worth the cost of an extra trip to the other store. This eliminates the possibility of consumers buying eggs at store 1 and the rest of goods, B, at store 2, and vice versa. While cherry picking and multi store shopping is common among some consumers, a large portion of consumers are one trip shoppers and are the focus of

retailers. This is also consistent with the modeling assumptions of Lal and Matutes (1994) and Johnson (2017). Moreover, recent studies have shown the one trip shopper is the consumer that retailers target and set prices on (Thomassen 2017).

Moreover, even among multi store shopping consumers, it is unlikely that consumers only purchase eggs during a shopping trip as 60% of purchases are unplanned (see Kollat and Willett 1967; Park, Iyer, and Smith 1989; Heilman, Nakamoto, and Rao 2002; Johnson 2017). Even if multi store shopping consumers don't switch their entire baskets due to egg provision strategies, they can still be profitable for retailers.

Simplifying Assumption 2: Retailers price eggs at cost $p_{iCF} = c_{CF}, p_{iNCF} = c_{NCF}$.

This assumption follows from assumption 1 and is based on the multiproduct nature of food retailing. Based on the Lal and Matutes (1994) and Johnson (2017) model of loss leading, I assume that eggs are a loss leading good that stores aggressively price compete on to draw in consumers to make profits on additional purchases. This practice of loss leading is a well-known strategy in retailing, and eggs are often used as loss leaders where the products are priced at cost or at low margins to attract consumers. Hosken and Reiffen (2004) extends the Lal and Matutes model to show that more frequently purchased goods are selected as loss leaders, which is consistent with the perishability nature of eggs. Industry evidence supports this idea that eggs are low margin items (Kilroy et al. 2016). Allender and Richards (2010B) also show that egg margins are below what would be expected of Nash-Betrand competition on eggs alone.

This assumption allows me to abstract from (1) pricing competition for eggs and (2) factoring in the profits on eggs into store profits. Introducing price competition into the model would be complex and distracts from the main goal of this article. As multiproduct firms, I would have to

model egg prices and other background good prices as a bundle. Moreover, the goal of this exercise is to model strategic provision as Ellickson (2006), Ellickson (2007), and Ellickson (2013) find that a lot of supermarket competition stems from quality competition. I could potentially assume a small and fixed margin on eggs, but this would not significantly impact the conclusions as a low margin product, the profit margins on eggs likely pale in comparison to the profit margins of other goods.

Next, I define $Q_{iN} = Q_{ib} - Q_{iNCF} - Q_{iCF}$ or the total demand for basket goods of consumers that don't buy eggs. Applying the two assumptions, the store profit equation simplifies to:

$$\pi_i = (Q_{iN} + Q_{iNCF} + Q_{iCF})B - F_{NCF} - F_{CF}$$

With the two assumptions, my model assumes stores make no profits on eggs, and eggs are utilized as positive store amenities that draw in consumers. Stores make profits from the other goods that consumers purchase once they come into the store and the profit amount depends on how many consumers come in the store.

3.3.2 Solution for Outcome D:

I now solve for the profits of each store for each of the 4 outcomes in Table 1. I start with Outcome D. As consumer will only shop at one store and purchase one egg product (or no eggs), consumers essentially have 6 choices if both stores offer both cage-free and non–cage-free eggs:

1. $U_c = r - tx$
2. $U_c = r - t(1 - x)$
3. $U_c = r - tx + (\theta_c + e - c_{CF})$
4. $U_c = r - t(1 - x) + (\theta_c + e - c_{CF})$
5. $U_c = r - tx + (e - c_{NCF})$

6. $U_c = r - t(1-x) + (e - c_{NCF})$

Consumers can choose not to purchase any eggs and shop at either store 1 or 2, which results in choice 1) and 2) respectively. Shopping at store 1 and 2 and purchasing cage-free eggs results in choice 3) and 4). Shopping at store 1 and 2 and purchasing non–cage-free eggs results in choice 5) and 6).

