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Compositional Standards, Import Permits and Market Structure: The Case of Canadian Cheese Imports

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Abstract: The imposition of new cheese compositional standards by the Canadian authorities has created divisions within the Canadian dairy industry and has motivated criticisms from several of Canada's trade partners. The standards impose minimum limits on the percentage of casein coming from fluid milk which vary across cheese types. We develop a theoretical model to investigate the implications of Canada's compositional cheese standards while accounting for-Canada's tariff rate quota specificities. The "use it or lose it" clause on import permits makes it possible for cheeses not directly constrained by the standards to be strongly impacted. We also show that the regulations on cheese composition may or may not increase the domestic demand for milk. Without information on technical coefficients in the cheese industry, we were unable to resolve through empirical simulations the ambiguities arising from our theoretical results. Our empirical investigation focused instead on the pricing and composition of cheese imports. We identified structural breaks in the processes determining import unit values shortly before or shortly after the beginning of the implementation of the standards. We found differences in break dates across cheese types and also across countries supplying the same type of cheese. Thus, the standards had some impact on the market shares of our trade partners as well as inflationary effects on cheese prices.

Résumé: L'imposition de normes de composition du fromage par les autorités canadiennes a créé des divisions au sein de l'industrie laitière Canadienne et a fait l'objet de vives critiques de la part de plusieurs partenaires commerciaux du Canada. Ces nouvelles normes introduisent des limites minimales sur la teneur en caséine provenant du lait et varient d'un fromage à l'autre. Nous avons élaboré un modèle théorique pour analyser les implications de ces normes en tenant compte de la spécificité du contingent tarifaire Canadien sur le fromage La règle assujettissant tout détenteur de permis d'importation sous-utilisé à une coupure de permis définitive fait qu'il est possible pour des fromages dont la production n'est pas directement contrainte par les normes de composition d'être finalement très affectés par celles-ci. Nous montrons aussi que les normes de composition peuvent faire augmenter ou diminuer la demande interne de lait. Les coefficients techniques de l'industrie fromagère n'étant pas disponibles, nous n'avons pas été en mesure de simuler les effets des normes de composition pour dénouer les ambiguïtés dans nos résultats théoriques. Notre analyse empirique focalise plutôt sur les prix et la composition des importations de fromage. Nous avons identifié des changements structurels dans les processus de détermination des valeurs unitaires des importations de fromage juste avant ou juste après l'application des nouvelles normes. Les dates des changements diffèrent d'un type de fromage à un autre et aussi, pour un même type de fromage, selon les sources. Les normes de composition semblent avoir eu un impact sur les parts de marché de nos partenaires commerciaux et des effets inflationnistes sur les prix des fromages.

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1. Introduction

Canada adopted cheese compositional standards in 2008 in response to the growing use of dairy protein isolates by cheese manufacturers. The new standards impose minimum limits on the percentage of casein coming from fluid milk and maximum limits on the whey protein to casein ratio which cannot exceed that of milk. The limits vary depending on the type of cheese, as shown in Table 1, but concern both domestic and imported cheese. Only Feta cheese and cream cheese are completely spared by the standard: even though processed cheese is not included in the table, cheese used as an ingredient in any other food, including processed cheese, must meet the standard. These new compositional standards are likely to impact the competitiveness of cheese exporters in the Canadian market. Our objective is to analyze the impacts of the new standards on domestic cheese production and value of Canadian cheese imports from both a theoretical and empirical perspectives.

Domestic cheese production in Canada is dominated by four firms, Saputo, Kraft, Agropur and Parmalat, which together process roughly 75% of all the milk domestically produced.[1] They all produce several types of cheese, though Saputo is mostly known as a mozzarella manufacturer. All three have made several acquisitions at home or abroad, notably in the United States[2] and South America. In 2004, Saputo had the largest share of the Canadian cheese market (38%) followed by Kraft (23%), Agropur (18%) and Parmalat (12%). They compete against a fringe of small manufacturers in the market for specialty cheeses, particularly in Quebec, but they are the only firms with the R&D capacity to be competitive in mozzarella manufacturing.[3] Canada produces a lot of traditional cheeses (cheddar 24%, mozzarella 20%, processed cheese 11% and cottage cheese 3%), but all of the specialty cheeses make up 42% of the national cheese production. The large cheese manufacturers have become increasingly fond of dairy protein isolates because these ingredients have

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[1] See www.dairyinfo.gc.ca/index_e.php?s1=cdi-ilc for additional information.

[2] Saputo is among the top 3 manufacturers of cheese in the United States and its sales of cheese and other dairy products makes it the world's 12th largest dairy processor. In July of 2011, Lactalis purchased 83% of Parmalat and became the world's largest dairy manufacturer.

[3] Prof. Denis Roy at Laval University, who holds a Canada Research Chair in lactic culture biotechnology for dairy and probiotic industries and a NSERC Industrial Research Chair on cheese technology and type characterization, likened the Mozzarella R&D to research on the performance of sophisticated plastics under extreme heat.

lowered their cost of production while making it easier to control quality variations that arise because of heterogeneity in milk from one season to the next.

The Canadian dairy industry is operating under a supply management policy that imposes constraints on domestic milk production and on imports of milk and dairy products. The objective of supply management is to increase the price of milk at the farmgate. The milk used for cheese manufacturing in Canada accounts for 37% of total domestic production, but most milk protein products are imported from New Zealand, Australia and the European Union. Saputo, Kraft and Parmalat have challenged in court the compositional standards championed by Canadian dairy producers.[4] Their argument was that the federal government had exceeded its authority in using regulations "to effect an economic transfer in favour of dairy producers to the detriment of dairy processors".[5] The processors lost in Federal Court and the subsequent appeal. Undeterred by these setbacks, Saputo and Kraft petitioned the Supreme Court of Canada to hear their arguments, but Canada's highest court decided on November 24 of 2011 not to rule on the case. Canada's compositional cheese standards are here to stay.

Import permits and import licenses are required for any firm wishing to import cheese. The former have been required for a long time, but import licenses were recently introduced along with the new standards. An import license can be revoked if the cheese imported does not comply with the standards. A tariff-rate-quota is used to limit cheese imports. Two thirds of the annual import quota of 20,412 metric tons is allocated for cheeses produced in the European Union. Cheese import permits are allocated on a historical basis, not on a first-come first-served basis. Permits are transferable between importers who must also hold an import licence to be able to import. Holders of specific in-quota permits can import duty-free from the United States and pay $0.032/kg on cheese imported from other sources. Over-quota imports are done under General Permit no.100 and are subject to an ad-valorem tax of 245.5% whose specific-equivalence is not allowed to fall below a certain threshold, depending on the type of cheese, when world prices are low.[6] Finally, it is

[4] In contrast, Agropur, which is a cooperative owned by Quebec dairy producers, publicly argued that the new standards would not have an incidence on its cheese manufacturing costs. See www.laterre.ca/?action=detailNouvelle&menu=4&section=production&idArticle=6118.

[5] The wording is from the Federal Court of Appeal ruling which can be viewed from http://decisions.fca-caf.gc.ca/en/2011/2011fca69/2011fca69.html.

[6] For example, for blue-veined cheeses, the specific threshold is $5.33/kg, but $4.52/kg for fresh cheese (unripened/uncured) cheese, including whey cheese and curd.

important to note that permits are not specific to any particular type of cheese, thus giving flexibility to importers to adjust the mix of imported products based on variations in domestic and import prices. However, permits are accompanied by a "use it or lose it" clause that forces importers to fill their permit in each allocation period.

The next section features a descriptive analysis of the Canadian import market for cheese. We then develop a simple theoretical model to shed some light on the effects of the standards and the setting of the import quota. Our objective is to characterize the incidence of the standards on domestic production, cheese imports value and consumption while accounting for Canada's dairy market structure. Then, because we suspect new compositional standards to have significant impact on cheese import unit values, we search for disruptions in the processes determining them. We use a structural change test developed by Andrews (2003) that is specially designed to detect structural change occurring near the end of the sample.

2. Canadian Cheese Imports and Compositional Standards

Table 2 lists the main countries exporting cheese to Canada. All the data come from the Canadian Dairy Information Centre.[7] The main category of cheese imports falls under HS code 0406.90: this category accounted for 81% of Canada's total cheese imports in 2010. . The top 5 cheese types imported under that category are Parmesan (1.8 million kg), Jarlsberg (1.34 million kg), Gouda (1.07 million kg), Grana (0.99 million kg) and Cheddar (0.96 million kg). Considering other categories, Canada imported in 2010: 0.59 million kg of fresh cheeses, 0.59 million kg of grated/powdered cheeses, 1.05 million kg of blue-veined cheeses and 1.19 million kg of processed cheeses. European countries, like France, Italy and Switzerland dominate the list of main exporters along with the United States

Because countries have different traditions when it comes to food preparations and because firms may not all have the same technologies, standards may not bind for some firms while being a major constraint for others. Accordingly, it is interesting to compare Canada's new regulations with the regulations used by its main trading partners. In the United States, many dairy products must conform to an official Food and Drug Administration (FDA) description about the components and/or processes used in production. These are called "standards of identity". Standards of identity for food are mandatory federally-set

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[7] www.dairyinfo.gc.ca.

requirements about the content of foods to be marketed under a certain name in inter-state commerce. Milk protein concentrates are not allowed for use in cheese products bearing a standard of identity. The use of protein concentrates in non-standardized cheese (e.g., pizza cheese or some kinds of processed cheese) is legal. For example, there are standards of identity for "Pasteurized processed cheese", "Pasteurized processed cheese food" and "Pasteurized processed cheese spread", but many processed cheese products are designated "Pasteurized Prepared Cheese Product" or "Pasteurized Processed Cheese Product" and are not linked to any standard of identity.

In France, milk proteins ingredients may be used in cheese, cottage cheese, blue cheese, whey cheese, processed cheese, blended cheese, cheese specialties and processed cheese specialties, but only to a certain extent. The protein content of the source mixture cannot be increased by more than 5g/l for a specific list of specialty cheeses (Brie, Camembert, Emmental ,…) and 10g/l for the others (Décret no 2007-628 du 27 avril 2007 relatif aux fromages et spécialités fromagères). The cheese regulations adopted in 2006 in France are quite similar to their Canadian counterparts.

Figures 1 and 2 present annual Canadian cheese imports from France and the U.S., respectively, by product types. In and out of themselves, these figures do not reveal anything about the effects of Canadian compositional standards on foreign firms' competitiveness. Yet, the variability in the value of Canadian cheese imports and the fact that imports of different product categories are moving in different directions suggest that standards may have had an impact on the ability of foreign firms to compete in the Canadian market. The next two sections investigate this possibility from a theoretical and empirical perspective.

