

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

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Abstract

NAFTA Rules of Origin (ROO) are used to determine which goods are attributable to NAFTA member countries and thus eligible for a preferential tariff. These rules create incentives for NAFTA producers to source inputs from potentially higher priced North American suppliers. As such, a ROO is an implicit tax on the intermediate goods produced by the rest of the world. Most computable general equilibrium (CGE) studies assessing the welfare impact of moving from NAFTA to a deeper form of integration, for example a North American Customs Union (CU), typically proxy the integration as the adoption of a common external tariff towards the rest of the world. Thus, these studies do not explicitly consider the impact of eliminating the distortion created by the NAFTA ROO.

This paper shows that the failure to account for the removal of ROO in these studies would likely lead to biased estimates. I explicitly consider the impact of removing the NAFTA ROO in a multi-country multi-sector dynamic general equilibrium model. The objective is to provide better estimates of this shock on production and welfare. Although the removal of distortionary ROO is likely to lower the unit cost of production within NAFTA, it may also deteriorate NAFTA terms of trade with the rest of the world. The net effect on welfare is ambiguous and is thus an empirical issue, which is addressed in this paper. This is illustrated using three distinct scenarios for which I do not take sides, but that I propose as a springboard for a general discussion.

1. 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 NAFTA, such as the harmonization of border measures, common external tariff, customs union, harmonization of regulatory procedures, free movement of labor, elimination of NAFTA rules of origins, etc. However, some observers fear that a deeper integration with the U.S. could potentially be at the expense of Canada's economic relationship with other countries.¹ One objective of this paper is to illustrate that eliminating NAFTA rules of origin is actually a measure that can potentially increase Canada's trade with countries outside NAFTA.

Rules of origin (ROO) are particularly difficult to model, and this may explain why they have been somewhat overlooked in the empirical literature, and more specifically in computable general equilibrium modeling analyses. This paper is thus a step towards filling that gap and proposes some modeling leads that might permit to gauge the economic and welfare impact of removing ROO. I first start by defining basic concepts, and point to some useful papers in the 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 Rules of Origin (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. As pointed out by Krishna (2005), if transport costs are significant, deflection has real costs since transshipping wastes resources, and ROO might prevent or reduce such waste.

Although ROO contribute to some extent to the well functioning of FTAs, they also come with a cost. Governments incur administrative costs, while importers, exporters, and producers bear compliance costs (paper work and proving origin) in order to obtain the

¹ Helliwell believes the emphasis should be on policies that will make Canada a base for world trade rather than just North American trade. By developing worldwide trade networks, Canada can reduce its dependence on North America, where the asymmetry in size and power between the United States and other economies is a problem (as cited in Micro-Economic Policy Analysis Branch Bulletin, Summer/Fall 2003).

preferential treatment. Furthermore, there is a distortionary cost when ROO induces firms to change their production methods or input mixes in order to fulfill ROO requirements. The ROO distortion should not be confused with the typical trade diversion effect of a customs union. The latter effect induces, say, Canadian firms to switch to U.S. tariff-free intermediary goods because they are cheaper than the low-cost but tariff ridden world sources. The ROO distortion, on the other hand, induces Canadian firms to switch to a U.S. source *despite* the fact that the tariff-ridden world source is *cheaper*. 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. A ROO is thus 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) and can be used by, say, the U.S., to secure its NAFTA intermediary market for the exports of its own intermediate products. Thus, beyond their economic justification of curbing trade deflection, ROO are largely employed to favor intra FTA industry linkages over those between the FTA and the rest of the world, and, as such, to indirectly protect FTA-based input producers vis-à-vis their extra-FTA competitors. In the longer-term, ROO may also cause *investment* distortion. Firms within the FTA may rather locate 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 alone.

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.

Tapp (2005) surveys the literature on ROO and concludes that there is a wide range of estimates of the overall costs of NAFTA ROO, none of which can claim to be entirely conclusive, and that the distortionary costs estimates are particularly suspect. Among the various empirical methodologies, he suggests that computable general equilibrium analysis is potentially the most fruitful approach to address 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 (1985), Department of Finance (1988)] 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 points *interval* is due to different assumed scenarios of ROO restrictiveness.

It is often claimed that a FTA requires preferential ROO whereas a customs union (CU) does not. Why is it so? A CU requires the negotiation of a common external tariff (CET)

(*i.e.*, a common tariff with respect to non members), a revenue sharing agreement for the customs duties collected at the external border, and harmonized external trade policies. The CET eliminates trade deflection and thus the economic rationale for ROO. Furthermore, movements of goods within a CU are not based on their “originating status” but on the fact that they comply with provisions on “free circulation”. Thus, preferential ROO and their distortionary effects are typically viewed as absent from a CU arrangement.² And indeed, in the theoretical literature Krueger (1995) argues that CU are strictly Pareto superior to FTA *because* the distortionary impact of preferential ROO is absent from such an arrangement.³

After a decade of NAFTA, the interest of several trade researchers has switched from gauging the impact of moving from a Pre-FTA to a FTA or a CU, to estimating the impact of going from a FTA regime, to a deeper level of integration with the U.S. -- whether a CU or a “NAFTA+” regime. Most computable general equilibrium studies assessing the welfare impact of such a policy, typically proxy the integration as the adoption of a common external tariff towards the rest of the world. Thus, these studies do not explicitly consider the impact of eliminating the distortion created by the NAFTA ROO.

This paper shows that the failure to account for the removal of ROO in these studies would likely lead to biased estimates. First, there is a strong case for a more *complete* counterfactual experiment; beyond adopting a common external tariff, a CU is also an arrangement that allows for the elimination of ROO. Second, unless the model is recalibrated appropriately, there is no “room” for the ROO distortion and thus there is no way to remove it. Brown, Dearnorff and Stern (2001) try to gauge the impact of a North

² See European Commission which 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 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.

American CU but limit their experiment to the adoption of a common external tariff. Although Ghosh and Rao (2004) are aware of the presence of ROO, they cannot capture their impact in their CGE analysis because they do not model them explicitly nor do they calibrate their model to reflect the presence of ROO distortions in the benchmark data set. Finally, in an interesting paper, 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* additional 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.

In order to remain focused on the issue of ROO *per se*, this paper does not attempt to gauge the welfare impact of a CU. Instead, a multi-country multi-sector dynamic model that builds on the work of Mercenier (1995) is used to analyze the general equilibrium impact of removing the economic distortion generated by the presence of ROO within NAFTA. The model is calibrated to GTAP 5 (1997). Removing NAFTA ROO is shown to lower the unit cost of production within NAFTA countries. Although consumers from the rest of the world experience an unambiguous welfare gain, consumers from NAFTA countries may potentially experience a welfare loss from the removal of NAFTA ROO due to a deterioration in the terms of trade (with respect to the rest of the world). This reflects that US firms considerably substitute towards non-NAFTA intermediary goods once ROO are removed. Finally, simulation results 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. This is illustrated using three distinct scenarios for which I do not take sides.

The plan of the paper is as follows. Section 2 is an informal discussion on a smorgasbord of issues including ROO distortion in a partial equilibrium framework and calibration issues related to ROO. Section 3 presents simulation results while Section 4 concludes and provides qualifying caveats to our analysis. Appendix 1 describes the dynamic general equilibrium model that is used and formalizes many of the ideas and concepts introduced in Section 2.