For consumers with high preference, I assume that $\theta_h > c_{CF} - c_{NCF}$, which implies $\theta_h > c_{CF} - e$. This leads to $\theta_h + e > c_{CF}$ and $\theta_h + e - c_{CF} > e - c_{NCF}$, which means that high preference consumers will buy cage-free eggs always if eggs are priced at marginal cost. These consumers are willing to buy cage-free eggs and value the cage-free attribute more than the additional cost of production, so they will always buy cage-free eggs. Since both stores offer identical products and are symmetrical, at which store that consumers shop at depends on their location on the line. This is the standard Hotelling model (1929), and the standard solution method results with an indifferent consumer at point $\hat{x}$. Since the stores offer identical products, then the two stores split the consumers with $\hat{x} = \frac{1}{2}$ and $Q_{iCF} = \frac{1}{2}(1 - \lambda - \sigma)$. Total demand for cage-free eggs is half of the line multiplied by the share of consumers with high preference.

For consumers with switching preference, I assume that $c_{CF} - c_{NCF} > \theta_s > c_{CF} - e$. This leads to $\theta_s + e > c_{CF}$ and $\theta_s + e - c_{CF} < e - c_{NCF}$, which means consumers are willing to buy cage-free eggs but value the cage-free attribute less than the marginal cost difference between cage-free and non–cage-free eggs. They will buy non–cage-free eggs when available and switch to cage-free when non–cage-free eggs are not available. At which store that they shop at depends on their location on the line, and their store choice solution is similar to above with stores dividing up the line evenly.

Finally, for consumers with low preference, I assume that $\theta_l = 0$, which leads to $\theta_l = 0 < e - c_{CF}$. These consumers are not willing to buy cage-free eggs, but they will buy non–cage-free eggs. They will not buy eggs if only cage-free eggs are available. At which store that they shop at depends on their location on the line, and their store choice solution is similar to above with stores dividing up the line evenly.

Total demand for non–cage-free eggs, $Q_{iNCF} = \frac{1}{2}(\lambda + \sigma)$, is half of the line multiplied by both the share of consumers with switching preference and share of consumers with low preference. The profits for store 1 and store 2 are $\pi_1^D = \pi_2^D = (\frac{1}{2}(\lambda + \sigma) + \frac{1}{2}(1 - \lambda - \sigma))B - F_{NCF} - F_{CF}$, which simplifies to $\pi_1^D = \pi_2^D = (\frac{1}{2})B - F_{NCF} - F_{CF}$.

3.3.3 Solution for Outcome C:

In this scenario, store 1 is no longer offering non–cage-free eggs. Compared to Outcome D, consumers only have 5 choices now as choice 5 is no longer available.

1. $U_c = r - tx$
2. $U_c = r - t(1 - x)$
3. $U_c = r - tx + (\theta_c + e - c_{CF})$
4. $U_c = r - t(1 - x) + (\theta_c + e - c_{CF})$
5. ~~$U_c = r - tx + (e - c_{NCF})$~~
6. $U_c = r - t(1 - x) + (e - c_{NCF})$

Since cage-free eggs are available at both locations, high preference consumers still have their preferred options available and make the same choice as Outcome D.

For switching preference consumers to right of the midpoint, $x > 1/2$, their preferred choice is not affected since they shop at store 2. For switching preference consumers to left of the midpoint, $x < 1/2$, some are now willing to travel to store 2 since store 2 offers non–cage-free eggs and store 1 no longer does. However, at some point, the distance trade off for these consumers becomes too great and they stay at store 1. Since I assume a linear utility model, the trade off is addictive. For these switching consumers, purchasing cage-free eggs at store 1 dominates the option of purchasing no eggs at store 1 as $\theta_s + e - c_{CF} > 0$. The best alternative options for these consumers is to either travel to store 2 or purchase cage-free eggs at store 1 with the indifferent consumer located at:

$$r - t\hat{x} + (\theta_s + e - c_{CF}) = r - t(1 - \hat{x}) + (e - c_{NCF})$$

$$\hat{x} = \frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}$$

Intuitively, the indifferent consumer is located at a point at which gains from buying non–cage-free eggs at a further away store is balanced by the additional travel cost. Consumers to the left of the new indifference point will continuing shopping at store 1 but switch to cage-free eggs. In other words, for consumers that are relatively indifferent between store 1 and 2, the additional provision of non–cage-free eggs at store 2 might tip the balance for them to switch their shopping at the other store.

Similar to the consumers above, some low preference consumers will travel to store 2. Unlike switching consumers, low preference consumers' next best alternatives are travelling to store 2 or shopping at store 1 and not purchase eggs. Not purchasing eggs at store 1 strictly dominates purchasing cage-free eggs at store 1 as $c_{CF} > 0 + e$. The indifferent consumer is located at:

$$r - t\hat{x} = r - t(1 - \hat{x}) + (e - c_{NCF})$$

$$\hat{x} = \frac{1}{2} + \frac{c_{NCF} - e}{2t}$$

Similar to switching consumers, the indifferent consumer is located at a point at which gains from buying non–cage-free eggs at a further away store compared to not buying is balanced by the additional travel cost. Consumers to the left of the new indifference point will continue to shop at store 1 but buy no eggs.

