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Value Chain Analysis in the Canadian Egg Industry: Estimating the Bargaining Power of Farmers, Graders and Retailers in the Determination of Price

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Résumé/Abstract

Conventional egg production in Canada is supply managed and farm prices are determined by production costs. The context differs for specialty eggs, since the premium at the farm is individually negotiated between graders and farmers. Given that specialty egg production such as cage free or organic involved significant farm investment in fixed cost, it is of interest to assess potential bargaining power in the value chain, especially given significant commitments from retail store and fast food restaurant to move exclusively to cage free eggs in the next few years. This paper assesses theoretically and empirically the bargaining power of the value chain stakeholders (producers, graders and retailers) for specialty eggs and identifies the actor that benefit most. Five provinces are considered in our analysis, namely, Quebec, Ontario, Alberta, Saskatchewan and British Columbia. A theoretical model of joint profit maximization and price adjustment is developed and estimation is done to compare the bargaining power of the different actors of the value chain. The results show that the bargaining power of downstream actors is greater than the power of producers in most provinces and for most market.

Mots clés/Keywords: Bargaining power; Value chain; Market uncertainty; Specialty eggs

Codes JEL/JEL Codes: C22; L13; L19; Q13

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1 Introduction

In a recent issue, *Poultry Science (volume 90, issue 1, January 2011)* published several articles on the egg industry and especially on its main trends. From this series, it appeared that the sustainability of eggs production and animal welfare are central concerns of consumers, and these trends affect all of the stakeholders of the egg value chain. One of the fundamental changes affecting the sector concerns the modes of production, including a variety of housing systems ranging from conventional cages to free range (FPOQ 2014). This changing market behavior has led to the development of specialty eggs with certain attributes, such as nutriment enrichments of eggs and higher level of animal welfare and environmental standards (MAPAQ 2004, FPOQ 2015-2016). The share of specialty eggs in the quantity marketed is becoming increasingly important, 13 % in 2014 (FPOQ 2014).

In Canada, the egg production system is under supply management policy. The prices received by producers of conventional eggs are determined by Marketing Boards, based on the production cost. For specialty eggs, production premiums are negotiated directly between producers and graders. The latter negotiate the sale of their products with retailers and processors. The wholesale prices received by the graders are the result of these negotiations. This article seeks to examine the bargaining power of producers, graders and retailers in the Canadian egg production chain, focusing on specialty egg production. Our study is innovative in two ways. First, to the best of our knowledge, it is the first that integrates uncertainty arising from substitutability between the same products but with different attributes while analyzing theoretically the bargaining power within a supply chain. Second, we empirically analyze the Canadian egg sector while considering possible substitutability between conventional and specialty eggs. We provide empirical results of the relative bargaining power of producers and downstream of production at the Canadian and provincial levels. Although this study focuses on the egg sector, the theoretical and empirical approaches can be applied to a number of other agricultural products being perishable and having specific attributes that introduce, from consumers' standpoint, substitutability between products.

While the non-competitive behavior of processors and retailers is well known (Rogers and Sexton 1994; Anders 2008), two eggs grading companies (graders) share 95% of the market (FPOCQ, 2014). This high level of concentration can lead to increased market power and, consequently, to its inefficiency (Swinnen and Vandeplas, 2010; Swinnen and Vandeplas 2014; Levins 2001 and 2002; Banker et al., 2011). The concentration of markets, the perishability of agricultural products and the specificity of the relationship between actors in an agricultural sector are the main sources of buyers' market power in agriculture (Hueth and Marcoul, 2003; Swinnen and Vandeplas, 2010).

Few theoretical or empirical studies have been conducted to investigate the exercise of bargaining power in the pricing mechanism in agri-food value chains. Schroeter et al. (2000) evaluated the market power in pricing between sellers and buyers in the US wholesale beef market. Assuming a market structure characterized by a high degree of concentration of sellers and buyers, they used a bilateral oligopoly model. Truett and Truett (1993), Devadoss and Cooper (2000), and Dasgupta and Devadoss (2002) developed theoretical models of bilateral monopoly, assuming a market structure consisting of a single seller and a single buyer, where the seller produces a necessary input for the buyer's production. Devadoss and Cooper (2000) used the joint profit maximization strategy integrating bargaining powers as a mechanism for determining the equilibrium price. They derived a dynamic model of price adjustment based on the bargaining power of stakeholders. Dasgupta and Devadoss (2002) analyzed long-term cooperative contracts with unequal bargaining power. The two parties negotiate to determine prices and quantities by optimizing an objective function that considers profits and bargaining power. Using the same model, Gervais and Devadoss (2006) analyzed the chicken industry in Ontario, assuming that live chicken pricing is determined through a bargaining mechanism among Ontario chicken producers. Our paper contributes theoretically and empirically to research on bargaining power in agri-food value chains. In contrast to Gervais and Devadoss (2006), our paper theoretically considers the uncertainty of the market. Empirically, the autoregressive distributed lag (ARDL) model approach of Pesaran, Shin and Smith (2001) and non-stationary heterogeneous panel ARDL models are adopted. These econometric models are more robust than the regular price adjustment models of Engle and Granger (1987) and Johansen (1988), and in addition, ARDL models are more adapted to small sample of data.

The remainder of this paper is as follows. The next section presents the theoretical model followed by the presentation of the data and the results of the empirical estimates. Then, the results are discussed, while the final section presents the conclusion, implications and recommendations.

2 Theoretical model: Analysis of the value chain of egg consumption

2.1 Consumer choice of eggs in the retail market

Let Q_s be the quantity of specialty eggs supplied by retailers at price p_s. Consumers also have access to conventional eggs sold at price p_c, with $p_c < p_s$. The substitutability between the two types of products is high. Therefore, the choice of consumers is uncertain, which does not guarantee the purchase of the entire quantity Q_s at the premium price set by the retailer. Since the product is highly perishable, it must be sold as soon as possible; therefore, retailers must lower price p_s to price p_s^* with $p_c \leq p_s^* < p_s$ to sell the remainder of quantity Q_s^*. With this market structure, once the supply is set, there is a probability λ of selling to consumers the total quantity Q_s at premium price p_s, and (1-λ) is the probability of selling part γQ_s at price p_s and the remainder $(1-\gamma)Q_s$ at price p_s^* with $0 < \gamma < 1$. This uncertainty in the retail market, which is a source of demand disruption, can affect retailers' profitability. According to Qi et al. (2004), the supply of the product on the market depends on the behavior of demand in the previous period; therefore, the disruption of demand will affect the supply to the next period. Indeed, retailers fully support market risk if the decisions are decentralized (individual profit maximization). In contrast, if the decisions are centralized, the risk is shared with the other stakeholders in the supply chain. Therefore, if companies are able to vertically coordinate, they can increase the overall profit of the chain (Sexton et al., 2007).

2.2 Price negotiation strategy between retailers and graders: Maximizing profit seals

2.2.1 Retailers' behaviors

Retailers and graders negotiate during each period t the price at which retailers will purchase specialty eggs from graders. Let Q_s be the quantity of specialty eggs purchased by retailers at price p_t^c. We hypothesize that depending on market characteristics, retailers might not purchase the full number of specialty eggs offered by graders at premium prices. Then, let α be the probability that Q_s is bought at premium price p_t^c, $(1-\alpha)$ is the probability that ρQ_s is sold at the premium price, and $(1-\rho)Q_s$ is sold at the price of the conventional eggs p_t (with $\rho \in (0,1)$).

Let p_t^r be the consumer price of specialty eggs. Without loss of generality, we assume a constant proportion production technology. In other words, one egg produced at the farm generates one egg classified and one egg sold at the retail level. In addition to the price of eggs, retailers incur additional production costs (c_t^r), including transport, service and storage costs. Specialty eggs purchased from graders by retailers at the price of conventional eggs are sold on the retail market at the price of conventional eggs p_t^{rc}. This assumption implies that retailers cannot sell specialty eggs purchased from graders at conventional egg prices at the premium price of specialty eggs on the retail market.