2. Rules of Origin Distortion and Calibration Issue: An Informal Discussion

2.1 A simplified example

Suppose a firm that produces a good “ sd ” with some factors of production -- capital, K_{sd} , labor, L_{sd} , and a composite intermediary good $X_{s,sd}$ (*i.e.*, the quantity X of the intermediary good s used in the production of good sd). Suppose that the profit-maximizing firm has already selected in a first stage the cost minimizing input combination $(\bar{K}_{sd}, \bar{L}_{sd}, \bar{X}_{s,sd})$. The intermediary good is itself a composite of intermediary goods purchased from a NAFTA source, $X_{Nafta,s,sd}$, and from a non-NAFTA source, $X_{nonNafta,s,sd}$. In the decision of buying NAFTA versus non-NAFTA intermediary

goods, the firm wants to minimize the cost of the input combination $(X_{Nafta,s,sd}, X_{nonNafta,s,sd})$ given that the prices of these intermediary goods s are $(P_{Nafta,s}, P_{nonNafta,s})$ and that it needs a composite intermediary good given by the index value $\bar{X}_{s,sd}$. Figure 1 illustrates the minimizing problem of the firm, which algebraically is formulated as follows:

$$(1) \quad Min : Px_{s,sd} \bar{X}_{s,sd} = P_{Nafta,s} X_{Nafta,s,sd} + P_{nonNafta,s} X_{nonNafta,s,sd}$$

$$(2) \quad st : \bar{X}_{s,sd} = \left[\eta_{Nafta,s,sd} (X_{Nafta,s,sd})^{\frac{\sigma_s-1}{\sigma_s}} + \eta_{nonNafta,s,sd} (X_{nonNafta,s,sd})^{\frac{\sigma_s-1}{\sigma_s}} \right]^{\frac{\sigma_s}{\sigma_s-1}}$$

where the intermediary good price index $Px_{s,sd}$, is defined as the minimum expenditure such that $X_{s,sd} = 1$. Equation (2) is an isoquant from a CES function where $\eta_{Nafta,s,sd}$ and $\eta_{nonNafta,s,sd}$ are the distribution parameters of the CES and σ is the (Armington) elasticity of substitution between intermediary goods of different origins $(X_{Nafta,s,sd}, X_{nonNafta,s,sd})$.

The demand functions for the intermediary goods of different origin are:

$$(3a) \quad X_{Nafta,s,sd} = (\eta_{Nafta,s,sd})^{\sigma_s} \left[\frac{Px_{s,sd}}{P_{Nafta,s}} \right]^{\sigma_s} \bar{X}_{s,sd}$$

$$(3b) \quad X_{nonNafta,s,sd} = (\eta_{nonNafta,s,sd})^{\sigma_s} \left[\frac{Px_{s,sd}}{P_{nonNafta,s}} \right]^{\sigma_s} \bar{X}_{s,sd}$$

Substituting (3a) and (3b) into (2) and assuming $X_{s,sd} = 1$ gives the minimum expenditure such that $X_{s,sd} = 1$:

$$(4) \quad Px_{s,sd} = \left[(\eta_{Nafta,s,sd})^{\sigma_s} (P_{Nafta,s})^{1-\sigma_s} + (\eta_{nonNafta,s,sd})^{\sigma_s} (P_{nonNafta,s})^{1-\sigma_s} \right]^{\frac{\sigma_s}{\sigma_s-1}},$$

The cost-minimizing input combination is at the point of tangency between the isoquant and the isocost line as shown by point 1 in Figure 1.

Now suppose that the firm is faced with an additional constraint that the value of the NAFTA intermediary good must be at least equal to a pre-specified percentage A_{sd} of the total value spend on intermediary goods:

$$(5) \quad \frac{P_{Nafta,s} X_{Nafta,s,sd}}{P_{Nafta,s} X_{Nafta,s,sd} + P_{nonNafta,s} X_{nonNafta,s,sd}} \geq A_{sd} \quad (0 \leq A_{sd} \leq 1)$$

Figure 1 Distortion

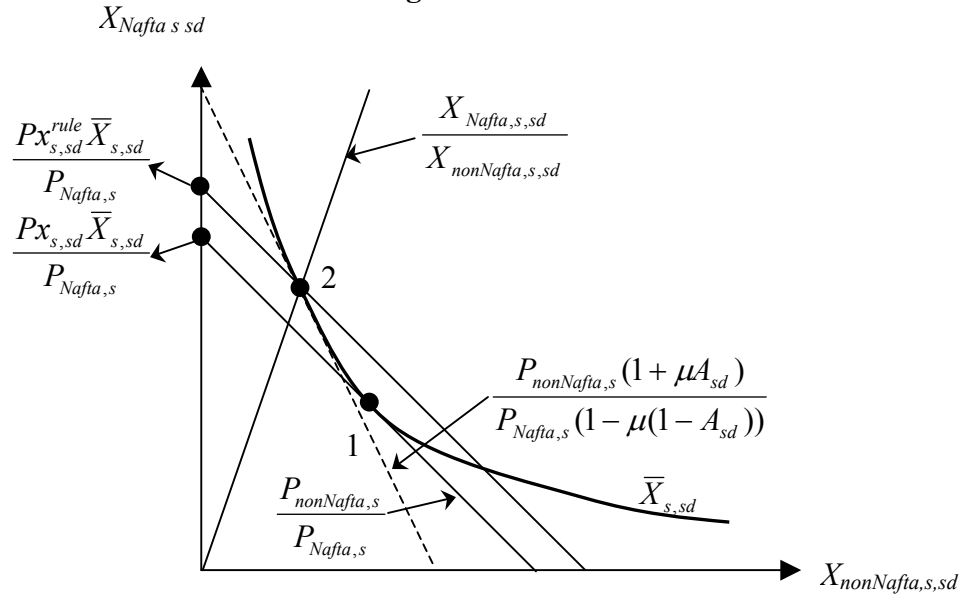
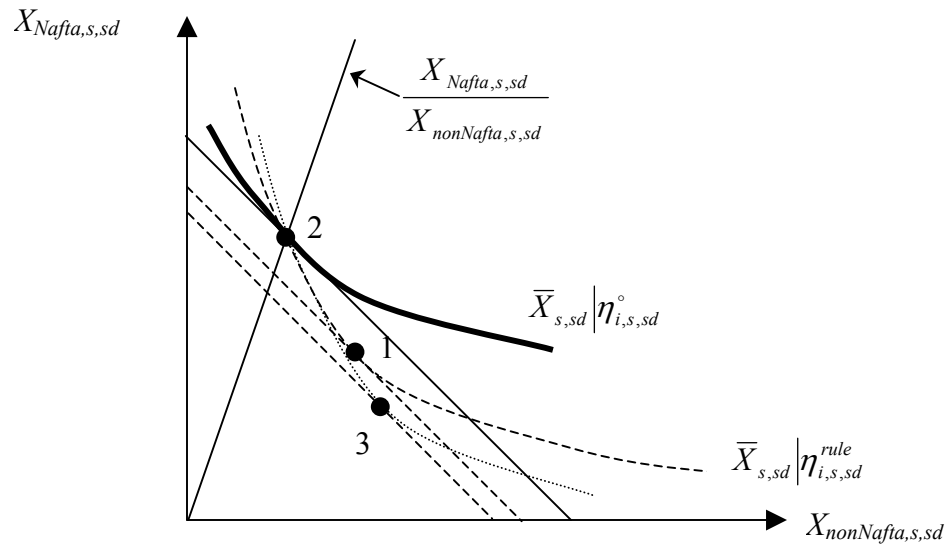


Figure 2 Calibration Issue



Clearly, this is not a rule of origin *per se*. Indeed, a ROO would likely combine both value added and the value of domestic intermediary goods in relation to the value of total sectoral production when judging on whether a specific good has achieved sufficient transformation within the NAFTA zone. Looking ahead to equations (17a) or (17b) in Appendix 1, we see conceptual representations of ROO that have been introduced in our model, and that are *closer* to effective ROO described, say, in NAFTA's Annex 401.⁴ For the time being however, equation (5) is enough to build the intuition as to how an additional constraint faced by the firm alters the model and the calibration procedure.