Total demand for non–cage-free eggs becomes $Q_{1NCF} = \left(\frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\right)\lambda$ and demand of shoppers with no egg purchases is $Q_{1N} = \left(\frac{1}{2} + \frac{c_{NCF} - e}{2t}\right)\sigma$. For store 2, the demands are $Q_{2NCF} = \left(\frac{1}{2} - \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\right)\lambda$ and $Q_{2N} = \left(\frac{1}{2} - \frac{c_{NCF} - e}{2t}\right)\sigma$. I note that $\theta_s - c_{CF} + c_{NCF} < 0$ and $c_{NCF} - e < 0$, so store 1 loses consumers to store 2 by not providing non–cage-free eggs. The profit for store 1 is $\pi_1^C = B\left(\frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF}$. The profit for store 2 is $\pi_2^C = B\left(\frac{1}{2} - \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF} - F_{NCF}$.

3.3.4 Solution for Outcome B:

Outcome B is a mirror of Outcome C with profits a mirror of Outcome C. The profit for store 1 is $\pi_1^B = B\left(\frac{1}{2} - \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF} - F_{NCF}$. The profit for store 2 is $\pi_2^B = B\left(\frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF}$.

3.3.5 Solution for Outcome A:

Consumers only have 4 choices now as choice 5 nor 6 are no longer available.

1. $U_c = r - tx$
2. $U_c = r - t(1 - x)$

3. $U_c = r - tx + (\theta_c + e - c_{CF})$
4. $U_c = r - t(1-x) + (\theta_c + e - c_{CF})$
5. ~~$U_c = r - tx + (e - c_{NCF})$~~
6. ~~$U_c = r - t(1-x) + (e - c_{NCF})$~~

Again cage-free eggs are available at both locations, and high preference consumers still have their preferred options available and make the same choice as Outcome D.

For consumers with switching preference, the decision for store choice goes back to Outcome D as neither store offers non–cage-free eggs. However, these consumers switch to cage-free eggs. Similarly, low preference consumers also shop at the stores in Outcome D but purchase no eggs. The profits for store 1 and store 2 are $\pi_1^A = \pi_2^A = \frac{1}{2}B - F_{CF}$.

Filling out Table 1 with the solved profits results in Table 2.

Table 2. Payoff Matrix

	$NCF_2 = 0$	$NCF_2 = 1$
$NCF_1 = 0$	Outcome A. Neither store 1 nor store 2 provide non–cage-free eggs. Profit $\pi_1^A = \frac{1}{2}B - F_{CF}$ $\pi_2^A = \frac{1}{2}B - F_{CF}$	Outcome C. Only store 2 provides non–cage-free eggs. Profit $\pi_1^C = B\left(\frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF}$ $\pi_2^C = B\left(\frac{1}{2} - \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF} - F_{NCF}$
$NCF_1 = 1$	Outcome B. Only store 1 provides non–cage-free eggs. Profit $\pi_1^B = B\left(\frac{1}{2} - \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF} - F_{NCF}$ $\pi_2^B = B\left(\frac{1}{2} + \frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) - F_{CF}$	Outcome D. Both store 1 and store 2 provide non–cage-free eggs. Profit $\pi_1^D = \frac{1}{2}B - F_{NCF} - F_{CF}$ $\pi_2^D = \frac{1}{2}B - F_{NCF} - F_{CF}$

Since Outcome D is the status quo, I normalize profits for Outcome A,B,C in relationship to Outcome D by setting the Outcome D profits to zero in Table 3. The payoffs in Table 3 show a straightforward two-by-two game.