3. The Theoretical Model

Compositional standards and costs

We posit that cheese is produced under a Leontief technology, with milk (*m*) being used in fixed proportion with an aggregate input (*x*) such that production of cheese of type *i* can be depicted as: $q_i \equiv \min(\alpha_i m, \beta_i x)$. When unconstrained, a manufacturer would use $1/\alpha_i$ units of *m* and $1/\beta_i$ units of *x* for every unit of cheese produced. Therefore, the cost function is $C_i = q_i\left(\frac{w_m}{\alpha_i} + \frac{w_x}{\beta_i}\right)$ where w_m and w_x are the prices of the milk and aggregate input and it follows that the unit cost function would simply be the constant sum $c_i = \left(\frac{w_m}{\alpha_i} + \frac{w_x}{\beta_i} \right)$.

This technology produces isoquants like the one shown in Figure 3. The slope of the line emanating from the origin and going through the cost minimizing bundle of inputs (point A) to produce q_i tells us about the unconstrained proportions by which inputs are used. Point A is the cheapest combination of inputs that allow quantity q_i of cheese to be produced. The effect of a binding compositional standard on the use of milk can be pictured by a lower input-proportions line going through point B which is the lowest cost input combination to produce output q_i under a higher mandated milk proportion. Clearly, a binding compositional standard s_i increases the per unit cost of cheese: the greater the standard relative to the unconstrained input requirement $1/\alpha_i$, the greater the impact on cost. Given that the compositional standard forces more input *m* to be used per unit of cheese produced, the increase in per unit cost is simply: $\Delta c_i = \left(s_i - \frac{1}{\alpha_i} \right) w_m$.

Number of products and firms

We consider a simplified case with only 2 types of cheese. We assume that there are m_1 domestic firms producing type 1 cheese at unit cost c_1 and m_2 domestic firms producing type 2 cheese at unit cost c_2. Furthermore, *n* importers potentially purchasing both types of cheese at prices r_1 and r_2 compete against domestic firms. Importers have strategic interactions with domestic firms, but have no market power when purchasing cheese from foreign suppliers. The model can be constrained to depict different market structures. For example, setting m_2=0 produces a market in which importers market a differentiated cheese and a cheese that is identical to the cheese produced domestically. Another alternative would be to have the *n* importers be domestic manufacturers of type 1 and type 2 cheeses, thus acting like multi-plant oligopolists.[8]

[8] If the firms were multinationals with plants at home and abroad with domestic and foreign per unit costs c_1, c_2, r_1 and r_2, they would optimize sourcing and produce at the lowest cost locations. Under constant returns to scale, this would imply closing plants at some locations.

Appealing to the concept of a representative consumer endowed with quasi-linear preferences, we expressed preferences as $U = Z + A_1X_1 + A_2X_2 - 0.5\left(X_1^2 + X_2^2\right) - \gamma X_1X_2$, where Z is an aggregate good, X_j is the demand for type *j*=1,2 cheese, $A_j > 0$ and $\gamma \in (0,1)$.[9] We can derive the following inverse demand equations for the two types of cheese:

$$p_1 = A_1 - \sum_{j=1}^{m_1} q_{1j}^A - \sum_{j=1}^{n} q_{1j}^B - \gamma \sum_{j=1}^{m_2} q_{2j}^A - \gamma \sum_{j=1}^{n} q_{2j}^B \tag{1}$$

$$p_2 = A_2 - \sum_{j=1}^{m_2} q_{2j}^A - \sum_{j=1}^{n} q_{2j}^B - \gamma \sum_{j=1}^{m_1} q_{1j}^A - \gamma \sum_{j=1}^{n} q_{1j}^B \tag{2}$$

where the superscripts A and B identify producing and importing firms, respectively.

The profit of a domestic producer *j* of type 1 cheese can be written as:

$$\pi_{1i}^A = \left(A_1 - \sum_{j=1}^{m_1} q_{1j}^A - \sum_{j=1}^{n} q_{1j}^B - \gamma \sum_{j=1}^{m_2} q_{2j}^A - \gamma \sum_{j=1}^{n} q_{2j}^B - c_1 \right) q_{1i}^A \tag{3}$$

The profit-maximizing first-order condition is:

$$\frac{\partial \pi_{1i}^A}{\partial q_{1i}^A} = \left(A_1 - \sum_{j=1}^{m_1} q_{1j}^A - \sum_{j=1}^{n} q_{1j}^B - \gamma \sum_{j=1}^{m_2} q_{2j}^A - \gamma \sum_{j=1}^{n} q_{2j}^B - c_1 \right) - q_{1i}^A \le 0$$

It holds with equality when a strictly positive quantity can be profitably produced.

Appealing to the concept of symmetric firms and assuming an interior solution, we can write the above equilibrium condition as:

$$\begin{aligned} j_1^A &\equiv A_1 - (m_1+1)q_1^A - nq_1^B - \gamma m_2 q_2^A - \gamma n q_2^B - c_1 \\ &= A_1 - (m_1+1)q_1^A - n(1-\gamma)q_1^B - \gamma m_2 q_2^A - \gamma n \overline{Q} - c_1 = 0 \end{aligned} \tag{4}$$

where the last equality results from the "use it or lose it" clause on import permits, which implies that $q_{2i}^B = \overline{Q_i} - q_{1i}^B$ always holds for importer *i*. Domestic type 1 cheese manufacturers choose a quantity that equates their marginal revenue to their marginal cost. The former is impacted by the fixed import level $n\overline{Q}$ (stemming from the "use it or lose it" clause) and by the number of firms and the volume they sell. As such, the first order condition defines a slightly unusual reaction function.

[9] This parameter determines how close a pair of substitutes type 1 and type 2 cheeses are. When $\gamma \to 0$, the two types of cheese are independent while when $\gamma \to 1$, the two types of cheese are perfect substitutes. We assume that the cheeses are imperfect substitutes.

The profit of a domestic firm producing type 2 cheese is:

$$\pi_{2i}^{A}=\left(A_2-\sum_{j=1}^{m_2}q_{2j}^{A}-\sum_{j=1}^{n}q_{2j}^{B}-\gamma\sum_{j=1}^{m_1}q_{1j}^{A}-\gamma\sum_{j=1}^{n}q_{1j}^{B}-c_2\right)q_{2i}^{A} \tag{5}$$

With symmetric firms, the "use it or lose it" clause and assuming an interior solution, we can write the following first-order condition which defines a reaction function:

$$j_2^A\equiv A_2-\gamma m_1 q_1^A+n\left(1-\gamma\right)q_1^B-(m_2+1)q_2^A-n\overline{Q}-c_2=0 \tag{6}$$

The Canadian cheese TRQ is set up with very low in-quota tariff and a prohibitively high over-quota tariff. Canada's TRQ are generally set up this way to mimic import quotas (Larue, Gervais, Pouliot, 2008; Larue, Lapan and Gervais, 2010). To keep the notation as simple as possible, we assume that the in-quota tariff on cheese is zero and the over-quota tariff is infinite. If the "use-it–or-lose-it" clause on import permits is credible, then $q_{2i}^B=\overline{Q_i}-q_{1i}^B$ always holds and the profit of importer *i* is :

$$\begin{aligned}\pi_i^B=&\left(A_1-\sum_{j=1}^{m_1}q_{1j}^A-\sum_{j=1}^{n}q_{1j}^B-\gamma\sum_{j=1}^{m_2}q_{2j}^A-\gamma\sum_{j=1}^{n}(\overline{Q_j}-q_{1j}^B)-r_1\right)q_{1i}^B+\\&\left(A_2-\sum_{j=1}^{m_2}q_{2j}^A-\sum_{j=1}^{n}(\overline{Q_j}-q_{1j}^B)-\gamma\sum_{j=1}^{m_1}q_{1j}^A-\gamma\sum_{j=1}^{n}q_{1j}^B-r_2\right)(\overline{Q_i}-q_{1i}^B)\end{aligned} \tag{7}$$

With symmetric firms, the last equation simplifies to:

$$j^B\equiv(A_1-A_2)-(r_1-r_2)-m_1(1-\gamma)q_1^A-(2n+1)(1-\gamma)q_1^B+m_2(1-\gamma)q_2^A+(n(1-\gamma)+1)\overline{Q} \tag{8}$$

We assume that firms have Cournot conjectures.[10] Thus, equilibrium quantities are determined by simultaneously solving the reaction functions/first order conditions of the three types of firms given by (4), (6) and (8).[11]

[10] Given that importers have a fixed volume, it could be argued that their reactions could easily be anticipated by domestic producers who would like to exploit a first-mover advantage. Harris (1985) contends that a voluntary export restraint (VER) on foreign firms would induce domestic and foreign firms to play sequentially when they play simultaneously according to Bertrand conjectures under free trade. In Harris's setting, sequential play can induce higher prices and profit for foreign firms. This is not the case when firms have Cournot conjectures.

[11] The expressions are rather messy in spite of the simplifying assumptions. Since we are interested in how the compositional standard affects the equilibrium, we focus our attention on the comparative statics.

Comparative statics about cost increases induced by a compositional standard

Changes in equilibrium quantities in response to exogenous variables can be analyzed by totally differentiating the reaction functions:

$$\begin{bmatrix} -m_1-1 & -n(1-\gamma) & \gamma m_2 \\ -m_1(1-\gamma) & -(2n+1)(1-\gamma) & m_2(1-\gamma) \\ \gamma m_1 & n(1-\gamma) & -m_2-1 \end{bmatrix}\begin{bmatrix} dq_1^A \\ dq_1^B \\ dq_2^A \end{bmatrix}=\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}dr_1+\begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix}dr_2+\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}dc_1+\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}dc_2 \qquad (9)$$

As previously mentioned, compositional standards vary across cheese types. Because cheese technologies and regulations vary across countries, the cost impact of the standard on firms is likely to depend on the country of origin and type of cheese. Given that Canada's trade partners have expressed concerns about the effect of Canada's compositional standard on the competitiveness of their cheese exporters, we begin by analyzing the effects of an increase in the import cost of type 1 cheese r_1. We will then analyze changes in r_2, c_1 and c_2. Define the determinant of the Hessian matrix as:

$$H \equiv -\left(1-\gamma\right)\left(1+2n+m_2(1+n(1+\gamma)+m_1\left(1+n(1+\gamma)+m_2(1-\gamma^2)\right)\right)<0 \qquad (10)$$

We can then analyze the impact of an increase in the cost of foreign type 1 cheese. This is like saying that the new standards have no effect on the cost of type 2 cheese and on the cost of domestic producers of type 1 cheese. Equilibrium quantities change as follows:

$$\frac{\partial q_1^A}{\partial r_1}=-n\left(1-\gamma\right)\left(1+m_2+m_2\gamma\right)/H>0, \qquad (11)$$

$$\frac{\partial q_1^B}{\partial r_1}=-\frac{\partial q_2^B}{\partial r_1}=\left(1+m_2+m_1(1+m_2-m_2\gamma^2)\right)/H<0, \qquad (12)$$

$$\frac{\partial q_2^A}{\partial r_1}=n\left(1-\gamma\right)(1+m_1+m_1\gamma)/H<0 \qquad (13)$$

When the compositional standard binds only on foreign type 1 cheese manufacturers, each importer of foreign type 1 cheese imports less and each domestic producer of type 1 cheese produces more. One might be tempted to conclude from this outcome that the compositional standard could be used as a mechanism to shift rent from importers to domestic manufacturers. However, because of the "use-it-or-lose-it" clause and the ability of importers to change their import mix, individual importers fill their import permits by purchasing more type 2 cheese. Individual domestic manufacturers of type 2 cheese anticipate this effect and lower their production.[12]

Proposition 1: *If the compositional standard binds only on foreign producers of type 1 cheese, consumption of type 1(2) cheese falls (increases), and total quantity of domestic cheese produced can decrease/stay the same/increase as* $m_1 \underset{>}{\overset{<}{-}} m_2$.