The demand functions resulting from this new minimization problem are now given by:

$$(3'a) \quad X_{Nafta,s,sd} = (\eta_{Nafta,s,sd})^{\sigma_s} \left[\frac{Px_{s,sd}}{P_{Nafta,s}(1 - \mu(1 - A_{sd}))} \right]^{\sigma_s} \bar{X}_{s,sd}$$

$$(3'b) \quad X_{nonNafta,s,sd} = (\eta_{nonNafta,s,sd})^{\sigma_s} \left[\frac{Px_{s,sd}}{P_{nonNafta,s}(1 + \mu A_{sd})} \right]^{\sigma_s} \bar{X}_{s,sd}$$

which in ratio term is:

$$(6) \quad \frac{X_{Nafta,s,sd}}{X_{nonNafta,s,sd}} = \left[\frac{\eta_{Nafta,s,sd}}{\eta_{nonNafta,s,sd}} \frac{P_{nonNafta,s}(1 + \mu A_{sd})}{P_{Nafta,s}(1 - \mu(1 - A))} \right]^{\sigma_s}$$

and where $\mu \geq 0$ is the Lagrange parameter associated to the additional constraint in the minimization problem of the firm. The ray from the origin in Figure 1 represents the locus of points given by (6), which is also given by equation (5) when the equation holds strictly.⁵ The cost minimizing firm will thus clearly chose the intermediary input bundle

⁴ It must be warned, however, that translating legally-expressed technical measures into a well-defined mathematical function is a daunting task. We can at best hope to capture the spirit of the law.

⁵ When equation (5) holds as a strict equality, then (5) can be rewritten as:

$$(5') \quad \frac{X_{Nafta,s,sd}}{X_{nonNafta,s,sd}} = \left[\frac{A_{sd}}{1 - A_{sd}} \frac{P_{nonNafta,s}}{P_{Nafta,s}} \right]. \text{ Given the distribution parameters and the elasticity of}$$

substitution of the CES function, the Lagrange parameter μ in (6) will take the value that guarantees the equality between (6) and (5'). (In the calibration procedure where both μ and η are unknown, a special procedure must be envisaged to fix both μ and η , as discussed later in the text.) A not so innocuous assumption that is made is that the ROO is *just* binding. More generally, the optimal solution is so that, either the constraint holds as equality or else, the Lagrange parameter takes a zero value, or both (complementary slackness condition). As shown in Appendix 2, there is a possibility that the ROO is not binding. In this case the Lagrange parameter μ equals 0, (5) is a strict inequality and the solution in (3') turns out to be the one observed under the unconstrained setting –equations (3a-b) -- so that relaxing the constraint would not affect the optimal solution. Furthermore, as shown in Appendix 2, the ROO “constraint” is even not mandatory, but only guarantees NAFTA preferential access if fulfilled. The end of Section 2.3 proposes a strategy to deal with these issues.

given by point 2, which is on a higher isocost line (in the price system $(P_{Nafta,s}, P_{nonNafta,s})$) than bundle 1. The effect of this rule is that the firm will buy less intermediary good from non-NAFTA origin, and more from NAFTA origin. Thus this rule acts as an implicit tax on the non-NAFTA good and an implicit subsidy on the NAFTA good. Analytically, the implicit tax is given by $P_{nonNafta,s} \mu A_{sd}$ and the implicit subsidy is: $P_{Nafta,s} \mu(1 - A)$. The (implicit) isocost line in the price system that includes the implicit subsidy or penalty is tangent to the isoquant at point 2.

The intermediary good price index when constraint (5) is included is again noted $Px_{s,sd}$ and defined as the minimum expenditure such that $X_{s,sd} = 1$. Substituting (3'a) and (3'b) into (1) and assuming $X_{s,sd} = 1$ gives that:

(7)

$$Px_{s,sd}^{rule} = \left[(\eta_{Nafta,s,sd})^{\sigma_s} (P_{Nafta,s} (1 - \mu(1 - A_{sd}))^{1-\sigma_s} + (\eta_{nonNafta,s,sd})^{\sigma_s} (P_{nonNafta,s} (1 + \mu A))^{1-\sigma_s} \right]^{\frac{\sigma_s}{\sigma_s - 1}}$$

where a superscript has been added to distinct between the minimum expenditure when (5) is included in the firm's problem with the minimum expenditure absent constraint (5). As shown in Figure 1, the overall spending on intermediary good $\bar{X}_{s,sd}$ has increased due to the additional constraint, pushing the vertical intercept of the isocost line to

$$\frac{Px_{s,sd}^{rule} \bar{X}_{s,sd}}{P_{Nafta,s}} > \frac{Px_{s,sd} \bar{X}_{s,sd}}{P_{Nafta,s}}.$$

Observe that a higher A_{sd} in equation (5) makes the ROO more restrictive, so that the ray from the origin in Figure 1 rotates counterclockwise [as is obvious from (5') in footnote 4], which increases further $Px_{s,sd}^{rule}$.

It is simple enough to realize that if a firm is faced with the ROO constraint (5) and is effectively at point 2 in Figure 1, then, removing the ROO would lead the firm to select the input combination given by point 1, increasing its purchase of non-NAFTA intermediary good and decreasing the purchase of NAFTA intermediary goods, which would lower its total spending on intermediary goods. Analytically, it suffices to set $\mu = 0$ in (3'a) and (3'b).

The simplicity of the argument is, however, deceptive and Figure 2 illustrates this. If all that is observed is the choice of the firm as given by point 2, the challenge remains, however, to position the isoquant of the firm in Figure 2. This leads us to discuss the calibration procedure in a CGE model, which consists in fitting the model to the database. Therefore, suppose that a CGE modeler observes point 2 in his data set, but, for some reason, neglects to take into account the existence of constraint (5) faced by the firm. He will then calibrate the distribution parameters of the CES function so that when "running" his parameterized model without shock, and assuming producer behavior given in (1) and (2), he will be able to replicate his data set. Graphically, he will fix $\eta_{Nafta,s,sd}$ and $\eta_{nonNafta,s,sd}$ to $(\eta_{Nafta,s,sd}^{\circ}, \eta_{nonNafta,s,sd}^{\circ})$ so that this specific parameterization of the CES

function (2) positions the isoquant $\bar{X}_{s,sd} \left| \eta_{i,s,sd}^\circ \right.$, just tangent to the isocost line at point 2 in Figure 2.

On the other hand, a CGE modeler who is aware of the presence of the additional constraint (5) faced by the firm must parameterize (2) by fixing $\eta_{Nafta,s,sd}$ and $\eta_{nonNafta,sd}$ to $(\eta_{Nafta,s,sd}^{rule}, \eta_{nonNafta,s,sd}^{rule})$, positioning the isoquant at: $\bar{X}_{s,sd} \left| \eta_{i,s,sd}^{rule} \right.$. This permits to replicate the benchmark data set (point 2) when running the constrained model. This also permits to envisage a counterfactual experiment whereby the constraint (5) is removed, pushing the economy to point 1; an experiment that cannot be conducted under the alternative set of calibrated parameters. The problem does not stop here, however. Indeed, why not choose the third isoquant drawn in Figure 2? As will be shown shortly, a key additional information is indeed needed to calibrate the distribution parameters of the CES function.

Although this simple example does not reflect the complexity of a ROO (which is analyzed more fully in Appendix 1), it shows that a CGE modeler that wants to take into account the presence of a distortion in his data set caused by a ROO of some kind, must (re-) calibrate his model so that the parameters of the CES aggregator function reflects the presence of that rule.

