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Tariff-Rate Quota Liberalization in a Supply-Managed Industry

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Abstract : A supply management system governs Canada's poultry sector. Tariff Rate Quotas (TRQs), with prohibitive above-quota tariffs and low in-quota tariff, mimic import-quotas limit international competition in Canada's poultry market. The quota part of the TRQs is a minimum access commitment under international trade agreement that is defined as a fraction of domestic production. We show in a 3-stage game involving negotiations between retailers and processors and between processors and farms that increasing minimum access commitment under current trade agreements can produce Metzler effects with larger price increases observed at the farm and processing levels. Simulations based on 2008 data support the Metzler paradox and shed light on import license allocations between retailers and poultry processors in Canada.

Résumé: Le secteur de la volaille est soumis à une politique de gestion de l'offre. Des contingents tarifaires, avec des tarifs hors-quota prohibitifs et de faibles tarifs sur les importations à l'intérieur des contingents limitent la concurrence sur le marché canadien. Les contingents sont des accès minimum négociés dans le cadre d'ententes internationales qui sont spécifiés comme des fractions du marché interne. Par le biais d'un jeu à trois étapes, nous démontrons que des élargissements des accès minimum tels que spécifiés actuellement peuvent causer des effets Metzler, c'est-à-dire des augmentations de prix. Celles-ci sont plus élevées à la ferme et au niveau de la transformation. Des simulations basées sur des données pour 2008 illustrent la plausibilité d'observer le paradoxe de Metzler et l'importance de l'allocation des permis d'importation entre producteurs et transformateurs.

JEL codes: F13, Q17

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…for Canada the most politically sensitive issue [in the Doha Round] is supply management in dairy and poultry

Mike Gifford (2005)
Canada's former chief agricultural trade negotiator

1. Introduction

Market access for agricultural products has been a main issue of contention in agricultural trade negotiations. In the Uruguay Round of multilateral negotiations, World Trade Organization (WTO) members agreed on a process of tariffication of non-tariff barriers. Because too many of the proposed tariffs were prohibitive and that exporters wanted to at least maintain historical market access levels, tariff-rate-quotas (TRQs) emerged as a necessary compromise. Under a TRQ, an import volume defined as a minimum access commitment is taxed at an "in-quota" tariff rate while any additional imports are taxed at an "over-quota" rate. The goal of the tariffication process was to assure a 5% minimum market access to imports after 2004 for all countries member of the WTO. Thus, the quota portion of a TRQ is set to a minimum of 5% of the domestic production. In July 2010, there were more than 1,100 different TRQs for agricultural products covering more than 6,000 tariff lines. In some cases, the in-quota and the over-quota tariff rates are the same, making the quota irrelevant. In some rare cases, like the imports of some rice products by South Korea, the over-quota tariff is lower than the in-quota tariff. However, most TRQs have an over-quota tariff that is much higher than the in-quota tariff. In fact, many TRQs have a prohibitive over-quota tariff rate, making the TRQs equivalent to the import quotas they replaced.

WTO members have disagreed in the Doha Round of negotiations on the liberalization of so-called "sensitive" products protected by TRQs. One proposal is that in exchange for less aggressive tariff reductions, sensitive products would be subject to increases in minimum access commitment. For TRQs set up to replicate import quotas, the expansion of the minimum access commitment means that a larger share of the domestic production can be imported. This paper is concerned with the consequences of such expansion on domestic production, domestic prices and welfare when domestic production is imperfectly competitive. We demonstrate that TRQ liberalization forcing a larger share of the domestic production to be imported can trigger domestic price increases. This peculiar domestic price response is known in the literature as the Metzler paradox in honor of the pioneering work of Lloyd Metzler (1949a,b). Metzler showed that the imposition of a tariff can lower the domestic price. In a partial equilibrium setting, this

can occur when a large importing country faces a backward-bending foreign export supply curve. Bhagwati, Panagariya and Srinivasan (1998, p. 212-214) show that the paradox also arises in general equilibrium models when the offer curve of the country trading with the tariff-imposing country is backward bending. The paradox also arises for the imports of an inferior good. Other contexts may yield to a Metzler paradox. For instance, Helpman and Razin (1978) show that a tariff need not protect the import-competing sector under uncertainty and in the absence of international trade in securities. Panagariya (1982) show that the Metzler paradox can arise in a general equilibrium model when the import-competing sector is monopolized. Benson and Hartigan (1983) show that Metzler effects can arise in a spatial oligopoly setting if demand takes a positive exponential form. Ishikawa and Mukunoki (2008) use a three-country regional integration model with monopolized production and rising marginal revenues to uncover Metzler effects.

Clearly, the Metzler paradox is a theoretical possibility supported by different conditions. However, no case of a Metzler paradox has been empirically demonstrated yet (p. 168 in Bowen, Hollander and Viane 1998). We show that the WTO's tariffication of non-tariff barriers into TRQs that link market access commitment to domestic production and agricultural policies aimed at securing market power to upstream primary producers, like Canada's supply management policy, can induce Metzler effects. We use simulations for Canada's poultry industry to gauge how large Metzler effects might be and the extent by which they are robust to changes in the distribution of import licenses and other elements affecting negotiations between farmers (producers), processors and retailers. Canada's poultry industry is most interesting because domestic production has been growing steadily with little effective domestic support even though it has been operating under supply management and restrictive quotas/TRQs for several decades.[1]

Our model considers a three-stage industry. The price paid to farmers is negotiated between farmers and processors in the first stage. The second stage concerns the determination of the domestic production and imports because the minimum access commitment is set as a fraction of domestic production. In the third stage, a distinguishing feature of our model,

[1] Until 2004, the OECD was reporting producer support estimates (PSEs) and consumer support estimates (CSEs) for different commodities and countries. For 1999-2004, the average percentage PSEs for Canadian poultry and milk were respectively 3% and 57% (OECD 2005).

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domestic processors and retailers bargain over the wholesale price. We calibrate our model to replicate past prices and quantities. TRQ liberalization in the form of imports representing a larger fraction of domestic production induces increases in domestic prices when import rents are part of the negotiations between retailers, processors and farmers. These results are most interesting for two reasons. First, they contrast most vividly with conventional priors regarding the effects of market liberalization. Second, the Canadian government has become increasingly isolated in its attempt to shield supply-managed industries from trade liberalization at the WTO and seems determined to make concessions on market access commitments to maintain high over-quota tariffs (WTO 2008).

The next section describes the institutions governing the marketing of domestic and imported chicken in Canada. We focus on the interactions between retailers, processors and farmers along the supply chain. The third section features a theoretical model to analyze how the expansion of minimum access commitment under a TRQ and how the distribution of import licenses affects domestic production and the total quantity marketed. The fourth section shows simulations of TRQ liberalization outcomes under different assumptions about import license allocation and the structure of the negotiations between firms in the supply chain. Finally, the last section summarizes our results and their policy implications.

2. The Institutions Governing Supply Management

A supply management system governs Canada chicken production since 1979. The purpose of the policy is to restrict domestic production and imports to increase and stabilize prices and revenues of Canadian chicken producers. TRQs replaced import quotas for Canadian imports of chicken after the conclusion of the Uruguay Round of negotiations in 1995. These TRQs are characterized by high over-quota tariffs rates in excess of 200% and low in-quota tariff rates to replicate the import quotas they replaced. The minimum access commitment portion of the TRQs is managed with import licenses that are allocated between firms at different stages of production.

Supply management is a simple theoretical concept but its implementation is often complex. In the Canadian chicken industry, some elements of supply management are under different jurisdictions and the system involves large downstream processing and retailing firms. In what follows, we describe how quantities of live chicken and prices along the supply chain are

determined. We also discuss the allocation of import licenses. This description of the institutions motivates the structure of our theoretical and simulation models.

2.1. Production

Chicken Farmers of Canada (CFC) was created in 1978 under the Farm Products Agencies Act with the stated goal "*To build a strong, competitive, consumer-centered Canadian chicken industry that meets the challenges of a changing world, and to profitably grow its position as the protein leader in Canada*." The CFC board of directors is composed of 14 industry members. Chicken producers have 10 provincial representatives to protect their interests, including the Chair of the CFC board. Two representatives of the Canadian Poultry and Egg Processors Council (CPEPC), one representative of the Further Poultry Processors Association of Canada (FPPAC) and one representative of the Canadian Restaurant and Foodservices Association (CRFA) complete the board of directors.

Since 1994, the production of chicken in Canada is coordinated by a so-called "bottom-up" approach.[2] The bottom-up approach first requires the CFC to survey provincial commodity boards about their desired quantity of chicken. At the same time, other industry stakeholders such as the CPEPC and the FPPAC consult their members and then present their desired quantity to the CFC Board. Production quotas are approved by CFC by a double majority vote every 8 weeks.[3] Table 1 shows the desired quantities by the CFC and the CPEPC, the domestic allocation approved by the CFC board and the domestic production between period A-66 (June 26 and August 20, 2005) and period A-89 (January 4 and February 28, 2009). The desired quantities by the CFC and the domestic allocations are always larger than the desired quantity by the CPEPC. During the period covered by Table 1, the domestic allocation was on average 1.7% larger than the CPEPC desired allocation. The CPEPC has formulated complaints to the National Farm Products Council over the domestic allocation voted by the CFC Board with the objective of bringing about a review of the current method under which domestic production is set (Farm Products Council of Canada 2009).

[2] Prior to 1994, a "top-down" approach was used. Under that approach, the CFC allocated the national quota to provincial marketing boards which in turn allocated provincial quotas to individual producers.