Proof: From (10), (11), (12) and (13), we get: $\frac{\left(m_1 \partial q_1^A + n \partial q_1^B\right)}{\partial r_1} = \frac{n\left(1 + m_2 + m_1\gamma\right)}{H} < 0$, $\frac{\left(m_2 \partial q_2^A - n \partial q_1^B\right)}{\partial r_1} = -\frac{n\left(1 + m_1 + m_2\gamma\right)}{H} > 0$, $\frac{\left(m_1 \partial q_1^A + m_2 \partial q_2^A\right)}{\partial r_1} = \frac{n\left(1 - \gamma\right)\left(m_2 - m_1\right)}{H} \underset{>}{\overset{<}{-}} 0$ as $m_1 \underset{>}{\overset{<}{-}} m_2$. **QED**

Even though the standard binds only foreign producers of type 1 cheese, domestic production can contract, unlike imports, for which the decrease in one type of cheese is matched by an increase of the same size for the other type. This case occurs when there are more type 2 cheese domestic manufacturers than type 1 cheese domestic manufacturer (i.e., when the standard favors (hurts) the least (most) competitive segment of domestic cheese manufacturing). Opposite changes in the domestic production of types 1 and 2 cheese are perfectly offsetting when $m_1 = m_2$.

Corollary: *If the compositional standard binds only on foreign producers of type 1 cheese, then total cheese consumption can decrease/stay the same/increase as* $m_1 \underset{>}{\overset{<}{-}} m_2$.

The above corollary follows automatically from Proposition 1 since changes in consumption and changes in domestic production are the same given that the level of import is fixed. The possibility of an increase in total cheese consumption resulting from a cost-increasing standard is rather interesting given that the result hinges on domestic market structure and that the standard binds only foreign-made type 1 cheese. There are few domestic firms that

[12] Pouliot and Larue (2012) show that a « use it or lose it » clause can induce perverse domestic price increases when tariff-rate quota are liberalized. However, allowing firms to "sleep" on import permits/quotas can have anti-competitive effects, as shown by Cunha and Santos (1996).

have the required R&D capacity to compete in mozzarella manufacturing. On the other hand, there are many domestic manufacturers of fine cheeses. If the standard was to bind only on foreign-made mozzarella (resp. fine cheeses), then total cheese consumption in the domestic market would decrease (resp. increase).

Proposition 2: *The standard can decrease/keep constant/increase the domestic demand for milk if* $\frac{m_1+B}{m_2+B} \begin{smallmatrix} < \\ = \\ > \end{smallmatrix} \frac{\alpha_1}{\alpha_2}$*, where* $B \equiv m_1 m_2 \left(1+\gamma\right)$

Proof: Recall that the milk requirement per unit of cheese of type i is $\frac{1}{\alpha_i}$. If the standard binds only on foreign producers of type 1 cheese, the increase in milk demand from domestic type 1 cheese manufacturers must be less/equal/larger than the decrease in milk demand from domestic type 2 cheese producers: $\frac{m_1 \partial q_1^A / \partial r_1}{\alpha_1} \begin{smallmatrix} < \\ = \\ > \end{smallmatrix} -\frac{m_2 \partial q_2^A / \partial r_1}{\alpha_2}$ which entails from (10), (11) and (13): $\frac{m_1 + m_1 m_2 \left(1+\gamma\right)}{m_2 + m_1 m_2 \left(1+\gamma\right)} \begin{smallmatrix} < \\ = \\ > \end{smallmatrix} \frac{\alpha_1}{\alpha_2}$. **QED**

Clearly, if milk requirements are identical across cheese types, $\frac{\alpha_1}{\alpha_2}=1$, then $m_1 < m_2$ is a sufficient condition for milk demand to fall. Even though the intent behind cheese compositional standards is to boost domestic milk production, as reflected by the intense lobbying made by Canadian milk producers, the outcome may be a reduction in the domestic demand for milk by cheese manufacturers if the least competitive segment of the domestic cheese industry is benefitting at the expense of the most competitive segment. The compositional standard can yield the opposite of what domestic dairy producers wish it would achieve.

By assumption, import permits are “just” filled and the volume of imports is unaffected by the standard. However, the value of cheese imports, and hence unit values, need not stay constant.

Proposition 3: *The value of trade can increase/stay constant/decrease in response to the imposition of a compositional standard that binds only on type 1 cheese exporters.*

Proof: The volume of trade is simply $n\bar{Q} \equiv n\left(q_1^B + q_2^B\right)$. The change in the value of trade is:

$$n\left(q_1^B + r_1\frac{\partial q_1^B}{\partial r_1} + r_2\frac{\partial q_2^B}{\partial r_1}\right) = nq_1^B\left(1+\frac{\left(r_1 - r_2\right)}{q_1^B}\frac{\partial q_1^B}{\partial r_1}\right) = nq_1^B\left(\frac{r_1 - r_2}{r_1}\right)\left(\frac{r_1}{r_1 - r_2} + \varepsilon_1^B\right)$$ where

$\varepsilon_1^B \equiv \frac{\partial q_1^B}{\partial r_1}\frac{r_1}{q_1^B} < 0$. If $r_1 < r_2$, the value of trade can only increase with a standard-induced increase in r_1. If $r_1 > r_2$, then the value of trade increases, stay the same or decreases as $\left(\frac{r_1}{r_1 - r_2}\right)\begin{matrix} > \\ = \\ < \end{matrix} -\varepsilon_1^B$. **QED**

The value of trade and unit values increase when the compositional standard binds on imported type 1 cheese unless imported type 1 cheese is "sufficiently" more expensive than imported type 2 cheese (e.g., $r_1 > 2r_2, -\varepsilon_1^B < 2$). The range of cheese prices is very wide and this tends to increase the likelihood of a decrease in trade, provided that the standard binds on "high-end" cheeses. Conversaly, if type 1 cheese is the least expensive (e.g., mozzarella), then the compositional standard will induce an increase in the value of imports. This is equivalent to the policy-induced quality upgrading effect discussed by Falvey (1979), documented by the empirical analysis of Aw and Roberts (1986) and further developed by Larue and Gervais (1996). Discussions with industry representatives led us to believe that the standards bind the most on mozzarella, thus favouring the quality upgrading hypothesis. Still, it is ironic that the forced substitution of milk for milk protein concentrate, which is often wrongly perceived as a mean to increase the quality of cheese, *could* lead to lower unit values and hence "quality downgrading in import composition. Proposition 3 has important implications for empirical applications involving gravity models or structural change tests on unit values, and hence provides a foundation for our empirical analysis.

From the total differentiation of the equilibrium conditions, it is easy to see that $\partial q_j^k / dr_2 = -\partial q_j^k / dr_1$ and that the above results can simply be reversed in sign to apply to the case of an increase in r_2 resulting from a binding compositional standard on imported type 2 cheese. Accordingly, let us now consider the case for which the standard binds only on domestic type 1 cheese. This would induce an increase in c_1. The changes in the equilibrium quantities are:

$$\frac{\partial q_1^A}{\partial c_1} = \left(1 + 2n + m_2(1 + n + n\gamma)\right)\left(1 - \gamma\right) / H < 0 \tag{14}$$

$$\frac{\partial q_1^B}{\partial c_1} = -\frac{\partial q_2^B}{\partial c_1} = -m_1\left(1 - \gamma\right)(1 + m_2(1 + \gamma)) / H > 0 \tag{15}$$

$$\frac{\partial q_2^A}{\partial c_1} = -m_1\left(1 - \gamma\right)(\gamma + n(1 + \gamma)) / H > 0 \tag{16}$$

Naturally, if the standard binds only on the domestic type 1 cheese manufacturers, these firms will reduce their output while importers of foreign type 1 cheese that already meet the standard would increase their purchases. Because of the prohibitive over-quota tariff rate, imports of type 2 cheese would fall so that the quota of the TRQ is just filled. Domestic production of type 2 cheese would increase, compensating for the decrease in type 2 cheese imports.

Proposition 4: *If the compositional standard binds only on domestic type 1 cheese manufacturers, then: type 1 cheese consumption decreases, type 2 cheese consumption and milk demand can decrease/stay constant/increase and domestic cheese production decreases*.
Proof: The effect of the standard on type 1 cheese domestic consumption is: $\frac{\partial\left(m_1 q_1^A + n q_1^B\right)}{\partial c_1} = m_1\left(1 - \gamma\right)(1 + m_2 + n) / H < 0$. For type 2 cheese consumption, we have: $\frac{\partial\left(m_2 q_2^A + n q_2^B\right)}{\partial c_1} = m_1\left(1 - \gamma\right)(n - m_2\gamma) / H \overset{<}{\underset{>}{-}} 0$ as $\frac{n}{m_2} \overset{>}{\underset{<}{-}} \gamma$. Type 2 cheese consumption can increase if the number of domestic manufacturers is large relative to the number of importers. It is easy to see that the volume of national cheese production decreases when the standard binds only on domestic type 1 cheese manufacturers: $m_1 \frac{\partial q_1^A}{\partial c_1} + m_2 \frac{\partial q_2^A}{\partial c_1} = m_1(1 + m_2(1 - \gamma) + 2n)\left(1 - \gamma\right) / H < 0$. Using (14) and (16), the change in the demand for milk $\frac{m_1}{\alpha_1}\frac{\partial q_1^A}{\partial c_1} + \frac{m_2}{\alpha_2}\frac{\partial q_2^A}{\partial c_1} \overset{<}{\underset{>}{-}} 0$ as $\frac{1 + 2n + m_2\left(1 + n + n\gamma\right)}{m_2\left(\gamma + n + n\gamma\right)} \overset{>}{\underset{<}{-}} \frac{\alpha_1}{\alpha_2}$. **QED**

Clearly, if the milk requirements for domestic type 2 and type 1 cheeses are similar, ($\frac{1}{\alpha_2} \approx \frac{1}{\alpha_1}$), then demand for milk unambiguously fall and the strategy to force the substitution of milk for milk protein concentrate backfires.