Finding the calibrated parameter values $(\eta_{Nafta,s,sd}^{rule}, \eta_{nonNafta,s,sd}^{rule})$ is not immediate, however, because these parameters will be intricately linked to the distortion parameter μ as obvious when inverting (3'a and 3'b):⁶

$$(8a) \quad (\eta_{Nafta,s,sd})^{\sigma_s} = \frac{X_{Nafta,s,sd}}{\bar{X}_{s,sd}} \left[\frac{P_{Nafta,s} (1 - \mu(1 - A_{sd}))}{P_{x,s,sd}} \right]^{\sigma_s}$$

$$(8b) \quad (\eta_{nonNafta,s,sd})^{\sigma_s} = \frac{X_{nonNafta,s,sd}}{\bar{X}_{s,sd}} \left[\frac{P_{nonNafta,s} (1 + \mu A_{sd})}{P_{x,s,sd}} \right]^{\sigma_s}$$

Thus, a calibration strategy must be developed that determines $\eta_{Nafta,s,sd}$ and $\eta_{nonNafta,sd}$ conjointly with the distortion parameter μ . A possibility is to argue that the constraint (5) has increased firm's minimum expenditure (per unit of $X_{s,sd}$) by a pre-specified percentage $\theta_{sd} \geq 0$, so that for example:

$$Px_{s,sd}^{Rule} \bar{X}_{s,sd} = Px_{s,sd} (1 + \theta_{sd}) \bar{X}_{s,sd}$$

or

$$(9) \quad Px_{s,sd}^{Rule} = Px_{s,sd} (1 + \theta_{sd})$$

where $Px_{s,sd}$ and $Px_{s,sd}^{Rule}$ are given by equations (4) and (7).

⁶ I am grateful to Yazid Dissou for discussions that clarified this issue.

Equations (8a, 8b, and 9) form a system of three equations and three unknowns η_{Nafta} , $\eta_{nonNafta}$, and μ so that the calibration of the technology (distribution) parameters and the distortion parameter can be solved. Clearly, this strategy requires external information on the parameter θ_{sd} . I have applied this general methodology in Appendix 1 where equation (5) is generalized to a more conventional ROO constraint [see equations (17a) and (17b) in that Appendix]. As is shown, equation (9) must then be generalized to establish a relation between the *unit cost of production*, v , with and without ROO, given by equation (30) and reprinted here for convenience as:

$$(10) \quad v_{sd}^{rule} = v_{sd} (1 + \theta_{sd}) \quad \theta_{sd} \geq 0$$

Information on the parameter θ_{sd} is a key input. A possibility is to use information given by Appiah (1999) -- more on this in Section 2.2, or to use an indirect method as explained in Section 2.3.

2.2 Appiah versus this study

As both this paper and Appiah's are the only two studies that attempt to model *explicitly* distortionary ROO into a CGE framework, it is useful to highlight the features that distinguish them. Appiah revisits traditional CGE analysis of FTA/NAFTA. According to the author, most studies that gauge the welfare impact of moving from a *pre*-FTA to a FTA/NAFTA regime overestimate the welfare gain of this move because ROO -- typically introduced with Free-Trade regimes -- are not modeled in these studies. Although Figure 2 cannot encompass the richness of a CGE analysis, it may be used to illustrate Appiah's point, albeit in a somewhat loosely manner. Assume a *pre*-FTA benchmark data that may conceptually be thought of as a given point (not shown) in Figure 2. Then, suppose that a counterfactual NAFTA simulation exercise (*i.e.*, adoption of a preferential tariff among members states) pushes the economy to point 1 in that figure. For Appiah, this move to 1 cannot be the full story because NAFTA also introduces distortionary ROO that should be part of the full counterfactual simulation exercise. ROO *per se* will push the economy from 1 to 2, and this move leads to an increase in unit cost of production from v_{sd} to v_{sd}^{rule} , so that Appiah effectively derives an estimate for θ_{sd} . (His estimates are given in Table 1A). The move from 1 to 2 illustrates the extent of the mistake that is done when not taking ROO into the analysis. The ROO argument advanced by Appiah is thus a case for a more *complete* counterfactual experiment. Because ROO are absent in the pre-FTA benchmark database, however, Appiah does not need to conceive a specific calibration strategy related to ROO *per se*. In other words, ROO are strictly limited to the counterfactual sphere of a CGE analysis.

The ROO argument advanced in my paper is, however, *also* a calibration issue. Starting from point 2 that is now assumed to represent the benchmark situation under NAFTA, a CGE modeler might be interested in gauging the impact of, say, moving to a CU. Because this policy change may also potentially eliminate NAFTA ROO, the model should be calibrated so that ROO distortions, which are *now* present in the NAFTA

database, are fully taken into account. As discussed previously, the isoquants underlying the analysis should be parameterized with $\eta_{i,s,sd}^{rule}$ instead of $\eta_{i,s,sd}^{\circ}$ (the latter would be the natural candidate of a CGE modeler that abstracts away from ROO concerns in his NAFTA benchmark data set). Then, in a counterfactual simulation, the removal of ROO *per se* pushes the economy from point 2 to point 1. In terms of the analytical framework developed above, this is achieved by setting the distortion parameter μ equal to zero. Thereafter the CGE modeler may pursue his assessment of a CU by simulating the impact of, say, a CET and a tariff revenue sharing agreement between potential members.

As mentioned in the introduction, Ghosh and Rao (2004) 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-US 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.

2.3 Proposal

The crux of the paper relies on external information about parameter θ_{sd} in equation (10), that is, by how much ROO have increased the unit cost of production of NAFTA firms in sectors sd . This information has been computed by Appiah and is reported in Table 1A. Although he obtains different results depending on the degree of ROO restrictiveness that he imposes in the counterfactual experiment, I choose his less restrictive scenario. As can be seen, the increase in unit cost of production, even in this scenario, is far from being negligible. For example, the unit cost of production in the Canadian agriculture sector has increased by about 5% due to NAFTA ROO.

Table 1A External information on $\theta_{j,sd}$ -- Appiah

	Canada	USA	Mexico
agri	5.03	2.02	2.4
reso	3.36	3.08	1.98
food	4.13	2.59	3.63
text	6.16	2.83	3.78
manu	3.15	2.07	2.5
tech	5.41	3.55	4.61
auto	3.31	3.4	2.45
serv	0	0	0

Source: Appiah (1999).

Table 1B External information on $\theta_{j,sd}$ – 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 1C External information on $\theta_{j,sd}$ – Weighted Tariff Preference

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

It is clear that the external information about parameters θ_{sd} as provided by Appiah is, at best, a starting point of the analysis and should not be taken too literally. I therefore propose two other scenarios, without taking sides. Revealed preference approach (discussed in Appendix 2) also attempts to provide indirect information on θ_{sd} by observing the tariff preference (*i.e.*, the difference between MFN and NAFTA tariffs) that NAFTA exporters would obtain when exporting to another NAFTA member if they fulfilled ROO. It is intuitive that an exporter would not take the trouble to satisfy ROO if the ensuing increase in unit cost of production, due to a change in the input mix, was larger than the tariff preference. The tariff preference can thus be viewed as an upper bound estimate for θ_{sd} and is reported in Table 1.B. (Both preferential and MFN tariffs were computed from GTAP-1997). For any NAFTA country, the preference is calculated as a trade-weighted average of the preferences given by the other two NAFTA partners. The major problem with this second proxy for θ_{sd} , however, is that the tariff preference is not weighted by the share of sectoral export to domestic production and may at best be consistent with the extreme scenario of a NAFTA firm that sells its production entirely to the other two NAFTA members. Taking the other extreme case, if a firm sells its entire production domestically, it is unlikely that it will make an attempt to change its input mix, and incur an increase in unit cost of production, in an effort to satisfy a ROO and obtain a tariff preference. Therefore, Table 1.C presents a third proxy for θ_{sd} , given by a weighted tariff preference where the weights are the shares of sectoral export over total sectoral production.

