DÉPARTEMENT DE SCIENCE ÉCONOMIQUE
DEPARTMENT OF ECONOMICS

CAHIERS DE RECHERCHE / WORKING PAPERS

 # 0705E

Modeling the Removal of NAFTA Rules of Origin: A Dynamic Computable General Equilibrium Analysis

by

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October 2007

ISSN: 0225-3860

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* I am particularly grateful to Yazid Dissou for discussions on preliminary ideas that made this project feasible and for valuable comments. I would also like to thank Jean Mercenier, Randall Wigle, Thomas Hertel, Marcel Mérette, Frank Lee, Benoît Robidoux and Maximilian Baylor for discussions or comments at some stages of this project. All remaining errors are my own. Graduate School of Public and International Affairs, University of Ottawa, University of Ottawa, 55 Laurier Street East, Desmarais Building, 11th Floor (11108), Ottawa (Ontario) K1N 6N5, Canada. Phone: 613-562-5800 ext. 4188. Fax: 613-562-5241, E-Mail: pgeorges@uottawa.ca
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Abstract

Most computable general equilibrium (CGE) studies assessing the welfare impact of moving from a North American Free Trade Agreement (NAFTA) to a deeper form of integration, for example a Customs Union (CU), typically proxy the integration as the adoption of a common external tariff towards the rest of the world. However, a CU is also an arrangement that allows for the elimination of FTAs preferential Rules of Origin (ROO), which is typically not captured in CGE studies. The paper addresses this issue using a multi-country, multi-sector dynamic CGE model. Although the removal of distortionary ROO is likely to lower the unit costs of production within North America, it may also deteriorate North American terms of trade with the rest of the world. Thus, the net effect of the removal of NAFTA ROO on welfare is ambiguous and is an empirical issue.

Keywords: *NAFTA; Customs Union; Rules of Origin; Common External Tariff; Computable General Equilibrium*
JEL classification*: C68; D58; F13; F15*

Résumé

La plupart des études recourant à l'équilibre général calculable (EGC) évaluent l'impact en terme de bien-être de passer de l'ALÉNA à une forme plus profonde d'intégration, par exemple une Union Douanière (UD), en approximant l'intégration par un tarif extérieur commun avec le reste du monde. Cependant, une UD est également un arrangement qui permettrait l'élimination des règles d'origine (RO) préférentielles de l'ALÉNA, ce qui n'est typiquement pas examiné dans les études en EGC. Cette question est étudiée dans ce document avec l'aide d'un modèle dynamique d'EGC multi-pays, multi-secteurs. Bien que l'élimination des RO distortionaires fasse baisser les coûts de production au sein de l'ALÉNA, elle pourrait également entraîner une détérioration des termes de l'échange avec le reste du monde. Donc, l'effet net sur le bien-être est ambigu et est une question empirique.

Mots clés: *ALÉNA; Union douanière; Règles d'origine; Tarif extérieur commun; Équilibre général calculable*
Classification JEL: *C68; D58; F13; F15*

Introduction

Over the last few years there has been a wide public debate in Canada on the future of Canada-U.S. economic relations. A number of researchers [*e.g.*, Harris (2003), Goldfarb (2003)] have suggested measures to broaden and deepen the North American Free Trade Agreement (NAFTA). Suggestions include harmonization of border measures, common external tariff, customs union, harmonization of regulatory procedures, free movement of labor, and elimination of NAFTA rules of origin. The most ambitious proposal calls for a strategic bargain coupling areas of interest to the United States (such as border security, immigration, defense-related policies and access to continental energy resources) in exchange for a deeper trade integration, possibly in the context of a customs union or a common market, and negotiations to curb U.S. trade remedy laws [Dobson (2002)].

However, some observers have questioned the merits of these proposals by arguing that further economic integration with the U.S. might not be in the best interest of Canada. Jackson (2003) believes that to the extent that Canada's comparative advantage lies in sectors less exposed to the dynamic gains from trade, such as the natural resource and resource-based manufacturing sectors, the inter-industry resource reallocation induced by trade may have hindered the closing of the labor productivity gap with the United States. Moreover, it is argued that a customs union with the U.S. would imply giving up an independent trade policy, which might have an adverse impact on Canada's broader trade policy priorities. Other observers fear that a deeper integration with the U.S. could potentially weaken Canada's economic relationship with other countries. For example, Helliwell (2002) claims that: "North America is destined, through the joint forces of demography and catch-up, to be a smaller and smaller share of the world economy. To focus emphasis on the smaller part of the global pie may seem attractive during booming times in the United States economy, but would be a short-sighted strategy".

Among different forms of integration, the implications of removing NAFTA rules of origin (ROO) are probably least well understood. For instance, although removing ROO is viewed as a deeper form of integration with the U.S., it can potentially increase Canada's trade with countries outside NAFTA. ROO are particularly difficult to model, which may explain why they have been somewhat overlooked in the empirical literature and, more specifically, in computable general equilibrium modeling analyses. The contribution of this paper to the literature is to provide a step towards filling that gap and, in particular, to demonstrate how to design the removal of NAFTA ROO in a CGE model and to analyze its general equilibrium impact.

Gauging the impact of moving from NAFTA to a customs union (CU) requires estimating the *joint* effect of adopting a common external tariff (CET) *and* eliminating the ROO, which can (roughly) be decomposed into two effects: (1) the *pure* effect derived from the adoption of a CET, and (2) the *pure* effect derived from the elimination of ROO.[1] Since many CGE studies have analyzed the first effect but virtually no study has taken into consideration the second effect, this paper focuses mainly on the impact of removing ROO. The simulation results presented in the paper should not be understood, however, as pertaining to an FTA whose ROO have been removed -- such an FTA is not sustainable because of trade deflection (as will be shown in Section 1). Rather, the results should be understood as the *pure* general equilibrium impacts of removing ROO, when a CU is adopted (from an initial FTA benchmark). All this is illustrated with a multi-country, multi-sector dynamic general equilibrium model that builds on the work of Mercenier (1995) and that is calibrated to GTAP-5 database [Dimaranan and McDougall (2002)].

The results in this paper illustrate that a complete elimination of ROO is potentially welfare improving for Canada, although terms of trade effects should not be neglected in this evaluation. The welfare impacts that Canada can expect from the removal of ROO through a more efficient re-allocation of factors of production, which leads to lower unit costs of production and thus lower aggregate consumption prices, are somewhat offset by an increase in prices of foreign goods, due to the additional demand by North American firms for intermediary goods from the rest of the world. As a result, consumers in Canada will face an aggregate consumption price that reflects both the lower unit cost of production in North America and the higher price of goods from the rest of the world. The net effect depends on the relative magnitude of each factor and their relative importance in the composition of consumption goods. In particular, the net effect depends crucially on whether NAFTA ROO originally emerged as the result of an agreement between partners of equal or unequal bargaining power (negotiation power of the USA is either assumed equal or larger than negotiation powers of Canada and Mexico).

Simulation results across different scenarios also show that the removal of ROO increases real GDP in all countries, generally lowers the volume of trade among NAFTA members, but increases the volume of trade between NAFTA and non-NAFTA countries. Therefore, as noted above, removing NAFTA ROO leads to a reduction in the importance of the U.S. in Canada's trade, not to a deeper North American integration. Finally, the paper shows that the effects, on GDP and welfare, of removing ROO, could be substantially larger than the impacts of introducing a CET.

The plan of the paper is as follows. Section 1 starts by defining basic concepts discussed in the literature. Section 2 describes the dynamic general equilibrium model that is used, formalizes the firm's problem in the presence of a ROO constraint, and addresses the calibration issue of the technological parameters that is raised by the presence of a ROO distortion in the benchmark NAFTA data set. Section 3 presents simulation results while Section 4 concludes and provides qualifying caveats to the analysis.

1. Basic Concepts and Selected Literature

A free trade agreement (FTA) is made up of a number of countries that agree to eliminate all customs duties (*i.e.*, tariffs) among themselves or at least, to grant themselves a preferential tariff treatment. Members of a FTA generally retain their individual trade and external tariff policies with respect to non-member states. This gives an opportunity for a non-member that plans to export a good to the high external tariff country, to first transit through the low-external tariff one and then transship, with preferential treatment, to the final destination. Taking advantage of the differential in the external tariff of members of a FTA is called trade *deflection*.

The main *economic* argument in support for preferential ROO in a FTA is to curb trade deflection. ROO are used to determine which goods are attributable to member countries and thus eligible for duty-free (or preferential) treatment when crossing partners' borders, and which goods are not as they are simply being transshipped through, or undergoing only minor transformations in a member country.

Whereas a FTA requires preferential ROO to prevent trade deflection, a CU does not. Indeed, a CU requires the negotiation of a CET (*i.e.*, a common external tariff with respect to non members), a revenue sharing agreement for the customs duties collected at the external border, and harmonized external trade policies. By getting rid of the differential in the external tariff with respect to non-members, the CET eliminates *de facto* trade deflection and thus removes the economic rationale for ROO. Thus, preferential ROO are typically absent from a CU arrangement and movements of goods within a CU are not based on their "originating status" but on the principle of "free circulation".[2]

Therefore, when assessing the economic and welfare impact of moving from a FTA to a CU, it is not sufficient to proxy the integration as the adoption of a common external tariff towards the rest of the world. It is also necessary to explicitly consider the impact of eliminating the ROO. For example, Krueger (1995) argues that CU are "preferable" to FTA *because* the distortionary impact of preferential ROO is absent from such an arrangement.[3]

Preferential ROO can be costly. Governments incur administrative costs, while importers, exporters, and producers bear compliance costs (paper work and proving origin) in order to obtain the preferential treatment. Furthermore, there is a distortionary cost when ROO induce firms to change their production methods or input mixes in order to fulfill ROO requirements and obtain the tariff preference. Indeed, it can be shown that a ROO is an implicit tariff on the intermediate goods produced by the rest of the world (or an implicit subsidy on intermediate goods produced within the FTA zone). Thus, beyond their economic justification of curbing trade deflection, ROO tend to favor intra FTA industry linkages over those between the FTA and the rest of the world, and, as such, to "protect" FTA-based input producers vis-à-vis their extra-FTA competitors. Indeed, as mentioned by Krueger (1993), a ROO can effectively extend the protection that the U.S. intermediary industry receives within the U.S., to Canada, so that the ROO can be used by, say, the U.S., to secure its NAFTA intermediary market for the exports of its own intermediate products.

The ROO distortion should not be confused with the typical trade diversion effect of a CU. The latter effect induces, say, Canadian firms and consumers to switch to U.S. tariff-free goods because they are cheaper than the low-cost but tariff ridden world sources. The ROO distortion, on the other hand, induces Canadian final good producers to switch to U.S. intermediary goods *despite* the fact that the tariff-ridden world source is *cheaper*. In the longer term, ROO may also cause *investment* distortion. Firms within the FTA may prefer re-locating in the largest market of the FTA, continue to import third-country inputs required for the final product, and sell the final products within that particular country or to the rest of the world (so that it does not need to fulfill a ROO).

Empirical research has explored different venues to estimate the cost of ROO and typically suggests that ROO have restricted the full realization of the potential benefit of FTAs, that is, partially offsetting the effects of tariff reductions among members. Some research [*e.g.*, Estevadeordal and Suominen (2004)] attempts to explicitly incorporate an index of ROO restrictiveness as an independent variable in a gravity-type equation to explain the impact that ROO might have had on trade flows. Another strand of research [*e.g.* Cadot *et al*. (2002)] uses a revealed preference approach by observing the tariff preference faced by firms and whether they apply for preferential treatment or not, which leads to an upper or lower bound estimate of the cost of ROO. Finally, the participation constraint approach [*e.g.*, Anson *et al.* (2005)] shows that there is substitutability between tariff rate and ROO restrictiveness as instruments of intra-bloc protection in North-South preferential trading arrangements.

Computable general equilibrium analysis is potentially the most fruitful approach to gauge the distortionary costs of ROO. In this strand of the literature, Appiah (1999) claims that typical computable general equilibrium (CGE) studies [*e.g.,* Harris and Cox (1983) and (1985)], must have overestimated the potential gains of NAFTA because they have not considered the losses due to the introduction of distortionary NAFTA ROO. For example, he shows in his CGE model that NAFTA

ROO *per se* shaves 0.3 to 2.8 percentage points off the initially estimated gain of 4.3% increase in real income attributable to NAFTA. The percentage point *interval* is due to different assumed scenarios of ROO restrictiveness.

Appiah gauges the impact of moving from a Pre-FTA to a FTA (without and with ROO). However, after a decade of NAFTA, the interest of several trade researchers has switched to estimating the impact of going from a FTA regime (that includes ROO) to a deeper level of integration with the U.S. -- either a CU or a "NAFTA+" regime. In the case of a move to a CU, the failure to account for the removal of ROO would likely lead to biased estimates. Indeed, there is a strong case for a more *complete* counterfactual experiment. As mentioned earlier, beyond adopting a common external tariff, a CU is also an arrangement that allows for the elimination of ROO. However, unless the CGE model is calibrated appropriately, there is no "room" for the ROO distortion (that is only implicitly present in the initial benchmark database) and thus there is no way to remove it.