Proposition 5: *The value of trade can increase/stay the same/decrease if the standard binds only on domestic type 1 cheese manufacturers as* $r_1 \gtreqless r_2$.

Proof: The value of trade is $T = n\left(r_1 q_1^B + r_2 q_2^B\right)$ and differentiation with respect to c_1, taking into account that the quota of the TRQ always binds, yields: $\frac{\partial T}{\partial c_1} = n\left(r_1 - r_2\right)\frac{\partial q_1^B}{\partial c_1}$. From (15), we can assert that $sign\left(\frac{\partial T}{\partial c_1}\right) = sign\left(r_1 - r_2\right)$. **QED**

A standard binding only on domestic type 1 cheese manufacturers impacts the value of trade unless both cheese types have exactly the same price. The value of trade increases if the standard binds on the domestic production of the more expensive type of cheese. Then, the standard ends up tilting the composition of imports toward more (away from less) expensive cheeses. The implication for our subsequent empirical analysis is that an increase in import unit values does not necessarily imply that the standard binds on (or raised the costs of) imported cheese.

The case for which the standard binds on domestic producers of type 2 cheese can be inferred by interchanging types 1 and 2 in the previous analysis and hence do not need to be reported. The two cases we analyzed assumed that the compositional standards were binding on only one group of suppliers. In reality, there are more than two types of cheese and more than one group of suppliers might be directly impacted, which makes it harder to characterize the consequences of compositional standards. Because some of the consequences of compositional standards are ambiguous, the only way to ascertain their effect is through an empirical analysis. Even though our model also points out that the compositional standard might have an incidence on domestic manufacturers and milk producers, our empirical analysis focuses on consequences for cheese imports.

4. Empirical Analysis

As argued in propositions 3 and 5, binding compositional standards could manifest themselves through changes in Canadian cheese import unit values. Our theoretical model demonstrates that sudden increases or decreases in cheese import value are likely as standard-induced changes in the import mix can favour more or less expensive cheeses. By the same token, detecting a sudden change in cheese import values around the standard's implementation date, while controlling for other possible influences, would be evidence that the standard impacts on the cost of some suppliers. We focus on import unit values and as such we deviate from the many studies in the literature that have investigated the trade implications of non-tariff barriers through gravity models (e.g., Yue, Beghin, and Jensen, 2006; Disdier, Fontagné, and Mimouni, 2008; etc.). In our case, the TRQ on Canadian cheese imports and its very high over-quota tariff restrict the total volume of imported cheese to the quantity that can be taxed at the in-quota tariff rate. Furthermore, changes in the sourcing of imports are severely restricted by the rule that grants EU countries two-thirds of the minimum access commitment. Because of that and the fact that countries produce several types of cheeses, the standard has a limited effect on bilateral trade flows.

We propose to ascertain whether the standards had a significant impact on import unit values by testing for structural change, while simultaneously controlling for certain external factors. There are two challenges associated with what essentially amounts to testing propositions 3 and 5. First, import unit values are function of a host of factors which need to be controlled for if we are to properly assess the impact of changes in the market equilibrium induced by the new compositional standards on import unit values. In what follows, we control for external factors to detect potential structural changes in the behaviour of unit values induced by the new compositional standards. The second challenge is of an empirical nature. New standards were implemented in December of 2008 and this implies that the post-implementation period is short. This would be problematic for most structural change tests, but Andrews (2003) has developed a powerful procedure to detect end-of-sample structural change.

Andrews (2003) proposes a variant of the Chow test (labelled the *S* test) for stationary regressions/processes that is valid under non-normal, heteroskedastic and/or autocorrelated errors and with potentially endogenous regressors. To illustrate this approach, consider the following multiple-regime linear regression model with Y_t denoting the dependent variable and X_t' a vector that includes *d* regressors:

$$Y_t = \begin{cases} X_t\beta_1 + u_t & t = 1,\ldots,n \\ X_t\beta_2 + u_t & t = n+1,\ldots,n+m \end{cases} \tag{17}$$

where *n* denotes the number of observations in the first regime, *m* denotes the number of observations in the period of potential change and $T \equiv n+m$. Structural change occurs at changepoint *n* in the above regression framework. The null hypothesis of model stability entails $\beta_1 = \beta_2$ while the alternative posits that there is a change in the parameter vector and/or in the distribution of the error term in the period of potential instability.

The Chow test is based on the difference between the residuals sum of squares of the unrestricted (two individual models) and the on for the restricted (single linear model). Under strong distributional assumptions, the asymptotic distribution of the test converges to a *F* distribution under the null that the coefficients in β_i are not different. The computation of Andrews' *S* test is done much the same way as the Chow test: the weight matrix of the quadratic form depends on whether the number of post-change observations, *m*, is greater or less than the number of regressors (*d*). When $m \geq d$, the *S* statistic is defined as: $S = S_{n+1}\left(\hat{\beta}_{n+m}, \hat{\Sigma}_{n+m}\right)$, where $S_j\left(\beta,\Sigma\right) = A_j\left(\beta,\Sigma\right)' V_j^{-1}\left(\Sigma\right) A_j\left(\beta,\Sigma\right)$, $A_j\left(\beta,\Sigma\right)$ = $X'_{j,j+m-1}\Sigma^{-1}\left(Y_{j,j+m-1} - X_{j,j+m-1}\beta\right)$, $V_j\left(\Sigma\right) = X'_{j,j+m-1}\Sigma^{-1}X_{j,j+m-1}$. $\hat{\beta}_{n+m}$ is the LS estimator of β using all observations $\left(t = 1,\ldots,n+m\right)$ and $\hat{\Sigma}_{n+m}$ is the estimator of the $m \times m$ covariance matrix of the errors defined as: $\hat{\Sigma}_{n+m} = \left(n+1\right)^{-1}\sum_{j=1}^{n+1}\hat{u}_{j,j+m-1}\hat{u}'_{j,j+m-1}$. When $m \leq d$, the *S* statistic simplifies to: $S = P_{n+1}\left(\hat{\beta}_{n+m}, \hat{\Sigma}_{n+m}\right)$, where $P_j\left(\beta,\Sigma\right) = \left(Y_{j,j+m-1} - X_{j,j+m-1}\beta\right)'\Sigma^{-1}\left(Y_{j,j+m-1} - X_{j,j+m-1}\beta\right)$.

The critical values of the *S* test are based on a parametric sub-sampling procedure over the first *n* observations. The j^{th} subsample is constructed by leaving out the *q* observations starting at observation *j*, for *j*=1,*N*-*m*+1. *N*-*m*+1 sample *S* statistics, S_j , are then computed. From a simulation study, Andrews concludes that choosing *q* equal to the smallest integer greater than or equal to $\frac{m}{2}$ is a good compromise. The 1 - α sample *S* test statistic becomes the critical value of the *S* test at significance level α. This procedure is shown to be robust to serial correlation in the residuals.

In this paper, the structural change tests are applied to univariate AR models. Our sample is made up of monthly observations starting on January 1997.[13] The estimation procedure proceeds as follows: Series are first tested for unit roots and, if necessary, differenced to induce stationarity. All series are then corrected for seasonality and variations in oil prices and exchange rate to capture broad macroeconomic factors affecting the pricing of agri-food products.[14]

Part of the maintained hypothesis of Andrews' S test is structural stability over the first *n* observations. Hence, as a first approach to test for structural stability, we apply the method developed by Bai and Perron (1998, 2003) that endogenously determines the number and dates of structural breaks in single regressions. Even if Bai and Perron's test was not specifically developed to detect end-of-sample breaks, the minimum segment length can be set as small as 5% of the total sample size ($h = \text{int}\left(\varepsilon\left(n+m\right)\right)$ where ε =0.05,0.1,0.15,0.2 or 0,25.). If Bai and Perron's test detects a break very near the end of the full sample, Andrews' test is used to confirm the result. If a break is estimated in the middle of the full sample, a stable subsample is defined and Andrews' test is applied on this subsample. Finally, if no break is endogenously detected, Andrew's test is applied on the full initial sample.

When testing for structural change, it is not always obvious to match the date at which the structural change occurred to the date of the event responsible for the structural change. In our case, the new regulation was notified to the World Trade Organization on June 2007, but the Canadian Parliament adopted the new regulation only in December of 2007. Moreover, the enforcement of the compositional standard began a year later, in December of 2008. Finally, milk protein isolates (specifically, "Milk protein substances with a milk protein content of 85% or more by weight") were added to the Canadian Import Control List in September of 2008 as a complementary measure.

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[13] Source: Canadian International Merchandise Trade (*CIMT*) online database.

[14] We would like to thank John Beghin for suggesting including the price of oil in our models. It turned out significant, which is not surprising considering its impact on transportation costs and on the overall price level of agricultural commodities and foods.

The range of possible breakpoints is enlarged by the possibility that the regulations be anticipated, thus triggering adjustments in firms' behaviour before any official announcement. In his analysis of the trade creation and diversion effects of regional trade agreements (RTAs), Magee (2008) found that trade flows began adjusting before the implementation of RTAs. However, delayed responses are often observed because firms might be confronted to severe short run constraints. For example, Felt, Gervais and Larue (2010) found that pork exporters from the United States, Canada and Denmark were slow to take advantage of Japan's embargo on Taiwan pork exports.[15] Delayed responses can also be attributed to the regulating country's difficulties in putting in place and implementing enforcement procedures. It is also worth reiterating that, as per our theoretical analysis, a cheese category may be affected by standards even if the standard that applies to this particular category does not bind or if there is no standard for this cheese category.

Unlike Bai and Perron's procedure, Andrews' stability test does not detect endogenously the break dates. Therefore, we must test every potential break point, from around June 2007 to the most recent observation, May of 2010. Table 3 presents our analysis of the unit values derived from Canadian cheese imports for five HS6 categories. The stars beside the date at which a break is detected indicates the levels of significance for the structural change test: 0.01=***, 0.05=** and 0.1=*.

For grated/powdered cheese (040620), blue-veined cheese (040640) and other cheese (040690), the null hypothesis of structural stability cannot be rejected by either of the two tests. For fresh cheese (040610), Bai and Perron's procedure detects a break at the very end of the sample, which is confirmed by Andrews' procedure. On the subsample ending in May 2010, June 2007 is then identified as a significant changepoint. Observe that June 2007 corresponds to the new regulation's notification to the WTO. Finally, Bai and Perron's procedure estimates a structural break in November 2002 for the category 040630, processed cheese. Andrews' test, when applied on the subsample starting on December 2002, rejects the null of stability at the 10% level of significance when the changepoint is July 2008. This is after the standard was adopted, but a few months before its enforcement officially began. For this series, February 2009 is also identified as a break date.

[15] Ultimately, the ejection of Taiwan, which had the largest share among exporters of fresh pork meat in Japan, translated into increased market power for US pork exporting firms.