Although the issue of providing an estimate for θ_{sd} is a difficult one, it is not an end in itself. The next issue is: what would be the impact for the Canadian economy if firms did not have to face such an increase in costs due to the presence of NAFTA ROO? This paper addresses that key issue by proposing a general equilibrium analysis of a hypothetical removal of ROO. For example, if the removal of ROO decreased the unit cost of production by θ_{sd} (percent) because of a better reallocation of the mix of factors of production, then NAFTA goods would be cheaper than otherwise, increasing the domestic and foreign demand for these goods. On the other hand we would observe a lower demand for NAFTA intermediary goods, but a higher demand for intermediary goods originating from the rest of the world. This higher demand would tend to increase the rental prices of factor of production and with it the unit cost of production, in non-NAFTA countries. A higher rental price of capital outside NAFTA would induce domestic saving to flow out of NAFTA in search of higher rates of return. A CGE model may help us to better understand those channels and the magnitudes of the impacts of removing NAFTA ROO.

In the CGE model, I use the assumption of a “representative” firm per sector. The representative firm can be thought of as a composite of several types of firms. In other words, instead of modeling heterogeneous behavior as discussed in Appendix 2, the key insight that is proposed is to shift emphasis by considering that NAFTA ROO pushed the economy towards the currently observed values of A_{sd} for each sector sd and that this move increased the unit cost of production in the order of magnitude θ_{sd} as suggested in Tables 1A, 1B, or 1C. Thus, for example, with equation (5) and its counterparts (17a or

17b in Appendix 1), instead of debating whether the left hand side (l.h.s.) member of the equation is or not above an institutionally given A_{sd} in sector sd , I claim that the l.h.s. term *determines* the level of A_{sd} . In other words, I suppose that NAFTA ROO pushed the economy to the level of A_{sd} currently observed by the l.h.s. of the equation. From there, I proceed to examine the CGE impact of removing the ROO in all sectors sd of NAFTA countries.

2.4 Overall presentation of the dynamic CGE 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. The model is fully documented in Georges (2005) and is sketched with some details in Appendix 1.

The world economy J , consists of seven countries/regions composing two blocks: Canada, USA, Mexico, ($NAFTA \in J$), Latin America, Mercosur, Europe, and the Rest of the World ($NONNAFTA \in J$). All countries are fully modelled. Each country has eight sectors of production, all perfectly competitive. These sectors are agriculture, food processing, resources sectors, textiles and clothing, manufactures (excluding machinery and equipment), automotives, machinery and equipment, and services. Trade flows among countries is organised through an Armington system discussed in Appendix 1.

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 maximising 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. The household who effectively owns firms (by owning primary factors, namely labour and 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. 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 (see Abel and Blanchard 1993).

Sectors of activity are identified by indices $s, sd \in S$. Countries are identified by indices $i, j \in J$; $J = NAFTA \cup NONNAFTA$. Finally, the time-horizon is infinite and $v = 0, \dots, T, \dots$, 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 . Notation of main symbols used in the paper is given in Table A1.

The ROO constraint is introduced in the firm problem in a way somewhat similar but more general than in the partial equilibrium presentation of Section 2.1. Observe from conditional demand functions [Equations (23), (24), (26), (27) in Appendix 1] that the solution suggests that NAFTA firm sd pays a penalty ($\mu_{j,sd,v} A_{j,sd,v}$) for the use of intermediary goods purchased outside NAFTA but receives a subsidy $\mu_{j,sd,v}(1 - A_{j,sd,v})$ for the use of materials purchased within NAFTA, *as well as* for the use of domestic factors of production, labor and capital.

3. Benchmark and Simulation results

3.1 Benchmark

In the simulation results I present the percent difference of some economic variables in the counterfactual from their benchmark level. Tables 2 to 4 present some salient features of the benchmark. The GTAP database for the year 1997 has been used to calibrate the model. As mentioned earlier, the model consists of seven countries/regions composing two blocks: Canada, USA, Mexico, (NAFTA \in J), and Latin America, Mercosur, Europe, and the Rest of the World (NONNAFTA \in J). Each country has eight sectors of production: 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 composite commodity.

Table 2 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 3 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 4 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 export from Canada and from Mexico went to the USA, while more than 60% of their total imports is from the USA. Note that Mexico is slightly more dependent to the USA for its trade than is Canada (Table 4), but that Mexico is, overall, less dependent on trade than Canada (Table 2).

A key determinant of the simulation results is the implicit subsidy to capital, labour and NAFTA-produced intermediary goods, and the implicit penalty for the non-NAFTA intermediary goods due to the presence of NAFTA ROO. Recall from Section 2.4 that the implicit penalty on the use of non-NAFTA intermediary good is given by the term

Table 5 gives the values for parameter $A_{j,sd}$. Observe that this parameter is 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 very small, accounting for 12% in the Canadian textile industry to 1% in Mexican agriculture industry. In order to compute the penalties and subsidies, I also need to calibrate the distortion parameter $\mu_{j,sd}$ which requires the knowledge of an external parameter $\theta_{j,sd}$ discussed in Section 2, that reflects by how much the unit cost of production has increased due to introduction of ROO. (Note that for Table 5, the values for $\theta_{j,sd}$ given in Table 1A have been used). There is no closed-form solution that permits to determine $\mu_{j,sd}$. It must be calibrated together with the technological parameters of the firms, and is obtained by solving a highly non-linear system of equations as discussed in Section 2 (equation 8a, 8b, and 9) or in Appendix 1 for the CGE model itself.

With this information, we can now compute the implicit tax and subsidy for each sector within NAFTA countries, and this is reported in Table 5. *Ceteris paribus*, the higher $\theta_{j,sd}$ is, (*i.e.*, the higher the assumed impact that ROO have had on unit cost of production), and the higher the initial implicit penalty. Similarly, there is a positive monotonic relationship between $A_{j,sd}$ and the distortionary parameter $\mu_{j,sd}$, so that the higher $A_{j,sd}$ in a sector, the higher the required distortion to achieve a same percentage change in the unit cost of production. Finally, the elasticity of substitution between domestic intermediary goods and import varies across sectors and the higher the elasticity of substitution, the lower the distortionary parameter. The values of the substitution elasticities reported in Table 5 are taken from GTAP.⁷

TABLE 5 Distortion, implicit penalty, and elasticities of substitution

	CANADA				USA				MEXICO				sig	
	A	μ	μA	dist	A	μ	μA	dist	A	μ	μA	dist	USA CAN	MEX
agri	0.98	0.80	0.78	1.81	0.98	0.52	0.50	1.52	0.99	1.37	1.36	2.38	5.2	3.5
reso	0.97	0.59	0.57	1.60	0.98	0.69	0.68	1.70	0.99	1.01	1.00	2.02	6.3	4.2
food	0.96	0.58	0.56	1.59	0.97	0.51	0.50	1.52	0.96	0.73	0.70	1.75	5.3	3.6
text	0.88	0.43	0.38	1.46	0.90	0.30	0.27	1.31	0.98	0.86	0.85	1.87	7.6	5.0
manu	0.94	0.42	0.39	1.43	0.94	0.36	0.34	1.37	0.94	0.49	0.46	1.51	5.2	3.5
tech	0.90	0.44	0.40	1.46	0.93	0.44	0.41	1.46	0.92	0.57	0.53	1.60	6.3	4.2
auto	0.90	0.25	0.22	1.25	0.93	0.33	0.30	1.33	0.91	0.31	0.28	1.32	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

⁷ 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)].

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 Appendix 1, consists in setting the parameter $\mu_{j,sd}$ equal to zero in equations (23) to (29). The first effect of this shock is to change the demand for factors of production in each sector of NAFTA countries, lowering the demand for capital, labour, and NAFTA intermediary good, but increasing the demand for non-NAFTA intermediary goods. This has the potential to increase export of goods from non-NAFTA to NAFTA countries. This efficient reallocation of factors of production within NAFTA is, however, supposed to lower the unit cost of production in every sector of NAFTA countries. This has in turn the potential to increase export of goods from NAFTA to non-NAFTA countries. Thus, clearly, we should expect an increase of trade between the NAFTA and non-NAFTA countries.