Brown, Deardorff and Stern (2001) gauge the impact of a North American CU but typically limit their experiment to the adoption of a common external tariff. Although Ghosh and Rao (2005) stress the relevance of estimating the welfare cost of ROO, their impact is not captured adequately in their CGE analysis because they do not model ROO explicitly nor do they calibrate their model to reflect the presence of ROO distortions in the benchmark data set.[4] Finally, Papadaki *et al.* (2005) calibrate tariff equivalent of unobservable trade cost between Canada and the U.S., and then remove them in the counterfactual analysis of their static CGE model. This experiment captures the impact of a "deeper tighter NAFTA" but inevitably leads to further trade diversion effects with respect to the rest of the world, which corroborates the fears of some observers that a deeper integration with the U.S. is likely to be at the expense of Canada's economic relationship with other countries.

The rest of this paper proposes a modeling approach to the removal of ROO in a CGE model and an analysis of its general equilibrium impact.

2. The Model

2.1 Overall presentation of the dynamic CGE model

The model is both a simplification and an extension of Mercenier (1995): a simplification because all firms in the model are assumed to be in perfect competition; an extension because the model is dynamic and NAFTA firms face a ROO constraint. The model is briefly described below and discussed in further detail in the appendix.

The world economy *J*, consists of seven countries/regions composing two blocks: Canada, USA and Mexico ($NAFTA \subset J$), and Latin America, Mercosur, Europe, and the Rest of the World ($NONNAFTA \subset J$); $J = NAFTA \cup NONNAFTA$. All countries are fully modelled. Each country has eight sectors of production, all perfectly competitive. These sectors are agriculture (agri), resource sectors (reso), food processing (food), textiles and clothing (text), manufactures excluding machinery and equipment (manu), machinery and equipment (tech), automotives (auto), and services (serv). Each of these industries is assumed to produce a single commodity. Trade flows among countries is organised through an Armington system.

Final demand decisions are made in each country by a single representative utility-maximizing agent (the "household"). Sectoral production is made by a representative profit maximizing firm. Dynamics is introduced in the model through a consumption – saving decision by the representative household of each country, leading to an accumulation of physical capital. There exists a world financial market that globally equilibrates net savings and net borrowing from all regions in the world. Financial and physical capital are assumed to be perfect substitutes so that their returns are equalized. The household who effectively owns firms (by owning primary factors, namely labour and physical capital, which are rented to domestic firms at competitive prices) is in charge of all *inter*-temporal decisions. Firms only face an *intra*-temporal problem in each period, expressing a demand for (the services of) capital, labour, and intermediary goods that is based on their marginal productivity.[5]

Sectors of activity are identified by indices s, $sd \in S$. Countries are identified by indices $i, j \in J$. Finally, the time-horizon is infinite and $v = 0,\ldots,T,\ldots$, indexes the time period where T is the steady state. Trade flows are tracked by a sequence of indices identifying (from left to right) the country of origin followed by the country of destination, the sector (from the country of origin) supplying the good, the sector (of the destination country) purchasing the good, and finally the period. Therefore the sequence i,j,s,sd,v identifies a trade flow from industry s of country i to industry sd of country j in period v. Shorter sequences of indices create no confusion. For example $Q_{j,sd,v}$ refers to the production of sector sd of country j, in period v. The appendix gives further detail on the household problem and the general equilibrium while section 2.2 analyses in detail the problem of the firm in presence of ROO.

2.2. The firm's problem in presence of ROO

All sectors are assumed to operate under perfectly competitive settings. The representative firm in sector sd of country j has access to a separable constant return to scale technology (Cobb-Douglas), combining at time v, variable capital $K_{j,sd,v}$, labour $L_{j,sd,v}$ and intermediary inputs (raw materials) $X_{j,s,sd,v}$ to produce sectoral output $Q_{j,sd,v}$. Intermediate inputs are introduced in the production function as a CES composite: competitively produced goods from different geographical origins enter as imperfect substitutes (the Armington specification). Thus, the technology of the firm is characterised by two nested production functions specified by equations (1) and (2):

$$(1) \qquad Q_{j,sd,v} = B_{j,sd}\left(L_{j,sd,v}\right)^{\alpha_{L\,j,sd}}\left(K_{j,sd,v}\right)^{\alpha_{K\,j,sd}}\prod_{s}\left(X_{j,s,sd,v}\right)^{\alpha_{X\,j,s,sd}} ,$$

$$(2) \qquad X_{j,s,sd,v} = \left[\sum_{i}\eta_{i,j,s,sd}\left(X_{i,j,s,sd,v}\right)^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}}\right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}} ,$$

where the assumption of constant returns to scale implies that the share parameters of the Cobb Douglas production function sum to one:

$$\alpha_{L_{j,sd}} + \alpha_{K_{j,sd}} + \sum_s \alpha_{X_{j,s,sd}} = 1,$$

$B_{j,sd}$ is a scaling parameter, $\eta_{i,j,s,sd}$ are distribution parameters in the CES function, $X_{i,j,s,sd,v}$ represents the demand for good *s* produced in country *i* and used as an intermediary good by the representative firm operating in sector *sd* of country *j*, and $\sigma_{j,s}$ are Armington substitution elasticities in country *j*, between goods *s* from different geographical origins $i \in J$.

Given the perfect competition assumption, the firm takes primary factor prices, respectively $w_{j,v}$ and $r_{j,v}$ for the rental price of labour and physical capital, as given. Observe from notation that the primary factors are perfectly mobile across sectors of an individual country *j* (*e.g.*, $w_{j,sd,v} = w_{j,v}$ for all *sd*), but internationally immobile. The cost of intermediary goods used in the production process of good *sd* of country *j* is given by:

(3) $$\sum_s Px_{j,s,sd,v} X_{j,s,sd,v} = \sum_{i \in Nafta} \sum_s P_{i,s,v}(1+\tau_{i,j,s}) X_{i,j,s,sd,v} + \sum_{i \notin Nafta} \sum_s P_{i,s,v}(1+\tau_{i,j,s}) X_{i,j,s,sd,v} .$$

This cost can be decomposed into the cost of material inputs originating from NAFTA and non-NAFTA countries as shown in (3) where $Px_{j,s,sd,v}$ is a price index that represents the minimum spending by firm *sd* of country *j* on intermediary good *s* from both NAFTA and non-NAFTA origins in order to reach a composite index of intermediary goods of type *s* of level $X_{j,s,sd,v} = 1$. Tariff rates are given by $\tau_{i,j,s}$, which represents the tariff imposed by country *j* on good *s* of country *i*, and $P_{i,s,v}$ is the price of good *s* produced in country *i*.

The assumption of constant returns to scale technology implies that the cost function is linear in the level of output and in this case, both the average cost and the marginal cost equal the unit cost *v*. Therefore, marginal cost pricing implies that:

(4) $$P_{j,sd,v} = v_{j,sd,v}.$$

In absence of any ROO constraint, input demands result from minimizing the total cost of production for given output levels $Q_{j,sd,v}$, that is:

$$(5)\quad \underset{L_{j,sd,v},K_{j,sd,v},X_{j,s,sd,v},X_{i,j,s,sd,v}}{Min} v_{j,sd,v} Q_{j,sd,v} = w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_{s} Px_{j,s,sd,v} X_{j,s,sd,v}$$

subject to (1), (2) , and (3).

ROO appear in the minimisation problem of the firm under either equation (6a) or (6b):

$$(6a)\qquad \frac{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_{i \in Nafta} \sum_{s} P_{i,s,v} (1+\tau_{i,j,s}) X_{i,j,s,sd,v}}{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_{s} Px_{j,s,sd,v} X_{j,s,sd,v}} \geq A_{j,sd,v}\,; \quad 0 < A_{j,sd,v} \leq 1,$$

or,

$$(6b)\qquad \frac{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v}}{\sum_{i \notin Nafta} \sum_{s} P_{i,s,v} (1+\tau_{i,j,s}) X_{i,j,s,sd,v}} \geq A^{*}_{j,sd,v}\,.$$

Substantial transformation is the basic criterion that determines the origin of a good. This is a complex criterion, involving different components that can be used as stand-alone or in combinations with each other. Two main components that lend to a possible modeling are *value content* and *change in tariff classification*. The value content component requires the product to acquire a certain minimum value in country *j* where $j \in NAFTA$. In (6a), the value content is expressed as the ratio of the sectoral value added in country *j* plus the value of raw materials/intermediaries from North American origin to the overall value of sectoral production (*i.e.*, including the value of intermediary goods from non-NAFTA origins). The change in tariff classification is a requirement that the imported (or non-originating) materials used in the production of a good must be “substantially” transformed in country *j* so that the produced good belongs to a new tariff classification. This requirement implies that the firm in country *j* must add a significant value added per imported material from outside NAFTA. The rule in (6b) shows that the value added of the firm *sd* of country *j*, as a ratio of the cost of all intermediary goods *s* originating from all countries $i \notin NAFTA$ and required to produce the good *sd* in period *v*, must be at least equal to some minimum level required for a tariff classification change, $A^{*}_{j,sd,v}$. Although both constraints have been simulated separately in the model, only (6a) will be discussed here.

Let us assume that equation (6a) is strictly binding for all firms *sd* of countries $j \in \text{NAFTA}$ so that it can be re-written as a strict equality. (Section 2.4 discusses the reason why this case is relevant for the present study.) In this case, input demands by a representative firm (of sector *sd* of $j \in \text{NAFTA}$) resulting from the minimizing of total cost of production (5) subject to (1), (2) , (3) and (6a) are as follows:

(7) $$L_{j,sd,v} = \frac{\alpha_{L_{j,sd}} v^{roo}_{j,sd,v} Q_{j,sd,v}}{w_{j,v}\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right)},$$

(8) $$K_{j,sd,v} = \frac{\alpha_{K_{j,sd}} v^{roo}_{j,sd,v} Q_{j,sd,v}}{r_{j,v}\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right)},$$

(9) $$X_{j,s,sd,v} = \frac{\alpha_{X_{j,s,sd}} v^{roo}_{j,sd,v} Q_{j,sd,v}}{Px^{roo}_{j,s,sd,v}} \quad \text{for all } s \in S,$$

(10) $$X_{i,j,s,sd,v} = (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[\frac{Px^{roo}_{j,s,sd,v}}{P_{i,s,v}(1+\tau_{i,j,s})\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right)}\right]^{\sigma_{j,s}} X_{j,s,sd,v}$$

for $i \in \text{NAFTA}$,

(11) $$X_{i,j,s,sd,v} = (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[\frac{Px^{roo}_{j,s,sd,v}}{P_{i,s,v}(1+\tau_{i,j,s})(1+\mu_{j,sd,v}A_{j,sd,v})}\right]^{\sigma_{j,s}} X_{j,s,sd,v} \quad \text{for } i \notin \text{NAFTA}.$$

Observe that a superscript "roo" has been added to v and *Px* to emphasize the presence of ROO and that $\mu_{j,sd,v}$ is the Lagrange parameter associated to the ROO constraint (6a). These input demand functions demonstrate the well-known result that a ROO constraint acts as an implicit subsidy [$\mu_{j,sd,v}(1-A_{j,sd,v})$] to firm *sd* for the use of labor, capital, and the materials purchased within NAFTA, but as a penalty $(\mu_{j,sd,v}A_{j,sd,v})$ for the use of intermediary goods purchased outside NAFTA [Krishna and Krueger (1995)].

Does everything add up in terms of subsidies spending and penalty proceeds? The answer is yes and the proof is simple but it is important to ensure an appropriate calibration of the model (Section 2.3). The subsidy spending and penalty proceeds are respectively given by:

$$(12)\ Subsidy_{j,sd,v} = \mu_{j,sd,v}(1-A_{j,sd,v})\left(w_{j,v}L_{j,sd,v} + r_{j,v}K_{j,sd,v} + \sum_{s}\sum_{i\in Nafta} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v} \right),$$

and:

$$(13)\qquad Penalty_{j,sd,v} = (\mu_{j,sd,v}A_{j,sd,v})\sum_{s}\sum_{i\notin Nafta} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v}\ .$$

Recall that firm *sd* of country *j* is assumed to fulfill exactly the constraint (6a), and substituting (3) into (6a), it follows that:

$$(14)\qquad \begin{aligned}(1-A_{j,sd,v})&\left[w_{j,v}L_{j,sd,v} + r_{j,v}K_{j,sd,v} + \sum_{s}\sum_{i\in Nafta} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v} \right] = \\ &A_{j,sd,v}\left[\sum_{i\notin Nafta}\sum_{s} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v} \right]\end{aligned}$$

Substituting the values for subsidies and penalties derived in (12) and (13) into (14), we finally obtain that the subsidy spending is equal to the penalty proceeds for each firm *sd* and for each country $j \in$ NAFTA as a whole (for $\mu_{j,sd,v} \neq 0$):

$$\frac{Subsidy_{j,sd,v}}{\mu_{j,sd,v}} = \frac{Penalty_{j,sd,v}}{\mu_{j,sd,v}} \Rightarrow Subsidy_{j,sd,v} = Penalty_{j,sd,v} \Rightarrow$$

$$\sum_{sd} Subsidy_{j,sd,v} = \sum_{sd} Penalty_{j,sd,v} \Rightarrow Subsidy_{j,v} = Penalty_{j,v}\ .$$

2.3 Calibration issue

Calibration of the technology parameters of the model is complicated by the presence of a ROO distortion in the NAFTA benchmark data set that must be taken into account. It requires the joint determination of the (*j* x *sd*) distortion parameters $\mu_{j,sd}$ [the Lagrange parameters associated with the (*j* x *sd*) constraints (6a)] and the set of technology parameters: $\{\alpha_{L_{j,sd}};\alpha_{K\,j,sd};\alpha_{X_{j,s,sd}};\eta_{i,j,s,sd};B_{j,sd}\}$

for $s, sd \in S$ and for $i,\, j \in J$. (The calibration is done for a specific year *v* so that the time index can be removed, *e.g.*, $\mu_{j,sd,v} = \mu_{j,sd}$ or $A_{j,sd,v} = A_{j,sd}$.) Care must be taken to distinguish ROO-constrained NAFTA countries versus unconstrained non-NAFTA countries. This section briefly describes the procedure used for countries $j \in$ NAFTA.