Given the uncertainty in consumer choice between conventional eggs and specialty eggs and their sensitivity to prices, the total sale of specialty egg amount ρQ_t^s offered is uncertain. Let us define by λ the probability that this quantity is entirely sold at premium price p_t^r, (1-λ) is the probability that the share γ of the quantity ρQ_t^s is sold at premium price p_t^r , and ($(1-\gamma)\rho Q_t^s$) is sold at reduced price ap_t^r with $p_t \leq ap_t^r < p_t^r$, $0 < a < 1$ and $0 \leq \gamma \leq 1$. The expected revenue and cost are:

$$E(RT_t^r) = \lambda\rho p_t^r Q_t^s + (1-\lambda)[\gamma\rho p_t^r Q_t^s + (1-\gamma)\rho a p_t^r Q_t^s] + (1-\rho)p_t^{rc}Q_t^s \quad (1)$$

$$E(CT_t^r) = \alpha p_t^c Q_t^s + (1-\alpha)[\rho p_t^c Q_t^s + (1-\rho)p_t Q_t^s] + c_t^r Q_t^s \quad (2)$$

The expected profit of retailers is:

$$\begin{aligned} E(\Pi_t^r) &= [\lambda\rho p_t^r + (1-\lambda)[\gamma\rho p_t^r + (1-\gamma)\rho a p_t^r] + (1-\rho)p_t^{rc}]Q_t^s \\ &\quad - [\alpha p_t^c + (1-\alpha)[\rho p_t^c + (1-\rho)p_t] + c_t^r]Q_t^s \\ &= \left[\left(\lambda\rho + (1-\lambda)(\gamma\rho + (1-\gamma)\rho a)\right)p_t^r + (1-\rho)p_t^{rc}\right]Q_t^s \\ &\quad - [(\alpha + (1-\alpha)\rho)p_t^c + (1-\alpha)(1-\rho)p_t \\ &\quad + c_t^r]Q_t^s \end{aligned} \quad (3)$$

2.2.2 Behavior of graders

Graders purchase quantity Q_s of specialty eggs from producers at the price of p_t^p. The producer price is set through negotiation between graders and specialty eggs farmers. Graders and retailers negotiate the selling prices of the final products of the graders. The premium selling price p_t^c is determined by this trading mechanism. We assume a constant transport and services marginal cost (s_t). The expected revenue and cost during period *t* are given by:

$$E(RT_t^c) = \alpha p_t^c Q_t^s + (1-\alpha)(\rho p_t^c + (1-\rho)p_t)Q_t^s \tag{4}$$

$$E(CT_t^c) = \left(p_t^p + s_t\right)Q_t^s \tag{5}$$

Thus, the expected profit of the graders is given by the following expression:

$$E(\Pi_t^c) = E(RT_t^c) - E(CT_t^c)$$

$$E(\Pi_t^c) = [(\alpha + (1-\alpha)\rho)p_t^c + (1-\alpha)(1-\rho)p_t]Q_t^s - \left(p_t^p + s_t\right)Q_t^s \tag{6}$$

Given that the market depends on a small number of intermediaries and retailers, that products are highly perishable, and that storage opportunities are limited, Hueth and Marcoul (2003) suggested that there are number of specific relationships between the actors. As a result, individual production decisions (prices and quantities) within the supply chain are more likely to disrupt activities and increase risk of losses. Thus, the strategy of centralization of production decisions would be the best strategy for improving profit and sharing risk between actors. The sum of equation (3) and equation (6) yields the expected joint profit for graders and retailers:

$$\begin{aligned} E(\Pi_t^{r+c}) = {} & \left[\left(\lambda\rho + (1-\lambda)(\gamma\rho + (1-\gamma)\rho a)\right)p_t^r + (1-\rho)p_t^{rc}\right]Q_t^s \\ & - \left(p_t^p + c_t^r + s_t\right)Q_t^s \end{aligned} \tag{7}$$

The maximization of this joint profit leads to several equilibria (Truett and Truett, 1993). In this context, the actors first determine the price of the product (Gervais and Devadoss, 2006). Because eggs are highly perishable, the two stakeholders will end up with a unique result in their price negotiation (Pouliot and Larue, 2012). The equilibrium price thus depends on the level of bargaining power of the producers and graders.

2.2.3 Graders' price dynamic adjustment model based on the bargaining power of graders and retailers

We use the dynamic price adjustment mechanism, which includes trading continuity at each period between the relevant links, developed by Devadoss and Cooper (2000) and used by Gervais and Devadoss (2006).[4] This price adjustment mechanism is represented by the following equation (Devadoss and Cooper, 2002; Gervais and Devadoss, 2006):

$$\Delta p_t^c = \xi \, \mathrm{E}(\Pi_t^r/\Omega_{t-1}) - \delta \, \mathrm{E}(\Pi_t^c/\Omega_{t-1}); \, \xi, \delta > 0 \tag{8}$$

where ξ and δ capture the bargaining power of retailers and graders, respectively, and Ω_{t-1} represents the information on market available at period *t*.[5] The equilibrium will be reached when $\Delta p_t^c = 0$, that is, when the exercise of bargaining powers results in an effective Pareto solution defined by the equality of weighted profit requirements of their respective bargaining powers ($\xi \, \mathrm{E}(\Pi_t^r/\Omega_{t-1}) = \delta \, \mathrm{E}(\Pi_t^c/\Omega_{t-1})$). Substituting expressions of expected profits (equations (3) and (6)) in equation (8) yields:

$$\begin{aligned}\Delta p_t^c = \ & \xi \mathrm{E}\big(\big[\big(\lambda\rho + (1-\lambda)(\gamma\rho + (1-\gamma)\rho a)\big)p_t^r + (1-\rho)p_t^{rc}\big]Q_t^s \\ & - [(\alpha + (1-\alpha)\rho)p_t^c + (1-\alpha)(1-\rho)p_t + c_t^r]Q_t^s /\Omega_{t-1}\big) \\ & - \delta \mathrm{E}\big([(\alpha + (1-\alpha)\rho)p_t^c + (1-\alpha)(1-\rho)p_t]Q_t^s \\ & - \big(p_t^p + s_t\big)Q_t^s /\Omega_{t-1}\big)\end{aligned} \tag{9}$$

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[4] Pouliot and Larue (2012) used static Nash models to determine the equilibrium price and quantity.

[5] As in Gervais and Devadoss (2006), if retailers have greater bargaining power (ξ low), then they will cause a rapid decrease in the price paid to the grader if $\Delta p_t^c < 0(\xi \, \mathrm{E}(\Pi_t^r/\Omega_{t-1}) < \delta \, \mathrm{E}(\Pi_t^c/\Omega_{t-1}))$. Similarly, if graders have greater bargaining power, i.e., a small δ, then they can cause a rapid increase in the selling price of their products to retailers $\Delta p_t^c > 0(\xi \, \mathrm{E}(\Pi_t^r/\Omega_{t-1}) > \delta \, \mathrm{E}(\Pi_t^c/\Omega_{t-1}))$.