As mentioned by Krueger (1993), ROO generate additional trade diversion (on top of the traditional trade diversion of a FTA or a CU), so that eliminating ROO *per se* should eliminate these diversions. The implication in terms of welfare impact is the following. Less trade diversion is typically viewed as welfare improving, abstracting from terms of trade consideration. However, it is clear that NAFTA countries will experiment 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 their export) must fall, whereas the additional demand for non-NAFTA goods (that will be used as intermediate materials) must increase the price for these non-NAFTA goods (NAFTA imports). Hence, the net effect on welfare is ambiguous and is thus an empirical issue.⁸

As said in Section 2, I propose three scenarios that are based on different assumptions related to the increase in unit cost of production that resulted from the introduction of NAFTA ROO (Tables 1A, 1B, and 1C) and thus, the extent to which these costs would fall, *ceteris paribus*, if ROO were removed. For each of these three scenarios, I also propose a sub-scenario where the US is not part of the shock. This implies setting θ_{sd} equal to zero for the US in Tables 1A-B-C. The rationale for doing this is the following. Canadian and Mexican firms were largely interested in market access in the US, for which they were willing to pay some cost related to the introduction of NAFTA ROO. On the other hand, the US must have been worried about trade deflection from non-members and thus, must have imposed NAFTA ROO that both protected their intermediary-good producing sectors, while also minimizing any negative impact that these rules could have had on US firms that export to Canada or Mexico. Thus, in sub-

⁸ Observe that the terms of trade is a ratio of *world* prices, that is, excluding tariff and ROO distortions. It is clear that in the model, the price index of intermediary goods P_x as given in equation (29 in Appendix) decreases due to the removal of ROO. This lowers the relative price of non-NAFTA intermediary goods and generates an increased import demand for these non-NAFTA intermediary goods, which triggers a demand-induced increase in P_x that does not offset the initial price decrease.

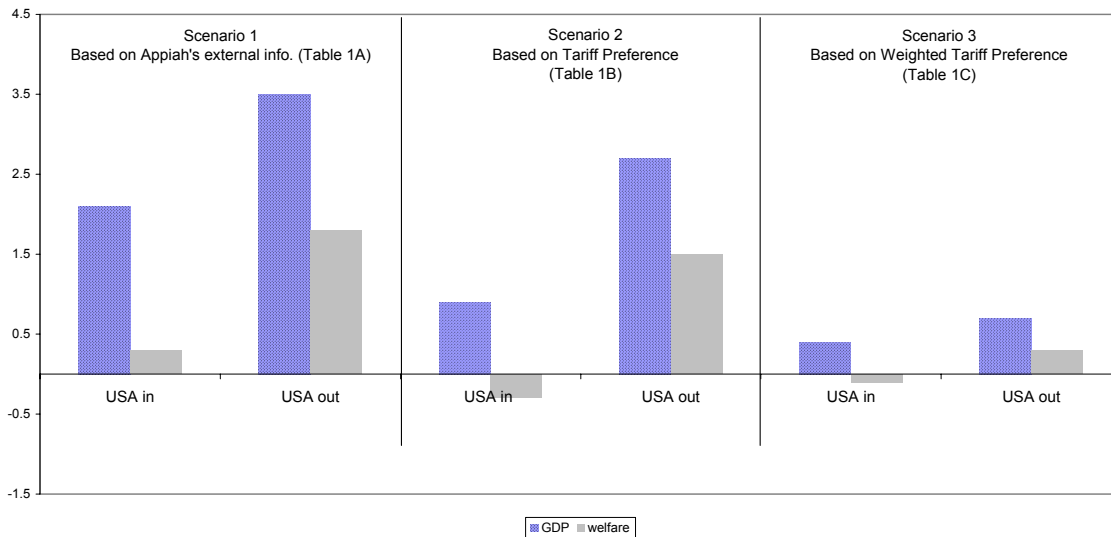
scenario “USA out”, I assume that eliminating ROO does not lower US firms’ unit costs of production.

For each of these scenarios Figure 3 reports the impact of eliminating NAFTA ROO on the steady-state Canadian GDP and the inter-temporal measure of welfare. Real GDP increases by as much as 3.5% or by as low as 0.5% depending on the scenario. Sub-scenarios that remove the US from the shock are clearly more favourable to Canada. This is due to a deterioration of terms of trade that is considerably reduced when US firms do not modify their input mix, as this mitigates any demand-induced price increase of non-NAFTA goods.

How to explain a negative welfare measure in some scenarios? If the inter-temporal budget constraint suggests that consumption spending should fall, 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, and with it the intertemporal welfare of the representative household. 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 effect.

The analysis is pursued in further details in Section 3.2.2. However, to avoid the multiplicity of scenarios I will focus on Scenario 1, which is based on Appiah’s external information. This should not be viewed, however, as an implicit endorsement.

Figure 3 Percent change in real GDP and welfare for Canada, different scenarios



3.2.2 macro results

The macro-impacts of removing NAFTA ROO are given in Table 6. In each principal column the left-hand side cell refers to the short-term impact of removing the ROO, whereas the right-hand side cell refers to the long-term impact, once the new steady-state is reached.

Observe that the volumes of export and import increase in all countries. For Canada, real export increases by 15.2%, while import increases by 10.3% in steady state. Real net export and real consumption increases in NAFTA countries drive the increase in real GDP, whereas real domestic investment falls. For non-NAFTA countries, the increase in real GDP is mainly driven by the increase in real consumption and investment, whereas net export contribution is generally negative.

Table 6 Impact and Long-run effects of removing NAFTA ROO on real aggregate variables (using $\theta_{j,sd}$ as given in Table 1A)

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)	Terms of Trade	
CAN	17.1	15.2	9.1	10.3	0.4	0.3	-4.8	-1.6	2.7	2.1	0.3	-4.8	-4.5
USA	40.0	37.4	22.1	24.0	0.1	0.2	-2.3	-0.7	1.3	1.0	0.1	-6.8	-6.4
MEX	21.5	16.9	11.7	13.2	1.6	1.2	-6.9	-1.4	3.2	2.3	1.3	-5.3	-4.7
MER	12.2	13.0	12.3	11.6	-0.2	0.5	2.4	0.8	0.1	0.5	0.4	2.8	2.6
LAT	9.6	23.5	28.7	21.3	1.1	3.4	23.9	6.3	0.3	3.9	2.9	8.0	5.5
EUR	11.2	11.5	16.8	16.5	0.2	0.7	1.7	0.7	-0.1	0.2	0.6	2.0	2.1
ROW	10.1	11.5	18.4	17.6	0.5	1.2	1.9	1.2	0.1	0.6	1.1	4.0	3.7

	PCON (PC)		PINV (PI)		GDP deflator		RREAL		WREAL		Tariff Revenue		Interest Revenue (Foreign Asset)	
CAN	-1.3	-1.2	-1.2	-1.1	-3.8	-3.6	-0.8	0.2	0.2	-0.2	41.2	43.2	0.0	10.0
USA	-0.1	-0.1	-0.1	-0.2	-1.3	-1.3	-0.4	0.1	0.1	-0.1	31.0	34.6	0.0	7.5
MEX	-2.8	-2.5	-1.9	-1.6	-4.8	-4.3	0.2	0.8	0.6	0.1	60.6	62.8	0.0	14.7
MER	9.0	8.2	8.6	7.8	9.3	8.5	0.4	0.0	0.1	0.5	13.9	12.9	0.0	-10.3
LAT	12.3	9.7	10.6	8.5	15.1	11.6	2.4	-0.3	2.2	4.5	30.5	22.8	0.0	-52.1
EUR	8.6	8.0	8.3	7.7	9.0	8.4	0.4	0.0	0.2	0.5	11.3	11.8	0.0	-9.8
ROW	9.4	8.6	9.1	8.4	10.0	9.2	0.6	0.0	0.4	0.9	18.1	17.4	0.0	-15.9

Consumption

Real consumption in Canada slightly declines along the optimal dynamic transitional path (from +0.4% to +0.3), and this is accompanied with a small increase in the aggregate price of consumption (PC) along that path (from -1.3% to -1.2%). 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 dynamics 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. 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. 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. Appendix 3 illustrates graphically how to determine the level of consumption spending in the model, and thus real consumption given the consumption prices. For Canada, for example, the inter-temporal budget constraint is so that consumption spending decreases by 0.9% [0.3% + (-1.2%)]. Given that aggregate consumption price falls by as much as 1.2% in the steady state, this implies that real consumption must increase by 0.3% in the steady state (as shown in Table 6). In other words, Canada experiences a slight positive wealth effect due to the removal of ROO.