[3] Specifically, each quota allocation must be approved by more than 50% of the board members present at the moment of the vote and the quota allocation must be approved by members accounting for at least 50% of the total domestic production of chicken.

The CFC allocates production quotas at the provincial level based on the desired quantities of each province, on historical market shares and by following rules that limit production growth in all of Canada and in each province. Provincial boards are responsible for the allocation of quotas to individual producers.

2.2. The price of live chicken

Provincial marketing boards determine the price paid to farmers for live chicken in each province. The price paid to Ontario farmers serves as a basis for setting the price paid to farmers in other provinces. Since May of 2003, the price of live chicken in Ontario is determined by a "live price formula". The formula has three components: producer margin, feed cost, and chick cost. The price is adjusted for changes in feed and chick costs every quota period. The producers and processors negotiate every six quotas periods over the producer margin portion of the price. If an agreement cannot be reached, arbitration takes place.[4]

2.3. The wholesale and retail prices of chicken

The market determines chicken prices at the wholesale and retail levels. Chicken producers are represented by national and provincial organizations when it comes to the determination of quantities and prices upstream. Farmers in each province sell chicken to a handful of processors and there is little trade between provinces. Downstream, a few large integrated firms dominate the distribution and retail markets. Retail in Canada is dominated by four grocery chains: Loblaw, Sobeys, Safeway, and Métro.[5] Fulton and Tang (1999) found evidence of departure from perfect competition in the chicken retailing and processing sectors in Canada, but they were not able to determine who among processors and retailers can harness that market power. Gervais and Devadoss (2006) measured the bargaining power of processors and farmers in

[4] Before May of 2003, the price paid to Ontario producers was determined by a bargaining process involving representatives of the Ontario chicken marketing board and representatives from the Ontario processing industry. The price was set after production quotas were known. When bargaining failed, an arbitrator selected one of the party's final offers. Arbitration was often required which motivated the implementation of a new mechanism to determine the price of live chicken in Ontario. Gervais, Guillemette and Romain (2007) find that the new system yields higher expected utility for processing firms, but lower expected utility for farmers.

[5] Harrison and Rude (2004) report that the average CR4 for chicken processing in all of Canada was in excess of 60% during the 1990s. From Table IV in Lambert, Criner and Rancourt (2004), we calculate a CR4 of 61% for Canadian grocery stores.

negotiations over the price of live chicken in Ontario between March 1997 and December 2002 and found asymmetric weights favoring processors.

2.4. Imports controls

Import controls are necessary for supply management programs. Imports of live chicken and poultry meat are limited by TRQs. The minimum access commitment for chicken in Canada under the WTO is 39,844 metric tons, but the larger commitment under the North American Free Trade Agreement (NAFTA) of 7.5% of the previous year's domestic production takes precedence. The in-quota preferential tariff for fresh, chilled or frozen poultry meat and edible offal is zero under several trade agreements, including NAFTA. The most favored nation in-quota tariff under GATT varies between 4% and 8% depending on the type of chicken products. The over-quota tariff on imports of meat and edible offal of poultry fresh, chilled or frozen is 238% regardless of origin (Canada Border Service, 2008). The over-quota tariff is prohibitive and no chicken enters Canada at the over-quota tariff. Huff, Meilke, and Amedei (2000) find that the tariff that would have preserved the average level of imports between 1995 and 1999 based on United States prices was 28.3%.

Table 2 shows Canadian imports between 2001 and 2007. The size of import licenses issued has varied to keep the import-production ratio close to the 7.5% level agreed upon under NAFTA. [6] Canada issues supplementary import permits to prevent product shortages or for re-exportation. These supplementary import permits allow firms to import chicken at the in-quota tariff rate. As Table 2 shows, the quantity of chicken imported under supplementary import permits has steadily increased between 2001 and 2007. However, most of these supplementary import permits were issued for re-exportation, meaning that the importing firms agreed to export the same volume of processed chicken.[7]

[6] TRQs at the WTO are set as a fraction of domestic consumption while TRQs for chicken under NAFTA are defined as a fraction of domestic production. These two methods are equivalent. Defining consumption *C* as the sum of imports *M* and domestic production *Q*, setting $M = \xi C = \xi\left(M + Q\right)$ implies $M = \frac{\xi}{1-\xi} Q = \gamma Q$. Thus, despite different semantics, NAFTA and WTO TRQs settings are equivalent.

[7] The import for re-exportation scheme is motivated by Canadian preferences for white chicken meat over dark chicken meat which contrasts with the greater appreciation of dark meat in other countries (Huff, Meilke, and Amedei, 2000).

3. A Model of Canada's Chicken Industry

The model in this section is a simple representation of the institutions and policies described in the previous section. Yet, because the model considers retailers-processors and processors-farmers (producers) interactions, it provides new insights about supply-managed supply chains. To keep the model tractable, we assume that farmers, processors and retailers are each represented by a single entity. The simulation model in the next section relaxes this assumption, but the results derived in this section are qualitatively robust. Our three-stage model considers that: 1) the price paid to the farmer is negotiated between the farmer and the processor in the first stage; 2) domestic production is determined in the second stage; and 3) the price received by the processor is the outcome of a processor-retailer negotiation in the third stage. We solve the model by backward induction.

We rely on the Nash (1953) solution to approximate a game in which buyers and sellers bargain by making alternating offers and in which the bargaining power of an agent is determined by haggling cost (Rubinstein 1982). The cost of haggling for farmers may be important because of the perishable nature of chicken and storage costs. For retailers, the cost of haggling may come from the cost of having to ration consumers. The Nash solution is meant to characterize the outcome of an unspecified bargaining game without having to describe the game itself. The Nash solution implies absence of delay. Given that chicken is perishable and that the negotiations are conducted on a frequent basis, it is reasonable to assume that negotiations always succeed. Because domestic production must be sold on the domestic market under a supply management policy, there is no outside value to processors.

The Nash bargaining solution is conditioned by threat points that correspond to the profits of players in the event of failed negotiations. We assume that the threat point of the processor is zero when bargaining with the retailer for the price of eviscerated chicken because the processor must go through the retailer to market chicken intended for the domestic market. The threat point of the retailer can take different values depending on who owns the import licenses and whether imports are part of the negotiations. We first assume that the retailer owns the import licenses and that its threat point is zero. Second, in the absence of an agreement with the processor, the retailer could import chicken to the extent allowed by its import licenses and use its refrigerated counter space for other meat products. In that case the imports improve the

bargaining position of the retailer. Finally, we consider that the processor owns all the import licenses and that its threat point remains zero in all negotiations.

3.1. The retailer owns the import licenses and zero threat point

When the retailer owns the import licenses and the rent from imports does not constitute a threat point, the profit of the retailer is given by

$$\pi_r\left[p_p, Q\right] = P\left[Q(1+\gamma)\right]Q(1+\gamma) - p_p Q - p_w \gamma Q - c_r Q(1+\gamma)$$

where $P\left[Q(1+\gamma)\right] \equiv A - BQ(1+\gamma)$ is the inverse consumer demand for chicken, Q is the domestic production and γ is the share of the domestic production imported under the minimum access commitment such that $Q(1+\gamma)$ is the total quantity of chicken marketed. p_p is the price paid to the domestic processor, p_w is the price paid for the imported product inclusive of the in-tariff and c_r is the constant marginal cost of the retailer. Because the over-quota tariff is prohibitive, the minimum access commitment γQ acts like a binding import quota.

The profit of the processor is

$$\pi_p\left[p_p, Q, p_f\right] = \left(p_p - p_f - c_p\right)Q \tag{1}$$

where c_p is the constant marginal cost and p_f is the farm price. The price p_p is negotiated with the retailer in the last stage while the price paid to the farmer, p_f, is negotiated with the farmer in the first stage. Q is determined in the second stage. As a result, p_f and Q are known by all when p_p is negotiated.

The Nash product with zero threat points for the negotiation for the price paid to the processor is given by

$$\underset{p_p}{Max}\, \pi_r\left[p_p, Q\right]^{\delta} \pi_p\left[p_p, Q, p_f\right]^{1-\delta},$$

where δ and $1-\delta$ are respectively the bargaining weights of the retailer and the processor The solution to the first order condition yields the conditional processor price

$$p_p\left[Q, p_f\right] = \left(\left(A - c_r\right)(1+\gamma) - BQ(1+\gamma)^2 - p_w\gamma\right)(1-\delta) + \left(c_p + p_f\right)\delta \tag{2}$$

which is decreasing in the retailer's marginal cost, the world price and domestic production, but increasing in the processor's marginal cost and the fraction that can be imported by the retailer.

Moving to the second stage of the model, we can insert (2) into (1) and maximize over domestic production to determine the profit maximizing quantity for the processor. The quantity presented for approval at the CFC board by the processor is given by

$$Q_p\left[p_f\right]=\frac{A(1+\gamma)-c_p-c_r(1+\gamma)-p_f-p_w\gamma}{2B(1+\gamma)^2}.$$

Recall that domestic production is voted by a producers' dominated CFC board. Therefore, we must not only consider the processor's desired domestic production but also the farmer's desired domestic production. The farmer maximizes its profit given by

$$\pi_f\left[Q,p_f\right]=\left(p_f-c_f\right)Q \tag{3}$$

where c_f is a constant marginal/average cost. This implies that the unconstrained profit-maximizing quantity $Q_f\left[p_f\right]$ of the farmer is infinity when the profit margin is not negative. Even though the CFC is dominated by producers, the institution would not be viable if processors were to incur systematic losses. In our model, this implies that the farmer must set a quantity that yields a nonnegative profit for the processor. The first order condition to this problem is

$$p_f-c_f+\mu\frac{\partial\pi_p\left[Q,p_f\right]}{\partial Q}=0,$$

where μ is the Lagrange multiplier and the expression for $\pi_p\left[Q,p_f\right]$ is found by inserting (2) in (1). The desired domestic production by the farmer systematically exceeds the processor's desired quantity because $\frac{\partial\pi_p\left[Q,p_f\right]}{\partial Q}<0$ as long as $p_f>c_f$ and hence $Q_f\left[p_f\right]>Q_p\left[p_f\right]$. This is consistent with the empirical evidence presented in Table 1 where the domestic allocation voted by the CFC board systematically lies between the CPEDC and the CFC desired quantities.