The proposed solution to the calibration problem is as follows. It is well known that when the ROO constraint is binding there is an efficiency cost, which translates into an increase of the unit cost of production in comparison to what it would be without the ROO [Francois (2005), Krishna (2005)]. External information related to the cost increase induced by the ROO will be used to calibrate $\mu_{j,sd}$. Let us assume that the efficiency cost of the ROO expressed in percentage increase of the unit cost of the firm is θ. Let v^{roo} and v be respectively the unit cost of production (output prices) with and without ROO. Their expressions are given by:

(15)

$$v^{roo}_{j,sd,v} = \frac{1}{B_{j,sd}} \left(\frac{w_{j,v}\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right)}{\alpha_{L\,j,sd}} \right)^{\alpha_{L\,j,sd}} \left(\frac{r_{j,v}\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right)}{\alpha_{K\,j,sd}} \right)^{\alpha_{K\,j,sd}} \prod_{s} \left(\frac{Px^{roo}_{j,s,sd,v}}{\alpha_{X\,j,s,sd}} \right)^{\alpha_{X\,j,s,sd}}$$ w

here the intermediary good price index $Px^{roo}_{j,s,sd,v}$ is the minimum expenditure in presence of ROO such that $X_{j,s,sd,v} = 1$, and is given by:

(16) $$Px^{roo}_{j,s,sd,v} = \left\{ \begin{array}{l} \sum\limits_{i \in Nafta} (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[P_{i,s,v}(1+\tau_{i,j,s})\left(1-\mu_{j,sd,v}(1-A_{j,sd,v})\right) \right]^{1-\sigma_{j,s}} \\ + \sum\limits_{i \notin Nafta} (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[P_{i,s,v}(1+\tau_{i,j,s})(1+\mu_{j,sd,v}A_{j,s,v}) \right]^{1-\sigma_{j,s}} \end{array} \right\}^{\frac{1}{1-\sigma_{j,s}}},$$

and:

(17) $$v_{j,sd,v} = \frac{1}{B_{j,sd}} \left(\frac{w_{j,v}}{\alpha_{L\,j,sd}} \right)^{\alpha_{L\,j,sd}} \left(\frac{r_{j,v}}{\alpha_{K\,j,sd}} \right)^{\alpha_{K\,j,sd}} \prod_{s} \left(\frac{Px_{j,s,sd,v}}{\alpha_{X\,j,s,sd}} \right)^{\alpha_{X\,j,s,sd}},$$

where $Px_{j,s,sd,v}$ is the minimum expenditure in absence of ROO, such that $X_{j,s,sd,v} = 1$, and is given by: :

$$(18) \qquad Px_{j,s,sd,v} = \left\{ \begin{array}{l} \sum_{i \in Nafta} (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[P_{i,s,v} (1+\tau_{i,j,s}) \right]^{1-\sigma_{j,s}} \\ + \sum_{i \notin Nafta} (\eta_{i,j,s,sd})^{\sigma_{j,s}} \left[P_{i,s,v} (1+\tau_{i,j,s}) \right]^{1-\sigma_{j,s}} \end{array} \right\}^{\frac{1}{1-\sigma_{j,s}}} .$$

The additional efficiency cost expression that links (for each sector of every NAFTA country) the unit cost of production with ROO and the unit cost if they were removed (*ceteris paribus*) is then:

$$(19) \qquad v^{roo}_{j,sd} = v_{j,sd}\left(1+\theta_{j,sd}\right) \text{ for } j \in NAFTA,\ \theta_{j,sd} \geq 0,$$

where $\theta_{j,sd}$ -- the efficiency cost of the ROO expressed in percentage increase of the unit cost -- is an external parameter that must be estimated. (Note again that the time index can be removed at this stage.) Substituting (15)-(18) into (19) yields the additional (*j x sd*) equations (19) that, together with equations (7) to (11) and (1), permit to calibrate the distortion parameters $\mu_{j,sd}$ together with the technological parameters $\{\alpha_{L\,j,sd}; \alpha_{K\,j,sd}; \alpha_{X\,j,s,sd}; \eta_{i,j,s,sd}; B_{j,sd}\}$.[6] Information on the parameter $\theta_{j,sd}$ is a key input and an indirect method of estimation is explained in the next section as well as a methodology to deal with the parameter $A_{j,sd,v}$ in equation (6a).

2.4 Proposal

The crux of the paper relies on external information about parameter $\theta_{j,sd}$ in equation (19), that is, by how much the introduction of ROO has increased the unit cost of production for each sectors *sd* of each NAFTA country, and thus the extent to which these costs would fall, *ceteris paribus*, if ROO were removed. There are at least two theories in the literature on ROO that closely link $\theta_{j,sd}$ with tariff preferences [*i.e.*, the differences between MFN tariff and preferential (NAFTA) tariff]. These two theories are the “revealed-preference” approach and the “participation constraint” approach.

Following Herin (1986), Cadot *et al.* (2002), Goldfarb (2002), Kunimoto and Sawchuk (2005) and Anson *et al*. (2005), we can estimate the *cost* of complying with ROO indirectly via a revealed-preference mechanism, using data on NAFTA utilization rates (*i.e*., data on the proportion of firms that apply for tariff preferences and, therefore, comply with the ROO). It is intuitive that an exporter would not try to satisfy a ROO if the ensuing increase in unit cost of production, due to a change in the input mix, was larger than the benefit he would gain (*i.e.*, obtaining the tariff preference) by satisfying the ROO. The typical conclusion from these studies is that tariff preference gives a "rough estimate" of compliance costs, and this estimate for $\theta_{j,sd}$ is reported in Table 1A.[7]

In equation (19) $\theta_{j,sd}$ is a percentage increase in the *average* (unit) cost of production (so that it applies to each unit produced) whereas tariff preference only applies to the production that is exported to NAFTA countries. Therefore, in order to use tariff preference as a proxy for the increase in unit cost of production, it must be weighted by the share of sectoral production that is exported to the NAFTA member (that provides the preference).[8] Table 1B gives the weighted tariff preference, and this is the proxy used for $\theta_{j,sd}$ in the simulations presented in the rest of the paper.

The second theory that closely links $\theta_{j,sd}$ with tariff preferences is the participation constraint approach [Cadot *et al.* (2002) and Anson *et al.* (2005)]. Accordingly, the terms of a free trade agreement are set to leave partners close to or on they participation constraint (*i.e*., close to being indifferent between signing and not signing) so that there is substitutability between tariff rate and ROO restrictiveness as instruments of intra-bloc protection (deeper tariff preference implies more restrictive ROO). This approach also leads to proxy the cost of the ROO $\theta_{j,sd}$ with the tariff preference. This proxy is an upper bound to the cost of ROO, but the approach implies that it is not far off the true estimate because partners are assumed to be "close to", if not "on" their participation constraint.

The participation constraint framework permits to consider two distinct sub-scenarios -- a symmetric ("USA in") and a asymmetric ("USA out") scenario -- depending on whether NAFTA is the result of an agreement between partners of equal or unequal bargaining power (negotiation power of the USA is either equal or larger than negotiation powers of Canada and Mexico).[9] The "USA in" scenario is the one that emerges from purely equal negotiation powers. All three countries are assumed to be able to push their partners on their participation constraints so that the proxy for $\theta_{j,sd}$ in Table 1B is assumed to hold for Canada, Mexico *and* the USA. In the asymmetric scenario ("USA out"), the USA is able to push Canada and Mexico closely to or on their participation constraint so that a proxy for $\theta_{j,sd}$ equal to the tariff preference (Table 1B) is relevant for these two countries, but Canada and Mexico cannot push the USA on its participation constraint so that $\theta_{usa,sd}$ is set equal to 0.

NAFTA ROO, under the asymmetric scenario, are rules that largely reflect the interests and the lobbying of U.S. intermediary good producers. To be granted tariff preference Canadian and Mexican final good producers must purchase intermediate goods within NAFTA, say in the USA if Mexico and Canada does not produce them. If they do so, U.S. producers of intermediate goods enjoy captive markets and they emerge as the winners. Thus they can be expected to lobby in favor of restrictive ROO and deep tariff preference in their downstream sectors (just enough to trigger the change in input mix in Canadian and Mexican production processes). Therefore Mexican and Canadian firms are close to their participation constraint, and trade negotiators of Mexico and Canada must have signed NAFTA for reasons other than market access. Basically, Mexico was engaged in substantial reforms in need of political anchoring and Canadians feared to be marginalized if they were left out of the negotiations between Mexico and the USA.[10]

The U.S. final good producers, however, receive substantial tariff concessions from their partners without being significantly constrained by ROO -- the participation constraint does not hold for the U.S. firms for at least two reasons. First, the asymmetric scenario assumes that the much smaller Mexican and Canadian intermediary sectors do not have the negotiation power to lobby for ROO. Second, if the large U.S. intermediary good industry has developed under the protection of U.S. MFN tariff, then most of the intermediaries used in the production of the U.S. final goods are of U.S. origin so that the production process *already* meets the ROO criterion.[11] Under these assumptions, the introduction of NAFTA ROO did not increase U.S. firms' unit costs of production ($\theta_{usa,sd}$ is set equal to zero in Table 1B) so that eliminating ROO (when moving to a customs union) would not induce U.S. firms to change their input mix and thus would not lower their unit costs of production, *ceteris paribus*.

To sum up, the "symmetric" scenario is based on the assumption that NAFTA ROO have induced U.S., Canadian, and Mexican firms to change their input mix in order to obtain NAFTA preferential tariff, so that removing ROO would also modify the production process of all NAFTA firms. The "asymmetric" scenario assumes that NAFTA ROO have not changed the behaviour of U.S. firms (while ROO changed the behaviour of Canadian and Mexican firms) so that removing ROO would not change the behaviour of US firms ("USA out"). The asymmetric scenario is probably more realistic than the symmetric one, although the truth is likely to lie in between these two extreme scenarios (*i.e.*, NAFTA ROO have emerged as a set of rules that reflect an asymmetric bargaining power but with some input from Canada and Mexico). However, a comparison between both scenarios permits to gauge the impact of the U.S. negotiation power. (In this context, it is not surprising, as we will see in Section 3, that removing ROO from an asymmetric (instead of a symmetric) scenario is more favorable to Canada and Mexico as it eliminates ROO that reflect the interests of the dominant country.)

Estimating $\theta_{j,sd}$ is a key issue in order to capture the effects of NAFTA's ROO.[12] However, the objective in this paper is to go one step further and to gauge the impact of removing ROO as part of a more general counterfactual experiment of moving to a CU. The relevance of a general equilibrium framework to address the impact of removing ROO should be clear when we recall that a ROO acts as an implicit subsidy to NAFTA firms for the use of labor, capital and intermediary good purchased within NAFTA, but as an implicit tax for the use of intermediary goods purchased outside NAFTA.[13] Therefore, it is essential to take into account interactions between agents and repercussions on all markets in the economy following the elimination of ROO, and the knowledge of

$\theta_{j,sd}$ is only an initial step in understanding the general equilibrium impacts of removing ROO. This analysis is pursued in Section 3.

One last important issue before turning to simulation results is the choice of the parameter $A_{j,sd,v}$ in equation (6a). If $A_{j,sd,v}$ was chosen to be an institutionally given parameter, then, comparison with the benchmark NAFTA data set [the left hand side member (l.h.s.) of (6a)] would lead us to discuss whether a specific ROO is or is not binding.[14]

In this paper, however, instead of debating whether the l.h.s. member of equation (6a) (the benchmark data set) is or is not above an institutionally given $A_{j,sd,v}$ in sector *sd*, the l.h.s. term is assumed to *determine* the level of $A_{j,sd,v}$. This is also the reason why equation (6a) is used as a strict equality in Section 2.2 when solving the firm's problem, which explains the use of classical optimization instead of non-linear programming and Kuhn-Tucker conditions.[15] These values for $A_{j,sd,v}$ are given in Table 2. They are very high in all sectors, from 88% in the textile and clothing industry in Canada to 99% in agriculture in Mexico. This shows that the cost of non-NAFTA intermediary goods in total costs of production is quite small, accounting for 12% in the Canadian textile industry and for 1% in Mexican agriculture industry.