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 is positive for both NAFTA and non-NAFTA countries.

Observe the large increase in consumer prices in non-NAFTA countries (+8.0% 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. The explanation behind this result is due to a term of trade effect. If we define the consumption price index as:

$$PC_{j,v} = \prod_s (PC_{j,s,v})^{\rho_{j,s}}$$

$$\text{where } PC_{j,s,v} = \left[\sum_i (\delta_{i,j,s})^{\sigma_{j,s}} [P_{i,j,s,v} (1 + \tau_{i,j,s,v})]^{1-\sigma_{j,s}} \right]^{\frac{1}{1-\sigma_{j,s}}},$$

any change in PC must result from a change in the price of goods from all origins. The consumption basket of the representative Canadian household is made up of goods from both NAFTA and non-NAFTA origin with specific weight attached (δ). 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 an 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 4, 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 as seen in Table 2.

Table 7 shows that the terms of trade effect is largely reduced when the US is removed from the shock (“USA out”). Observe the smaller increase in the consumer price index in non-NAFTA countries (+1.7% in Europe), and the larger welfare gain for both Canada (+1.8%) and Mexico.

Table 7 Impact and Long-run effects of removing NAFTA ROO on real aggregate variables (using $\theta_{j,sd}$ in Table 1A but setting $\theta_{USA,sd}=0$)

	Export		Import		CON (C)		INV (I)		Real GDP		Welfare (inter-temporal)		Terms of Trade	
CAN	29.2	28.8	24.9	25.2	1.7	1.8	-0.8	-0.2	3.6	3.5		1.8	-4.2	-4.1
USA	0.2	0.0	0.0	0.3	-0.1	0.0	-0.1	0.0	-0.1	-0.1		0.0	-0.3	-0.3
MEX	26.1	28.4	25.5	25.2	2.7	3.1	3.6	0.8	4.0	4.5		3.0	-3.9	-4.1
MER	2.9	3.1	2.7	2.7	0.0	0.1	0.5	0.2	0.0	0.1		0.1	0.7	0.7
LAT	1.9	3.5	4.1	3.3	0.2	0.5	2.9	0.8	0.1	0.5		0.4	1.2	0.9
EUR	2.7	2.9	4.0	3.9	0.1	0.2	0.5	0.2	0.0	0.1		0.2	0.7	0.7
ROW	1.5	1.5	2.4	2.4	0.1	0.2	0.2	0.1	0.0	0.1		0.2	0.6	0.6

	PCON (PC)		PINV (PI)		GDP deflator		RREAL		WREAL		Tariff Revenue		Interest Revenue (Foreign Asset)	
CAN	-1.3	-1.3	-1.0	-1.0	-3.3	-3.3	0.2	0.3	1.3	1.3	82.1	82.4	0.0	3.0
USA	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-8.8	-8.5	0.0	1.0
MEX	-1.9	-2.3	-1.0	-1.3	-3.2	-3.6	1.5	1.2	1.7	2.1	98.9	99.1	0.0	-3.2
MER	1.9	1.7	1.8	1.6	1.9	1.8	0.1	0.0	0.0	0.1	3.1	3.0	0.0	-2.0
LAT	2.0	1.6	1.7	1.4	2.3	1.9	0.3	0.0	0.4	0.7	4.4	3.7	0.0	-6.1
EUR	1.8	1.7	1.8	1.6	1.9	1.8	0.1	0.0	0.1	0.1	3.5	3.5	0.0	-2.5
ROW	1.7	1.6	1.7	1.5	1.7	1.6	0.1	0.0	0.1	0.1	2.7	2.8	0.0	-1.0

Investment and factor prices

NAFTA firms desire to substitute out of capital, labour, and NAFTA intermediary goods into non-NAFTA intermediary goods. Given a fixed labour supply, wage rate will necessarily have to fall [e.g., $w = WREAL + PCON = -1.4\%$ ($-0.2\% + -1.2\%$) in Canada] in Table 6.

The driving forces behind the changes in real investment, price of investment, and rental price of capital are more complex. The representative household is the owner of the domestic stock of physical capital so that they can respond to a lower demand for the service of capital by NAFTA firms by progressively reducing the stock of capital in the economy. To do this, the household needs to have an investment rate that is below the amount of depreciation of the capital stock during the transition phase to a lower (steady state) stock of capital. For example, for Canada, investment falls in the short-run by -4.8% , and in the long-run investment recovers slightly to -1.6% of what it was in the benchmark. The household inherits the stock of capital from past period so that, given a lower demand for capital services by firms in the impact period and given a fixed short-term supply of capital, the rental price of capital must decrease immediately. As the household progressively reduces the supply of domestic capital, the rental price of capital can progressively increase.

The lower domestic investment leads the household to place excess saving into foreign financial market. The return on international market, ρ , is chosen as the numéraire, so that it is exogenously fixed. Thus, to ensure equality of returns between domestic investment and foreign investment, 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. In the impact period, the household receives a lower rental price of capital, as seen above. To ensure international arbitrage condition, the household must therefore expect 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 -1.2% and increase slightly to -1.1% along the optimal path. This generates only a small expected capital gain, but also a lower depreciation cost per unit of capital good $\delta_i PI_{i,v}$. Eventually, as a new steady state is reached, capital gains vanish and the nominal rental price of capital (r) reaches the level consistent with the depreciation cost and the world interest rate.

Trade flows

Table 8 shows 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 has created additional trade diversion beyond and above 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 take advantage of the fact that final NAFTA goods are now produced at a lower cost than before. Clearly these additional trade flows between NAFTA and non-NAFTA countries is done at the expense of “intra-NAFTA” and “intra-non-NAFTA” regions.

TABLE 8 Impact on Bilateral Trade Flows (in percent, steady state)

EXPORTERS	IMPORTERS note: elements on main diagonal: percent change in domestic demand							
		CAN	USA	MEX	MER	LAT	EUR	ROW
	CAN	-2.73	-1.06	-11.02	49.93	62.71	70.05	50.46
	USA	-16.11	-1.82	-17.60	42.65	48.39	66.42	46.74
	MEX	-8.95	4.27	-1.95	57.64	63.71	76.68	50.72
	MER	73.64	50.96	127.18	0.11	2.84	-1.12	1.64
	LAT	88.28	54.81	117.26	-5.00	1.45	-9.18	-3.49
	EUR	61.47	30.66	81.47	-1.32	3.13	-0.27	1.73
	ROW	54.28	29.78	75.24	-2.90	-2.35	-4.48	0.16

3.2.3 Sectoral Impacts

(To be discussed using Table 9, 10, and 11)

TABLE 9 Impact on Sectoral Trade Flows (in percent, steady state)
NAFTA Countries