Because of our linear demand assumption and constant marginal cost, the quantity that makes the processor's profit nil is twice the processor's desired quantity

$$Q_f\left[p_f\right]\Big|_{\pi^p=0}=\frac{(A-c_r)(1+\gamma)-c_p-p_f-p_w\gamma}{B(1+\gamma)^2}.$$

Consistent with the data in Table 1, we assume that the observed quantity is a weighted average of the desired processor's quantity and the one that makes the processor's profit zero

$$Q\left[p_f\right] = \phi\left[\frac{(A - c_r)(1+\gamma) - c_p - p_f - p_w\gamma}{2B(1+\gamma)^2}\right]; \phi \in (1,2). \tag{4}$$

The parameter ϕ is a relative bargaining power parameter. If $\phi = 1$ then $Q\left[p_f\right] = Q_p\left[p_f\right]$ but if $\phi = 2$ then $Q\left[p_f\right] = Q_f\left[p_f\right]$. Hence, a high (low) ϕ favors the farmer (processor).

Recall that the price of live chicken is based on the price determined under the Ontario system. The price of live chicken in Ontario is fixed using a formula that accounts for the producers' input cost and a profit margin. Producers and processors periodically meet to negotiate the profit margin allocated to producers. We do not model the profit margin but rather, and equivalently, we solve for the price paid to the farmer by the processor. We use the Nash bargaining solution to obtain the farm price (price of live chicken) using $\sigma \in (0,1)$ and $1-\sigma$ as the weights on the farmer's and the processor's profits. We assume for the time being that the threat points of the processor and the farmer are zero. Thus, the Nash product is given by

$$\underset{p_f}{Max}\, \pi_p\left[p_f\right]^{\sigma} \pi_f\left[p_f\right]^{1-\sigma},$$

where the expression for $\pi_p\left[p_f\right]$ and $\pi_f\left[p_f\right]$ are found by plugging the solutions for Q and p_p into (1) and (3) respectively. We find that the negotiated price is given by

$$\overline{p}_f = \frac{\left((A - c_r)(1+\gamma) - c_p - p_w\gamma\right)(1-\sigma) + c_f(1+\sigma)}{2}. \tag{5}$$

The equilibrium farm price paid to the farmer is increasing in the farmer's marginal cost c_f, the intercept of the retail demand *A*, the proportion γ of domestic production that can be imported, and decreasing in the world price p_w and in the processor's bargaining power σ. We find the equilibrium domestic production by inserting (5) into (4) and find

$$\overline{Q} = \phi\left[(1+\sigma)\frac{(A - c_r)(1+\gamma) - c_f - c_p - p_w\gamma}{4B(1+\gamma)^2}\right]. \tag{6}$$

We can now investigate the incidence of trade liberalization when imports and domestic production are linked through the TRQ.

Proposition 1: *Provided that the retailer has all of the import licenses, that profits from imports do not constitute a negotiation threat point and that* $p_w > c_p + c_f$*, then the domestic price of chicken rises in response to an increase in the regulated ratio* γ *of imports to domestic production and the Metzler paradox arises.*

Proof: The domestic price is inversely related to the total quantity marketed which is obtained by multiplying (6) by $(1+\gamma)$. The Metzler paradox arises when the following is negative

$$\frac{\partial \bar{Q}(1+\gamma)}{\partial \gamma} = \frac{(c_f + c_p - p_w)(1+\sigma)\phi}{4B(1+\gamma)^2}, \tag{7}$$

which requires $p_w > c_p + c_f$ for the total quantity marketed to decline. **QED**

The intuition behind the above proposition is that the ratio of imports to domestic production increases sourcing costs of the supply chain when $p_w > c_p + c_f$ and hence shrinks the gains to be negotiated in the various stages of the game. The "forced imports" bring about a large enough reduction in domestic supply to increase the farm price in (5). The Metzler result clearly hinges on the quota part of the TRQ being a minimum access commitment and on being linked to domestic production. It is worth pointing out that joint producer-processor-retailer profit decreases with the imports-domestic production ratio if $p_w > c_p + c_f$. As such, it would be jointly profitable if retailers could "sleep" on the import licenses, as in Cunha and Santos (1996). However, as long as $p_p > p_w$, the retailer would use the licenses.

3.2. What if the imports are the retailer's threat point?

The rent from import licenses is a potential threat point when the retailer controls all of the import licenses. We analyze the implications of that threat point in what follows. We find the price paid to the processor by maximizing the Nash product

$$\underset{p_p}{Max}\left(\pi_r\left[p_p, Q, p_r\right] - \left(P\left[(1+\gamma)Q\right] - p_w\right)\gamma Q\right)^{\delta} \pi_p\left[p_p, Q, p_r\right]^{1-\delta}.$$

Simplifying this expression yields

$$\underset{p_p}{Max}\left(\left(A - BQ(1+\gamma) - c_r - p_p\right)Q\right)^{\delta}\left(\left(p_p - c_p - p_f\right)Q\right)^{1-\delta}.$$

Observe that imports given by the product of γ and Q are no longer directly part of the negotiation because imports only impact negotiation through a change in the price paid to the retailer. The steps to solve the model are the same as for Proposition 1.

Proposition 2: *An increase in the ratio γ of imports to domestic production has no impact on the retail price when the import license's rents constitute the threat point of the retailer in its negotiation with the processor.*

Proof: Even though import rents are taken out of the retailer's profit in the Nash product for the retailer-processor negotiation, the Nash product is still function of γ because imports set aside from the negotiation still impact on the domestic retail price. Maximizing the Nash product we find that the conditional price paid to the processor is $p_p\left[Q, p_{-f}\right] = (A - c_r)(1-\delta) - BQ(1+\gamma)(1-\delta) + (c_p + p_f)\delta$. The conditional negotiated quantity, $Q\left[p_f\right] = \dfrac{(A - c_p - c_r - p_f)\phi}{2B(1+\gamma)}$, depend on γ, but the negotiated farm price, $p_f = \dfrac{1}{2}\left((A - c_p - c_r)(1-\sigma) + c_f(1+\sigma)\right)$ does not. Inserting the solution for p_f into $Q\left[p_f\right]$ gives us the equilibrium domestic production $\bar{Q}$ and multiplying by $(1+\gamma)$, we can show that the equilibrium total quantity marketed does not change, $\dfrac{\partial \bar{Q}(1+\gamma)}{\partial \gamma} = 0$, as the increase in γ is fully offset by the decrease in domestic production. **QED**

Intuitively, if the rents from import licenses are shielded from the negotiations, trade liberalization should have a lesser impact on negotiated prices and quantities. Still imports affect the marginal revenue of the processor and the farm through a change in the price paid to the retailer. Because of the assumption of constant marginal costs, the change of price at retail is reflected by a proportional change in the marginal revenue for the processor and the farm which cause the domestic production to fall by the same quantity that is imported.

3.3. What if the processor controls the import licenses?

The retailer's profit when the import rents accrue to the processor is

$$\pi_r = \left(A - BQ(1+\gamma) - c_r - p_p\right)Q(1+\gamma),$$

while the processor's profit is

$$\pi_p = \left(p_p(1+\gamma) - p_f - p_w\gamma - c_p\right)Q.$$

Because Canadian firms import mostly frozen chicken, we consider that the processor imports eviscerated chicken to be later sold to the retailer without additional processing.[8] The steps to obtain equilibrium quantities and prices remain as before. We assume that the import rent of the processor is not a threat point in the negotiation with the farmer. The conditional price paid to the processor is

$$p_p\left[Q, p_f\right] = \frac{1}{1+\gamma}\left((A - c_r)(1+\gamma)(1-\delta) - BQ(1-\delta)(1+\gamma)^2 + \delta\left(c_p + p_f + c_p\gamma + p_w\gamma\right)\right).$$

The negotiated conditional domestic production is

$$Q\left[p_f\right] = \phi\frac{(A - c_r)(1+\gamma) - p_f - \left(c_p + p_w\right)\gamma)}{2B(1+\gamma)^2}, \tag{8}$$

and the negotiated farm price is

$$\overline{p}_f = \frac{\left((A - c_r)(1+\gamma) - c_p - p_w\gamma\right)(1-\sigma) + c_f(1+\sigma)}{2}. \tag{9}$$

Finally, by inserting (9) into (8) we find the solution for the domestic production:

$$\overline{Q} = \phi\frac{\left((A - c_r)(1+\gamma) - c_p - c_f - p_w\gamma\right)(1+\sigma)}{4B(1+\gamma)^2}. \tag{10}$$

We can then state whether trade liberalization can induce a Metzler effect when import licenses are all allocated to the processor.