The dynamics of our price adjustment model suggest that the retail prices, the price of conventional eggs, and the production cost follow autoregressive processes:

$$\begin{aligned}
p_t^r &= \eta_r + \mu_r p_{t-1}^r + \varepsilon_t^r; \\
p_t &= \eta + \mu\, p_{t-1} + \varepsilon_t; \\
p_t^p &= \eta_p + \mu_p p_{t-1}^p + \varepsilon_t^p; \\
c_t^r &= \eta_c + \mu_c c_{t-1}^r + \varepsilon_t^c; \\
s_t &= \eta_s + \mu_s s_{t-1} + \varepsilon_t^s; \\
p_t^{rc} &= \eta_{rc} + \mu_{rc} p_{t-1}^{rc} + \varepsilon_t^{rc}
\end{aligned} \tag{10}$$

where ε_t^r,ε_t, ε_t^p, ε_t^c, ε_t^s and ε_t^{rc} respectively follow white noise processes of respective variances σ_r^2,σ^2, σ_p^2, σ_c^2, σ_s^2 and σ_{rc}^2. By substituting equation (10) into equation (9) under the equilibrium condition $\Delta p_t^c = 0$, the equilibrium price paid to graders by retailers is:

$$\begin{aligned}
p_t^{c*} = {} & \frac{\xi\big(\lambda\rho + (1-\lambda)(\gamma\rho + (1-\gamma)\rho a)\big)}{(\xi+\delta)(\alpha + (1-\alpha)\rho)}(\eta_r + \mu_r p_{t-1}^r) \\
& + \frac{\xi(1-\rho)}{(\xi+\delta)(\alpha + (1-\alpha)\rho)}(\eta_{rc} + \mu_{rc} p_{t-1}^{rc}) \\
& + \frac{\delta}{(\xi+\delta)(\alpha + (1-\alpha)\rho)}(\eta_p + \mu_p p_{t-1}^p) \\
& + \frac{\delta}{(\xi+\delta)(\alpha + (1-\alpha)\rho)}(\eta_s + \mu_s s_{t-1}) \\
& - \frac{\xi}{(\xi+\delta)(\alpha + (1-\alpha)\rho)}(\eta_c + \mu_c c_{t-1}^r) \\
& - \frac{(1-\alpha)(1-\rho)}{(\alpha + (1-\alpha)\rho)}(\eta + \mu\, p_{t-1})
\end{aligned} \tag{11}$$

The equilibrium price depends on the consumer price of specialty eggs, the farm price of specialty eggs, the consumer price of conventional eggs, the price of conventional eggs paid to graders and the additional production costs incurred by graders and retailers, bargaining powers (ξ, δ), and parameters of market uncertainty $(\lambda, \rho, \gamma, \alpha)$.

2.3 Egg Producer Price Negotiation Strategy Between Graders and Producers: Maximizing Joint Profit

2.3.1 Producer behavior

Specialty egg farmers negotiate the prices of their products with graders. In each period, the market exists if both parties agree in their negotiations to a given price and quantity. Let p_t^p and Q_t be the farmer price and the quantity produced at time *t*. Define by c_t the marginal cost of producing a specialty eggs. The expected profit of the producers at the period *t*, is:

$$\Pi_t^p = p_t^p (Q_t) Q_t - c_t Q_t \tag{12}$$

The joint profit of producers (equation (12)) and graders (equation (6)) is:

$$E\left(\Pi_t^{p+c}\right) = [(\alpha + (1-\alpha)\rho)p_t^c(Q_s) + (1-\alpha)(1-\rho)p_t - (c_t + s_t)]\, Q_t \tag{13}$$

In each period *t*, the producer price is determined through a negotiation between farmers and graders. The change in producer price in each period depends on the bargaining power of the two links in the chain.

2.3.2 Model of dynamic producer price adjustment based on bargaining powers of producers and graders

The dynamic producer price adjustment model is described by the following equation:

$$\Delta p_t^p = \zeta\, \mathrm{E}(\Pi_t^c/\Omega_{t-1}) - \psi \mathrm{E}(\Pi_t^p/\Omega_{t-1});\ \zeta, \psi > 0 \tag{14}$$

where ζ and ψ are parameters that respectively determine the bargaining power of graders and producers. Price adjustment occurs when producers and intermediaries succeed in their negotiations to satisfy the optimality condition. As before, we assume that the sales prices of intermediaries and the unit costs of production follow an autoregressive process (Gervais and Devadoss, 2006):

$$p_t^c = \beta_c + \mu_c p_{t-1}^c + \vartheta_t^c; c_t = \beta + \mu^c c_{t-1} + \vartheta_t \tag{15}$$

where ϑ_t^c and ϑ_t are white noise processes of variances ν_c^2 and ν^2, respectively. By substituting equations (6), (12) and (15) into equation (12) and applying the equilibrium bargaining power condition in the pricing mechanism $\left(\Delta p_t^p = 0\right)$, we obtain the equilibrium price p_t^{p*}:

$$p_t^{p*} = \frac{\zeta\,(\alpha + (1-\alpha)\rho)}{\zeta + \psi}\,(\beta_c + \mu_c p_{t-1}^c) + \frac{\zeta\,(1-\alpha)(1-\rho)}{\zeta + \psi}\,(\eta + \mu\, p_{t-1}) - \frac{\zeta}{\zeta + \psi}\,(\beta_s + \mu_s s_{t-1}) + \frac{\psi}{\zeta + \psi}\,(\beta + \mu^c c_{t-1}) \tag{16}$$

The equilibrium price depends on the bargaining powers and is the weighted sum of the price of graders reduced by their transportation and service costs and by the producers' cost of production (Gervais and Devadoss, 2006).

2.3.3 Effects of bargaining power and uncertainty of demand on producer prices

Using equations (11) and (16), marginal changes in the equilibrium price based on bargaining power are given by the following functions:

$$\frac{\partial p_t^{p*}}{\partial \zeta} = \frac{\psi}{(\zeta+\psi)^2}[(\alpha+(1-\alpha)\rho)(\beta_c+\mu_c p_{t-1}^c) + (1-\alpha)(1-\rho)(\eta+\mu\, p_{t-1}) - (\beta_s+\mu_s s_{t-1}+\beta+\mu^c c_{t-1})] > 0 \tag{17}$$

$$\frac{\partial p_t^{p*}}{\partial \psi} = \frac{\zeta}{(\zeta+\psi)^2}[-(\alpha+(1-\alpha)\rho)(\beta_c+\mu_c p_{t-1}^c) - (1-\alpha)(1-\rho)(\eta+\mu\, p_{t-1}) + (\beta_s+\mu_s s_{t-1}+\beta+\mu^c c_{t-1})] < 0 \tag{18}$$

Equations (17) and (18) describe the marginal effects of bargaining powers on the equilibrium price. The higher that the bargaining power of graders is (ζ small), the lower that the equilibrium price is, and the higher that the bargaining power of the producers (ψ small) is, the higher that the equilibrium price is.

$$\frac{\partial \mathrm{p}_{\mathrm{t}}^{\mathrm{p}*}}{\partial \mathrm{p}_{\mathrm{t}-2}^{\mathrm{r}}} = \frac{\partial \mathrm{p}_{\mathrm{t}}^{*}}{\partial \mathrm{p}_{\mathrm{t}-1}^{\mathrm{c}*}}\frac{\partial \mathrm{p}_{\mathrm{t}-1}^{\mathrm{c}*}}{\partial \mathrm{p}_{\mathrm{t}-2}^{\mathrm{r}}} = \frac{\zeta\xi}{(\zeta+\psi)(\xi+\delta)}\big(\lambda\rho+(1-\lambda)(\gamma\rho+(1-\gamma)\rho\mathrm{a})\big)\mu_{\mathrm{c}}\mu_{\mathrm{r}} \tag{19}$$

$$\left.\frac{\partial \mathrm{p}_{\mathrm{t}}^{\mathrm{p}*}}{\partial \mathrm{p}_{\mathrm{t}-2}^{\mathrm{r}}}\right|_{\lambda=1} - \left.\frac{\partial \mathrm{p}_{\mathrm{t}}^{\mathrm{p}*}}{\partial \mathrm{p}_{\mathrm{t}-2}^{\mathrm{r}}}\right|_{\lambda} = \Delta^{\mathrm{m}} = \frac{\zeta\xi\rho}{(\zeta+\psi)(\xi+\delta)}(1-\gamma)(1-\mathrm{a})(1-\lambda)\mu_{\mathrm{c}}\mu_{\mathrm{r}} \text{ si } 0<\lambda<1 \tag{20}$$

Equation (19) represents the effect of changes in the retail market price on the prices received by farmers. This effect depends on: the uncertainty parameter λ in the retail market, the uncertainty in the grader-retailer market which is captured by share ρ of the quantity of specialty eggs acquired by retailers at the price of conventional eggs, and the bargaining powers' parameters of the three links in the value chain.[6] Equation (20) explains the marginal gain or loss due to the uncertainty of the total sale of specialty eggs in the retail market. These results allow us to state two propositions.