Table 4 presents structural change results by exporting countries and major types of cheese (HS6 categories). For five series out of twelve, both tests fail to reject the null of structural stability. Looking at fresh cheese (040610) and processed cheese (040630) imported from the United States, we identify the exact same break dates as when considering total imports of these two categories: June 2007 and February 2009, respectively. This is not surprising since the Unites States is by far the largest supplier of fresh cheese to Canada, with a share that increased from about 70% of the volume in the mid 2000s to 88% in 2010 (CIMT database). It is also Canada's second supplier of processed cheese, with approximately 20% of the volume- France leads with a share varying between 30 and 40% of the total volume imported.

Just as processed cheese imports from the US, "other cheese" (040690) imports from the US shows signs of structural break in early 2009, that is just after the enforcement of the new regulation. A break was also identified in the unit values of blue-veined cheese from Denmark before the new regulation was enforced, but after it was adopted by the Canadian Parliament. Finally, for three other unit values series, the null hypothesis of stability is rejected only more than one year after the enforcement of the new regulation.[16] In such cases where estimated breaks are at the extreme end of the sample, it is not pertinent to try to observe in which direction the change operated. In all other cases, we can look at the plots of the corrected series (figures 4-7). In summary, the new standard have their greatest influence on imports from the US than from other sources as imports from the US exhibit a structural break for three HS6 categories. Also, the standard has a stronger effect on fresh cheese and processed cheese than on other cheese categories regardless of the sources considered. These changes are difficult to interpret as we have shown that the type of cheese that is mostly impacted is not necessarily the type that was directly aimed at by the new regulation.

There remains much volatility in the unit values, but in most cases there is an upward trend from the date at which the structural change occurred, with the exception of "other cheese" imported from the Unites States whose unit value unambiguously falls after the break. Once again, there is no unique interpretation for this result: the upward trend suggests that the standard binds, but it could be on domestic manufacturers only, foreign ones only or

[16] Note that the fact that we identified different dates for the same cheese category could be attributed to product differentiation within the product category or to differences in contractual arrangements.

on both domestic and foreign manufacturers. It could be that foreign manufacturers are "passing on" standard-induced cost increases. Our theoretical model also points out that import composition could be skewed toward more expensive varieties if the standards were to bind mainly on domestic manufacturers of more expensive cheeses. This would create winners and losers among exporters.

Alternatively, if the standards increase only the cost of domestic manufacturers and if the latter had strategic interactions with foreign manufacturers, which we did not consider in our theoretical model, the increase in import unit values would be the result of rent shifting. In this instance, foreign exporters would gain at the expense of domestic manufacturers. Given that exporting countries seem to have abated their complaints about Canada's cheese compositional standards while Canadian manufacturers were challenging the constitutional validity of the standards before the courts, it could be conjectured that the standards are a greater annoyance for domestic manufacturers.

Table 5 shows what happened to the unit value processes for imports of milk protein concentrates. The popularity of these concentrates is the main reason behind the introduction of the new regulation regarding the composition of domestic and imported cheeses. We expect structural change as the standard reduced the import demand for milk protein concentrates and isolates. The results shown in table 5 are surprisingly similar to the ones pertaining to cheese imports in terms of the timing of the break. We identified breaks in October of 2008 and January of 2009 for the unit values of milk protein concentrates imported from New Zealand and from all destinations combined which coincide with the start of the implementation of the standard and the addition of milk protein isolates on Canada's Import Control List.

Figure 8 illustrates the breaks in unit values of milk protein concentrates imported by Canada from all sources, from the US and from New Zealand. In all cases, the latest unit value process trends below the previous one(s). It reflects most likely a "quality downgrading" effect as opposed to a terms of trade improvement because the import volume of milk protein isolates has been rising since the late 1990s. Figure 9 shows the evolution of imports of milk protein isolates from all sources and from New Zealand. The unit values followed an upward trend that stopped until the standards began being implemented. A decline ensued that lasted until the last few months of 2009. Unit values have been relatively stable since, but they are lower than they would have been in the absence of structural change.

Finally, units values of whey imports are illustrated in Figure 10. They experienced a structural change that brought them to a much lower level at the end of 2008 when the cheese standards were first implemented and stayed low until the first few months of 2011 at which point they increased very rapidly, a change that has more to do with world market fundamentals than Canadian dairy regulations. The volume of whey imports has been on the decline since the implementation of the cheese standards.

5. Conclusion

The imposition of cheese compositional standards by the Canadian authorities has created divisions with the Canadian dairy industry and has motivated criticisms from several of Canada's trade partners. The new standards impose minimum limits on the percentage of casein coming from fluid milk and maximum limits on the whey protein to casein ratio which cannot exceed that of milk. The standards apply to domestic and imported cheeses and vary across types of cheeses. At the heart of the matter was the growing demand for imported milk protein concentrates by domestic cheese manufacturers which was seen as a breech in Canada's supply management policy regulating milk production and the allocation and pricing of milk to dairy processors.

Cheese production is dominated by a few large firms in Canada. As for foreign manufacturers, they have invested in R&D to lower cost and improve and stabilize the quality of their products. Milk protein concentrates help them adjust for seasonal variations in milk quality and hence give them more control over an essential input. Discussions with food scientists and cheese manufacturers lead us to believe that the standards bind more on some types of cheese than on others, but it was impossible to obtain precise estimates of average costs of production. Similarly, our analysis of cheese regulations in other countries suggested that some foreign cheese manufacturers could be impacted more severely than others.

We developed a theoretical model to investigate the implications of Canada's compositional cheese standards while accounting for Canada's trade policy. The tariff-rate quota and the "use-it-or-lose-it" clause on import permits set the total quantity that can be imported, but holders of import licences can import different types of cheeses. This creates "ratchet" effects, as a decrease in the import of one type of cheese triggers an increase in imports of other cheeses and hence a decrease in the domestic production of these cheeses, which explains why a type of cheese that is not directly impacted by the standards might end up being most affected. We show that domestic market structure plays a very important role in the impact assessment of the standards, even when the standards are only binding on foreign firms. We find that the standards can have very peculiar effects, whether one looks at the change in the domestic demand for milk, cheese consumption or the value and composition of imports.

Our empirical analysis focused on import unit values. The idea is that if the standards bind on some manufacturers, domestic and/or foreign, the effect would show up in import unit values. This is true even if the standard binds only on domestic manufacturers because of the strategic interactions between domestic manufacturers and importers. Because the standards were implemented very recently, we relied on a procedure developed by Andrews (2003) specifically designed to detect structural change for cases when the break occurs near the end of a sample, including cases when the number of observation after the break can be smaller than the number of coefficients to estimate.

We identified breaks shortly before or shortly after the beginning of the implementation of the standards. We found differences in break dates across cheese types and also across countries supplying the same type of cheese. We also investigated whether unit values of imports of milk protein concentrates experienced change and we found that they had decreased very abruptly a few months after the cheese standards were implemented and milk protein isolates were added to Canada's Import Control List. New Zealand is undoubtedly among the losers in this case. The European Union is protected by its fixed share of the import quota of the TRQ and by the "use-it-or-lose-it" clause preventing Canadian importers to "sleep" on their import permits. Also, it is worth noting that most of the structural changes detected for cheese import unit values can be characterized as upward shifts. This could be caused by a standard-induced increase in cost or a composition effect favouring (hurting) exporters of more (less) expensive cheeses. The EU benefits from these increases in import unit values.

The EU had voiced objections when Canada notified the WTO about its compositional standards in 2008 as it was feared that some European cheeses may be forced out of the Canadian market. While such an outcome cannot be precluded, the EU's position in the Canadian market is protected by the manner with which the TRQ is administered. This effectively removes much of the “downside” risk, but it also impedes any growth. Only changes in the administration of the TRQ could change that.

Except for one, the largest domestic cheese manufacturers have challenged the legality of the compositional standards in court. This signals that the standards are restricting the manufacturers’ ability to exploit current and perhaps more importantly future technologies revolving around the use of milk protein concentrates. Our theoretical analysis and our empirical analysis did not investigate the effect of the compositional standards on innovation. This may be an interesting avenue to pursue in the future.

6. References

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Table 1. Estimated compositional norms used by the cheese manufacturing industry and compositional standards

Types of cheese	Ratio casein from fluid milk / casein from all sources used by the industry prior to the imposition of compositional standards	Ratio fixed by new compositional standards
Pizza Mozzarella cheese Part Skim Pizza Mozzarella cheese	60%	63%
Cheddar and cheddar-type cheeses (Brick, Canadian Munster, Canadian Brick, Colby, Farmer's, Jack, Monterey (Monterey Jack), Mozzarella (Scamorza), Part skim Mozzarella, Part skim Pizza cheese, Pizza cheese,Skim Milk cheese and any other variety ,.	70%	83% 100% Old cheddar
Specific speciality cheeses (Asiago, Baby Edam, Baby Gouda, Blue, Butterkäse, Bra, Brie, Caciocavallo, Camembert, Danbo, Edam, Elbo, Emmental, Swiss, Esrom, Feta, Fontina, Fynbo, Gouda, Gournay, Gruyère, Havarti, Kasseri , Limburger , Maribo, Montasio , Muenster, Neufchâtel, Parmesan, Provolone , Romano, St. Jorge, Saint-Paulin, Samsoë, Tilsiter, Tybo, Harzkase)	80%	95%

Source: Regulations Amending the Food and Drug Regulations and the Dairy Products Regulations

Table 2. Canada's main cheese suppliers by category

HS 0406	**HS 0406.10** **Fresh** *1% of total cheese imports* *Cream cheese (55%)*	**HS 0406.20** **Grated/Powdered** *6% of total cheese imports*	**HS 0406.30** **Processed** *6% of total cheese imports*	**HS 0406.40** **Blue** *6% of total cheese imports*	**HS 0406.90** **Other** *81% of total cheese imports*
USA	USA	USA	Switzerland	Denmark	France
France	Italy	Italy	France	UK	USA
Italy	Denmark	Netherlands	USA	France	Italy
Switzerland	Greece	Germany	Netherlands	Germany	Netherlands
Netherlands	France	United Kingdom	Denmark	Italy	Switzerland