It is unlikely that ROO are the only factors explaining the high values for $A_{j,sd,v}$. Therefore, the key insight that is proposed is to consider that both the introduction of ROO and other (undetermined) factors have pushed the economy towards the high NAFTA-content that is observed in data and given by the l.h.s. of (6a). To disentangle ROO from other factors it is assumed that ROO *per se* increased the unit cost of production in the order of magnitude $\theta_{j,sd}$ (≥0) as suggested in Table 1B. With the information on parameter $\theta_{j,sd}$, the distortion parameter $\mu_{j,sd}$ and the technological parameters can be calibrated, as discussed in Section 2.3. This permits to compute, for each sector within NAFTA countries, the ROO's implicit tax on the use of non-NAFTA intermediaries $(\mu_{j,sd} A_{j,sd})$ and implicit subsidy to capital, labour, and NAFTA-produced intermediary goods $\mu_{j,sd}(1-A_{j,sd})$ (discussed in Section 2.2). This is reported in Table 2 in ratio terms:

$dist_{j,sd} = \frac{1+\mu_{j,sd} A_{j,sd}}{1-\mu_{j,sd}(1-A_{j,sd})}$. The values of the substitution elasticities in Table 2 are taken from GTAP.[16] With this information, Section 3 examines the general equilibrium impact of removing the ROO in all sectors *sd* of NAFTA countries.

3. Benchmark and Simulation results

3.1 Benchmark

Simulation results are reported as percentage change from the benchmark equilibrium. Tables 3 to 5 present some salient features of the benchmark. The GTAP 5 database (2002 release of 1997 data) has been used to calibrate the model.

Table 3 shows that Canada, followed by Latin America and Mexico, are much more dependent on trade than USA, Europe, Mercosur, and the rest of the world (ROW). For instance, the ratio of exports to GDP is about 38% in Canada, compared to 30% for Mexico, and 11% for the USA. Table 4 shows that the sectoral distribution of value added is similar in Canada, USA, and Europe, although primary industries are more important to Canada than to the USA and Europe, while the service industry plays a somewhat bigger role in the USA (78.5%) and Europe (72.1%) than in Canada (69.8%). Finally, Table 5 illustrates the inter-country trade flows. The USA is the dominant trading partner of both Canada and Mexico. For example, in 1997, more than 70% of all exports from Canada and from Mexico went to the USA, while more than 60% of their total imports came from the USA. Note that Mexico is slightly more dependent on the USA for its trade than Canada (Table 5), but that Mexico is, overall, less dependent on trade than Canada (Table 3).

3.2 Simulation results

3.2.1 Some key results for Canada

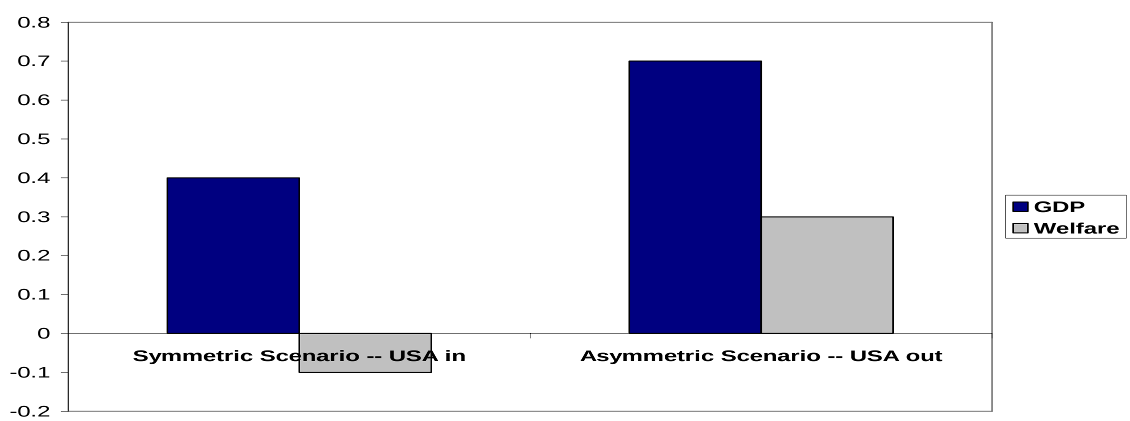
The counterfactual experiment consists in removing the ROO distortion, which, in terms of the model developed in Section 2, consists in setting the parameter $\mu_{j,sd,v}$ equal to zero in equations (7) to (11) and (15)-(16). By eliminating the implicit subsidy and penalty, this shock reallocates efficiently the demand for factors of production in each sector of NAFTA countries, lowering the demand for capital, labour, and NAFTA intermediary goods, but increasing the demand for non-NAFTA intermediary goods. This suggests an increase of export of non-NAFTA goods to NAFTA countries. The efficient reallocation of factors of production within NAFTA will also lower the unit cost of production in every sector of NAFTA countries. This in turn might increase export from NAFTA to non-NAFTA countries. Thus, clearly, we should expect an increase of trade between NAFTA and non-NAFTA countries.

As mentioned by Krueger (1993), ROO generate additional trade distortions (on top of the traditional trade diversion of a FTA or a CU), so that eliminating ROO *per se* should eliminate these distortions, which is *potentially* welfare improving. However, it is clear that NAFTA countries will suffer a terms of trade deterioration (defined as the ratio of the world price of NAFTA exports to the world price of NAFTA imports). Indeed, by design of the experiment, the price of NAFTA-produced good (and thus also the price of NAFTA exports) must fall, whereas the additional demand for non-NAFTA goods (NAFTA imports that will be used as intermediate materials by NAFTA firms) puts an upward pressure on their prices. Hence, the net effect on welfare is ambiguous and is thus an empirical issue.

For both the symmetric (USA in) and the asymmetric (USA out) scenarios proposed in Section 2.4, Figure 1 reports the impact of eliminating NAFTA ROO on the steady-state Canadian GDP and the inter-temporal measure of welfare (present value of real consumption path). Real GDP increases by, respectively, 0.4% and 0.7%, while welfare falls in the symmetric scenario by 0.1% but increases by 0.3% in the asymmetric scenario. The asymmetric scenario ("USA out") is clearly more favourable to Canada (and this is also true for Mexico). This is expected because removing ROO from an asymmetric scenario eliminates a distortion that is assumed to have been initially introduced in response to the lobbying and interests of the U.S. intermediary good sector. This illustrates the relevance of understanding whether NAFTA ROO initially emerged as the result of a negotiation process between partners of equal (symmetric) or unequal (asymmetric) bargaining powers.

In the symmetric scenario (“USA in”), Canadians experience a small welfare loss from the removal of NAFTA ROO due to a large deterioration in the terms of trade (with respect to the rest of the world). This reflects that U.S. firms altogether constitute a significant share of world demand for intermediary goods and hence have the potential to affect world prices by a substantial margin, and hence affect import prices of other countries such as Canada, if U.S. firms switch to non-NAFTA intermediary goods once ROO are removed. This also suggests an analogy with the theory on optimal tariff. However, once we consider the asymmetric case (“USA out”), simulation results suggest an unambiguous welfare gain for Canada from the elimination of ROO. In this scenario the deterioration of terms of trade is considerably reduced because U.S. final good producers do not modify their input mix once ROO are removed, which mitigates any demand-induced price increase of non-NAFTA goods.

Figure 1 Canada's GDP and Welfare Steady State Impacts of Removing NAFTA ROO (% change)



A terms of trade deterioration implies that for unchanged real import, real export must increase, so that, *ceteris paribus*, real consumption must fall, and with it the intertemporal welfare of the representative agent. Alternatively, if the inter-temporal budget constraint suggests that consumption spending should fall after the removal of ROO, and if the aggregate consumption price does not fall proportionally because of the terms of trade effect mentioned above, then, real consumption must indeed decrease. This shows the importance of understanding the impact that

ROO might have on both the intertemporal budget constraint of the household and the aggregate consumer price. The analysis is pursued in further detail in Section 3.2.2.

3.2.2 More detailed macro results

The macro-impacts of removing NAFTA ROO in both the symmetric and asymmetric scenarios are given in Tables 6 and 7. In each principal column the left-hand side results refer to the short-term impacts of removing the ROO, whereas the right-hand side results refer to the long-term impacts, once the new steady-state is reached.[17]

In the symmetric scenario (Table 6), the *volumes* of export and import increase in all countries. For Canada, real export increases by 7.2%, while import increases by 5.9% in steady state. Real net export in NAFTA countries drives the small increase in real GDP, whereas real domestic investment falls. In the asymmetric case (Table 7), the increase in real GDP in Canada is also due to an increase in real consumption, whereas the impact on the USA is almost zero for all variables because, in this case, removing ROO does not directly modify the behaviour of U.S. firms (as is explained in Section 2.4).

Consumption

Although the Euler equation gives the rate of change for real consumption along the optimal path during the transition to the new steady state, it does not determine the *level* of real consumption.[18] This level, and with it the level of consumption spending is determined through an inter-temporal budget constraint so that the present discounted value of GDP minus investment and consumption spending plus the initial foreign asset position is zero. [See for example, Blanchard and Fischer (1989).] For Canada, for example, the inter-temporal budget constraint is such that consumption spending (PC.C) decreases by 0.3% [-0.1% + (-0.2%)]. Given that the aggregate consumption price only falls by 0.2% in the steady state, this implies that real consumption must also fall by 0.1% in the steady state (as shown in Table 6).

The change in real consumption is the factor that explains the inter-temporal measure of welfare. In the model, the measure of the welfare change resulting from the removal of the ROO is computed as the percentage increase in the benchmark real consumption that would make the household indifferent in present value terms to the counterfactual real consumption path. Table 6 shows that removing ROO has a negative impact on real consumption and welfare for both Canada and the USA while this has a positive impact for other countries.

Observe the large increase in consumer prices (and GDP deflators) in non-NAFTA countries (+3.1% in Europe) relative to NAFTA countries. Actually, this reflects an increase in the production price of non-NAFTA goods and this somewhat mitigates the benefit of removing ROO. This result is due to terms of trade effects (as is mentioned in Section 3.2.1). Although the price of NAFTA goods falls due to the removal of ROO, the price of goods produced outside NAFTA increases because of a higher demand for intermediary goods of non-NAFTA origin, which triggers a higher demand for factors of production so that wages and rental prices of capital increase, pushing up the unit cost of production and thus the price of goods originating from non-NAFTA countries. NAFTA consumers are thus faced with cheaper NAFTA goods and more expensive non-NAFTA goods. Only Mexico appears to be comparatively less affected by the increase in the price of non-NAFTA goods because, as seen in Table 5, imports of Mexico are more biased towards NAFTA goods than Canada and especially the U.S., while at the same time, less dependent on trade than Canada and the U.S., as seen in Table 3.

Table 7 shows that the terms of trade effect is largely reduced in the asymmetrical scenario ("USA out") when the U.S. is removed from the shock. Observe the smaller increase in the consumer price index in non-NAFTA countries (+0.8% in Europe), and the corresponding larger welfare gain for both Canada (+0.3%) and Mexico.

Investment

With the removal of ROO, NAFTA firms desire to substitute out of capital, labour, and NAFTA intermediary goods into non-NAFTA intermediary goods. The representative household is the owner of the domestic stock of physical capital so that they can respond to a lower demand by NAFTA firms for the service of capital by progressively reducing the stock of capital in the economy. To do this, the household must have an investment rate that is below the rate of depreciation of the capital stock during the transition phase to a lower (steady state) stock of capital. For example, for Canada, in Table 6 (7), investment falls in the short-run by 3.0% (2%), and in the long-run investment recovers slightly to –1.0% (-0.7%) of what it was in the benchmark.[19]

Trade flows

Tables 8a/b show the impact, on bilateral trade flows, of removing the ROO. The outstanding feature is that trade is fundamentally reorganised between NAFTA and non-NAFTA countries. This indeed illustrates the fact mentioned above that ROO have created additional trade distortion above and beyond the trade diversion due to NAFTA. Removing ROO creates an opportunity for NAFTA countries to import further goods, and in particular further intermediary goods from non-NAFTA countries, whereas non-NAFTA countries can also benefit from cheaper final NAFTA goods. Clearly, in Table 8a, these additional trade flows between NAFTA and non-NAFTA countries are done at the expense of “intra-NAFTA” trade and “intra-non-NAFTA” trade. In the asymmetric scenario (Table 8b), the removal of NAFTA ROO does not directly affect the behaviour of US firms. However, as expected in this case, USA imports more from Canada and Mexico while purchasing less from non-NAFTA countries given that the prices of Canadian and Mexican goods fall (as firms become more efficient due to the ROO removal). Furthermore, given that U.S. firms do not directly change their behaviour in this scenario, they do not affect the world price of goods so that Canadian and Mexican final good producers and consumers can benefit more fully from ROO removal, which implies an even stronger increase in Canada’s and Mexico’s imports from non-NAFTA countries (relative to the symmetric case in Table 8a).