Proposition 1: *Lower uncertainty of the retail market results in a higher marginal gain of producers. More specifically, an increase in the probability of selling the entire quantity of specialty eggs at the premium price would increase the marginal gain of producers.*

Proposition 2: *Lower uncertainty in the grader-retail market results in a weaker reduction of the producers' marginal gains.*

Propositions 1 and 2 derive from equations (19) and (20).

$$\frac{\partial \Delta^m}{\partial \zeta} > 0; \frac{\partial \Delta^m}{\partial \xi} > 0; \frac{\partial \Delta^m}{\partial \psi} < 0 \; et \; \frac{\partial \Delta^m}{\partial \delta} < 0$$

These results suggest that the greater that the bargaining power of sellers (sellers) is, i.e., ζ and ξ (ψ and δ low), the lower (higher) that the loss due to demand disruption is. The intuition is that if the sellers have strong bargaining power, they will cause a price increase. However, given the perishability of the product, buyers will demand a lower premium price given the disruptions in demand of previous periods; otherwise, the market does not exist. Figure 1 summarizes the model.

[6] The proposition 1 links the retail to the farm, when in fact it is not the case in the short term, because the graders act as a buffer. However, in the long run one might expect that if the grader gets stuck with a bunch of eggs that he paid specialty but sold as conventional, the next contract, he will pay less the farmer to cover his risk.

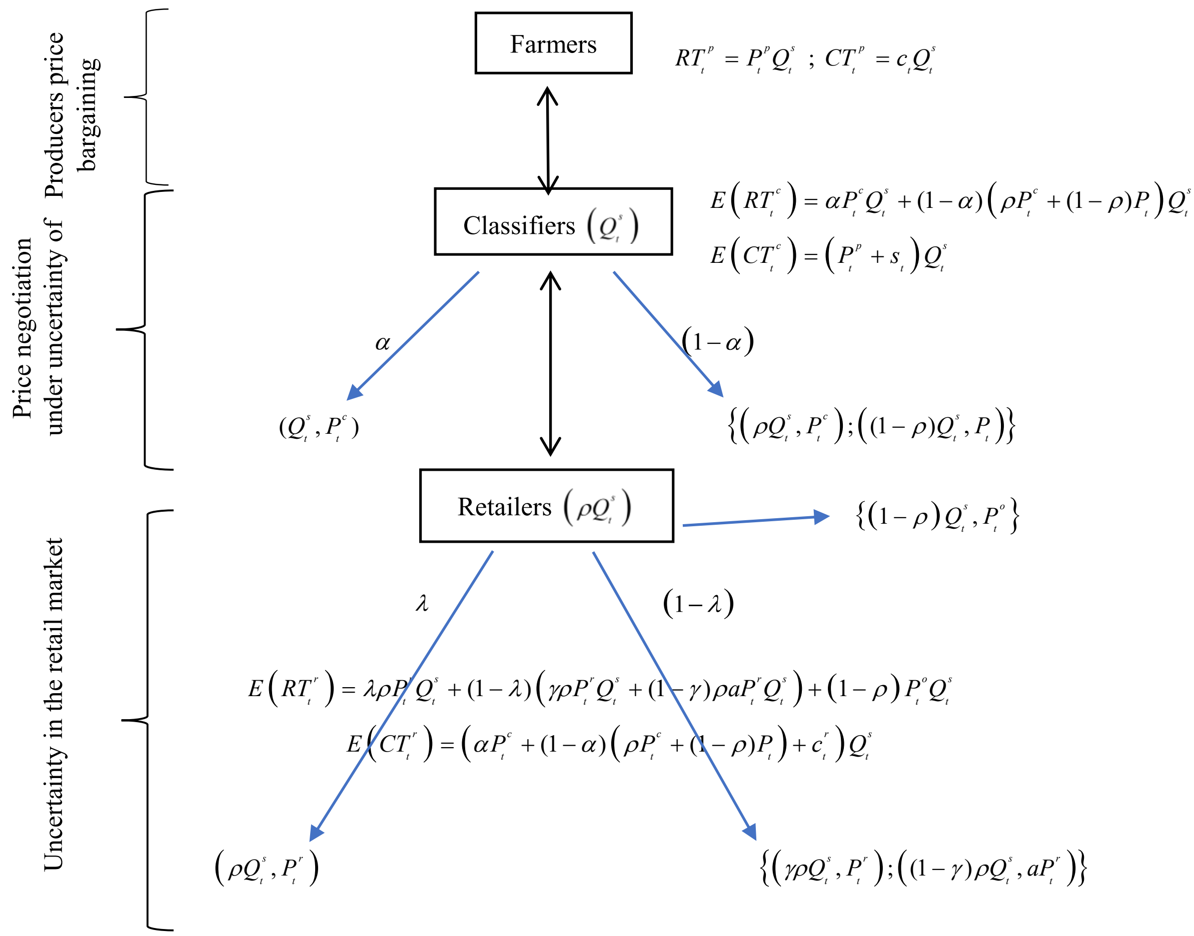


Figure 1. Theoretical diagram of the value chain

3 Empirical approach and data

Our empirical model focuses on the table egg industry in Canada. However, the middle segment (the graders) is highly concentrated creating data confidentiality issues. For example, in Quebec, two companies (Groupe Nutri and Burnbrae Farms) share 95% of the market in egg classification (MAPAQ, 2014). The empirical application thus concerns the two remaining segments of the value chain. We assume that producers of specialty eggs sell directly to retailers under the uncertainties of retailers. We also assume that producers sell all of their production to retailers at the premium price. In contrast, retailers face uncertainty about the sale of all of their specialty eggs at premium prices to consumers because of the characteristics of the market. This context is thus equivalent to that modeled above between producers and graders. Under this condition, the profit of the downstream of production is:

$$E(\tilde{\Pi}_t^r) = [(\tilde{\lambda} + (1 - \tilde{\lambda})\tilde{\rho})p_t^r + (1 - \tilde{\rho})(1 - \tilde{\lambda})p_t^{rc}]Q_t^s - [p_t^p + c_t^r]Q_t^s \qquad (21)$$

with $\tilde{\lambda}$ the probability that downstream of production will sell the whole quantity Q_t^s at the premium price p_t^r and $(1 - \tilde{\lambda})$ the probability that only a part $(\tilde{\rho}Q_t^s)$ will be sold at the premium price p_t^r and the rest $(1 - \tilde{\rho})Q_t^s$ at the price of conventional eggs p_t^{rc}. By substituting the expression of the graders' profit for this retailers' profit expression in equation (14) of market equilibrium and by applying the equilibrium condition $\Delta\tilde{p}_t^p = 0$, we obtain:

$$p_t^{p*} = \frac{\tilde{\zeta}\,(\tilde{\lambda} + (1 - \tilde{\lambda})\tilde{\rho})}{\tilde{\zeta} + \tilde{\psi}}\,(\beta_c + \mu_c p_{t-1}^r) + \frac{\tilde{\zeta}\,(1 - \tilde{\lambda})(1 - \tilde{\rho})}{\tilde{\zeta} + \tilde{\psi}}\,(\eta + \mu\, p_{t-1}) - \frac{\tilde{\zeta}}{\tilde{\zeta} + \tilde{\psi}}\,(\beta_s + \mu_s s_{t-1}) + \frac{\tilde{\psi}}{\tilde{\zeta} + \tilde{\psi}}\,(\beta + \mu^c c_{t-1}) \qquad (22)$$

Where $\tilde{\zeta}$ and $\tilde{\psi}$ represent the bargaining power parameters of the producer price between retailers (buyers) and producers (sellers), respectively. Equation (22) is estimated to obtain the bargaining power of each link in the context of uncertainty in the retail market.

3.1 Reduced model

The data provided on the premium margins of specialty eggs are confidential, and to produce this model, we estimate the reduced form of equation (22), which allows us to guarantee this confidentiality of the data while obtaining the parameters of bargaining power of the different actors of the value chain.