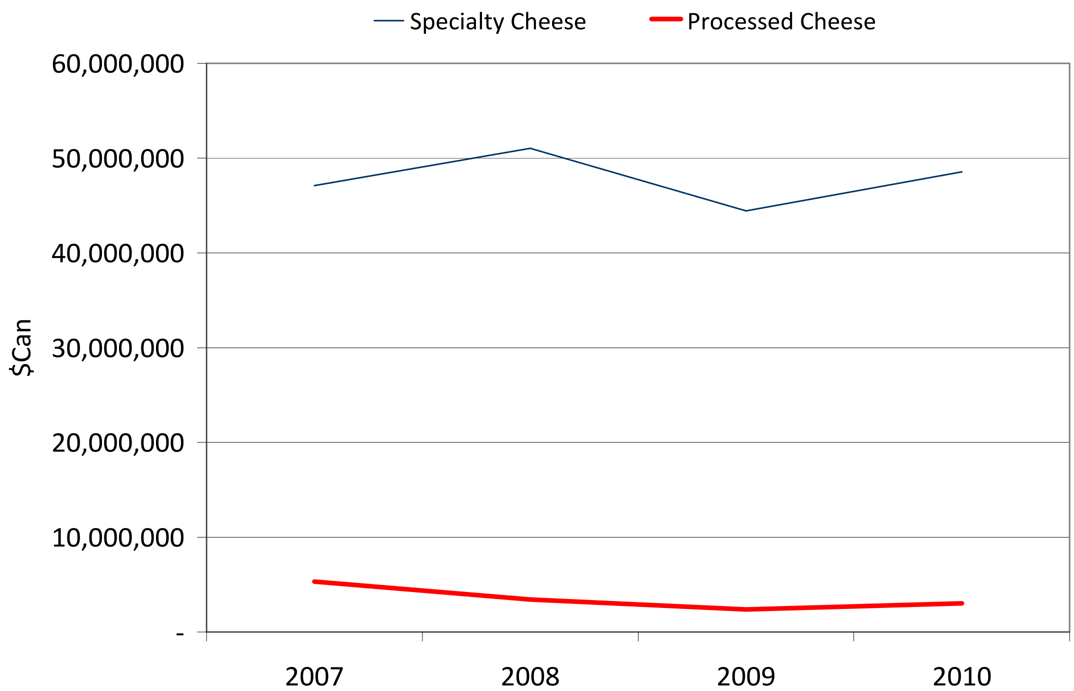


Figure 1. Canadian cheese imports from France, 2007-2010

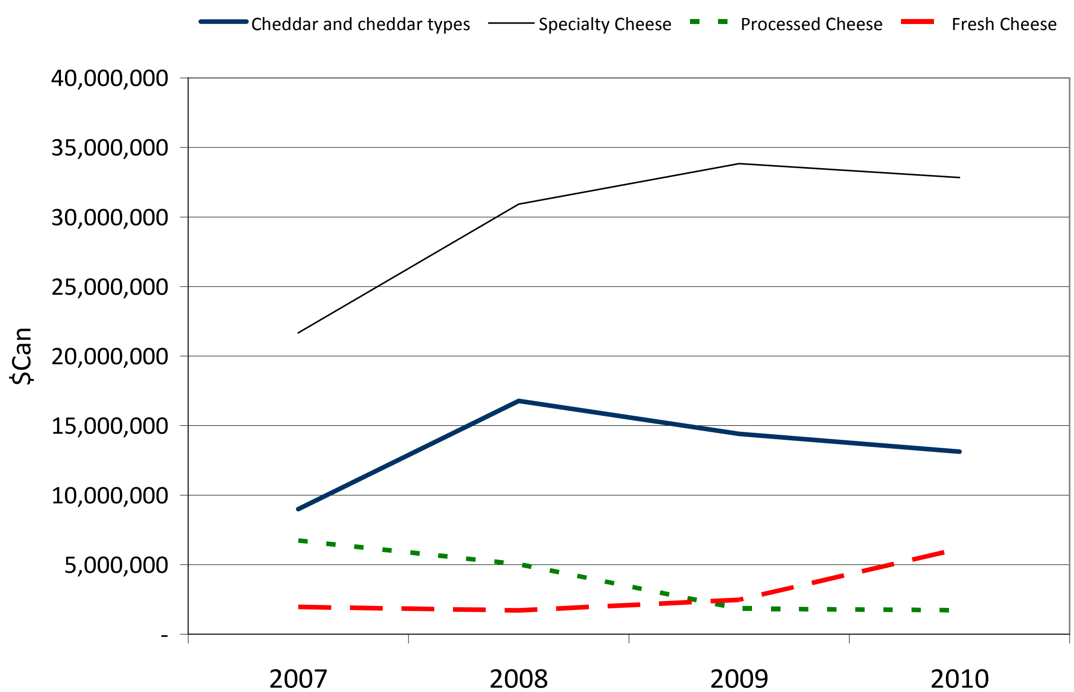


Figure 2. Canadian cheese imports from the U.S., 2007-2010

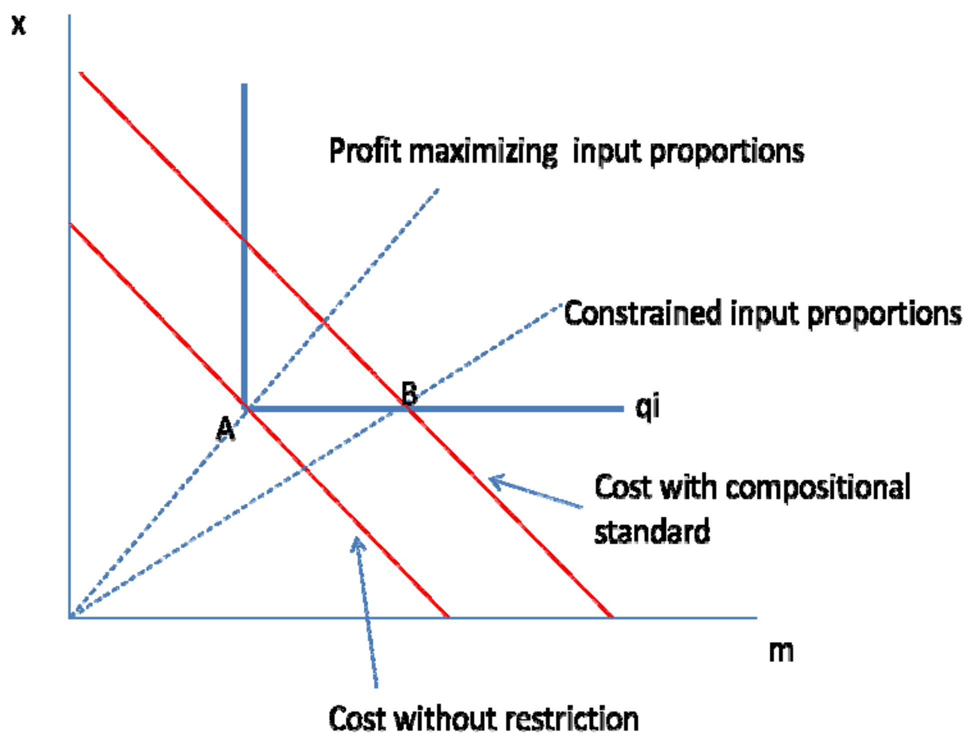


Figure 3. The effect of a binding compositional standard on cost.

Table 3. Structural change in unit values of Canadian cheese imports by HS6 category from all sources

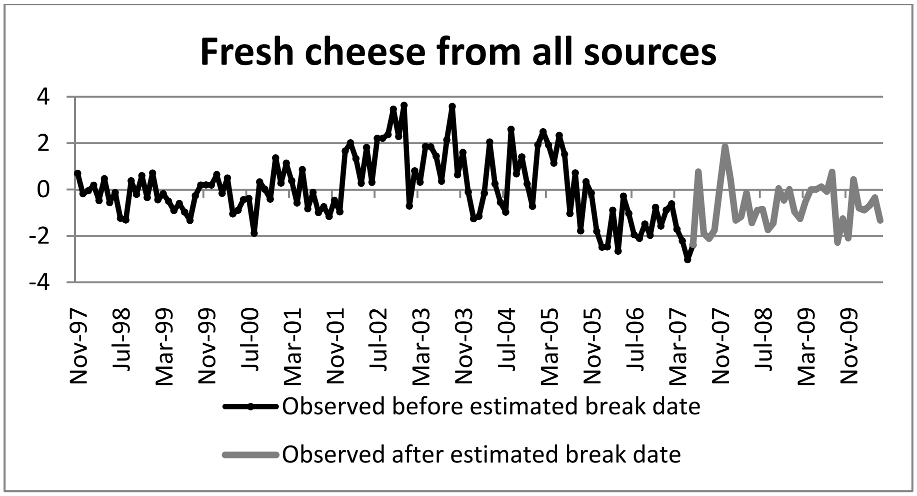
Origin	Cheese type	Bai and Perron structural break test	Andrews structural break test	
		Endogenous estimation of break date(s) on the full initial sample	Estimation period resulting from Bai and Perron break test	Test results: All potential break date from June 2007 to May 2011 are tested
World	040610 Fresh cheese	May 2010***[(1)]	Jan 1997 –May 2011	January 2010-June 2010***
			Jan 1997 –May 2010	June, Sept, Oct 2007*
	040620 Grated-Powdered cheese	Stability	Jan 1997 –May 2011	Stability
	040630 Processed cheese	November 2002**[(5)] November 2002*[(2,3,4)]	Dec 2002 - May 2011	February 2011** Feb 2009** July-Sept 2008*
	040640 Blue-veined cheese	Stability	Jan 1997 –May 2011	Stability
	040690 Other cheese	Stability	Jan 1997 –May 2011	Stability

[(1)]ε=0.05; [(2)]ε=0.1; [(3)]ε=0.15; [(4)]ε=0.2; [(5)]ε=0.25 ; ε is the minimum segment length parameter in Bai and Perron's procedure.

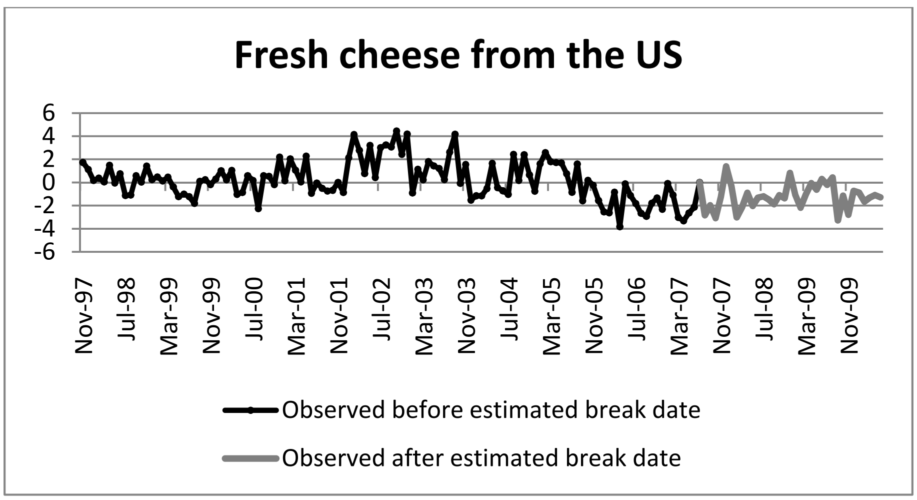
Table 4. Structural change in unit values of Canadian cheese imports by main suppliers and HS6 category