Another way to present the new bilateral trade flows is by examining the counterfactual shares of imports (from geographical origin) and shares of exports (to destination countries). Tables 9a/b show the percentage points difference between the 1997 shares and the counterfactual shares that would have been observed if ROO had been removed (so that counterfactual shares can be computed by adding numbers in Tables 5 and 9). For example, in the “USA-in” (“USA-out”) scenario, the share of Canadian imports originating from the U.S. falls by 10.2 (13.9) percentage points from 63.3% to 53.1% (49.4%) while imports originating from non NAFTA countries increase by the same proportion and overall real imports increase by about 5.9% in Table 6 (9.8% in Table 7).

3.2.3 Sectoral impacts

Table 10 illustrates the impact on sectoral output, of removing ROO. The most striking results, especially for Canada, are the decrease in the resource sector and the upsurge of the automobile sector. All sectors of the economy use resources intensively as an intermediary good. Note that ROO in our modelling approach generate an implicit penalty on intermediary goods from non-NAFTA countries but an implicit subsidy for NAFTA intermediary goods. Thus, the removal of ROO induces strong substitution towards non-NAFTA resources.

It is interesting to note the differential impact of removing ROO in the automobile sector [and to a lesser extent in the machinery and equipment (high tech) sector] if NAFTA ROO are initially assumed to have emerged from a symmetric ("USA in") or an asymmetric ("USA out") negotiation process. Although the U.S. automobile sector does not lose from the removal of ROO in Panel a, it would be the main loser in the asymmetric scenario (Panel b) while the Canadian and Mexican automobile sectors would be large winners as they would be in position to buy cheaper intermediary goods from the rest of the world and become more efficient. Finally, for sensitivity analysis, Panel c shows the more subdued sectoral output response to the elimination of ROO when elasticities of substitution are reduced by 25%.

3.2.4 Economic impact of a customs union

The results presented so far should be understood as the *pure* general equilibrium effects of removing ROO, when a CU is adopted. Clearly, however, gauging the impact of moving from a FTA to a CU requires estimating the *joint* effects of eliminating the ROO *and* adopting a common external tariff (CET). Table 11a illustrates for the asymmetric scenario ("USA-out") and for selected aggregates, the effects of introducing a CET and concomitantly removing ROO. The CET chosen by all three NAFTA countries is assumed to be the current U.S. MFN tariff with respect to non NAFTA countries. Table 11b illustrates the pure effect of adopting a CET. Given the actual convergence of Canadian and U.S. MFN tariffs, it is unlikely that the proposed CET would significantly impact the Canadian economy. The sizeable differential in the Mexican-US MFN tariffs, however, implies that Mexico would benefit from the CET, especially through increased investment and real GDP. Nevertheless, the key conclusion is that the effects of removing ROO largely dominate CET effects. This can be seen by comparing Table 7 with Table 11b.

Finally, subtracting Table 11b (impacts of adopting a CET) from Table 11a (joined effects of adopting a CET and removing ROO) gives Table 11c which illustrates the typical mis-estimation in the existing literature for not capturing the impact of ROO removal. Table 11c does not exactly capture the *pure* impact of removing ROO (Table 7) because Table 11c also includes second-order or crossed effects: the removal of NAFTA ROO *per se* modifies trade patterns between NAFTA and non-NAFTA countries. Therefore, second-order effects measure the impact that the adoption of a CET might also have on this *new* pattern of trade *due to* the ROO removal, with repercussions on all variables in the model.

4. Conclusion

Gauging the welfare gain of moving from a FTA to a CU requires estimating the joint impact of adopting a common external tariff (CET) and eliminating ROO. Most studies have emphasized the adoption of a CET while neglecting the ROO dimension of the experiment. The contribution of this paper to the literature is to demonstrate a way to design the removal of NAFTA ROO in a CGE model and to analyze its general equilibrium impact. Throughout the paper we distinguish between two scenarios to illustrate the relevance of understanding whether NAFTA ROO initially emerged as the result of a negotiation process between partners of equal (symmetric) or unequal (asymmetric) bargaining powers. The "truth" is likely to lie in between these two extreme scenarios (*i.e.*, NAFTA ROO have emerged as a set of rules that reflect an asymmetric bargaining power but with some input from Canada and Mexico).

The paper illustrates that a complete elimination of ROO is potentially welfare improving for Canada, although terms of trade effects should not be neglected in this evaluation. Removing ROO from an asymmetric (instead of a symmetric) scenario is shown to be more favourable to both Canada and Mexico as it potentially eliminates ROO that reflect the lobbying and interests of the U.S. intermediary good sector. The paper also shows that, when moving from NAFTA to a Customs Union, the impacts on GDP and welfare of removing ROO are potentially larger than the small effects associated with adopting a CET.[20]

There are a number of ways in which the contribution of this paper can be refined and extended. First, working towards a more refined proxy for parameter $\theta_{j,sd}$, that is, by how much ROO have increased the unit cost of production, would be useful. Using (weighted) tariff preference may provide at best an upper bound estimate (although the participation-constrained approach suggests that tariff preference is "close" to the true estimate). Second, this study focuses on the distortionary costs of ROO that induce firms to change their production methods or input mixes in order to fulfill ROO requirements and obtain a tariff preference. However, the paper did not attempt to disentangle (sector-specific) distortion costs from paper work and administrative costs of ROO (that are more likely to be homogeneous across activities). Anson *et al.* (2005) provide a methodology to separate these costs and this could be introduced in our framework.

Finally, a major issue in this area is the interaction between firms' location and the ROO regime. Although a dynamic model is proposed in this paper in order to address some issues related to domestic and foreign investment, more research is needed to capture foreign *direct* investment and eventually, the impact on firms' location, of removing ROO. To do this, production of goods and services should be differentiated by both place of production and country of ownership. This would imply that foreign varieties would be available not only as imports, but also when foreign direct investment is allowed, as local purchases from the subsidiaries of foreign firms. We plan to work on these extensions in the near-future.

Appendix 1 The Model

The model builds on earlier work by Mercenier. It is both a simplification and an extension of Mercenier (1995); a simplification because all firms in the model are assumed to be in perfect competition; an extension because the model is dynamic and NAFTA firms face a ROO constraint. This appendix lays down the representative regional household's problem, the representative regional and sectoral firm's problem and the general equilibrium. Notation of main symbols used is given in Table A1.

A.1 Households

For each country, we assume a single representative household, living infinitely and maximizing its utility. The preferences of the representative household in country *j* are represented by a three-level utility function (equations A1-A3).

In the first level [equation (A1)], the household maximises an *inter*-temporal utility function given by the present value of periodic utility functions assumed to belong to the iso-elastic (constant relative risk aversion) class; $1/\gamma$ is the constant inter-temporal elasticity of substitution (between consumption at two different points in time) and ψ is the household's constant rate of time preference (subjective discount rate). The sequence $\{C_{j,v}\}$ represents the time path of his consumption basket over the time horizon $[0,\infty)$. The consumer chooses the consumption sequence so that he maximises his utility, U_j. In the second level, [equation (A2)], the consumer decides the optimal combination of different final consumption goods $s \in S$, which make up his consumption basket. This is done assuming constant expenditure shares ($\rho_{j,s}$), (Cobb-Douglas assumption). Final consumption goods in the basket are themselves aggregates of goods from different geographical origins according to the Armington assumption. For example, oranges from different geographical origins are imperfect substitutes. To capture this assumption, we need a third preference level [equation (A3)], that determines the optimal composition of the consumption aggregates in terms of geographical origin where $\delta_{i,j,s}$ are country share parameters in the CES function, $\sigma_{j,s}$ are Armington substitution elasticities for consumption in j of good s, and $c_{i,j,s,v}$ represents the sale of the whole industry or sector s of country i to the representative consumer of country j for purpose of final consumption.

The preferences of the household are bounded by a series of budget constraints given in (A6-A11). The labour and capital incomes of the household in the budget constraint (A6) are generated by (equilibrium) rental prices of primary factors of production in combination with total endowments. The household supplies labour $L_{j,v}$ inelastically, and supplies capital services $K_{j,v}$ (which results from an investment decision described below) to firms of country j, for which he is paid at marginal productivity. Labour and physical capital are perfectly mobile factors across sectors of an individual country (so that for $w_{j,s,v} = w_{j,v}$ and $r_{j,s,v} = r_{j,v}$ for all s) but internationally immobile. The household also receives transfers from the government (essentially the tariff revenue perceived by the government, $G_{j,v}$) and interest revenues ($\rho_v F_{j,v}$) from his saving that is placed in international financial market (which also results from the saving/investment decision described below) and where ρ_v is the world financial interest rate.

The household problem: Equations

(A1) $$U_j = \sum_{v=0}^{\infty} \frac{U(C_{j,v})}{(1+\psi)^v} = \sum_{v=0}^{\infty} \frac{C_{j,v}^{\;1-\gamma}}{(1+\psi)^v(1-\gamma)} = \frac{C_{j,0}^{1-\gamma}}{1-\gamma} + \frac{C_{j,1}^{1-\gamma}}{(1+\psi)(1-\gamma)} + \frac{C_{j,2}^{1-\gamma}}{(1+\psi)^2(1-\gamma)} + \ldots$$

(A2) $$C_{j,v} = A_{j,s} \prod_s (c_{j,s,v})^{\rho_{j,s}} \quad ; \sum_s \rho_{j,s} = 1; \; s \in S,$$

(A3) $$c_{j,s,v} = \left[\sum_i \delta_{i,j,s} (c_{i,j,s,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}} \right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}} ; \; i, j \in J; \; J = NAFTA \cup NONNAFTA.$$

(A4) $$I_{j,v} = A_{j,s}^{*} \prod_s (i_{j,s,v})^{\omega_{j,s}} \quad ; \sum_s \omega_{j,s} = 1; \; s \in S,$$

(A5) $$i_{j,s,v} = \left[\sum_i \beta_{i,j,s} (i_{i,j,s,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}} \right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}} ; \; i, j \in J; \; J = NAFTA \cup NONNAFTA.$$

(A6) $$\underbrace{F_{j,v+1} - F_{j,v}}_{\substack{\text{Foreign Asset Accumulation} \\ \text{(net foreign investment)}}} + \underbrace{PI_{j,v} I_{j,v}}_{\text{Domestic investment spending}} = \underbrace{\underbrace{\rho_v F_{j,v} + w_{j,v} L_{j,v} + r_{j,v} K_{j,v} + G_{j,v}}_{\text{Revenue (GNP)}} - \underbrace{PC_{j,v} C_{j,v}}_{\text{Consumption spending}}}_{\text{Saving}}$$

(A7) $$K_{j,v+1} - K_{j,v} = I_{j,v} \phi_j - \delta_j K_{j,v}$$

(A8) $$PC_{j,v} C_{j,v} = \sum_s Pc_{j,s,v} c_{j,s,v}$$

(A9) $$Pc_{j,s,v} c_{j,s,v} = \sum_i P_{i,j,s,v} (1 + \tau_{i,j,s,v}) c_{i,j,s,v}$$

(A10) $$PI_{j,v} I_{j,v} = \sum_s Pi_{j,s,v} i_{j,s,v}$$

(A11) $$Pi_{j,s,v} i_{j,s,v} = \sum_i P_{i,j,s,v} (1 + \tau_{i,j,s,v}) i_{i,j,s,v}$$

Given his income path, the household decides on the time-paths for final consumption spending $\{PC_{j,v} C_{j,v}\}$ and savings (borrowings). His savings leads, at each period *v*, to domestic investment ($PI_{j,v} I_{j,v}$) and net foreign investment as shown in (A6) and therefore to an accumulation of foreign assets $F_{j,v}$ (or an issuance of foreign debt) and an increment in the stock of domestic capital as shown in (A7).[21] The parameter ϕ_j in (A7) is a scaling factor that converts the units of $I_{j,v}$ (a composite of *physical* goods) in the units of measurement of $K_{j,v}$ (a stock of *services* of capital).

Observe the difference between the concept of *destination* of $I_{j,v}$ – a transformation into a stock of service of capital (through equation A7) owned by the household and eventually rented out to firms – and the concept of *origin* of $I_{j,v}$. Indeed, once the household has decided on how much physical capital accumulation is optimal, there is still a need to generate a demand for "inventories"; Final good production is either consumed or otherwise leads to a demand for investment, which may be viewed as investment by "origin". Equations (A4) and (A5) permit in each period, to allocate the origin of total physical investment $I_{j,v}$ between different sectors and countries, in a two-stage process parallel to (A2) and (A3).[22]

To recap, the first level inter-temporal consumption/saving decision is thus a problem of maximising (A1) subject to (A6) and (A7). Then, given the decision on consumption spending for period v, $PC_{j,v}C_{j,v}$, the consumer chooses in the second level the optimal *mix* of different final consumption goods $s \in S$ in order to reach the index level $C_{j,v}$. This determines a level of spending $Pc_{j,s,v}c_{j,s,v}$ for each good s in the basket of goods, which, in the third level permits to choose the optimal origin $i \in J$ of each of these goods s to reach the index level $c_{j,s,v}$. This is done by maximising (A2) subject to (A8), and (A3) subject to (A9) where $P_{i,j,s,v}$ (= $P_{i,s,v}$) is the price of good s produced in country i and $\tau_{i,j,s,v}$ is the tariff rate imposed by country j on good s from country i, at time v, and $Pc_{j,s,v}$ and $PC_{j,v}$ are composite index price. Similarly for the investment good, the consumer maximizes (A4) subject to (A10) and (A5) subject to (A11), where $Pi_{j,s,v}$ and $PI_{j,v}$ are composite index price.