The estimation of this model requires preliminary tests to examine the validity of this linear relationship between the variables. To avoid a fallacious regression, we perform the Augmented Dickey Fuller (1979, 1981) and Phillips Perron (1988) stationarity tests. Tables A1 and A2 (see annexes) present the results of these tests. The series are stationary in the first difference (integrated of order 1); therefore, there is a possible relation of cointegration (long-term relation) between the variables in level.

In addition, the stationarity tests made on the prices of specialty eggs p_t^r, of conventional eggs p_t and of the various cost variables imply that $\mu_c = \mu = \mu_s = \mu^c = 1$ (Gervais and Devadoss, 2006). With:

$$Ɣ_1 = \frac{\tilde{\zeta}\left(\tilde{\lambda} + (1-\tilde{\lambda})\tilde{\rho}\right)}{\tilde{\zeta} + \tilde{\psi}}; Ɣ_2 = \frac{\tilde{\zeta}\,(1-\tilde{\lambda})(1-\tilde{\rho})}{\tilde{\zeta} + \tilde{\psi}}; Ɣ_3 = -\frac{\tilde{\zeta}}{\tilde{\zeta} + \tilde{\psi}}; Ɣ_4 = \frac{\tilde{\psi}}{\tilde{\zeta} + \tilde{\psi}}$$

Equation (22) becomes:

$$p_t^{p*} = Ɣ_0 + Ɣ_1 p_{t-1}^r + Ɣ_2 p_{t-1} + Ɣ_3 s_{t-1} + Ɣ_4 c_{t-1} + \nu_t$$

We have $Ɣ_3 = Ɣ_4 - 1$. By substituting $Ɣ_3$ for its expression in the equation of equilibrium (equation 16) and considering the transformations performed previously, we get the following equation:

$$(p_t^{p*} + s_t) = Ɣ_0 + Ɣ_1 p_{t-1}^r + Ɣ_2 p_{t-1} + Ɣ_4 (c_{t-1} + s_{t-1}) + \nu_t \qquad (23)$$

where $(p_t^{p*} + s_t)$ represents the retailers total cost (CTD), $(c_{t-1} + s_{t-1})$ the sum (SC) of the farm cost; the retailer's residual cost per dozen eggs, p_{t-1}^r is the premium price of a dozen specialty eggs in the retail market, and v_t is the error term of zero mean and variance σ^2. The estimated parameters of equation (23) provide the link that yields the bargaining power in the specialty egg pricing mechanism by computing the bargaining power ratio (BPR):

$$BPR = \frac{\widehat{\gamma}_4}{1 - \widehat{\gamma}_4} = \frac{\widehat{\widehat{\Psi}}}{\widehat{\widehat{\zeta}}}$$

If the bargaining power ratio is 1, the producers and the downstream of production actors (graders/retailers) have the same bargaining power in the producer price-setting mechanism and therefore share equitably the profits from the production of specialty eggs. A BPR ratio greater than 1 suggests that the downstream of production has greater bargaining power than producers and benefits more from the production of specialty eggs than the producers.

Equation (24) represents the long-term relationships of retailer total cost (CTD), specialty egg retail price (SPR), conventional eggs retail price (RP) and the sum of the marginal farm cost and the residual retail cost (SC). Different econometric approaches make it possible to test the existence of this long-term relationship. The Engels and Granger approach is adapted for two-variable models (Engels and Granger, 1987). Johansen's (1988) approach makes it possible to test the existence of the cointegration relation for more than two variables. For these two approaches, the variables must be integrated in the same order d (I (d)). Moreover, Pesaran, Shin, and Smith (2001) developed a more sophisticated approach than the two previous ones to test for the existence of the level relationship between a dependent variable and a set of explanatory variables when it is uncertain whether explanatory variables are stationary in trend or first differences. The proposed tests are based on standard Fisher and Student statistics, which are used to test the significance of delayed levels of variables in a univariate equilibrium correction mechanism (Pesaran et al., 2001). The null hypothesis of this test is that there is no level relationship between the variables, regardless of whether the variables are stationary in level (I (0)) or first difference (I (1)). The critical values of the asymptotic statistics are provided for both cases in which the variables are I (0) and I (1). Both values thus define the limits of critical values for each confidence level. The autoregressive distributed lag (ARDL) model is used to simultaneously estimate short- and long-term relationships and to test the statistical significance of the cointegration relationship. The ARDL functional form of the model (equation (24)) is as follows:

$$\begin{aligned}\Delta \mathrm{CTD}_t = {} & \gamma_0 + \sum_{i=1}^{P} \Gamma_i^{ctd} \Delta CTD_{t-i} + \sum_{i=1}^{P} \Gamma_i^{r} \Delta p_{t-i}^{r} + \sum_{i=1}^{P} \Gamma_i \Delta p_{t-i} \\ & + \sum_{i=1}^{P} \Gamma_i^{sc} \Delta SC_{t-i} + \gamma_1 p_{t-1}^{r} + \gamma_2 p_{t-1} + \gamma_3 s_{t-1} + \gamma_4 c_{t-1} \\ & + h_t \end{aligned} \qquad (24)$$

The cointegration relationship between variables allows us to derive our bargaining power parameters from the estimated parameters of the long-term relationship. The ARDL non-stationary heterogeneous panel model is investigated to estimate bargaining power at the Canadian level. In doing so, we control for the province effect while estimating the model. The ARDL panel model is expressed as:

$$\Delta CTD_{j,t} = \gamma_j + \sum_{i=1}^{P} \Gamma_i^{ctd} \Delta CTD_{j,t-i} + \sum_{i=1}^{P} \Gamma_i^{r} \Delta p_{j,t-i}^{r} + \sum_{i=1}^{P} \Gamma_i \Delta p_{j,t-i} + \sum_{i=1}^{P} \Gamma_i^{sc} \Delta SC_{j,t-i}$$
$$+ \varphi_j \left(CTD_{j,t-1} - \gamma_1 p_{j,t-1}^{r} - \gamma_2 p_{j,t-1} - \gamma_3 s_{j,t-1} - \gamma_4 c_{j,t-1} \right) + h_{j,t} \tag{25}$$

where *j* is the province of Canada in the case of panel estimation, and is $\boldsymbol{\varphi_j}$ the adjustment speed.

3.2 Data description

In contrast to the two variables model estimated by Gervais and Devadoss (2006), considering uncertainty in each value chain, the market allows us to account for the effect of the price of conventional eggs in our model. The introduction of conventional egg price captures the effect of demand disruption on the producer price for specialty eggs.

We estimate equations (24) and (25) for omega-3 and cage free eggs.[7] Information on specialty eggs production costs is not produced and is important to our analysis. Thus, the choice of omega-3 and cage free eggs is conditioned on the availability of information in the literature to infer their production costs (Sumner et al., 2011, Tamini, Doyon and Zan, 2018). The omega-3 eggs production system is the same as that for conventional eggs, except for dietary modification. Conversely, the production of cage free eggs requires a complete production system restructuring and therefore involves important investments. As a result, assets become more specific for cage free eggs. Therefore, it is possible to expect that the bargaining power of the upper link is greater in the cage free eggs sector

[7] In Quebec in 2010, omega-3 eggs accounted for 8.2% of eggs marketing quotas, while cage free eggs accounted for 0.5% of quotas. In total, specialty eggs (excluding brown eggs) accounted for 12.6% of marketing allowances (FPOCQ, 2011). EFC (2008), cited by Huang (2013), showed that in Canada, omega-3 eggs accounted for 12% of demand, and specialty eggs accounted for 3.5%.

than in the omega-3 eggs sector. Five provinces (Quebec, Ontario, Alberta, Saskatchewan and British Columbia) are selected based on their share of eggs production in Canada and the availability of data. They share more than 82% of the production quotas at the federal level. Quebec holds 19.73% of production quotas, Ontario 36.06%, British Columbia 12.06%, Alberta 9.70%, and Saskatchewan 4.52% (Eggs Framers of Canada, 2015).