Cheese type	Origin	Bai and Perron structural break test	Andrews structural break test	
		Endogenous estimation of break date(s) on the full initial sample	Estimation period resulting from Bai and Perron break test	Test results: All potential break date from June 2007 to May 2011 are tested
040610 Fresh cheese	Italy	December 2001**(2,3,4,5) December 2001*(1)	Jan 2002 –May 2011	March 2010**
	United States	May 2010***(1) February 2010**(2)	Jan 1997 –May 2011	Nov 2009-June 2010**
			Jan 1997 –May 2010	June 2007, Oct 2007*** May 2007,July-Sept 2007, Nov 2007**
040620 Grated-Powdered cheese	United States	Stability	Jan 1997 –May 2011	Stability
040630 Processed cheese	France	Stability	Jan 1997 –May 2011	Stability
	Switzerland	September 2002***(2,3,4,5) February 2002 and September 2002**(1)	Oct 2002-May 2011	Oct-Nov 2010*
	United States	Stability	Jan 1997 –May 2011	February 2009*
040640 Blue-veined cheese	Denmark	Stability	Jan 1997 –May 2011	March-May 2008*
	France	Stability	Jan 1997 –May 2011	Stability
040690 Other cheese	France	Stability	Jan 1997 –May 2011	Stability
	Italy	Stability	Jan 1997 –May 2011	Feb-April 2011** Nov 2010-Jan 2011*
	Switzerland	Stability	Jan 1997 –May 2011	Stability
	United States	March 2005**(5) March 2005*(2,3,4)	April 2005- May 2011	May 2009** July 2009*

(1) $\varepsilon=0.05$; (2) $\varepsilon=0.1$; (3) $\varepsilon=0.15$; (4) $\varepsilon=0.2$; (5) $\varepsilon=0.25$; ε is the minimum segment length parameter in Bai and Perron's procedure.

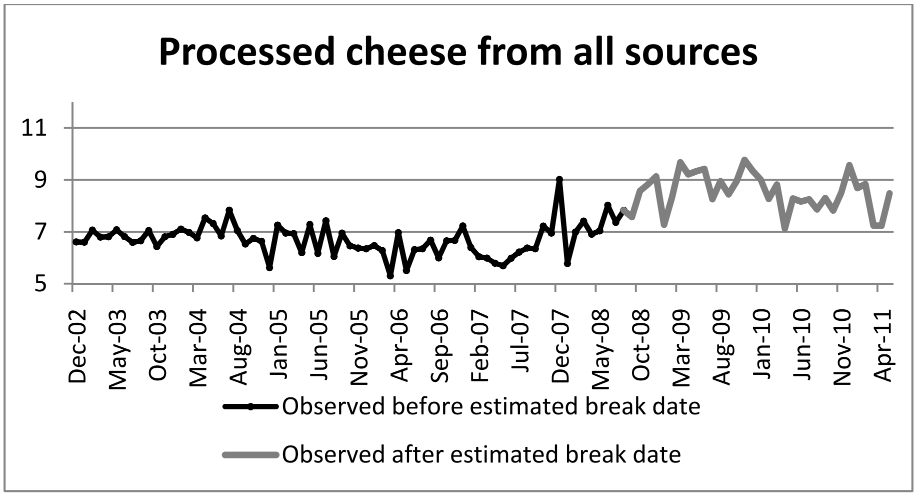


Estimated changepoint: June 2007*

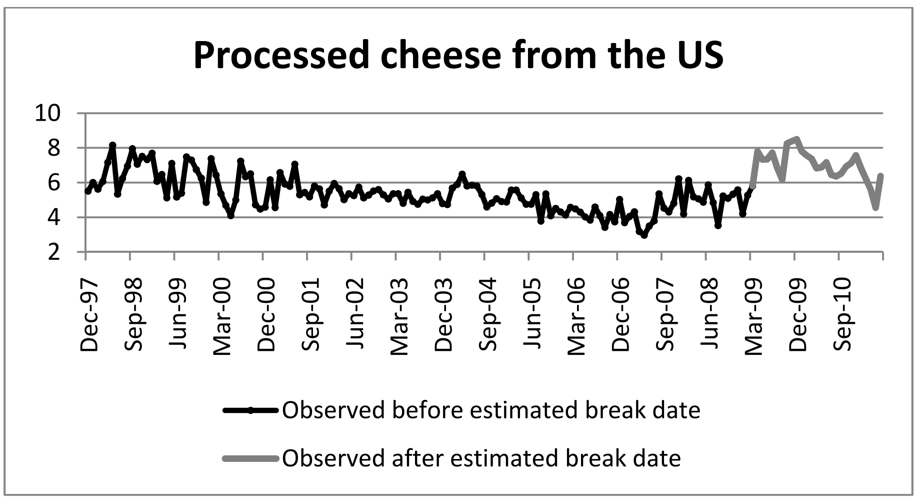


Estimated changepoint: June 2007***

Figure 4. Structural change in the unit value of Canadian fresh cheese (040610) imported by Canada from various sources

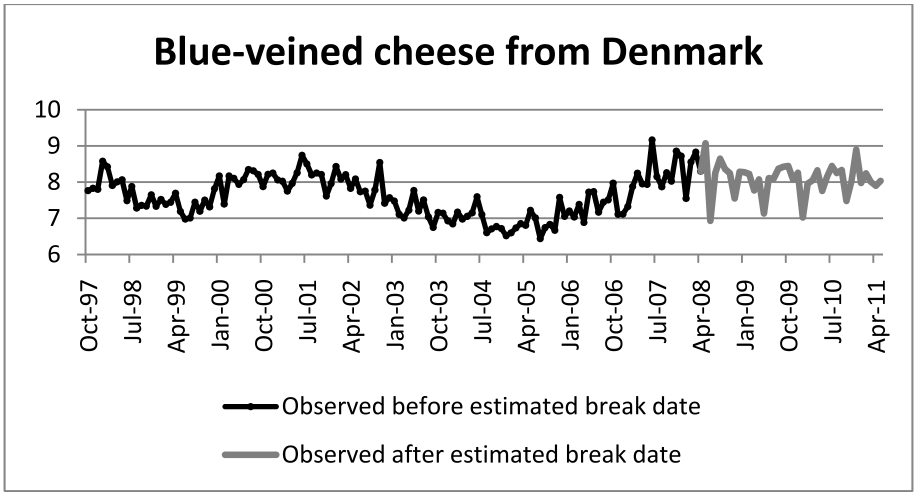


Estimated changepoint: July 2008*



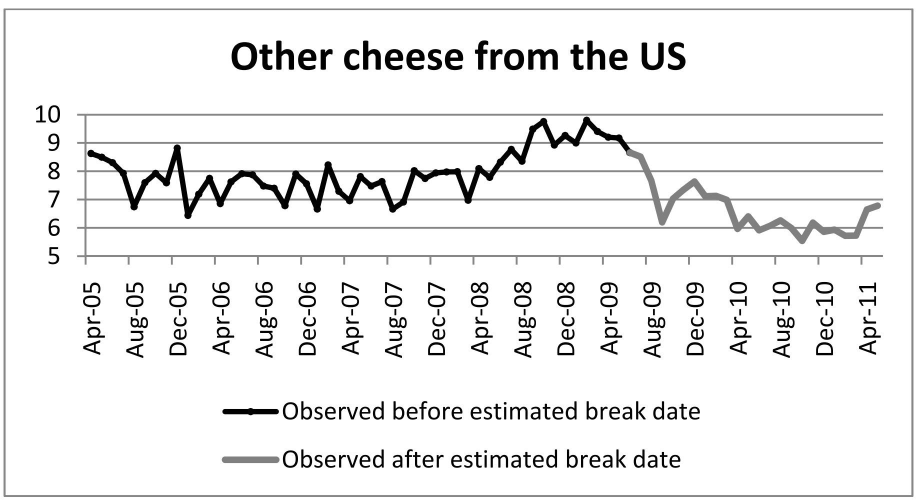
Estimated changepoint: February 2009*

Figure 5. Structural change in the unit value process of processed cheese (040630) imported by Canada from various sources



Estimated changepoint: March 2008*

Figure 6. Structural change in the unit value process of blue-veined cheese (040640) imported by Canada from Denmark



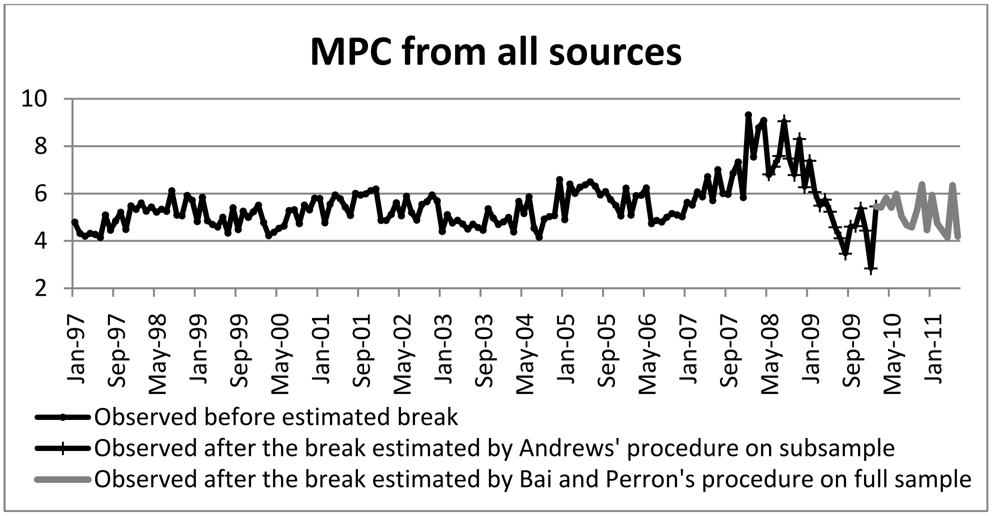
Estimated changepoint: May 2009**

Figure 7. Structural change in the unit value process of “other cheese” (040690) imported by Canada from the United States

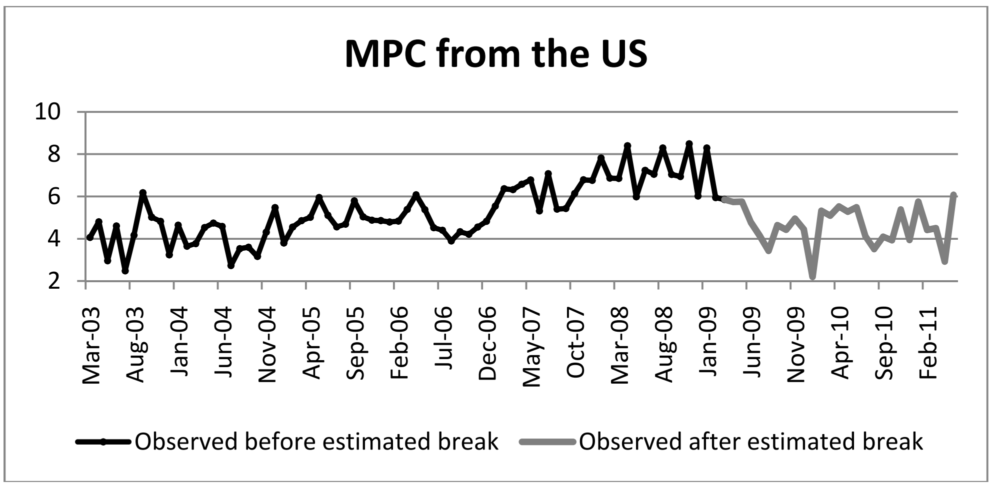
Table 5. Structural change in unit values from milk protein ingredients imports