A.2 Firms

All sectors are assumed to operate under perfectly competitive settings. The representative firm in sector *sd* of country *j* has access to a constant return to scale technology (Cobb-Douglas), combining at time v, variable capital $K_{j,sd,v}$, labour $L_{j,sd,v}$ and intermediary inputs (raw materials) $X_{j,s,sd,v}$ to produce sectoral output $Q_{j,sd,v}$. Intermediate inputs are introduced in the production function as a CES composite: competitively produced goods from different geographical origins enter as imperfect substitutes (the Armington specification). Thus, the technology of the firm is characterised by a weakly separable production function specified by equations (A12) and (A13), where we assume constant returns to scale so that the share parameters sum to one: $\alpha_{L_{j,sd}} + \alpha_{K_{j,sd}} + \sum_s \alpha_{X_{j,s,sd}} = 1$. $B_{j,sd}$ is a scaling parameter, $\eta_{i,j,s,sd}$ are distribution parameters in the CES function, $X_{i,j,s,sd,v}$ represents the demand for good *s* produced in country *i* and used as an intermediary good by the representative firm operating in sector *sd* of country *j*, and $\sigma_{j,s}$ are Armington substitution elasticities in country *j*, between goods *s* from different geographical origins $i \in J$.

Given the perfect competition assumption, the firm takes primary factor prices, respectively $w_{j,v}$ and $r_{j,v}$ for the rental price of labour and physical capital, as given. The cost of intermediary goods used in the production process of good *sd* of country *j* is given by (A14). This cost can be decomposed into the cost of material inputs originating from NAFTA and non-NAFTA countries as shown in (A14) where $Px_{j,s,sd,v}$ is a price index that represents the minimum spending by firm *sd* of country *j* on intermediary good *s* from both NAFTA and non-NAFTA origins in order to reach a composite index of intermediary goods of type *s* of level $X_{j,s,sd,v}$ =1. ROO appear in the firm problem under equation (A15). The value content is expressed as the ratio of the sectoral value added in country *j* plus the value of raw materials/intermediaries from North American origin to the overall value of sectoral production (*i.e.*, including the value of intermediary goods from non-NAFTA origins).

The assumption of constant returns to scale technology implies that the cost function is linear in the level of output and in this case, both the average cost and the marginal cost equal the unit cost *v*. Therefore, marginal cost pricing implies that: $P_{j,sd,v} = v_{j,sd,v}$, and the cost minimisation program of a NAFTA firm can be written down as:

$$\underset{L_{j,sd,v},K_{j,sd,v},X_{j,s,sd,v},X_{i,j,s,sd,v}}{Min} v_{j,sd,v} Q_{j,sd,v} = w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_s Px_{j,s,sd,v} X_{j,s,sd,v}$$

subject to (A12)-(A15).

(A12) $$Q_{j,sd,v} = B_{j,sd}\left(L_{j,sd,v}\right)^{\alpha_{L_{j,sd}}}\left(K_{j,sd,v}\right)^{\alpha_{K_{j,sd}}}\prod_{s}\left(X_{j,s,sd,v}\right)^{\alpha_{X_{j,s,sd}}}$$

(A13) $$X_{j,s,sd,v} = \left[\sum_{i}\eta_{i,j,s,sd}(X_{i,j,s,sd,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}}\right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}}$$

(A14) $$\sum_{s} Px_{j,s,sd,v}X_{j,s,sd,v} = \sum_{i\in Nafta}\sum_{s} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v} + \sum_{i\notin Nafta}\sum_{s} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v}$$

(A15) $$\frac{w_{j,v}L_{j,sd,v} + r_{j,v}K_{j,sd,v}\sum_{i\in Nafta}\sum_{s} P_{i,s,v}(1+\tau_{i,j,s})X_{i,j,s,sd,v}}{w_{j,v}L_{j,sd,v} + r_{j,v}K_{j,sd,v} + \sum_{s} Px_{j,s,sd,v}X_{j,s,sd,v}} \geq A_{j,sd,v}$$

A.3 General equilibrium

A competitive general equilibrium is a consumption and production allocation, supported by a vector of prices $(p_{j,sd,v}, w_{j,v}, r_{j,v}, \rho_v),\quad sd \in S,\ j \in J$, such that households maximise their utility at given prices and with income generated by those prices in combination with total endowments (Section A.1), firms minimize their cost (Section A2), and supply equals demand in each markets: good, labour, capital, and world financial markets [equations (A16)-(A19)]:

(A16) $$Q_{j,s,v} = \sum_{i\in J}\left(\underbrace{c_{j,i,s,v} + i_{j,i,s,v} + \sum_{sd} X_{j,i,s,sd,v}}_{q_{j,i,s,v}}\right)$$

(A17) $$\overline{L_j} = L_{j,v} = \sum_{s} L_{j,s,v}$$

(A18) $$K_{j,v} = \sum_{s} K_{j,s,v}$$

(A19) $$\sum_{i\in J}\left(\underbrace{w_{i,v}L_{i,v} + r_{i,v}K_{i,v} + G_{i,v} - PC_{i,v}C_{i,v} - PI_{i,v}I_{i,v}}_{NX_{i,v}} + \rho_v F_{i,v}\right) = \sum_{i\in J}\left(F_{i,v+1} - F_{i,v}\right) = 0$$

where $G_{i,v}$ is given by:

(A20) $$G_{i,v} = \sum_s \sum_j c_{j,i,s,v} \tau_{j,i,s,v} P_{j,s,v} + \sum_s \sum_j i_{j,i,s,v} \tau_{j,i,s,v} P_{j,s,v} + \sum_s \sum_j \sum_{sd} X_{j,i,s,sd,v} \tau_{j,i,s,v} P_{j,s,v}$$

The good market equilibrium condition [equation (A16)] states that the supply by firm *s* of country *j* in period *v* is equal to the demand originating from all origins $i \in J$ (and thus including domestic demand by country *j*) for purpose of final consumption, investment, and intermediary good purchase. Due to the specific trade policy of each country *i*, any bilateral flow will be subject to a given tariff rate, generating tariff revenues in period *v*, $G_{i,v}$, according to equation (A20). Tariff revenues in *i* are assumed to be redistributed as lump sum transfer to the representative household of country *i*.

The labor market equilibrium condition (A17) assumes that labor supply is exogenously given at $\overline{L_j}$ while the demand for labor, $\sum_s L_{j,s,v}$, is the sum of individual demands expressed by each firm *s* in *j*. In equation (A18), the supply of capital $K_{j,v}$ is endogenously determined (see A7) while the demand for the service of capital is the sum of firms demands in country *j*. Equation (A19) illustrates the world financial market condition according to which the world interest rate ρ_v, equilibrates world supply and demand of funds. Observe that the value of net export *NX* is the difference between GDP ($wL + rK + G$) and consumption and investment spending, whereas current account is the sum of *NX* and interest receipt/payment on foreign asset/debt, F_v. Thus, the left side of (A15) is the sum of current accounts of all countries $i \in J$. Recall that the flip side of a positive current account (*i.e.*, a surplus) is that the country is accumulating (buying) foreign assets because the country saves more than it is investing domestically. This excess saving is thus placed in foreign financial markets. Hence, the country's stock of foreign assets increases over that period of time by $\dot{F}_v = (F_{v+1} - F_v) > 0$. During the transition to the steady state, some countries will be "net savers" on the world financial market, while others will be net borrowers so that (A19) does not hold country by country. However, the world financial market is in equilibrium in each period so that world net supply of funds equals world net demand of funds, as given in (A19). Endogenous changes in the world interest rate ρ_v will bring about this equality.[23]

Finally, we have to assume that the household has perfect foresight, that is, he knows the sequence of prices $(p_{j,sd,v}, w_{j,v}, r_{j,v}, \rho_v)$ over the time-v horizon $[0,\infty)$. Consider arbitrary time-paths for these prices. These paths would lead the household to choose a path for consumption spending and saving which determines domestic capital and foreign asset accumulation. The path of capital and foreign asset accumulation will in turn imply a path for wages, rental price of capital, world interest rates, etc. The *equilibrium* price paths are defined as those paths that reproduce themselves given the optimal decisions by firms and households.

The steady state conditions impose that investment covers depreciation so that the stock of capital remains constant. Finally, the accumulation of foreign assets must equal zero, $\dot{F}_V = (F_{V+1} - F_V) = 0$, implying that future trade deficits must be covered by interest earnings on foreign assets held.

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Table 1A External information on $\theta_{j,sd}$ (in percentage) – Tariff Preference

	Canada	USA	Mexico
agri	8.67	0.00	5.09
reso	0.43	0.88	0.39
food	3.16	5.46	3.06
text	12.95	19.49	12.98
manu	2.92	6.26	2.97
tech	1.95	5.08	1.91
auto	2.37	6.23	2.52
serv	0	0	0

Table 1B External information on $\theta_{j,sd}$ (in percentage) – Weighted Tariff Preference

	Canada	USA in	USA out	Mexico
agri	1.06	0.00	0	0.34
reso	0.14	0.02	0	0.11
food	0.34	0.06	0	0.10
text	2.27	0.66	0	3.24
manu	0.85	0.21	0	0.34
tech	0.98	0.40	0	1.41
auto	1.54	0.50	0	1.21
serv	0	0	0	0

Note on abbreviations: agriculture (agri); resource sectors (reso); food processing (food); textiles and clothing (text); manufactures excluding machinery and equipment (manu); machinery and equipment (tech); automotives (auto); services (serv).
Preferential and MFN tariffs were computed from GTAP-5. In Table 1A, the preference for each NAFTA country is calculated as a trade-weighted average of the preferences given by the other two NAFTA partners. In Table 1B, the tariff preference is also weighted by the share of sectoral production that is exported to the NAFTA member (that provides the preference).

Table 2 Distortion, implicit penalty, and elasticities of substitution

	CANADA				USA				MEXICO				sig	
	A	μ	μA	dist	A	μ	μA	dist	A	μ	μA	dist	USA and CAN	MEX
agri	0.98	0.38	0.37	1.39	0.98	0.00	0.00	1.00	0.99	0.52	0.52	1.52	5.2	3.5
reso	0.97	0.13	0.12	1.13	0.98	0.06	0.06	1.06	0.99	0.24	0.24	1.24	6.3	4.2
food	0.96	0.18	0.18	1.18	0.97	0.09	0.09	1.09	0.96	0.12	0.12	1.12	5.3	3.6
text	0.88	0.26	0.22	1.26	0.90	0.15	0.13	1.15	0.98	0.80	0.79	1.81	7.6	5.0
manu	0.94	0.22	0.21	1.23	0.94	0.12	0.11	1.12	0.94	0.18	0.17	1.19	5.2	3.5
tech	0.90	0.19	0.17	1.19	0.93	0.15	0.14	1.15	0.92	0.31	0.29	1.32	6.3	4.2
auto	0.90	0.17	0.16	1.18	0.93	0.13	0.12	1.13	0.91	0.22	0.20	1.23	11.7	7.8
serv	0.98	0.00	0.00	1.00	0.98	0.00	0.00	1.00	0.99	0.00	0.00	1.00	4.3	2.9

Note on abbreviation: sig: elasticity of substitution between domestic intermediary goods and import.

Table 3 Trade to GDP (%)

	CAN	USA	MEX	MER	LAT	EUR	ROW
Import/GDP	34.5	12.9	26.1	9.0	27.2	11.7	11.2
Export/GDP	37.8	11.0	30.1	6.9	23.5	12.6	12.0

Note on abbreviations: Canada (CAN); Mexico (MEX); Mercosur (MER); Latin America excluding Mercosur (LAT); Europe (EUR); Rest of the World (ROW).