Price data for omega-3 and cage free eggs are available from the Agriculture and Agri-food Canada (AAC) Web site[8]. Producer prices were built from the producers of conventional eggs prices and marketing margins for specialty eggs relative to conventional eggs prices[9] (difference between the specialty eggs price and the conventional eggs price) obtained from major specialty eggs producers. Omega-3 and cage free production costs were inferred from the production costs of conventional eggs obtained at the eggs farmers' Web site. Sumner et al. (2011) calculated cage free and conventional eggs production costs in the United States. The authors used the main cost items (food, housing, work, chicks, and others) in their calculations. According to Tamini et al. (2018), these data were used to calculate the ratio of production costs between specialty and conventional eggs. This ratio indicator is used to extrapolate the costs of each product over the study period (see Table A3 in the appendix).

A ratio indicator between farm price and the retailer cost for eggs (producer price/retailer cost) published by the US Department of Agriculture for the period of 1965-1994 (Dunham

[8] http://www.agr.gc.ca/fra/industrie-marches-et-commerce/information-sur-les-marches-par-secteur/volaille-et-ufs/information-sur-le-marche-de-la-volaille-et-des-oeufs-industrie-canadienne/prix/?id=1384971854418#oeufs Accessed April 24, 2018

[9] Producer prices and production costs for conventional eggs are obtained from the Eggs Farmers of Canada Web site: http://www.producteursdoeufs.ca/information-sur-le-marche-tables/#tableau-2. Accessed April 24, 2018

1991, Elitzak 1995) is used to derive the cost of retailers. This indicator is extrapolated until 2017, using the results of the linear regression analysis, explaining the ratio as a function of time.[10] The total retailer cost (CTD) for a basket of a dozen eggs is defined as the sum of the farm price and the costs of transportation, energy and marketing service (residual cost). Thus, the residual cost is obtained by knowing the ratio of the farm price and the total cost of the retailers (farm price + residual cost). According to our extrapolation, the average ratio is 0.61 over the 2009-2017 period. The monthly price and production cost data covering the period from January 2009 to June 2017 are used for our empirical analysis. Tables 1 and 2 present the descriptive statistics of the variables considered.

Table 1 : Descriptive statistics of conventional egg prices

Provinces	Variables	Mean	SD	Obs.
Québec	RPO	2.945	0.245	102
Ontario	RPO	2.621	0.227	102
Alberta	RPO	2.466	0.262	102
Saskatchewan	RPO	2.522	0.287	102
Colombie Britannique	RPO	2.620	0.211	102

Notes: Standard Deviation (SD), Conventional egg retail price (RPO)

[10] This extrapolation method is used because of the strong linear relationship between this ratio and time (a linear correlation coefficient of -0.627 and an adjusted R-squared of 95.27%).

Table 2: Descriptive statistics of costs and prices of specialty eggs

Provinces	Variables	Mean	SD	Obs.
		Omega 3 eggs		
	CTD	3.091	0.185	102
Quebec	SC	3.290	0.201	102
	RPD	3.717	0.363	102
	CTD	3.067	0.214	102
Ontario	SC	3.269	0.252	102
	RPD	3.903	0.235	102
	CTD	3.220	0.287	102
Alberta	SC	3.427	0.263	102
	RPD	3.982	0.175	102
	CTD	3.161	0.285	102
Saskatchewan	SC	3.390	0.306	102
	RPD	3.903	0.215	102
	CTD	3.331	0.267	102
British Columbia	SC	3.539	0.300	102
	RPD	3.991	0.157	102
		Free-range eggs		
	CTD	3.307	0.198	102
Quebec	SC	3.717	0.227	102
	RPD	4.594	0.551	102
	CTD	3.284	0.231	102
Ontario	SC	3.703	0.275	102
	RPD	4.751	0.345	102
	CTD	3.339	0.311	102
Alberta	SC	3.867	0.294	102
	RPD	4.591	0.302	102
	CTD	3.292	0.305	102
Saskatchewan	SC	3.829	0.347	102
	RPD	2.522	0.287	102
	CTD	3.468	0.270	102
British Columbia	SC	3.995	0.340	102
	RPD	5.132	0.220	102

Notes: Standard Deviation (SD), Total retail cost (CTD), Specialty egg retail price (RPD), Conventional egg retail price (RPO), Marginal farm cost + residual retail cost (SC)

4 Empirical results and discussion

4.1 Empirical results

4.1.1 Estimation results

Tables 3 and 4 present respectively the results of the estimates of long-term relationships and the validity tests of these relationships for omega-3 and cage free eggs. If the empirical Fisher statistic (F-statistic) is greater than the critical value corresponding to the case in which all of the variables are I (1), then there is a level relationship between the variables. In contrast, if the F-statistic is lower than the critical value corresponding to the situation of the stationary variables in level (I (0)), then there is no relationship between the variables. If the F-statistic is strictly in the range of the critical values, then it is impossible to conclude regarding the existence or not of the level relationship between the variables.

Table 3: ARDL cointegration test for omega 3 eggs

Variables	Quebec	Ontario	Alberta	Saskatchewan	British Columbia
lnRPD	-0.00729	-0.0359	0.218***	-0.0141	0.0778
	(0.00865)	(0.0223)	(0.0630)	(0.0569)	(0.0515)
lnSC	0.909***	0.765***	0.836***	1.082***	0.891***
	(0.0165)	(0.0252)	(0.0313)	(0.0413)	(0.0208)
lnRPO	0.0823***	0.153***	0.171***	-0.0654*	0.0233
	(0.0112)	(0.0220)	(0.0274)	(0.0353)	(0.0245)
Constant	-0.0325**	0.116***	-0.315***	-0.0904*	-0.0529
	(0.0151)	(0.0257)	(0.0620)	(0.0532)	(0.0481)
Observations	100	101	101	101	101
R^2 ajusted	0.804	0.656	0.792	0.656	0.742
Adjustment speed	-0.498***	-0.225***	-0.179***	-0.248***	-0.202***
	(0.078)	(0.062)	(0.054)	(0.059)	(0.061)
Test ARDL (F-statistic)	10.350***	3.593	3.191	5.230**	4.114*
Conclusion	Cointegrated	Inconclusive	Inconclusive	Cointegrated	Cointegrated

ARDL bounded test critical values			
Seuil de confiance	1 %	5 %	10 %
Intervalle	[I (0); I (1)]	[I (0); I (1)]	[I (0); I (1)]
Valeurs critiques	[4.29; 5.61]	[3.23; 4.35]	[2.72; 3.77]

Notes: ** *p-value* < 0.05, *** *p-value* < 0.01, * *p-value* < 0.1, standard error (). Total retail cost (CTD), Specialty egg retail price (RPD), Conventional egg retail price (RPO), Marginal farm cost + residual retail cost (SC)

For omega-3 eggs, the cointegration relationships between the variables are statistically significant in Quebec, Saskatchewan and British Columbia. In contrast, the results for Ontario and Alberta do not allow us to conclude whether this relationship exists. The F-statistics for the ARDL test for Quebec, Saskatchewan and British Columbia are statistically higher than the critical values I (1) corresponding, respectively, to the 1%, 5% and 10% confidence levels.

For cage free eggs, the results show that there is a linear level relationship between the variables in each of the five provinces. Indeed, the empirical statistics of the ARDL test (Table 4) are statistically higher than the critical value I (1) at the 5% significant level.