Product	Origin	**Bai and Perron structural break test**	**Andrews structural break test**	
		Endogenous estimation of break date(s) on the full initial sample	Estimation period resulting from Bai and Perron break test	Test results: All potential break date from June 2007 to May 2011 are tested
040490 MPC	World	June 2009 and January 2010*(1) January 2010**(2)	Jan 1997 –May 2011	Jan 2010** Sept-Oct 2009*
			Jan 1997 –Jan 2010	May, Oct 2007* Apr-May, Aug 2008, May-Dec 2009**
	United States[A]	Dec 2010***(1)	Mar 2003 –May 2011	Feb, May 2009** Dec 2010-Jan 2011* March 2011***
			Mar 2003 –Dec 2010	Stability
	New Zealand	August 2008*(3,4)	Jan 1997 –May 2011	February 2009*
			Jan 1997 –Aug 2008	May-June 2007, Feb-March2008** July 2007-Jan 2008***
350400 MPI	World	Stability	Jan 1997 –May 2011	Dec 2008*** Mar-Apr 2009** May 2009; Feb, June 2010*
	United States	Stability	Jan 1997 –May 2011	Stability
	New Zealand[A]	January 2008**(1,3) Jan and Dec 2008**(2) January 2008***(4,5)	May 2002-May 2011	Stability
			May 2002-Jan 2008	Stability
040410 Whey	World	September 2010***(1)	Jan 1997 –May 2011	Nov 2008-Feb 2009, Jan-Apr 2010** March 2009-Dec 2009, May 2010-April 2011***
			Jan 1997 –Sept 2010	Stability
	United States	September 2010***(1) February 2010***(2)	Jan 1997 –May 2011	July-Sept 2008** Oct 2008-April 2011***
			Jan 1997 –Sept 2010	Stability

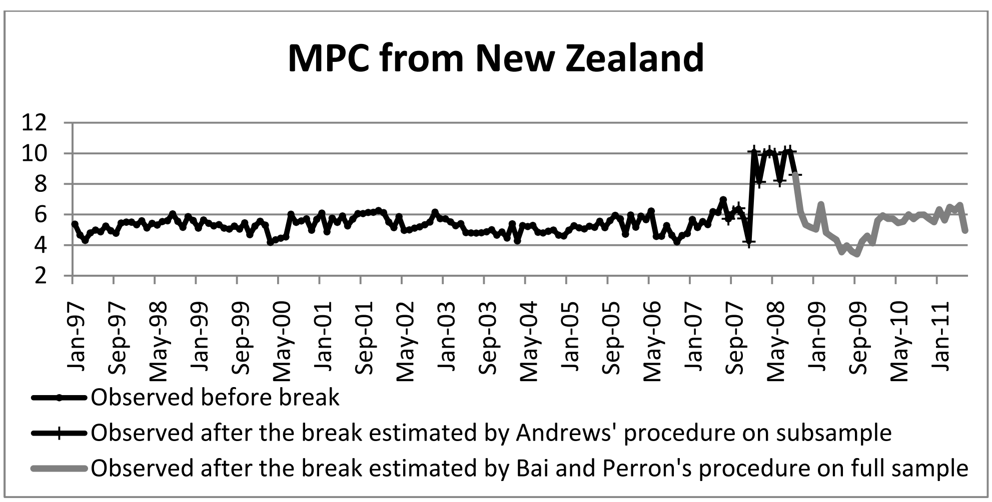
[A] Data for these variables start later than January 1997: March 2003 for the 040490 category from the United States and May 2002 for the 350400 category from New Zealand. MPC stands for milk protein concentrates, a milk protein substance with a milk protein content of less than 85%, while MPI stands for milk protein isolates, a milk protein substance with a milk protein content of 85% or more.



Estimated changepoints: January 2010** on full sample and April 2008**on subsample

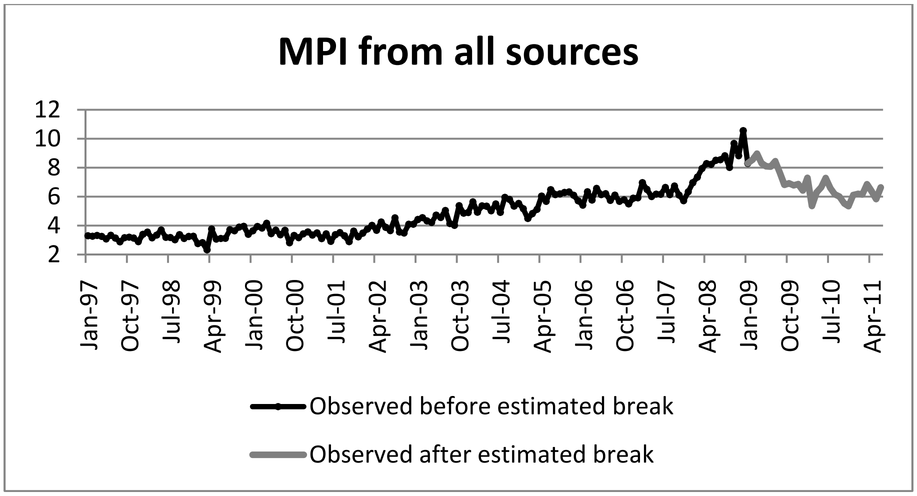


Estimated changepoint: February 2009**

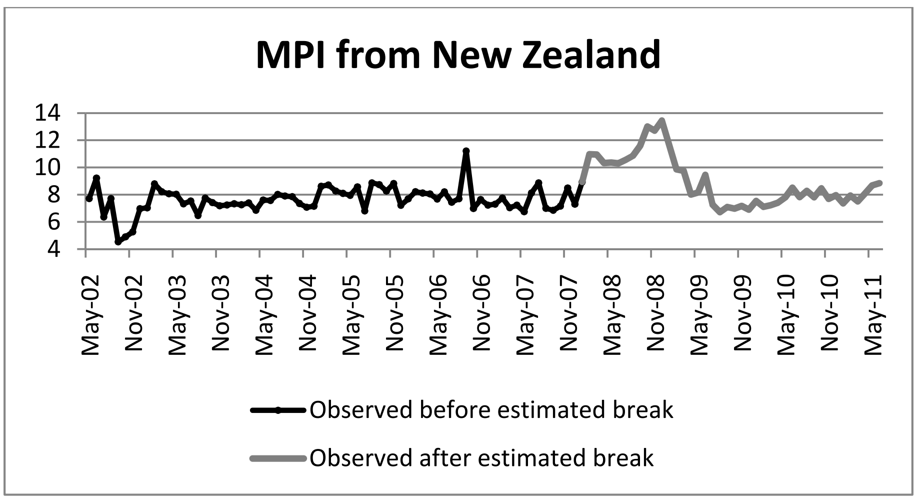


Estimated changepoint: August 2008* on full sample and July 2007***on subsample

Figure 8. Structural change in the unit value process of milk protein concentrate (040490) imported by Canada from various sources

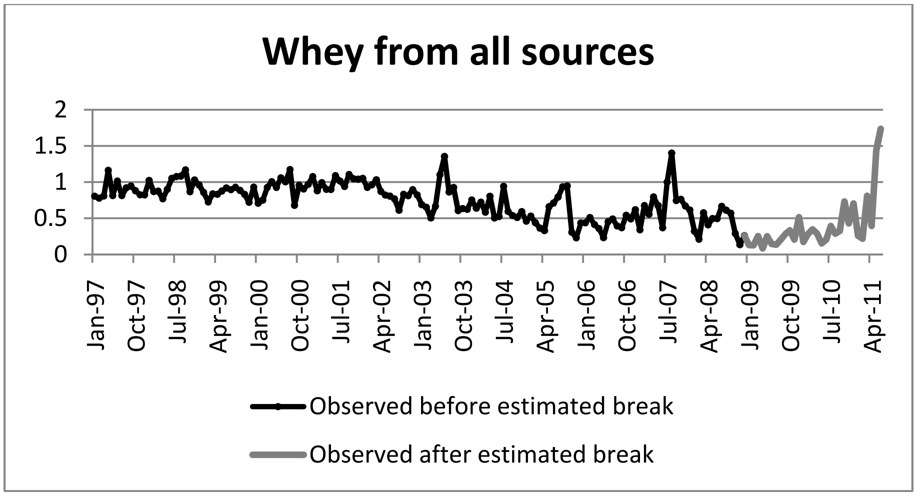


Estimated changepoint: December 2008***

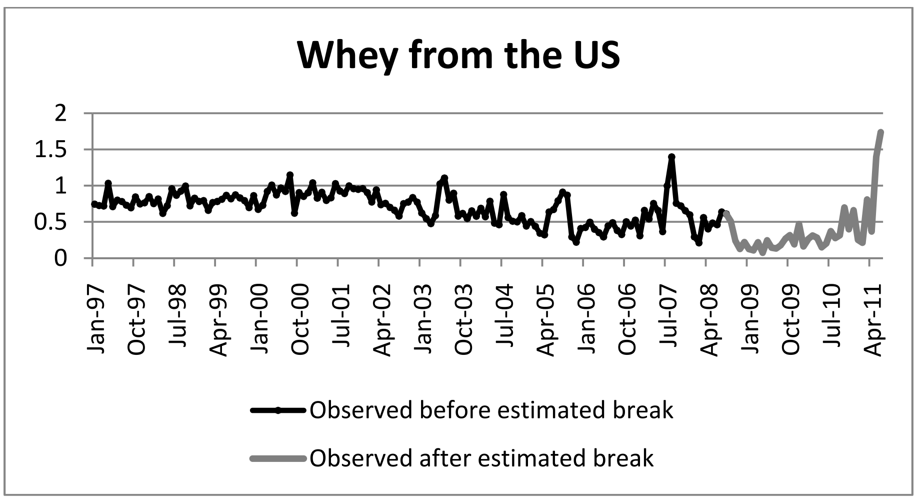


Estimated changepoint: January 2008***

Figure 9. Structural change in the unit values of milk protein isolates (350400) imported by Canada from various sources



Estimated changepoint: November 2008**



Estimated changepoint: July 2008**

Figure 10. Structural change in the unit value process of whey (040410) imported by Canada from various sources