Table 4 Sectoral distribution of value added (%)

	CAN	USA	MEX	MER	LAT	EUR	ROW
agri	1.9	1.2	8.1	9.4	10.0	2.1	6.0
reso	4.4	1.0	6.4	2.0	7.4	1.1	4.7
food	2.9	2.3	5.3	6.8	7.5	3.4	3.8
text	1.1	0.9	3.3	4.4	3.7	1.3	2.6
manu	12.8	8.5	11.9	14.4	11.1	12.2	11.5
tech	3.8	5.4	5.6	3.8	1.8	5.1	6.2
auto	2.6	1.9	2.7	2.4	1.2	2.2	2.0
serv	69.8	78.5	55.6	56.0	56.5	72.1	62.3

Table 5 Regional shares in total exports and imports (%)

	CAN		USA		MEX		MER		LAT		EUR		ROW	
	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP
CAN	--	--	15.7	16.7	3.2	1.3	1.7	2.3	2.5	2.3	3.3	2.6	3.1	3.1
USA	72.1	63.3	--	--	74.5	68.1	17.8	25.7	41.3	34.2	23.5	25.9	38.5	31.2
MEX	0.5	1.7	7.9	8.6	--	--	1.6	1.9	1.8	4.7	1.4	0.9	1.1	0.8
MER	0.5	0.6	3.0	1.4	1.7	1.3	--	--	5.8	8.7	3.5	2.5	2.3	2.4
LAT	1.2	1.2	4.8	4.3	4.9	1.8	13.6	6.1	--	--	2.7	2.9	2.8	2.1
EUR	10.6	15.7	28.5	23.8	7.7	14.0	30.3	36.2	26.3	22.9	--	--	52.2	60.4
ROW	14.6	17.4	40.1	45.3	7.9	13.5	34.9	27.9	22.2	27.1	65.6	65.2	--	--
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 6 Impact and long-run effects of removing NAFTA ROO on real aggregate variables (using $\theta_{i,sd}$ in Table 1B with "USA in")

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)
CAN	8.2	7.2	5.3	5.9	0.1	-0.1	-3.0	-1.0	0.8	0.4	-0.1
USA	9.9	9.0	5.0	5.9	-0.1	-0.2	-1.3	-0.4	0.1	0.0	-0.2
MEX	8.7	7.0	5.7	6.3	0.6	0.4	-2.8	-0.6	1.0	0.6	0.4
MER	3.5	3.8	3.2	3.0	-0.1	0.1	0.6	0.2	0.0	0.1	0.1
LAT	2.7	7.1	8.0	5.8	0.2	0.9	7.6	2.0	0.2	1.3	0.8
EUR	3.1	3.3	4.7	4.6	0.1	0.2	0.5	0.2	0.0	0.1	0.2
ROW	2.8	3.5	5.4	5.1	0.2	0.4	0.6	0.4	0.0	0.2	0.3

	PCON (PC)		PINV (PI)		GDP deflator		RREAL		WREAL		Tariff Revenue	
CAN	-0.4	-0.2	-0.3	-0.1	-1.3	-1.0	-0.6	0.1	-0.1	-0.4	25.5	26.7
USA	0.2	0.3	0.3	0.3	-0.1	0.0	-0.2	0.1	-0.2	-0.3	4.8	6.2
MEX	-0.6	-0.3	-0.3	-0.1	-1.3	-0.9	-0.1	0.1	0.1	-0.1	35.1	36.0
MER	3.2	3.1	3.1	3.0	3.3	3.1	0.1	0.0	0.0	0.1	3.5	3.2
LAT	4.2	3.4	3.8	3.1	4.9	3.9	0.8	0.0	0.5	1.2	8.6	6.2
EUR	3.3	3.1	3.2	3.1	3.4	3.2	0.1	0.0	0.1	0.2	2.8	3.0
ROW	3.5	3.3	3.4	3.3	3.7	3.5	0.2	0.0	0.1	0.3	5.2	4.9

Note on abbreviations: RReal is the real rental price of capital; WReal is the real rental price of labour; PCON is the price of aggregate consumption (CON) so that PCON.CON (or PC.C) is consumption spending. PINV is the price of aggregate investment. PCON, PINV and GDP deflator are nominal variables so that their levels depend on the choice of the numeraire.

Table 7 Impact and long-run effects of removing NAFTA ROO on real aggregate variables (using $\theta_{j,sd}$ in Table 1B with "USA out")

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)
CAN	11.4	10.6	9.5	9.8	0.4	0.3	-2.0	-0.7	1.0	0.7	0.3
USA	-0.4	-0.5	-0.5	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEX	9.8	9.8	9.2	9.3	0.8	0.9	0.0	0.0	1.2	1.2	0.9
MER	1.1	1.2	1.0	1.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0
LAT	0.7	1.3	1.5	1.2	0.1	0.2	1.2	0.3	0.0	0.2	0.2
EUR	1.1	1.2	1.7	1.6	0.0	0.1	0.2	0.1	0.0	0.0	0.1
ROW	0.6	0.7	1.0	1.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1

	PCON (PC)		PINV (PI)		GDP deflator		RREAL		WREAL		Tariff Revenue	
CAN	-0.8	-0.7	-0.7	-0.6	-1.5	-1.3	-0.3	0.1	0.2	0.0	37.8	38.2
USA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.5	-4.3
MEX	-0.6	-0.6	-0.4	-0.4	-1.0	-1.1	0.2	0.2	0.3	0.3	45.4	45.5
MER	0.8	0.8	0.8	0.7	0.8	0.8	0.0	0.0	0.0	0.0	1.2	1.1
LAT	0.8	0.7	0.8	0.6	1.0	0.8	0.1	0.0	0.1	0.2	1.7	1.3
EUR	0.8	0.8	0.8	0.8	0.9	0.8	0.0	0.0	0.0	0.1	1.4	1.3
ROW	0.8	0.7	0.8	0.7	0.8	0.8	0.0	0.0	0.0	0.1	1.1	1.1

Table 8 Impact on bilateral trade flows (in percent, steady state)
Panel a: using $\theta_{j,sd}$ in Table 1B with "USA in"

	IMPORTERS note: elements on main diagonal: percent change in domestic demand							
		CAN	**USA**	**MEX**	**MER**	**LAT**	**EUR**	**ROW**
EXPORTERS	**CAN**	-1.51	3.28	-5.06	15.50	18.90	21.24	15.54
	USA	-11.21	-0.72	-9.79	11.74	13.27	18.24	13.22
	MEX	-6.89	4.26	-1.05	17.14	18.59	21.58	14.82
	MER	38.33	8.84	58.54	0.03	0.95	0.42	1.00
	LAT	49.37	13.65	47.94	-1.35	0.48	-1.92	-0.42
	EUR	37.95	4.82	40.84	-0.79	0.56	-0.05	0.61
	ROW	36.22	6.86	41.84	-1.30	-1.09	-1.28	0.08

Panel b: using $\theta_{j,sd}$ in Table 1B but with "USA out"

	IMPORTERS note: elements on main diagonal: percent change in domestic demand							
		CAN	**USA**	**MEX**	**MER**	**LAT**	**EUR**	**ROW**
EXPORTERS	**CAN**	-1.48	11.40	-3.83	8.47	9.61	10.50	7.49
	USA	-14.23	-0.04	-10.97	2.85	2.54	4.41	2.86
	MEX	-7.38	11.14	-0.75	8.70	8.49	9.07	5.75
	MER	51.41	-4.45	71.67	0.01	-0.36	0.11	-0.08
	LAT	66.62	-3.82	61.24	0.22	0.09	0.37	0.13
	EUR	53.64	-4.61	52.35	-0.26	-0.51	-0.02	-0.24
	ROW	54.20	-4.50	55.08	-0.01	-0.63	0.18	0.01

Table 9 Regional shares in total exports and imports -- Percentage point differences from benchmark (Table 5)
Panel a: using $\theta_{j,sd}$ in Table 1B with "USA in"

	CAN		USA		MEX		MER		LAT		EUR		ROW	
	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP
CAN	--	--	-2.9	-0.4	-0.4	-0.1	0.6	0.3	1.0	0.3	1.1	0.4	1.0	0.3
USA	-2.7	-10.2	--	--	-1.9	-10.3	0.9	2.2	2.5	2.4	0.3	3.4	1.2	2.4
MEX	-0.1	-0.2	-1.4	-0.1	--	--	0.9	0.3	0.7	0.6	0.5	0.2	0.4	0.1
MER	0.1	0.2	0.1	0.0	0.2	0.6	--	--	-0.5	-0.4	-0.1	-0.1	-0.1	-0.1
LAT	0.1	0.5	0.2	0.3	0.5	0.7	-0.4	-0.3	--	--	-0.1	-0.2	-0.1	-0.1
EUR	1.4	4.8	2.4	-0.2	1.1	4.6	-1.0	-1.3	-2.2	-1.1	--	--	-2.4	-2.6
ROW	1.1	5.0	1.6	0.4	0.6	4.5	-0.9	-1.2	-1.6	-1.8	-1.7	-3.7	--	--
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Panel b: using $\theta_{j,sd}$ in Table 1B with "USA out"

	CAN		USA		MEX		MER		LAT		EUR		ROW	
	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP	EXP	IMP
CAN	--	--	-2.2	2.0	-0.5	-0.2	0.8	0.2	1.6	0.2	1.7	0.2	1.7	0.2
USA	0.5	-13.9	--	--	0.9	-12.6	-1.0	0.5	-2.1	0.5	-1.4	0.7	-2.0	0.6
MEX	-0.1	-0.3	-0.8	1.0	--	--	1.1	0.1	1.0	0.3	0.7	0.1	0.6	0.0
MER	0.0	0.2	0.1	-0.1	0.0	0.7	--	--	-0.1	-0.1	-0.1	0.0	0.0	0.0
LAT	0.0	0.6	0.1	-0.1	-0.1	0.9	-0.2	0.0	--	--	0.0	0.0	0.0	0.0
EUR	0.0	6.3	1.4	-1.0	0.0	5.5	-0.3	-0.5	-0.3	-0.4	--	--	-0.3	-0.8
ROW	-0.4	7.0	1.4	-1.8	-0.3	5.7	-0.4	-0.3	-0.3	-0.5	-0.9	-0.9	--	--
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 10 Impact on sectoral output (in percent, steady state)
Panel a: using $\theta_{j,sd}$ in Table 1B with "USA in"

	CAN	USA	MEX	MER	LAT	EUR	ROW
agri	5.30	1.20	0.81	0.26	-0.01	-0.06	-0.14
reso	-11.69	-9.38	-3.00	1.47	11.43	3.64	1.92
food	1.43	0.55	0.03	0.16	0.32	0.10	0.08
text	-2.91	-4.20	5.83	0.43	0.68	0.83	0.81
manu	0.51	-1.36	-1.83	0.36	1.94	0.69	0.61
tech	2.19	0.86	4.08	-0.44	-1.09	-0.10	0.38
auto	7.06	0.68	3.27	-0.05	-1.13	-0.06	-0.61
serv	0.12	0.10	0.02	0.07	0.63	0.02	0.14

Panel b: using $\theta_{j,sd}$ in Table 1B with "USA out"

	CAN	USA	MEX	MER	LAT	EUR	ROW
agri	3.03	0.30	0.53	0.06	0.05	-0.07	-0.04
reso	-8.06	-0.03	-0.12	0.32	1.06	2.30	0.22
food	0.83	0.13	0.17	0.05	0.17	0.03	0.05
text	-2.06	-0.48	7.42	0.11	-0.81	0.04	0.07
manu	1.30	-0.24	-1.61	0.11	0.93	0.16	0.11
tech	5.30	-0.02	8.62	-0.15	-0.39	-0.16	-0.14
auto	14.93	-2.32	6.01	0.13	-0.13	0.43	0.44
serv	-0.17	0.06	0.03	0.02	0.15	0.02	0.04

Panel c: using $\theta_{j,sd}$ in Table 1B with "USA out" and with <u>elasticity of substitution reduced by 25%</u>

	CAN	USA	MEX	MER	LAT	EUR	ROW
agri	2.67	0.23	0.51	0.06	0.09	-0.04	-0.01
reso	-6.09	-0.13	0.22	0.29	0.91	1.95	0.20
food	0.83	0.09	0.09	0.06	0.20	0.04	0.06
text	-2.21	-0.36	6.32	0.11	-0.57	0.06	0.08
manu	1.33	-0.21	-1.16	0.11	0.84	0.15	0.11
tech	4.56	-0.01	7.22	-0.08	-0.19	-0.10	-0.09
auto	12.00	-1.86	5.19	0.14	0.04	0.36	0.37
serv	-0.14	0.04	0.01	0.03	0.16	0.03	0.04

Table 11a Impact and long-run effects of removing NAFTA ROO and adopting a CET (using $\theta_{j,sd}$ in Table 1B with "USA out")

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)
CAN	14.8	13.8	12.3	12.7	0.4	0.3	-2.3	-0.7	1.2	0.9	0.3
USA	-0.2	-0.3	-0.5	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
MEX	15.3	20.0	18.2	17.2	0.2	0.9	7.4	1.6	1.5	2.6	0.8
MER	1.6	1.6	1.3	1.4	0.0	0.1	0.2	0.1	0.0	0.0	0.0
LAT	0.8	1.5	1.6	1.4	0.0	0.2	1.2	0.3	0.0	0.2	0.2
EUR	1.6	1.7	2.3	2.3	0.0	0.1	0.3	0.1	0.0	0.1	0.1
ROW	0.9	0.9	1.4	1.4	0.0	0.1	0.1	0.1	0.0	0.0	0.1

Table 11b Impact and long-run pure effects of adopting a CET (using $\theta_{j,sd}$ in Table 1B with "USA out")