Table 4: ARDL cointegration relationship test for free-range eggs

Variables	Quebec	Ontario	Alberta	Saskatchewan	British Columbia
lnRPD	0.0195 (0.0104)	0.167^{***} (0.0308)	0.234^{***} (0.0299)	0.0163 (0.0487)	0.0581 (0.0504)
lnSC	0.716^{***} (0.0213)	0.440^{***} (0.0325)	0.800^{***} (0.0282)	0.927^{***} (0.0432)	0.751^{***} (0.0202)
lnRPO	0.238^{***} (0.0116)	0.335^{***} (0.0212)	0.210^{***} (0.0298)	0.0705 (0.0396)	0.163^{***} (0.0334)
Constant	-0.0294 (0.0173)	0.0291 (0.0242)	-0.424^{***} (0.0447)	-0.143^{**} (0.0552)	-0.0492 (0.0617)
Observations	100	101	101	102	98
R^2 ajusté	0.859	0.604	0.772	0.983	0.721
Vitesse d'ajustement.	-0.453*** (0.078)	-0.265*** (0.065)	-0.263*** (0.058)	-0.241*** (0.058)	-0.272*** (0.067)
Test ARDL (F-statistic)	8.766***	4.602**	5.941***	5.084***	4.366**
Conclusion	Cointegrated	Cointegrated	Cointegrated	Cointegrated	Cointegrated

Valeurs critiques du test ARDL			
Seuil de confiance	1 %	5 %	10 %
Intervalle	[I(0) I(1)]	[I(0) I(1)]	[I(0) I(1)]
Valeurs critiques	[4.29; 5.61]	[3.23; 4.35]	[2.72; 3.77]

Notes: ** *p-value* < 0.05, *** *p-value* < 0.01, * *p-value* < 0.1, standard error (). Total retail cost (CTD), Specialty egg retail price (RPD), Conventional egg retail price (RPO), Marginal farm cost + residual retail cost (SC)

As previously mentioned, the conventional eggs sector is under supply management. Moreover, even if they are limited, there is interprovincial trade, and since the cost and price data for conventional eggs have been used to construct some of our variables, it is possible that agricultural policy and inter-provincial trade could have an influence on the producer price for specialty eggs in different provinces. As a result, supply management policy and interprovincial trade could affect the bargaining power of producers and other parts of the chain. It is therefore important to estimate bargaining power by adopting the panel model to control for the potential effects of these factors.

Panel model results

We adopted three unit-root tests when making panel data analyses: the augmented Fisher Dickey Fuller (F-ADF) test, the null hypothesis of which is that all panels are non-stationary against at least one panel that is stationary; the Levin, Lin and Chu (2002) test (LLC test), the null hypothesis of which is that all the panels are non-stationary against the alternative, and all of the panels are stationary; and the test of Im, Pesaran and Shin (2003), which tests the same null hypothesis against the alternative that some of the panels are stationary. The unit-root tests results (see Table A4 in the appendix) show that all of the panels are stationary in first difference. The ARDL pool mean groups (ARDL-PMG), ARDL means group (ARDL-MG) and ARDL fixed effects (ARDL-FE) models are estimated, and the results are reported in Table 5. The ARDL-PMG model forces the long-term coefficients to be identical across the panels (provinces). The estimator of this model is efficient when the homogeneity assumption is verified (Blackburne and Frank, 2007). In contrast to this model, the ARDL-MG model assumes the heterogeneity of the long-term relationship between the panels. The fixed effects model (ARDL-FE) assumes that short- and long-term parameters are homogeneous across provinces (Blackburne and Frank, 2007). Hausman's test is performed to choose the best model.

Table 5: Results of the panel models (ARDL panel model)

Variables	Omega 3 eggs		
	ARDL-PMG	ARDL-MG	ARDL-FE
lnRPD	-0.015 (0.016)	0.200* (0.110)	-0.006 (0.034)
lnSC	0.937*** (0.025)	0.944*** (0.072)	0.956*** (0.058)
lnRPO	0.056*** (0.019)	-0.024 (0.071)	0.052 (0.057)
V-ajusted	-0.190*** (0.057)	-0.254*** (0.038)	-0.138*** (0.038)
	Model comparison: Hausman test		
ARDL-MG vs ARDL-PMG	Chi2(3) stat.	Prob>Chi2	Best specification
	3.62	0.305	ARDL-PMG
ARDL-PMG vs ARDL-FE	0.00	1.000	ARDL-PMG
	Free-range eggs		
	ARDL-PMG	ARDL-MG	ARDL-FE
lnRPD	0.018 (0.015)	0.097* (0.058)	0.032 (0.022)
lnSC	0.752*** (0.027)	0.815*** (0.093)	0.778*** (0.060)
lnRPO	0.206*** (0.020)	0.137* (0.073)	0.203*** (0.061)
V-ajusted	-0.193*** (0.054)	-0.267*** (0.031)	-0.144*** (0.035)
	Model comparison: Hausman test		
ARDL-MG vs ARDL-PMG	Chi2(3) stat.	Prob>Chi2	Best specification
	6.88	0.076	ARDL-MG
ARDL-PMG vs ARDL-FE	0.00	1.000	ARDL-PMG

Notes: ** *p-value* < 0.05, *** *p-value* < 0.01, * *p-value* < 0.1, standard error (). Total retail cost (CTD), Specialty egg retail price (RPD), Conventional egg retail price (RPO), Marginal farm cost + residual retail cost (SC)

The results of Hausman's test suggest that the ARDL-PMG model is more effective for omega-3 eggs, and the ARDL-MG model is better for cage free chicken eggs.

4.1.2 Bargaining power

Table 6 presents the results of the bargaining power ratios and the bargaining power equality tests between producers and downstream actors (aggregate of retailer and grader) for specialty eggs farm price determination. Downstream actors have the greatest bargaining power for cage free and omega-3 eggs in all five provinces except the province of Ontario, where producers have bargaining power only in the cage free eggs sector. This result is in line with Gervais and Devadoss (2006) who found that that chicken processor exercised greater bargaining power than chicken producers in Ontario.

Table 6: Retailers and Farmers bargaining power comparison in pricing mechanism

Provinces	Type of eggs	BPR	Student t-test *BPR = 1*	Conclusion
Canada (Panel)	Omega 3 eggs	14,87	293.20***	retailers
	Free-range eggs	4,41	11.46***	retailers
Quebec	Omega 3 eggs	9,942	20,60***	retailers
	Free-range eggs	2,516	33,28***	retailers
Ontario	Omega 3 eggs	3,260	24,43***	retailers
	Free-range eggs	0,786	4,26**	Farmers
Alberta	Omega 3 eggs	5,084	12,40***	retailers
	Free-range eggs	4,010	18,09***	retailers
Saskatchewan	Omega 3 eggs	infinite	5,31 **	retailers
	Free-range eggs	12,779	4,44**	retailers
British Columbia	Omega 3 eggs	8,171	16,82***	retailers
	Free-range eggs	3,022	38,32***	retailers

Notes: $RPN = \frac{\hat{\gamma}_4}{1-\hat{\gamma}_4} = \frac{\hat{\hat{\Psi}}}{\hat{\hat{\zeta}}}$, where $\hat{\gamma}_4$ is the SC coefficient, *** p-value < 1 %, ** p-value < 5% et * p-value < 10 %