Table 3. Normalized Payoff Matrix

	$NCF_2 = 0$	$NCF_2 = 1$
$NCF_1 = 0$	Outcome A. Neither store 1 and store 2 provide non–cage-free eggs. Profit $\pi_1^A = F_{NCF}$ $\pi_2^A = F_{NCF}$	Outcome C. Only store 2 provides non–cage-free eggs. Profit $\pi_1^C = B\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) + F_{NCF}$ $\pi_2^C = B\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)$
$NCF_1 = 1$	Outcome B. Only store 1 provides non–cage-free eggs. Profit $\pi_1^B = B\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)$ $\pi_2^B = B\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right) + F_{NCF}$	Outcome D. Both store 1 and store 2 provide non–cage-free eggs. Profit $\pi_1^D = 0$ $\pi_2^D = 0$

3.4 Nash Equilibrium

Assumption 3: $B\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) > F_{NCF}$

The term $B\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)$ represents the sale stealing effect of attracting consumers from a rival store by providing non–cage-free eggs, but to steal comes at the cost F_{NCF}. In most instances, it is likely that the sale stealing effect is larger than the provision cost, so I assume that this inequality is true. This assumption is likely true as Outcome D is the outcome that we observe with retailers offering non–cage-free eggs.

With assumption 3, the payoffs in Table 3 show a straightforward two-by-two game. If the game is one shot, both store 1 and store 2's dominant strategy is to provide both eggs. For store 1, if store 2 only provides cage-free eggs, then store 1 can gain profits of $B\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda -\right.$

$\frac{c_{NCF}-e}{2t}\sigma\Big) - F_{NCF}$ by providing cage-free eggs. If store 2 provides both, then store can again gain profits of $B\left(-\frac{\theta_s-c_{CF}+c_{NCF}}{2t}\lambda - \frac{c_{NCF}-e}{2t}\sigma\right) - F_{NCF}$ by providing cage-free eggs.

As the dominant strategy for both stores is to provide both types of eggs, the Nash equilibrium outcome is Outcome D, where both stores provide both kinds of eggs. This is the prisoner's dilemma result as the Nash Equilibrium outcome in Outcome D is worse for both stores than Outcome A. Stores both gain profits of F_{NCF} in Outcome A compared to the profits in Outcome D. With the higher profits, Outcome A is the likely outcome that would result if the stores could cooperate.[9] However, Outcome A is unsustainable under competition because there is a strong economic incentive for stores to deviate and "steal" consumers by offering non–cage-free eggs.

3.5 Dynamic Game Setting and Solution

In the one-shot game above, both stores' dominant strategy is to provide non–cage-free eggs, which results in an equilibrium that is worse off for both stores. However, the equilibrium outcome could be different in a dynamic setting as first noted by Stigler (1964). Retailers often compete for a long period of time, and provision decisions are often strategic for the long run. I extend the one shot game of Table 3 into infinite periods and a repeating dynamic game similar to Rotemberg and Saloner (1986) and Chevalier et al. (2003) who model supermarket competition with infinite periods.

In terms of equilibrium outcomes, one of the most obvious and easily supported subgame perfect Nash equilibriums (SPNE) is Outcome D for infinite periods where retailers aggressively compete by offering both cage-free and non–cage-free eggs every period. However, in an

[9] I will refer to Outcome A as the cooperative equilibrium as that is outcome that both stores will likely reach and sustain if they could cooperate.

infinitely repeat game, the Folk Theorem shows a variety of strategies can sustain the cooperative equilibrium depending on the discount rate. I examine a game where both stores are playing the harshest punishment strategies, the grim trigger, and I solve for possible SPNEs.

I assume that stores have a discount rate of δ for profits in the next period. Following Table 3, in the cooperative case of both stores offering only cage-free eggs, both stores receive profits of F_{NCF} each period (Outcome A). For infinite periods, total profits become $\frac{F_{NCF}}{1-\delta}$ as shown in the series summation where δ is the discount rate.

$$F_{NCF}(1 + \delta + \delta^2 \dots .) = \frac{F_{NCF}}{1-\delta}$$

For a grim trigger strategy, if store 1 deviates, the grim trigger is applied in the next period, and everything collapses to Outcome D forever. The "sales stealing" strategy of deviating to outcome B receives a total payoff of $\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)$ as store 1 receives 0 normalized profit after period 1.

$$\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) + 0 * \delta + 0 * \delta^2 \dots \dots$$

As much, the cooperative equilibrium is sustainable if $\frac{F_{NCF}}{1-\delta} \geq \left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)$. Setting up the inequalities show that if the discount rate is high enough, then a cooperative outcome can be sustained, and no stores have incentives to cheat.

$$\delta \geq 1 - \frac{F_{NCF}}{\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)}$$