Proposition 3: *An increase in the ratio γ of imports to domestic production when the import licenses are controlled by the processor induces the Metzler paradox if $p_w > c_f + c_p$.*

Proof: Multiplying (10) by $(1+\gamma)$ and deriving with respect to γ, we find

[8] In 2008, 0.2% of the share of import permits was allocated for the import of live chicken, 0.02% for whole eviscerated chicken, 80.5% for chicken parts and 19% for further processed chicken.

$$\frac{\partial \bar{Q}(1+\gamma)}{\partial \gamma} = \phi \frac{(c_f + c_p - p_w)(1+\sigma)}{4B(1+\gamma)^2}, \tag{11}$$

which is negative only if $p_w > c_f + c_p$ as asserted. **QED**

The condition that makes (11) negative is the same that makes (7) negative in Proposition 1 because the sole processor imports chicken, but does not process it. As our simulations show in the next section, the allocation of import licenses matters when the number of processors and retailers differ. Furthermore, the condition for a Metzler paradox changes if licenses are used to import live chicken instead of eviscerated chicken. In this case, both domestic and imported chicken would require processing and the "competitive" condition required for the Metzler paradox would no longer involve processing costs. Defining p_w^L as the world price for live chicken and recalling that c_f is the domestic unit cost of production of live chicken, we can state that:

Corollary: *If the processor imports live chicken, the condition supporting a Metzler effect depends only on the relative sourcing cost of live chicken:* $p_w^L > c_f$.

As before, the Metzler effect arises because the negative impact of more expensive imports can be mitigated by cutting enough production to increase the domestic price. This peculiar outcome depends on 1) the quota component of the TRQ being directly linked to domestic production; 2) agents along the supply chain having market power; 3) the domestic industry having relatively low production costs.

The conditions above are derived for Canada's supply managed chicken industry, but supply management is not a necessary condition for the Metzler paradox to arise. We can find similar conditions with other market structures and other marketing system than the one in this model. For instance, a model with a competitive retail sector holding the import license and a monopolized domestic production sector would generate similar results. Our simplifying assumptions of linear demand and constant marginal costs are not paramount for the Metzler paradox to occur.

4. Simulations of the effects of TRQ Liberalization on Canada's Supply Managed Chicken Industry

We use simulations from a more general model based on 2008 industry statistics to gauge by how much domestic prices could rise as a result of trade liberalization. We also discuss welfare implications.

4.1. The simulation model

The simulation model is a generalization of the model in the previous section. The model in this section considers N identical retailers, M identical processors and many identical farmers represented by an assiciation. The model assumes arrangements between each processors and each retailers (i.e. each processor sells to the N retailers and analogously and each retailer buys from the M processors). Retailers and processors bargain over the price of eviscerated chicken in MN different negotiations. For generality, we define θ_r as an indicator of whether the retailers' imports constitute a threat point in the negotiation with the processors. If the rent from chicken imports is not a threat point, then $\theta_r = 1$. Conversely, if all the retailers' rent from chicken imports is a threat point, then $\theta_r = 0$. We also define λ as the share of total import licenses allocated to retailers. The remaining share is allocated among processors.

We use the Nash solution to describe the outcome of retailer-processor negotiations. The Nash product for a particular retailer-processor pair is $\left(\pi_{r,p}\right)^{\delta}\left(\pi_{p,r}\right)^{1-\delta}$ where:

$$\pi_{r,p} = \frac{1}{N}\frac{1}{M}\left(\left(1+(1-\lambda)\gamma\right)\left(P\left[Q(1+\gamma)\right]-p_p-c_p\right)+\theta_r\lambda\gamma\left(P\left[Q(1+\gamma)\right]-p_w-c_r\right)\right)Q,$$

$$\pi_{p,r} = \frac{1}{N}\frac{1}{M}\left(p_p\left(1+(1-\lambda)\gamma\right)-p_f-p_w(1-\lambda)\gamma-c_p\right)Q.$$

The solution for the price paid to processors for eviscerated chicken is given by

$$p_p\left[Q,p_f\right] = \frac{R+\delta p_f + S\,P\left[Q(1+\gamma)\right]}{1+(1-\lambda)\gamma}, \tag{12}$$

where $R \equiv \delta\left(p_w(1-\lambda)\gamma+c_p\right)-(1-\delta)\left(c_r\left(1+(1-\lambda)\gamma\right)+\theta_r\lambda\gamma\left(p_w+c_r\right)\right)$ and $S \equiv (1-\delta)\left(\left(1+(1-\lambda)\gamma\right)+\theta_r\lambda\gamma\right)$.

The desired quantity by farms, under the processors' profitability constraint is $Q_f\left[p_f\right]$ and the desired domestic production of processors is $Q_p\left[p_f\right]$. It might be tempting to assume that processors act as a cartel exerting monopoly power. However, studies of demand for meat in Canada show that the elasticity of demand for chicken is inelastic and because a monopolist's price-quantity pair must be in the elastic portion of the demand curve and the demand faced by processors is more inelastic than the demand faced by retailers, cartel-like behavior is inconsistent with the empirical evidence.[9] Therefore, it seems reasonable to assume that processors have Cournot conjectures in announcing their desired quantities to provincial boards which relay the information to the CFC board. Inserting the solution of the price paid by retailers for eviscerated chicken as a function of the domestic production allocated to the processor into the profit of a representative risk neutral processor, we find

$$\pi_p = \left(p_p\left[Q, p_f\right]\left(1+(1-\lambda)\gamma\right) - p_f - p_w(1-\lambda)\gamma - c_p\right)q,$$

where q is the desired domestic production for one processor. The first order condition with respect to q implicitly defines $q\left[p_f\right]$, the desired domestic production by one processor:

$$\frac{\partial \pi_p}{\partial q} = \left(\frac{\partial p_p\left[Q, p_f\right]}{\partial q}q + p_p\left[Q, p_f\right]\right)\left(1+(1-\lambda)\gamma\right) - p_f - c_p - p_w(1-\lambda)\gamma = 0, \qquad (13)$$

where $\partial p_p\left[Q, p_f\right]/\partial q = -SB(1+\gamma)/\left(1+(1-\lambda)\gamma\right)$.

We define $Q_p\left[p_f\right] \equiv Mq\left[p_f\right]$ as the total quantity desired by all the processors that is relayed to the CFC board. We know that the production target adopted by the CFC board is larger or equal to $Q_p\left[p_f\right]$, but smaller or equal to $Q_f\left[p_f\right]$. Thus, we denote by $Q\left[p^f\right] \in \left(Q_p\left[p^f\right], Q_f\left[p^f\right]\right)$ the domestic production approved by the CFC board. In the simulations, domestic production is determined by the desired domestic production plus a fixed percentage calculated from past observed desired quantities. This method is equivalent to weighing the desired quantities of farmers and processors.

[9] Eales (1996) finds an elasticity for chicken in Canada of -0.45 while Moschini (2001) finds an elasticity of -0.92. Lambert et al. (2006) find that the elasticity of demand in different regions of Canada to be around -1.

Unlike in the previous section, we consider that the threat point of processors may be different from zero when negotiating with the producers' association. For generality, we define the parameter $\theta_p \in \{0,1\}$ as an indicator of whether the rent from the import of chicken by processors that is a threat in the negotiation for the price of live chicken. The equilibrium farm price is negotiated by the processors' representative and the farmers' representative. Maximizing the Nash product ${\pi_{p,f}}^{\sigma}{\pi_f}^{1-\sigma}$ where the processors' profit is

$$\pi_{p,f} = \left(p_p\left[Q\left[p_f\right], p_f\right] - p_f - c_p\right)Q\left[p_f\right] + \theta_p\left(p_p\left[Q\left[p_f\right], p_f\right] - p_w\right)(1-\lambda)\gamma Q\left[p_f\right]$$

and the farmers' profit is

$$\pi_f = \left(p_f - c_f\right)Q\left[p_f\right]$$

we obtain the implicit solution through the first order condition

$$\sigma\pi^f \frac{\partial \pi_{p,f}}{\partial p_f} + (1-\sigma)\pi_{p,f}\frac{\partial \pi_f}{\partial p_f} = 0. \tag{14}$$

4.2. Calibration of the model

We calibrate the model using data for 2008 and parameters estimates from the literature. Table 3 shows the data and parameter estimates that serve as the basis for the calibration. To account for uncertainty about the true value of parameters, we rely on subjective distributions summarized in Table 4. We calibrate the model considering that domestic production, total consumption and the share of import licenses allocated to retailers are constant parameters. The other parameters, which are less precisely observed, are considered random. As in Gervais and Surprenant (2003), we assume that 58% of the import licenses are controlled by retailers. We obtained domestic production, the price paid to farmers, and the wholesale price from the Chicken Farmers of Canada (2009). We computed consumption as 107.5% of production to be consistent with the TRQ rule and the evidence presented in Table 1.

All random parameters are independently distributed and drawn from affine transformations of beta distributions. Consider a random parameter $x \in \left[\underline{x}, \overline{x}\right]$. The distribution of x is given by $x \sim \underline{x} + (\overline{x} - \underline{x})\beta(a,b)$, where $\beta(a,b) \in (0,1)$ is the beta distribution and a and b are scale parameters. The mean of the beta distribution is given by $a/(a+b)$ and the mean of

x is therefore given by $E[x] = \underline{x} + (\overline{x} - \underline{x})a/(a+b)$. For a given value of a, we can find the value of b that yields a mean x^*: $b = \frac{a(\overline{x} - \underline{x})}{x^* - \underline{x}} - a$. We set the value of a to five which assures us, given the mean, min and max of the parameters in our model, that $b > 1$ and that the distribution of x is bell shaped. The variance of x is given by: $V[x] = (\overline{x} - \underline{x})^2 ab/\left((a+b)^2(a+b+1)\right)$.