4.2 Discussion

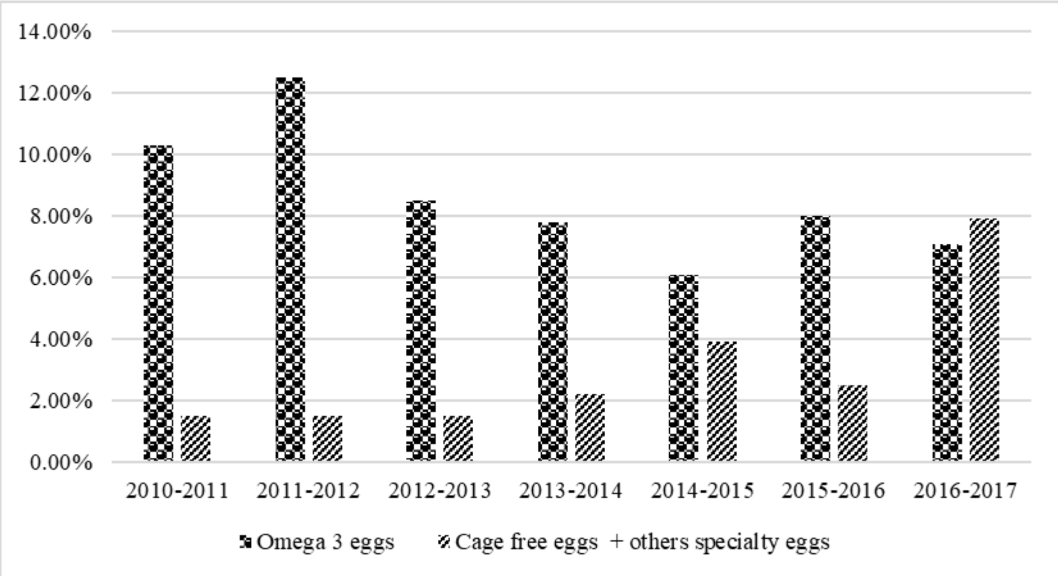
In sectors with strong asset specificity, one would expect from the hold-up theory a greater bargaining power. Thus, we would expect a greater bargaining power for buyers (downstream of production actors) for cage free eggs than for Omega-3 eggs. Our general results show that downstream actors have bargaining power in all cases (cage free and Omega-3) but for one exception (Table 6). However, results also indicate (Table 6) a greater bargaining power of downstream actors on Omega-3 eggs than for cage free eggs, as opposed to what asset specificity would predict. Given that producing Omega-3 eggs can be easily reversed, implies no permanent capital investments at the farm and has limited impact on cost of production, one might expect loose agreement between farmers and graders, as well as between graders and retailers. On the other hand, cage free eggs involved heavy capital investments at the farms and affect significantly cost of production. Therefore, the commitment between farmers and graders would imply formal contracts between farmers and graders, and tighter negotiation between graders and retailers. This could explain how downstream actors would gain more market power for Omega-3 eggs than for cage free eggs. This possible explanation has been confirmed by personal exchanges with professionals in the egg value chain[11].

This result is of importance in the context where Canadian consumers place a high value on the respect of animal health and animal welfare standards in the production system (MAPAQ, 2010). For instance, a survey conducted in 2013 on the perception of Quebec consumers showed that 83% of consumers were very or rather concerned about the well-being of animals intended for consumption, and more than half of Quebec consumers perceived the treatment of poultry as very bad or rather bad (MAPAQ, 2014). Several studies have shown that consumers are willing to pay premiums for specialty eggs in production systems that meet animal health and welfare standards (Goddard et al., 2007; Lu, 2013; Doyon et al., 2015; Doyon and Bergeron, 2015; Chen, 2017).

In addition, the cage free eggs and other specialty eggs sector is fast developing, as indicated in Figure 2. Because producers are not fully specialized in the production of cage

[11] One professional in Ontario related to production and one professional in Quebec related to grading.

free eggs, a strong influence of retailers on producer prices could lead to the lower farm entry from this growing market.



Source: Annual reports of Fédération des Poducteurs d'Oeufs de Quebec (FPOQ), http://oeuf.ca/la-fpoq/publication/)

Figure 2. Specialty egg market share in Quebec

A market solution for egg producers would be to increase their bargaining power by backward vertical integration (Acemoglu et al. 2010) or by signing forward contracts (Van Dick 1997; Soloh et al., 2009; Karantininis et al. 2010; Royer 2014). One should note that this backward vertical integration strategy is already observed with the important Canadian grader Nutri that is owned by Canadian egg producers[12]. Another solution would be to create a distinct cost of production for specialty eggs and to negotiate the farm price collectively, as the case for conventional eggs.

5 Conclusion

This article aimed to first analyze theoretically the bargaining power of the value chain for specialty egg in Canada. Little attention so far has been paid on how the value added of

[12] See at http://nutrigroupe.ca/fr/unites-affaires/nutri-oeuf/ . Accessed April 23, 2018.

specialty eggs has been distributed within the value chain. Although egg production in Canada is supply managed, the premium at the farm for specialty eggs is individually negotiated between graders and farmers. Given that specialty egg production such as cage free involved significant farm investment in fixed cost, it is of interest to assess potential bargaining power in the value chain, especially given significant commitments from retail store and fast food restaurant to move exclusively to cage free eggs in the next few years.

We innovate in using a joint profit maximization model that considers the uncertainties that exist at each level of the value chain within the egg supply chain. Thus, the bargaining power of producers, graders and retailers is analysed. The theoretical results indicate that the bargaining power of graders and retailers has negative effects on producer prices. Similarly, the analysis suggests that the less uncertainty that there is in the retail market, the lower that the marginal losses of producers are. This result is also obtained with the decrease in graders' uncertainty.

The model has then been tested empirically. Our empirical investigation is between producers and downstream of production actors (graders/retailers) due to the absence of data at the grader's level.

Our empirical investigation focuses on cage free eggs and omega-3 eggs in the five largest egg producing Canadian provinces (Quebec, Ontario, Alberta, Saskatchewan, British Columbia). The bounded cointegration test of the autoregressive distributed lag (ARDL) model was used to examine the validity of linear-level relationships between variables and to estimate our theoretical model. The results indicate that downstream of production actors have greater bargaining power than producer in all provinces for all products but one exception. This result suggests that prices received by producers are lower than prices resulting from a more competitive market. This in turn might reduce the interest from producers to enter cage free production.

Given our results, a market solution for egg producers would be to increase their bargaining power by backward vertical integration or by signing forward contracts. Another solution would be to create a distinct cost of production for specialty eggs and to negotiate the farm price collectively, as the case for conventional eggs.

Our study presents limitations due to the lack of data at the graders' level and the quality of the data on specialty eggs. Production costs and producer price data for specialty eggs do not exist yet and had to be derived from information provided by the literature and by conventional eggs production costs and conventional eggs prices. The results could be sensitive to data quality. It would of interest to replicate this empirical analysis when better data would be available to guide producers and decision makers in ensuring the sustainability of the specialty eggs sector.

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Appendix

Table A1: Production costs in $ per dozen eggs basket

Production cost items	Conventional eggs	Omega 3 eggs	Free-range eggs
Chicks	0.100	0.100	0.155
Feed	0.365	0.482	0.425
Labor	0.035	0.040	0.130
Housing	0.095	0.095	0.230
Other	0.159	0.159	0.110
Total cost	0.745	0.876	1.050
Cost ratio	1	1.176	1.409

Sources : Sumner et al. (2011), Tamini, Doyon and Zan (2018).

Table A2: Augmented Dickey Fuller (ADF) and Phillips Perron (PP) Test

Omega 3 eggs			In level		First difference	
Provinces	Variables	Lag	ADF	PP	ADF	PP
	lnCTD	1	-1.804	-3.013	-6.371***	-80.41***
Quebec	lnSC	2	-1.892	-3.311	-6.065***	-68.724***
	lnRPD	3	-2.847	-43.646***	-7.761***	-122.248***
	lnCTD	2	-1.93	-2.767	-5.118***	-72.169***
Ontario	lnSC	2	-1.839	-2.862	-5.131***	-75.000***
	lnRPD	4	-2.058	-34.219***	-5.850***	-102.972***
	lnCTD	2	-1.450	-1.446	-4.465***	-81.847***
Alberta	lnSC	2	-1.661	-2.004	-5.231***	-83.062***
	lnRPD	3	-1.483	-3.910	-6.463***	-125.768***
	lnCTD	2	-1.450	-1.480	-4.507***	-83.014***
Saskatchewan	lnSC	1	-1.211	-1.411	-6.491***	-92.295***
	lnRPD	3	-1.313	-4.632	-7.011***	-140.654***
	lnCTD	2	-1.410	-1.403	-4.495***	-81.933***
British Columbia	lnSC	2	-1.585	-1.432	-4.766***	-74.696***
	lnRPO	3	-0.919	-5.561	-6.009***	-124.315***

Notes: *, **, and *** represent respectively stationary at significant level of 10% , 5% and 1% threshold. Total retail cost (CTD), Specialty egg retail price (RPD), Conventional egg retail price (RPO), Marginal farm cost + residual retail cost (SC).