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)
CAN	2.4	2.2	2.0	2.1	0.1	0.1	-0.4	-0.1	0.2	0.1	0.1
USA	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEX	2.7	5.9	5.3	4.4	-0.4	0.1	5.3	1.1	0.2	0.9	0.0
MER	0.3	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAT	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EUR	0.4	0.4	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROW	0.2	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 11c (= Table 11a minus Table 11b) Typical mis-estimation in the literature for not accounting for ROO removal when evaluating the impact of a customs union (using $\theta_{j,sd}$ in Table 1B with "USA out")

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)
CAN	12.4	11.6	10.3	10.6	0.3	0.2	-1.9	-0.6	1	0.8	0.2
USA	-0.2	-0.3	-0.4	-0.2	-0.1	0	0	0	0	0	0
MEX	12.6	14.1	12.9	12.8	0.6	0.8	2.1	0.5	1.3	1.7	0.8
MER	1.3	1.3	1.1	1.1	0	0.1	0.2	0.1	0	0	0
LAT	0.7	1.4	1.5	1.3	0	0.2	1.2	0.3	0	0.2	0.2
EUR	1.2	1.3	1.8	1.8	0	0.1	0.3	0.1	0	0.1	0.1
ROW	0.7	0.8	1.2	1.2	0	0.1	0.1	0.1	0	0	0.1

Endnotes

[1] In addition to these two "pure" effects, there is also a second order or "crossed" effect. The removal of NAFTA ROO *per se* modifies trade patterns between NAFTA and non-NAFTA countries, so that the adoption of a CET will also have an impact on this new pattern of trade.
[2] The European Commission clearly states that preferential ROO are not part of a Customs Union arrangement at:
http://europa.eu.int/comm/taxation_customs/customs/customs_duties/rules_origin/index_en.htm. , and "The customs policy of the European Union" at
http://europa.eu.int/comm/publications/booklets/move/19/txt_en.htm#2. However, there are exceptions to the principle of free circulation so that some goods are still subject to a preferential treatment based on origin. As members of the European union have a common external tariff, no trade deflection exists, so that there is hardly any *economic* argument in support for ROO on these "exceptions" and they may be viewed as purely protectionist devices.
[3] Her proof relies on the argument that an FTA does not generate more trade creation (which is welfare improving) than does a CU, but generates more trade diversion (which is welfare decreasing) where trade diversion is taken "at large" that is, including the impact of ROO distortion. Moreover, she claims that the political economy of FTA is likely to be less conducive to (future) multilateral trade liberalization than is a CU because ROO favour FTA producers relative to more efficient world producers so that the firms producing for the partner country's market will constitute an additional opposition to any moves to globally freer trade. Appiah (1999) provides empirical support to this view and examines the gains of moving from a Pre-FTA regime to either a FTA or a CU. Appiah's simulation results suggest that a North American CU is always "superior" to a North American FTA *if* the common external tariff is not the maximum or "protectionist" CET. He examines three scenarios for the CET: set to the minimum, average, and maximum of the three countries external tariff, chosen separately by industry. The difference in aggregate gains of moving to a CU instead of moving to NAFTA can be as much as 1.1% of real income for Canada, 1.2% for the United States and 1.5% for Mexico.
[4] Ghosh and Rao give an estimate of a potential North American CU by first gauging the impact of removing NAFTA ROO. Their experiment is based on the anecdotal evidence reported in Krueger (1995) that Canadian producers have *on occasion* chosen to pay the relevant MFN duties rather than ask for preferential treatment and incur the cost of proving origins of their goods. Ghosh and Rao push this observation to the extreme and create an artificial benchmark whereby no preferential trade occurs among NAFTA members (no NAFTA member asks for preferential treatment so that the tariff applied to trade flows among NAFTA members are MFN). They then successively reintroduce preferential treatment in their counterfactual (all trade flows among NAFTA members attracts preferential tariff whether ROO are satisfied or not) and then a common external tariff with respect to non-members. The authors view the move from their artificial MFN benchmark to the preferential step as providing an upper bound estimate for the impact of removing NAFTA ROO. Astute as it might be, it is, however, impossible to disentangle this so-called upper bound estimate into the true contribution of removing ROO and the contribution of an artificial reforming of an already existing preferential trade arrangement (indeed, they must *de facto* recapture some of the trade gains that have already occurred due to over 15 years of combined Canada-U.S. FTA and NAFTA). The only way out of this problem is an explicit modeling of distortionary ROO and a proper calibration procedure, which is proposed in this paper.
[5] This central decision model has been shown to be equivalent (under some conditions) to a model where the firm would participate in the inter-temporal decision by maximizing the present value of the flows of present and future dividends (Abel and Blanchard 1993).
[6] Calibrating the technology parameters requires solving simultaneously equations (7) to (11) and (1), by using the data set $\{L_{j,sd,v}; K_{j,sd,v}; X_{j,s,sd,v}; X_{i,j,s,sd,v}; Q_{j,sd,v}\}$ observed in a given year *v*, to simulate a set of calibrated values for: $\{\alpha_{L_{j,sd}}; \alpha_{K_{j,sd}}; \alpha_{X_{j,s,sd}}; \eta_{i,j,s,sd}; B_{j,sd}; \mu_{j,sd}\}$ that are consistent with the data.
Clearly, there are more parameters to fit than equations so that $\mu_{j,sd}$ cannot be calibrated. Additional (*j* x *sd*) equations must be introduced. Adding the (*j x sd*) equations (6a) will not work, however, because we will assume in Section 2.4 that firms already fulfill equation (6a) in the initially observed data set. This explains why we have to resort to equation (19). For sure, in a standard optimization problem where

technological parameters are known, we would be able to solve endogenously for $\mu_{j,sd}$ with the use of (6a). In the calibration procedure, however, technological parameters are unknown and this requires additional information. I thank Yazid Dissou for discussions that clarified this issue. A graphical explanation of the calibration issue in a simplified problem for the firm is available from the author upon request.

[7] The typical argument in the revealed preference approach is as follows. In sectors where NAFTA's utilization rate is 100%, the benefit of tariff preference is revealed larger than compliance costs. Thus, in those sectors, the rate of tariff preference provides an upper bound on the ad-valorem equivalent of compliance costs. In sectors where NAFTA's utilization rate is zero, by the same reasoning, tariff preference provides a lower bound on compliance costs. Finally, in all sectors where utilization rates are strictly between 0 and 100%, if exporters had identical compliance costs they would be revealed indifferent between shipping under NAFTA or MFN, so the tariff preference would be revealed equal to the compliance costs. With heterogeneous compliance costs, all that can be said is that the tariff preference gives a rough estimate of compliance costs in the sense that at least some firms have higher compliance costs whereas some have lower ones. We can obviously assume that the aggregate utilization rates are between 0% and 100% in the highly aggregated sectors examined in Section 3.

[8] If a firm sells its entire production domestically, then tariff preference *per se* has no value, so that the firm would not change its input mix and incur an increase in unit cost of production (weight = 0) in order to satisfy a ROO. The weight equals 1 in the other extreme scenario of a NAFTA firm that exports all its production to the two other NAFTA members.

[9] The paper does not explore the implausible scenarios emerging from a weak US negotiation power with respect to either Canada and/or Mexico.

[10] To quote Wonnacott (1991): "As long as the United States and Mexico are going forward with a negotiated agreement, it is worse for Canada to stay away and not participate." However, Estevadeordal and Suominen (2004) show that NAFTA ROO are more restrictive than the ROO that applied under the previous Canada-USA FTA.

[11] The two assumptions underlying the asymmetric scenario (the lobbying for a captive market and the initial tariff protection of the U.S. intermediary sector) also underlie Krueger's (1993) point that ROO can effectively extend the protection that the U.S. intermediary industry receives within the U.S., to Canada and Mexico, so that the ROO can be used by the U.S. to secure its NAFTA intermediary market for the exports of its own intermediate products. It is as if the U.S. tariff on intermediary good applied to the rest of the world (before NAFTA) became a tariff imposed by NAFTA to the rest of the world.

[12] However, estimating $\theta_{j,sd}$ is also, in a sense, "fighting the last war" in that economists and CGE modelers should have addressed this issue when ROO were introduced together with NAFTA. As noted in the introduction, Appiah (1999) seems to be the first study that addressed this issue using CGE analysis.

[13] A general equilibrium framework is even more relevant when ROO (tax/subsidy) are removed from all sectors of NAFTA countries at the same time, as is the case in our analysis.

[14] The theoretical literature on ROO [*e.g.*, Grossman (1981), Krishna and Krueger (1985), Krishna and Ju (1998), Krishna (2005)] shows that by increasing ROO's restrictiveness $A_{j,sd,v}$, a relevant middle *range* $\left(\underline{A_{j,sd,v}}, \overline{A_{j,sd,v}}\right)$ emerges, over which ROO imply distortionary behavior so that the magnitude of distortion is not a monotonic transformation of restrictiveness. This would eventually lead us to model heterogeneous behavior within each sector.

[15] This procedure is valid because the main interest in this study is not to impose a ROO in the counterfactual, but to remove, in the counterfactual, a ROO that exists in the benchmark. The possibility of $\theta_{j,sd} = 0$ is important as this also permits to envisage a situation where the introduction of ROO did not affect behaviour, so that *ceteris paribus*, its removal will not affect behaviour either.

[16] Elasticity value for each commodity is an average of its top (between domestic and composite imports) and bottom level (between different sources of imports) elasticity values obtained from GTAP database. For obtaining country specific numbers, these are multiplied by 1.5 for Canada, U.S., and Europe, and by 1 for other regions, as per convention [see Perroni and Whalley (1996)].

[17] The simulations run for 40 periods, which is sufficient here to reach a steady state. The tables in this paper illustrate the impact -- the period just after the shock -- and the long term (steady state) when v = 40.

[18] Real consumption in Canada slightly declines *along* the optimal dynamic transitional path (from +0.1% to –0.1%), and this is accompanied with a small increase in the aggregate price of consumption (PC) along that path (from –0.4% to –0.2%). This dynamics reflects the Euler first order condition of the inter-temporal maximisation problem of the consumer, according to which consumption increases (decreases) along the optimal path when consumption prices are expected to decrease (increase). The Euler equation also embodies a transitional dynamic with respect to the spread between the world interest rate and the rate of time preference. However, in the model, the world interest rate has been chosen as the numéraire and set equal to the rate of time preference for all periods, so that the dynamic path for consumption is fully explained through the dynamics of the aggregate consumption price. This assumption for the world interest rate coupled with the assumption of an inter-temporal elasticity of substitution equal to 1 also implies that:

$$PC_{i,v-1}C_{i,v-1} = PC_{i,v}C_{i,v}$$

so that the consumption *spending* profile remains constant along the optimal path.

[19] The household inherits the stock of capital from past period so that, given a lower demand for the services of capital by firms in the impact period and given a fixed short-term supply of capital, the rental price of capital (RReal) must decrease immediately (as seen in Table 6). Although the household can react by placing excess saving into foreign financial market, equality of returns between domestic physical capital and foreign financial capital must continue to hold to ensure international arbitrage condition. The return on international financial market, ρ, is chosen as the numéraire, so that it is exogenously fixed. Thus, the components of the return from investing in domestic physical capital (rental price of capital, including gains in capital and depreciation cost) must adjust to the shock. A non-negative investment rate in physical capital therefore requires that the household expects either capital gains, or a lower depreciation cost of capital, or both. For Canada, we see in Table 6 that the price of investment (*PI*) falls in the first period to –0.3% and increase slightly to –0.1% along the optimal path. This generates only a small expected capital gain, but also a lower depreciation cost per unit of physical capital goods: $\delta_i PI_{i,v}$. As the household progressively reduces the supply of domestic capital, the rental price of capital can progressively increase along the optimal path. Eventually, as a new steady state is reached, capital gains vanish and the nominal rental price of capital (*r*) is at the level consistent with the depreciation cost and the world interest rate ρ.

[20] Current discussions within NAFTA countries to liberalize ROO apply to select products/sectors (*e.g.*, agri-food, metals and minerals, chemical and medical equipment), instead of a general across the board liberalization. Clearly, this very focused sectoral approach, although potentially beneficial to the firms involved, is not likely to have any of the general equilibrium effects of magnitude described in this paper.

[21] At each period, the gross marginal revenue from owning one extra unit of capital $r_{j,v}\phi_j$ plus capital gains ($PI_{j,v}$ - $PI_{j,v-1}$) minus the dollar cost of depreciation $\delta_j PI_{j,v}$ must be equal to the revenue that could have been generated if the acquisition price $PI_{j,v-1}$ of that unit of domestic physical investment had been invested instead at the world financial interest rate ρ_v. Observe that one unit of $I_{j,v-1}$ is transformed into ϕ_j units of capital services $K_{j,v}$, so that the gross marginal revenue in period *v* increases by $r_{j,v}\phi_j$.

[22] It is assumed that (A4) and (A5) are part of the preference system of the representative household. However, this allocation can alternatively be viewed as done by an unspecified agent.

[23] The world interest rate ρ_v has been chosen as the numeraire in the model and thus has been kept fixed. By Walras law, if (A12)-(A14) are in equilibrium then (A15) is automatically in equilibrium so that (A15) can actually be left out of the model.