Chicken Farmers of Canada (2009) reports retail prices for broilers, breast, wings, legs and drums. Our model treats chicken as a homogenous product. We must therefore calculate a retail price index. We obtained from the Australian Chicken Meat Federation (2007) the weight shares of chicken parts. We use these shares to compute the average value of a chicken sold by parts. Using the price of breast, wings, legs and drums with the corresponding weight shares, we find an average retail price of \$8.58 per kg.[10] This price is much higher than the price of a broiler (\$5.75 per kg), but much lower than the price of breast (\$15.17 per kg). The weight shares do not correspond to consumption shares because Canadians prefer white meat over dark meat: Canada is an importer of chicken breasts and an exporter of chicken legs. Given that Canadians favor more expensive breasts over cheaper legs, the average value of a chicken sold by parts should be higher than \$8.58 per kg. We conservatively account for the uncertainty over the retail price by treating the retail price as a random parameter distributed between \$6.00 per kg and \$12.00 per kg, with a mean of \$9.00 per kg.

We compute the farm price by dividing total cash farm price receipt by total production of eviscerated chicken. We find a farm price of \$1.95 per kg of eviscerated weight. Given that Chicken Farmers of Canada (2009) reports an average price paid to farms of \$1.44 per kg of live weight, this implies that one kg of live chicken yields 0.736 kg of eviscerated chicken. The farm price is distributed between \$1.85 per kg and \$2.05 per kg with a mean of \$1.95. Similarly, based on the value of reported by Chicken Farmers of Canada (2009), we consider that the price paid to processors is distributed between \$2.90 per kg and \$3.16 per kg with a mean of \$3.03 per kg.

We approximate the price of imported chicken by calculating the average unit value of chicken imported from the United States. The US International Trade Commission (2010) collects data on all US imports and exports. We collected the quantities and values of US

[10] Unless stated otherwise, prices are quoted in Canadian dollars per pound of eviscerated weight.

chicken exports to Canada at the 6-digit HTS codes 020711, 020712, 020713, 020714 (meat and edible offal of poultry, fresh, chill or frozen chicken) for 2008 and calculate a unit value of $US 2.12 per kg. Once converted in Canadian dollars using the exchange rate from the Bank of Canada (2009), we obtain an import price of $2.26 per kg. The import price is allowed to vary between $2.00 per kg and $2.50 per kg in the simulations.

The elasticity of demand is also specified as a random parameter. Based on estimates reported in the literature and the -0.8 estimate used in Gervais and Surprenant (2003), we assume that the elasticity of demand is distributed between -1.10 and -0.45 with a mean of -0.80. As for the marginal cost of producing chicken in Canada, we borrow Rude and Gervais's (2006) marginal cost of $0.78 per kg of live weight. This measure equals $1.06 per kg of eviscerated weight. We assume that the marginal cost of farms is distributed between $0.86 and $1.50 with a mean of $1.05 per kg of eviscerated weight. From Gervais and Surprenant (2003), Gervais and Devadoss (2006) and Gervais, Guillemette and Romain (2007), the marginal cost of processors is allowed to vary between $0.35 per kg and $1.00 per kg with a mean of $0.60 per kg of eviscerated weight. The marginal cost of retailers takes the same mean value, but varies from a minimum of $0.25 per kg to a maximum of $1.10 per kg.

We contend that if the rent from imports is not a threat point in the negotiation between retailers and processors, it is not a threat point in the negotiation between the processors' and farmers' associations. This means that we must consider two cases: A) $\theta_r = \theta_p = 1$ and B) $\theta_r = \theta_p = 0$. Under case A, threat points are zero while in case B import rents are the threat points. From the equations of the model, we can recover the parameters δ, M and σ. We do not need to recover the number of retailers N as the results of the model are independent of the number of retailers because of the assumptions that retailers are identical, have constant marginal cost and that each retailer bargains with each processor. We begin by finding the bargaining power of retailers, δ, consistent with equation (12). We consider that the domestic allocation is based on the desired quantity by processors and use equation (13) that describes the desired quantity by processor to find the number of processors, M. The calibration considers that processors desired quantity is 1.7% short of the domestic allocation, as per the data in Table 1. Finally, we use equation (14) that implicitly defines the price paid to farms to recover the value of the bargaining power of processors, σ, in the negotiation over the farm price.

We simulate the model 10,000 times for each of the two cases. Figure 1 shows the distribution of the calibrated parameters δ, M and σ. The mean of the bargaining power of retailers, δ, is robust across cases at about 0.91, meaning that retailers capture most of the rent in their negotiations with processors over the price of eviscerated chicken. The mean number of processors, M, is not affected by the assumption about threat points and is approximately equal to 1.86 which reflects the highly concentrated nature of food processing in Canada. The mean of the bargaining power of processors when bargaining with farmers, σ, is 0.91 when threat points are zero and 0.85 in the alternative case. Gervais and Devadoss (2006) find a similar result. We consider in the simulations below that imports are allowed to increase from 7.5% to 12.5% of domestic production and that the over-quota tariff remains prohibitive.

4.3. Scenario 1: Increase in the import-production ratio without changing in allocation shares

In this first scenario, we consider that γ increases, but that λ remains constant. We use our calibrated model to find the effect of that increase on the price paid to farmers, the domestic production of chicken, the price paid to processors and the price paid to retailers by consumers. Recall that case A considers that all the rents from imports are part of the negotiations while case B considers that imports rents are excluded from the negotiation. Figure 2 shows that for case A that the price paid to farmers, the price paid to processors and the price paid to retailers increase on average. In case B all prices decrease. Domestic production decreases in both cases. Under case A all the rent from imports are part of the negotiations. Given the distributions of the cost parameters and the world price, we observe a Metzler effect. The maximum increase in the retail price is 0.4%. We do not observe a Metzler effect under case B as the decrease in the retail price varies between 0.5% and 3%. Large negative changes are also simulated for the prices paid to processors and the price paid to farmers. These results are consistent with the propositions derived previously.

4.4. Scenario 2: Increase in the import-production ratio and more licenses allocated to retailers

In the second scenario, we consider that only the retailers are allowed to import more chicken after market liberalization. This means that we can write that the imports of processors remain constant such that $(1-\lambda_1)\gamma_1 Q_1^f = (1-\lambda_0)\gamma_0 Q_0^f$, where superscripts 0 and 1 respectively indicate before and after the change in the import licenses has occurred. The new share of licenses

allocated to retailers is approximately given by $\lambda_1 = 1-(1-\lambda_0)\gamma_0/\gamma_1 = 0.748$, with $\lambda_0 = 0.58$, $\gamma_0 = 0.075$ and $\gamma_1 = 0.125$. The simulations therefore assume that the import-production ratio goes up from 0.075 to 0.125 and that the share of import licenses allocated to retailers goes up from 0.58 to 0.685. The simulations results are presented in Figure 3. Under case B, the farm price, the price paid to processors and the retail price do not change and the increase in imports is matched by a decrease in production of the same size because of our linear demand and constant marginal cost assumptions (as in proposition 2). The rent from imports is not part of negotiations and therefore cannot be captured by upstream firms. Hence market liberalization with import licenses allocated to retailers do not affect retailers-processors and processors-farmers negotiations. This is unlike case B in scenario 1 where processors sell more imported chicken to retailers. Under the current scenario, processors are not allowed to import a larger share of domestic production after trade liberalization. The rents from the additional licenses accrue to the retailers. Because imports displace domestic production, there is a smaller pie to share for processors and farmers. In case A, processors can capture part of the rent from the import of chicken by retailers. As a result, the price paid to processors increases and the price of live chicken also increases. Domestic production decreases enough to more than offset the increase in the import-production ratio and to cause a Metzler effect. Comparing scenarios 1 and 2, we conclude that import license allocations do matter in the more general version of our model.

4.5. Scenario 3: Increase in imports licenses with all more licenses allocated to processors

This third scenario is about an increase in the import-production ratio with an allocation of licenses skewed toward processors. The retailers' imports remain constant such that $\lambda_1\gamma_1 Q_1^f = \lambda_0\gamma_0 Q_0^f$. Assuming that the change in domestic production is small, we can write that $\lambda_0\gamma_0/\gamma_1 = 0.348$. As before, we consider that the import-production ratio goes up from 0.075 to 0.125 but that the share of import licenses allocated to retailers goes down from 0.58 to 0.348. Figure 4 shows a Metzler effect under case A as the price paid to retailer goes up. Under case B, we observe a large decrease in the farm price and a somewhat smaller decrease in the price paid to processors. Two reasons are behind this. First, the import licenses cause processors to reduce their desired domestic production. However, the negative change in domestic production is small and the total quantity of chicken marketed increases, which yields a decrease in the price paid to

retailers. Second, trade liberalization favoring import by processors means that processors do not demand as much chicken from domestic farmers. Since import rents are the threat point and import rents cannot be passed on to farmers, the price paid to farmers decreases.

4.6. Trade liberalization, welfare and profits

Consumer surplus and welfare is a decreasing function of the price paid to retailers. Thus, whenever trade liberalization induces a Metzler effect, welfare decreases. We will focus on TRQ liberalization scenario 2, where more import licenses are allocated to retailers, to analyze profit changes along the supply chain. Scenario 2 generates more modest changes in the price paid to farmers under case B than the other scenarios. Figure 5 shows the changes in profits. In all cases the mean profit of firms decreases. Recall that imported chicken sourcing cost must be larger than domestic chicken for Metzler effects to be observed. As a result, forcing a larger import-production ratio on the supply chain can only reduce profit. Retailers are those that are the least affected, especially under case B because its import rent are not shared. The changes in the profit of processors in panel 2) of figure 5 and the changes in the profit of farmers in panel 3) are almost identical. The changes in profit range from minus 2% to almost minus 6%. Unlike retailers, profits of processors and farmers decrease more under case A, because of the large decrease in domestic production.