If I assume the threshold to be δ^*, I can show that the critical discount rate to sustain a cooperative outcome is a function of the fixed cost of providing non–cage-free, the marginal costs, and consumer demand parameters.

$$\delta^* = 1 - \frac{F_{NCF}}{\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)}$$

4. Comparative Statics

With the discount factor threshold as a function of underling cost parameters and consumer preferences, I then examine some comparative statics. Taking the derivative of δ^* with respect to F_{NCF}, c_{NCF}, c_{CF} are listed below.

$$\frac{\partial \delta^*}{\partial F_{NCF}} = -\frac{1}{\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right)} < 0$$

$$\frac{\partial \delta^*}{\partial c_{NCF}} = -\frac{\frac{F_{NCF}(\sigma + \lambda)}{2t}}{\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)^2} < 0$$

$$\frac{\partial \delta^*}{\partial c_{CF}} = \frac{F_{NCF}\left(\frac{\lambda}{2t}\right)}{\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)^2} > 0$$

First, I show that $\frac{\partial \delta^*}{\partial F_{NCF}} < 0$ or as the fixed cost of sourcing non–cage-free eggs goes up, the discount rate needed to sustain a cooperative outcome goes down. In the context of recent events, as the States bans on non–cage-free egg productions were passed, retailers probably expected sourcing non–cage-free eggs would have become a lot harder and would lead to higher sourcing costs.

Second, I show that $\frac{\partial \delta^*}{\partial c_{NCF}} < 0$ or as the marginal cost of non–cage-free eggs goes up, the discount rate needed to sustain a cooperative outcome goes down. Intuitively, non–cage-free egg purchasing consumers (either switchers or low preference) are less likely to switch their stores to non–cage-free eggs if the price of non–cage-free eggs are higher. As more producers switch to cage-free operations, there are likely economies of scale that are lost for non–cage-free eggs, and the marginal cost of non–cage-free eggs could go up as a result of the States bans.

Finally, I show that $\frac{\partial \delta^*}{c_{CF}} > 0$ or as the marginal cost of cage-free eggs goes down, the discount rate needed to sustain a cooperative outcome goes down. Retailers probably also expected the marginal cost of cage-free eggs going down as more producers started to produce cage-free eggs due to economies of scale.

Next, I examine how changing consumer preferences changes the threshold needed to reach a cooperative equilibrium.

$$\frac{\partial \delta^*}{\partial \lambda} = -\frac{\frac{F_{NCF}\,(\theta_s - c_{CF} + c_{NCF})}{2t}}{\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)^2} > 0$$

$$\frac{\partial \delta^*}{\partial \sigma} = -\frac{\frac{F_{NCF}\,(c_{NCF} - e)}{2t}}{\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)^2} > 0$$

$$\frac{\partial \delta^*}{\partial \theta_s} = -\frac{\frac{F_{NCF}(\lambda)}{2t}}{\left(\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda + \frac{c_{NCF} - e}{2t}\sigma\right)^2} < 0$$

With regards to the share of switching preference and low preference consumers, as the share of these consumers that purchase non–cage-free eggs goes down, the threshold to reach a

cooperative equilibrium also goes down, $\frac{\partial \delta^*}{\partial \lambda} > 0, \frac{\partial \delta^*}{\partial \sigma} > 0$. Intuitively, as the share of consumers that purchase non–cage-free eggs goes down, the profit gain of stealing those consumers goes down, which reduces the incentive to deviate.

Similarly, as the valuation for the cage-free attribute of switching consumers goes up, the threshold to reach a cooperative equilibrium also goes down, $\frac{\partial \delta^*}{\partial \theta_s} < 0$. Intuitively, as valuation for cage-free goes up, switching consumers are less likely to switch to non–cage-free eggs at a rival store, which reduces the incentive to deviate.

In summary, $\frac{\partial \delta^*}{\partial F_{NCF}} < 0, \frac{\partial \delta^*}{\partial C_{NCF}} < 0, \frac{\partial \delta^*}{c_{CF}} > 0, \frac{\partial \delta^*}{\partial \lambda} > 0, \frac{\partial \delta^*}{\partial \sigma} > 0, \frac{\partial \delta^*}{\partial \theta_s} < 0$. These comparative statics all predict that recent consumer trends and supply side changes surrounding cage-free eggs are likely for a cooperative outcome to be sustainable. On the supply side, the fixed cost and marginal cost of non–cage-free eggs going up along with marginal cost of cage-free eggs going down are likely to happen as a result of the States bans. These pledges also almost all occurred in 2016, after California and other States passed legislation banning confinement of hens. On the consumer side, as both the share of consumers start valuing cage-free eggs more, and consumers increase their valuation of the cage-free attribute, the incentives for retailers to offer non–cage-free eggs goes down even though a significant number of consumers still value non–cage-free eggs.