Conclusion

Even though the Metzler paradox is discussed in virtually all international trade textbooks (e.g. Bhagwati, Panagaryia and Srinivassan 1998 and Bowen, Hollander and Viane 1998), it is often seen as a theoretical curiosity of little empirical significance. We show theoretically and through numerical simulations that the liberalization of Canada's supply managed chicken industry is likely to induce domestic prices increases because of the manner with which the minimum access commitment of the Tariff Rate Quota (TRQ) is set up. The liberalization of supply managed industries has attracted much attention in academic (e.g., Alston and Spriggs, 1998; Rude and Gervais, 2006) and non-academic circles (Gifford, 2005) in part because of the domestic and trade distortions created by supply managed programs and the resolve of the Canadian government to defend these programs at the WTO. If all supply managed products could remain designated as sensitive, they could be exempt from significant tariff reductions. Sensitive

products are protected by TRQs which are usually set to mimic import quotas, with low in-quota tariffs and high over-quota tariffs. TRQs came about as a compromise on the tariffication of non-tariff barriers in the Uruguay Round because historical market access levels were threatened by highly restrictive proposed tariffs. The quota part of the TRQ on Canada's chicken import is a minimum access commitment defined as a fraction of domestic production. Under a hypothetical Doha Agreement, sensitive products would still be subject to trade liberalization, but the bulk of the adjustment would be on the quota part of the TRQ. For Canada's chicken industry, this would mean that a larger fraction of domestic production could be imported. We show that trade liberalization of this sort could induce perverse responses known as Metzler effects.

We develop a 3-stage theoretical model that captures the main institutional features of the supply-managed chicken supply chain to derive conditions under which the Metzler paradox. The model innovates by considering the retailers-processors and processors-farmers price negotiations in addition to the domestic output determination. We also investigate the implications of import license allocation between retailers and processors as well as the scope of the negotiations/threat points. A more general version of the model is calibrated using 2008 data and is then used to simulate 3 different liberalization scenarios for Canada's chicken supply chain. In the process, we find bargaining weights favoring retailers in retailers-processors negotiations and processors in processors-farmers negotiations. We show that a Metzler paradox is quite plausible, taking the form of substantial increases in the prices paid to Canadian chicken farmers and processors and rather small retail price increases. The TRQ-driven Metzler effect could arise under different imperfectly competitive market structures and marketing arrangements.

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Table 1: Desired quantities, domestic production and domestic allocation (Million kg)

Period	CFC desired quantity	CPEPC desired quantity	Domestic allocation	Domestic production	CFC vs. CPEPC	Domestic allocation vs. CPEPC	Domestic production vs. CPEPC
A-66*	151.4	144.5	146.7	141.7	4.5%	1.5%	-2.0%
A-67	143.3	139.7	140.4	140.8	2.5%	0.5%	0.8%
A-68	142.7	136.0	136.8	142.9	4.7%	0.6%	4.8%
A-69	139.1	133.0	135.8	139.6	4.4%	2.1%	4.7%
A-70*	145.5	142.0	143.4	143.6	2.4%	1.0%	1.1%
A-71	147.4	143.0	143.0	144.1	3.0%	0.0%	0.8%
A-72*	151.4	144.1	147.6	146.6	4.8%	2.4%	1.7%
A-73	145.6	138.0	139.2	137.9	5.2%	0.9%	-0.1%
A-74	141.8	138.0	139.3	142.8	2.7%	1.0%	3.4%
A-75	139.0	133.1	136.5	136.1	4.2%	2.5%	2.2%
A-76	147.1	143.0	144.6	145.2	2.8%	1.1%	1.5%
A-77	147.5	143.0	145.4	144.4	3.1%	1.7%	1.0%
A-78	156.8	149.0	153.0	152.4	5.0%	2.7%	2.2%
A-79*	153.8	148.0	151.8	147.6	3.8%	2.5%	-0.3%
A-80	146.2	142.4	144.5	144.9	2.6%	1.5%	1.7%
A-81	147.1	144.5	146.1	148.3	1.8%	1.1%	2.6%
A-82	141.5	137.3	139.6	142.5	3.0%	1.7%	3.6%
A-83	147.0	144.3	145.7	145.8	1.8%	1.0%	1.0%
A-84	153.4	149.0	151.9	151.9	2.9%	2.0%	1.9%
A-85	156.3	151.8	153.0	152.8	2.9%	0.8%	0.7%
A-86	151.2	145.8	147.9	146.0	3.6%	1.5%	0.1%
A-87*	149.0	141.0	146.7	-	5.4%	4.0%	-
A-88	139.6	131.6	135.0	-	5.7%	2.6%	-
A-89*	148.5	141.0	145.9	-	5.1%	3.5%	-
Average	147.1	141.8	142.2	144.7	3.7%	1.7%	1.6%

Note: * indicates a period where the CEPC has formulated a complaint to the National Farm Products Council over the domestic allocation approved by the CFC Board. Each period is eight weeks long. Period A-66 covered production between June 26 and August 20 of 2005. Period A-89 covered production between January 4 and February 28 of 2009. The data were obtained from Farm Products Council of Canada (2009).

Table 2: Imports of chicken (000 kg of eviscerated weight)

Year	Import permits	Import permit in % of production	Supplementary Import permits	Total import permits	Total import permits in % of production
2001	65 179	7.40 %	21 547	86 727	9.84 %
2002	68 638	7.38 %	26 843	95 481	10.27 %
2003	69 005	7.35 %	27 098	96 103	10.23 %
2004	70 371	7.53 %	33 706	104 078	11.14 %
2005	72 551	7.67 %	43 710	116 261	12.29 %
2006	74 582	7.60 %	57 676	132 258	13.48 %
2007	76 184	7.82 %	75 786	151 970	15.61 %

Note: The data were obtained from Chicken Farmers of Canada (2009). The percentages are calculated as the share of imports with respect to the previous year production.

Table 3: Data use as basis for model calibration

Data	**Source**	**Value**
Total farm cash receipt in 2008 ($000)	Chicken Farmers of Canada (2009)	1,987,926
Production (000 kg)	Chicken Farmers of Canada (2009)	1,017,216
Consumption (000 kg)	Chicken Farmers of Canada (2009)	1,047,946
Price paid to farms ($ per kg of live weight)	Chicken Farmers of Canada (2009)	1.444
Wholesale price – market composite ($ per kg)	Chicken Farmers of Canada (2009)	3.03
Retail price for broilers ($ per kg)	Chicken Farmers of Canada (2009)	5.749
Retail price for breast ($ per kg)	Chicken Farmers of Canada (2009)	15.17
Retail price for wings ($ per kg)	Chicken Farmers of Canada (2009)	8.14
Retail price for legs ($ per kg)	Chicken Farmers of Canada (2009)	5.27
Retail price for drums ($ per kg)	Chicken Farmers of Canada (2009)	5.78
Weight share of breast	Australian Chicken Meat Federation (2007)	0.41
Weight share of wings	Australian Chicken Meat Federation (2007)	0.12
Weight share of legs	Australian Chicken Meat Federation (2007)	0.31
Weight share of drums	Australian Chicken Meat Federation (2007)	0.17
Import of chicken from the US (000 kg)	US International Trade Commission (2010)	242,422
Import of chicken from the US ($US 000)	US International Trade Commission (2010)	114,555
Annual average exchange rate ($US/$Can)	Bank of Canada (2009)	1.066
Marginal cost of farms ($ per kg of live weight)	Rude and Gervais (2006)	0.78
Marginal cost of processors ($ per kg)	Gervais and Surprenant (2003)	0.89
Elasticity of demand	Gervais and Surprenant (2003)	-0.80
Share of import licenses allocated to retailers	Gervais and Surprenant (2003)	0.58

Note: All prices and quantities are expressed in terms of eviscerated weight except for the price paid to farms.