With the supply and demand conditions sustainable for a cooperative equilibrium, the pledges made by retailer served as an easy and costless form of communication of their intent and

conveyed their goals to other retailers to transitions to an equilibrium where only cage-free eggs are offered.[10]

5. Welfare

While the pledges and the cooperative equilibrium in Outcome A is better off for retailers, only providing cage-free eggs leads to welfare loss for consumers. Similar to the mechanisms captured by the empirical studies in Allender and Richards (2010), Lusk (2019), Oh and Vukina (2022), I show consumers that purchase non–cage-free eggs are forced to substitute to a less preferred option under the cooperative equilibrium.

For switching consumers, the utility loss is the utility difference between the more preferred non–cage-free eggs compared to cage-free eggs, which is $\theta_s - c_{CF} + c_{NCF}$. For low preference consumers, the utility loss is the utility of eggs $c_{NCF} - e$ as these consumers stop buying. The total consumer welfare loss is $CS = (\theta_s - c_{CF} + c_{NCF})\,\lambda + (c_{NCF} - e)\sigma$ if retailers only offer cage-free eggs. In the model, retailers do gain F_{NCF} individual in terms of provision cost savings with total retailer surplus change at $2F_{NCF}$. The cooperative equilibrium of pledges increases retailer profits at the expensive of consumer welfare loss in egg purchases.

6. Conclusion and Discussion

With the growth of food retail concentration at the national and local levels, retailers have become more important in dictating supply chains standards upstream (MacDonald et al. 2023; Saitone and Sexton 2017). As Caputo et al. (2023) discusses, much of the producer transition to

[10] I also note that there is the possibility where the changes in supply and demand could make $B\left(-\frac{\theta_s - c_{CF} + c_{NCF}}{2t}\lambda - \frac{c_{NCF} - e}{2t}\sigma\right) < F_{NCF}$, which would mean that Outcome A is a sustainable equilibrium even in an one-shot game.

cage-free eggs have been a result of retailers' decision to source only cage-free egg. With the influence that retailers can have on producers and consumers, examination of retailer decision making is critical for understanding the supply chain impacts of changing consumer perception surrounding animal welfare and associated changes in policy.

Modern food retailers are multiproduct firms that employ complex strategies including competition among price and variety across many product categories. Any examination of store egg provision decisions needs to be considered in the context of overall store profits.

I provide a theoretical model of retail competition that examines why retailers voluntary pledged to only provide cage-free eggs at potential detriment to their profits. I abstract from price competition but include variety competition as a key strategy of drawing consumers to stores. I show that retailers are better off only providing cage-free eggs to save on sourcing costs, but default to providing both non–cage-free and cage-free eggs in equilibrium due to competitive pressure. However, in a dynamic setting, I show the outcome of retailers only providing cage-free eggs is possible with the possibility of sustaining such an outcome more likely as sourcing costs and marginal cost of non–cage-free eggs increase, and marginal cost of cage-free eggs decrease. The recent bans and changing consumer trends around eggs likely increased or will increase the sourcing costs of non–cage-free eggs, marginal cost of non–cage-free eggs but decrease the marginal cost of cage-free egg. My model shows that these trends likely facilitated the only cage-free eggs outcome.

This model can be extended into examining the firm level motives behind other voluntary pledges in the food industry as variety provisions also plays an important role for competition among food manufacturers (Schmalensee 1978). Moreover, I show that the importance of examining and modelling tacit coordination in retail competition.

For consumers, much of the previous animal welfare literature has estimated the likely consumer welfare loss as a result of the transition. Allender and Richards (2010), Lusk (2019), Oh and Vukina (2022) estimate consumer welfare loss as non–cage-free egg purchasing consumers either switch to cage-free eggs or no eggs as a result of the ban on sales of non–cage-free eggs. My model shows consumer welfare loss due to the same mechanism. Moreover, I highlight the private market outcome is not always the most efficient outcome as a cooperative outcome makes retailers better off and consumers worse off. Competition can lead to a more favorable outcome for consumers but worse outcome for retailers.

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