Table 4: Parameter values in the calibrated model

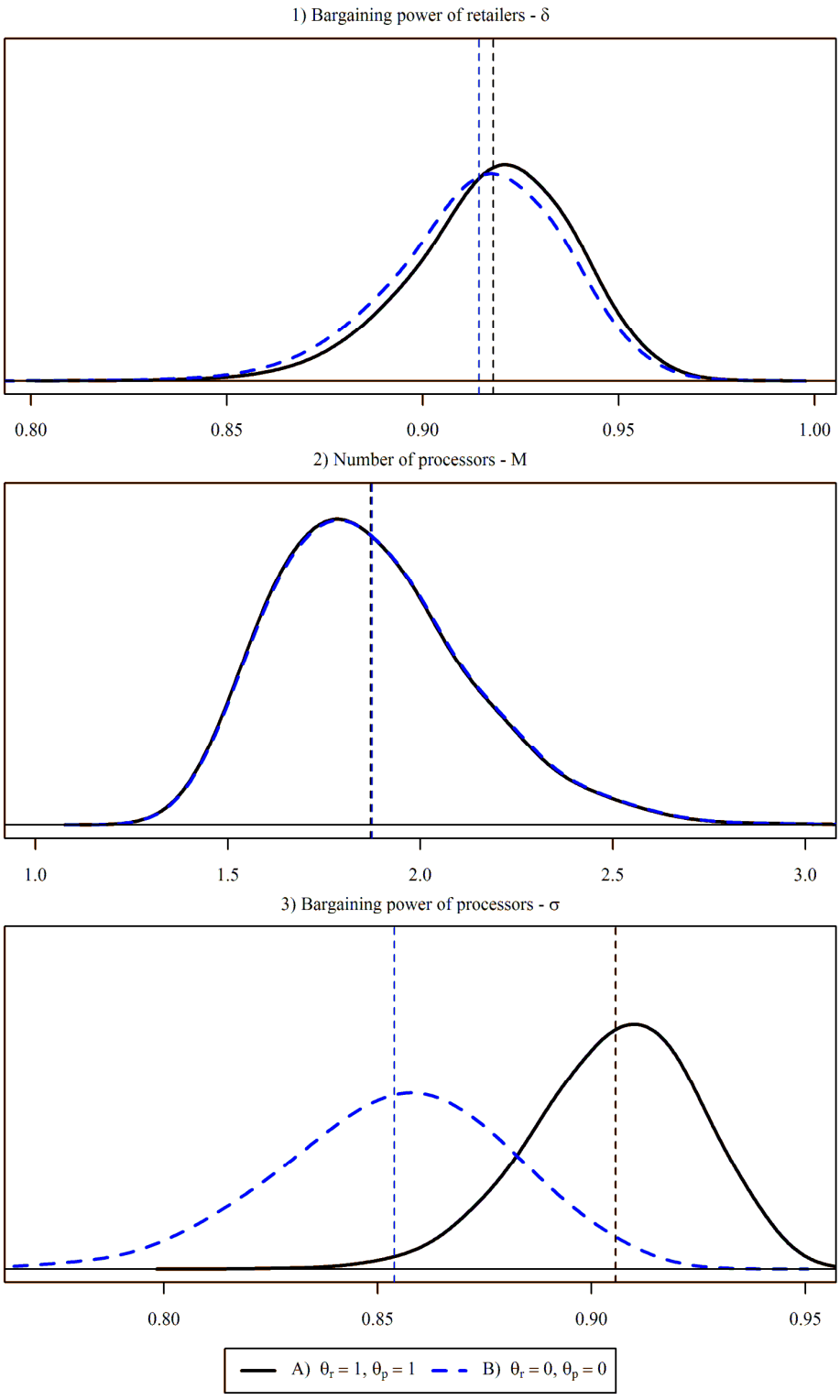
Constant parameters

Parameter	Description	Value
Q	Domestic production (000 kg)	1,017,216
$(1+\gamma)Q$	Consumption (000 kg)	1,093,507
λ	Share of retailers import licenses	0.58

Random parameters

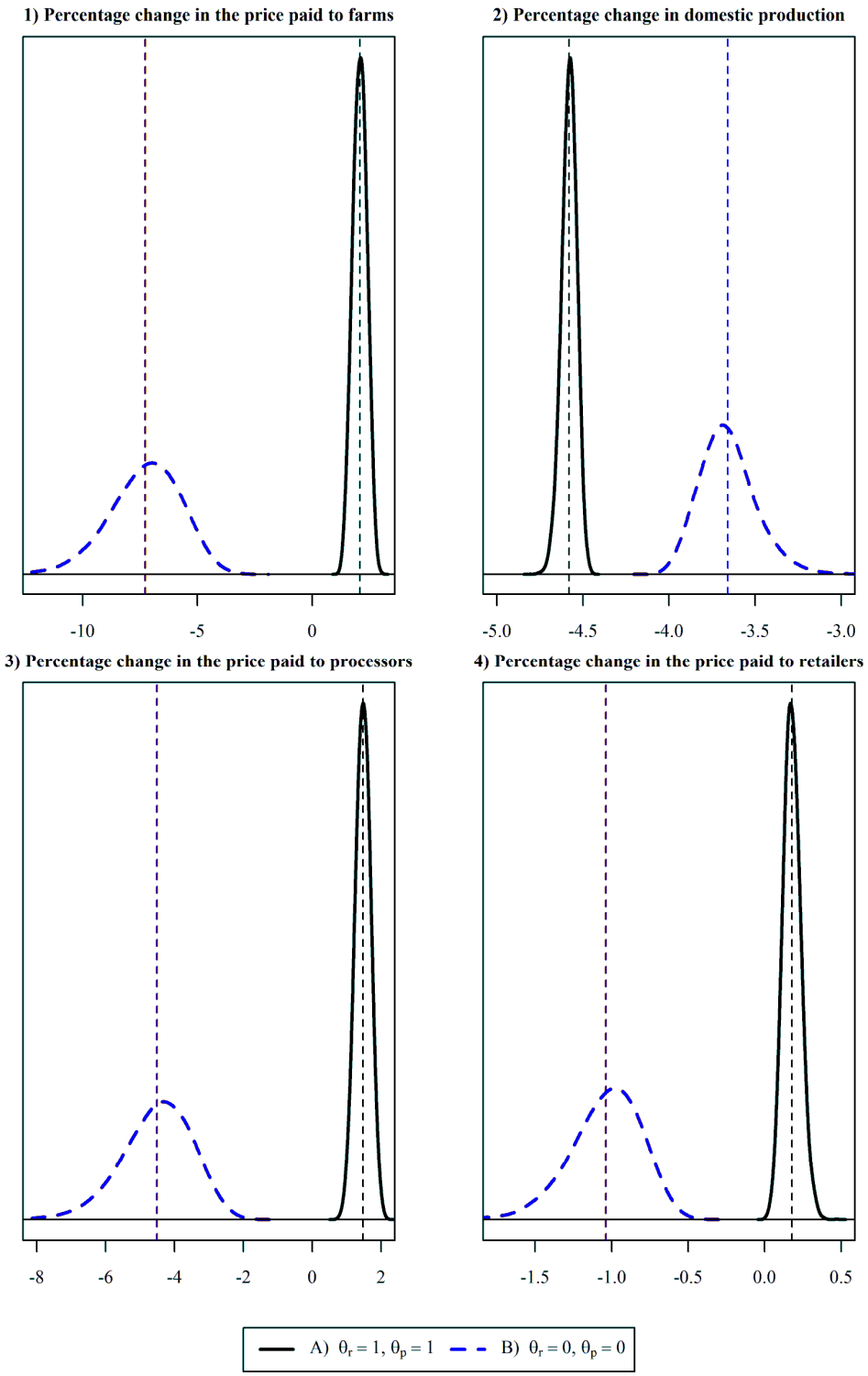
Parameter	Description	Min	Mean	Max	Variance
$P\left[(1+\lambda)Q\right]$	Retail price ($ per kg)	6.00	9.00	12.00	0.081
p_p	Wholesale price ($ per kg)	2.90	3.03	3.16	0.002
p_f	Price paid to farms ($ per kg)	1.85	1.95	2.05	0.001
p_w	Import price ($ per kg)	2.00	2.26	2.50	0.006
η	Elasticity of demand	-1.10	-0.80	-0.45	0.009
c_f	Marginal cost of farms ($ per kg)	0.60	1.05	1.50	0.019
c_p	Marginal cost of processors ($per kg)	0.35	0.60	1.00	0.007
c_r	Marginal cost of retailers ($ per kg)	0.15	0.60	1.10	0.020

Note: All prices and quantities are expressed in terms of eviscerated weight



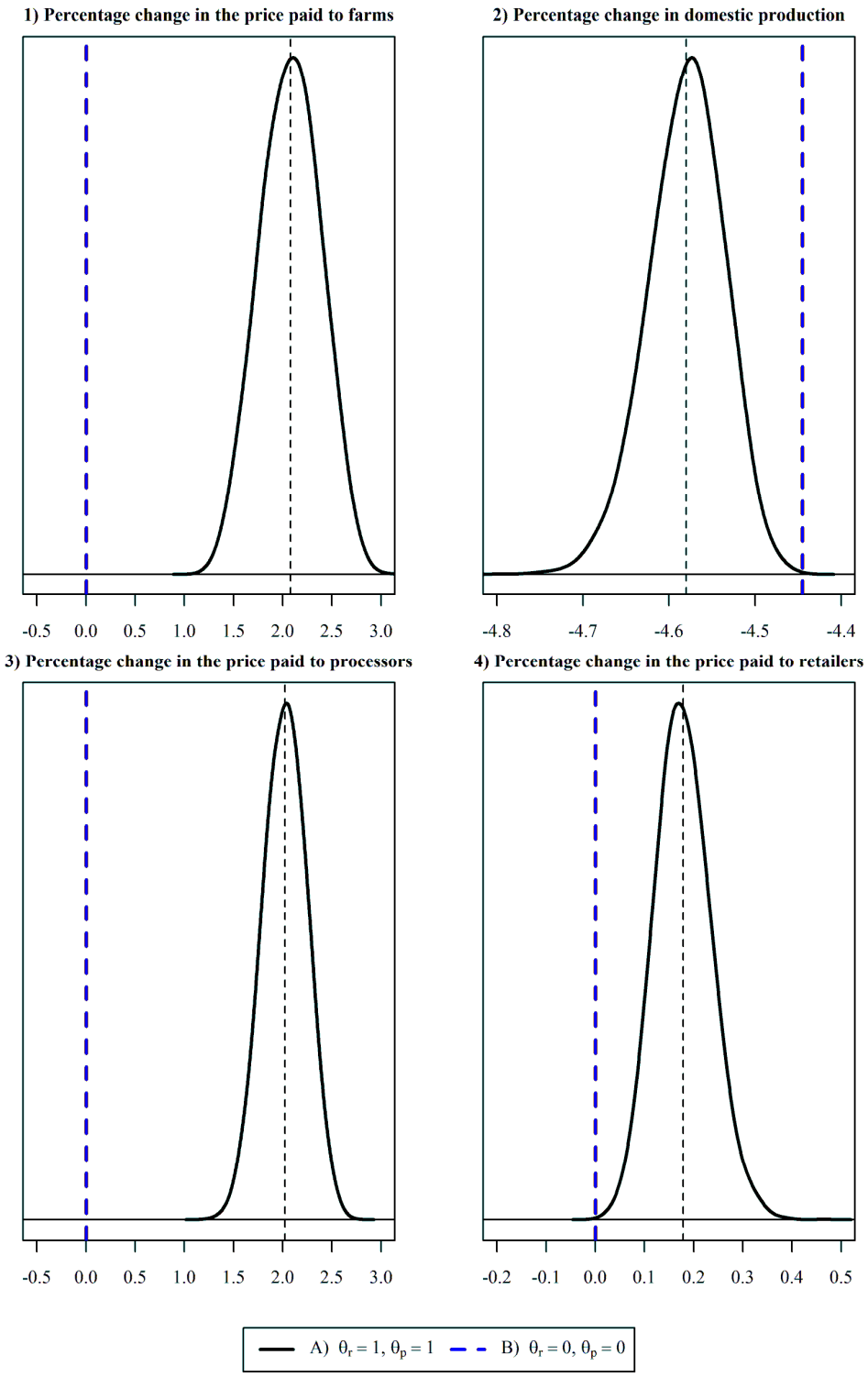
Note: the vertical dashed lines indicate the mean of parameters.

Figure 1: Distribution of parameters calibrated from the model



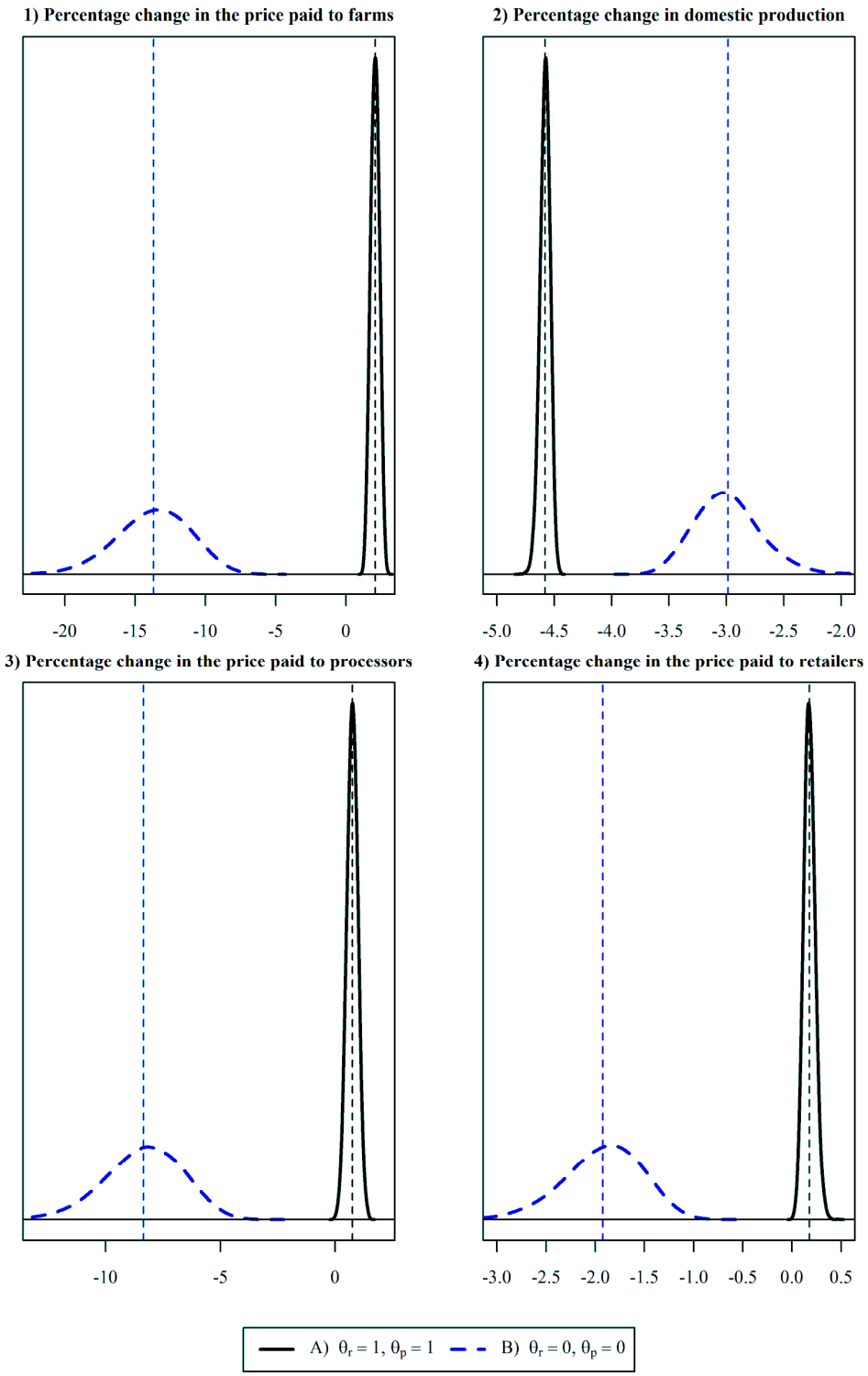
Note: the vertical dashed lines indicate the mean of percentage changes.

Figure 2: Percentage change in prices and domestic production when import licenses increase but the allocation of licenses remains the same



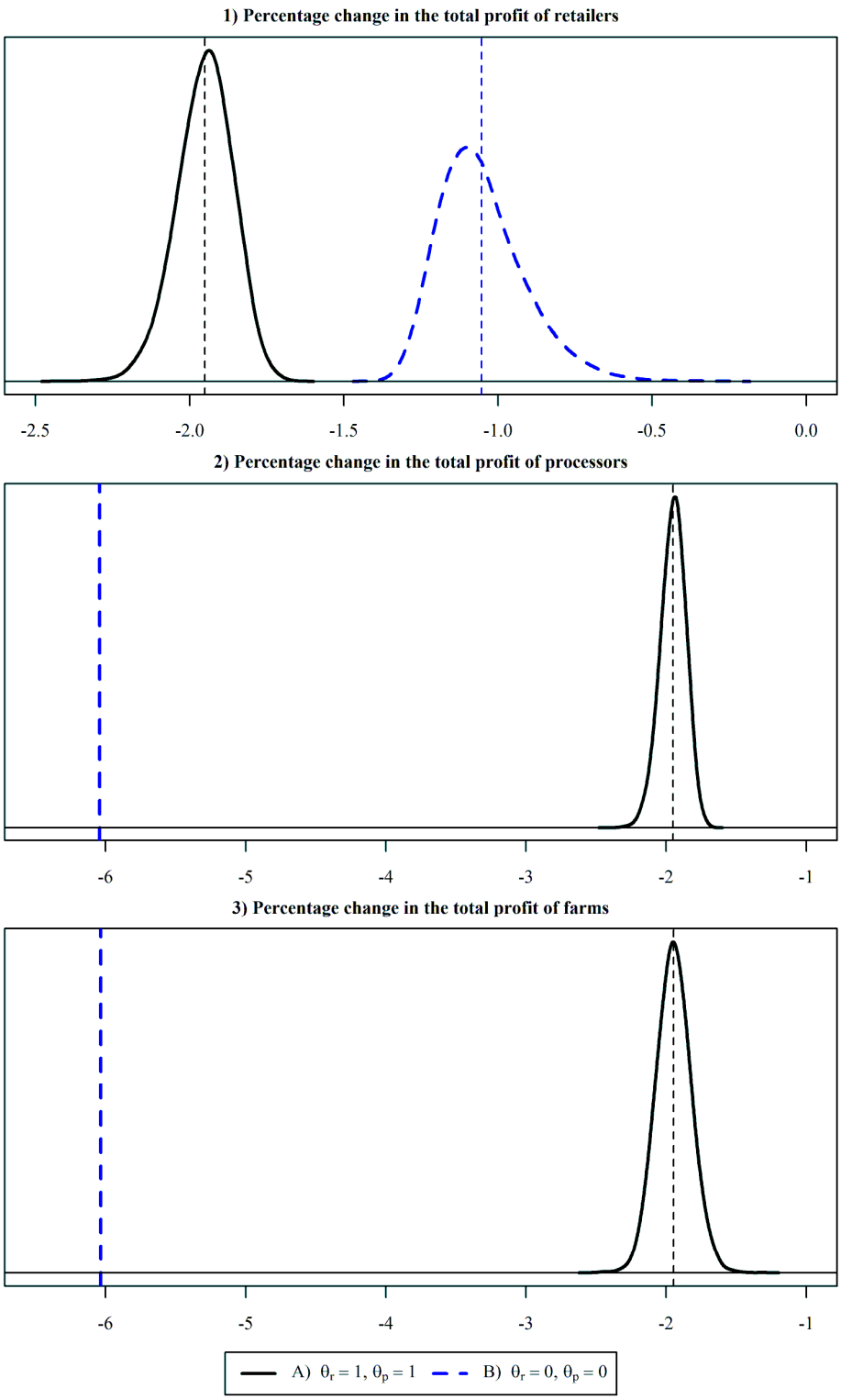
Note: the vertical dashed lines indicate the mean of percentage changes.

Figure 3: Percentage change in prices and domestic production when import licenses increase and more import licenses go to retailers



Note: the vertical dashed lines indicate the mean of percentage changes.

Figure 4: Percentage change in prices and domestic production when import licenses increase and more import licenses go to processors



Note: the vertical dashed lines indicate the mean of percentage changes.

Figure 5: Percentage change in profits when import licenses increase and more import licenses go to retailers (scenario 2)