	CAN		USA		MEX	
	EXP.	IMP.	EXP.	IMP.	EXP.	IMP.
agri	47.54	32.82	36.58	91.32	24.07	21.54
reso	-12.19	111.16	41.97	46.90	-4.32	84.39
food	29.28	14.94	37.21	40.61	32.56	31.75
text	37.19	8.94	34.23	11.09	42.77	18.50
manu	13.62	15.27	25.42	45.82	19.11	18.75
tech	17.14	2.03	37.68	17.94	10.98	0.68
auto	6.90	2.73	66.69	13.69	13.97	5.23
serv	33.75	1.26	33.19	-1.64	36.53	34.29

TABLE 10 Impact on Sectoral Trade Flows (in percent, steady state)
NON-NAFTA Countries

	MER		LAT		EUR		ROW	
	EXP.	IMP.	EXP.	IMP.	EXP.	IMP.	EXP.	IMP.
agri	21.44	14.06	42.22	40.19	24.23	9.63	23.13	29.02
reso	19.08	4.90	55.73	25.77	79.79	3.49	26.82	29.12
food	6.19	8.69	12.53	25.93	13.60	11.66	18.50	15.04
text	8.27	8.23	5.08	28.22	6.64	1.60	2.80	11.33
manu	22.89	11.65	26.89	23.78	21.26	13.87	26.43	13.05
tech	7.77	13.84	12.02	19.06	6.74	21.27	9.91	18.92
auto	13.95	23.55	-3.20	15.25	13.64	56.77	7.06	38.36
serv	0.99	6.32	-7.17	17.15	2.90	15.41	-1.98	12.77

TABLE 11 Impact on Sectoral Output

	CAN	USA	MEX	MER	LAT	EUR	ROW
agri	15.22	-2.64	0.56	2.20	9.27	0.78	0.15
reso	-21.21	-22.96	-5.38	3.56	26.97	7.72	5.05
food	5.14	1.16	2.31	0.93	3.43	1.14	0.81
text	3.18	-2.99	10.55	0.73	-1.84	1.72	0.82
manu	1.23	-3.78	-1.58	1.10	5.68	2.27	2.22
tech	10.32	7.81	9.41	-2.16	-5.54	-1.37	0.47
auto	1.60	11.93	4.89	-1.30	-6.30	-2.94	-3.95
serv	0.75	0.53	0.34	0.32	1.97	0.27	0.58

4. Conclusion

The preliminary 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. In other words, the welfare impact that Canada can expect from the removal of ROO is likely to be relatively small because the gains that firms obtain from a more efficient re-allocation of factors of production, which lead to lower unit cost of production and thus also lower aggregate consumption prices, are somewhat offset by an increase in prices of foreign goods due to the additional demand by NAFTA firms for non-NAFTA intermediary goods. As a result, consumers in Canada will face an aggregate *consumption* price that does not fall by the full extent of the lower unit cost of production in NAFTA. Indeed, the consumer price will also reflect the higher price of non-NAFTA goods. This term of trade deterioration following the removal of ROO suggests an analogy with the theory on optimal tariff.

Although the *sectoral* impact of removing ROO still remains to be analysed, I should indicate the limit of the analysis. First, this preliminary paper did not consider the gain from removing ROO that may occur due to the elimination of the compliance (paper work) and administrative costs. This would lead to modest additional welfare gain. Secondly, a complete elimination of ROO within NAFTA would require forming a customs union and the establishment of a common external tariff. It is straightforward enough to model this, and this would again lead to small additional welfare gains. Although I have extended the CGE model to take into account both compliance cost and the establishment of a common external tariff, these results will be reported in the finalised version of the paper only. Thirdly, it is important to stress that the current discussions within NAFTA countries to remove ROO apply to only a few very specific items (*e.g.*, spices, tea,...), instead of a general across the board removal. Clearly, this very focused sectoral approach, although potentially beneficial to the few firms involved, is not likely to have any of the general equilibrium effects of magnitude described in this paper. Finally, future research should attempt to model explicitly the heterogeneity of firms with respect to their fulfillment, or not, of ROO.

References

- Abel, A., and Blanchard, O. (1993), "An Intertemporal Equilibrium Model of Saving and Investment." *Econometrica* 51, 3, 675-692.
- Appiah, A. (1999), "*Applied General Equilibrium Model of North American Integration with Rules of Origin*", Unpublished Ph.D. Thesis, Simon Fraser University.
- Blanchard, O. and Fischer, S. (1989), "*Lectures on Macroeconomics*", The MIT Press, Cambridge, Massachusetts.
- Brown, D., Deardorff, A., and Stern, R., (2001), "Impact on NAFTA Members of Multilateral and Regional Trading Arrangements and Tariff Harmonization", in Harris, R., editor, *North American Linkages: Opportunities and Challenges for Canada*, University of Calgary Press.
- Cadot, O., de Melo, J., Estevadeordal, A., Suw-Eisenmann, A. and Tumurchudur, B., (2002), "Assessing the Effect of NAFTA's Rules of Origin", World Bank Working Paper.
- Estevadeordal, A. and Miller, E. (2002), "Rules of Origin and the Pattern of Trade between U.S. and Canada", *Working Paper*, Inter-American Development Bank.
- Estevadeordal, A. and Suominen, K. (2004), "Rules of Origin: A World Map and Trade Effects", *Working Paper*, Inter-American Development Bank.
- Georges, P. (2005), "How to Build a Dynamic Computable General Equilibrium Model? A Step-by-Step Guide", Unpublished manuscript, Department of Finance-Canada.
- Goldfarb, D. (2003), "The Road to a Canada-U.S. Customs Union: Step-by-step or in a Single Bound?", C.D. Howe Institute Commentary, No. 184.
- Ghosh, M. and Rao, S., (2004), "Economic Impacts of a Possible Can-US Customs Union: A Dynamic CGE Model Analysis", Industry Canada, Preliminary Draft.
- Grossman, G., (1981), "The Theory of Domestic Content Protection and Content Preference", *The Quarterly Journal of Economics*, Vol. 96, No.4, 583-603.
- Harris R., (2003), "*North American Linkage: Opportunities and Challenges for Canada*", Calgary University Press.
- Harris, R. and Cox, D. (1984), "Trade, Industrial Policy and Canadian Manufacturing", Ontario Economic Council.
- Krueger, A. (1993), "Free Trade Agreements as Protectionist Devices: Rules of Origin", *NBER Working Paper No. 4352*.

- Krueger, A. (1995), "Free Trade Agreements versus Customs Unions", *NBER* working Paper No. 5084.
- Krishna, K. (2005), "Understanding Rules of Origin", *NBER* Working Paper 11150.
- Krishna, K. and Krueger, A. (1995), "Implementing Free Trade Areas: Rules of Origin and Hidden Protection", *NBER* Working Paper, No. 4983.
- Krishna, K. and Ju, J. (1998), "Firm Behavior and Market Access in a Free Trade Area with Rules of Origin", *NBER* Working Paper 6857.
- Kunimoto, B. and Sawchuk, G., (2004), "NAFTA Rules of Origin: Empirical Evidence", Policy Research Initiative, memo.
- Lavoie, C., Souissi, M., and Mérette, M. (2001), "A Multi-Sector Multi-Country Dynamic General Equilibrium Model with Imperfect Competition", *Working Paper*, 2001-10, Department of Finance-Canada.
- Mercenier, J. (1995), "Nonuniqueness of Solutions in Applied General Equilibrium Models with Scale Economies and Imperfect Competition", *Economic Theory* 6, 161-177.
- Mercenier, J. and Michel, P. (1994), "Discrete-Time Finite Approximation of Infinite Horizon Optimization Problem with Steady-State Invariance", *Econometrica* 62, No. 3, 635-656.
- Mirus and Hoffmann (2003), memo, University of Calgary.
- Obstfeld and Rogoff (1996), "*Foundations of International Macroeconomics*", The MIT Press, Cambridge, Massachusetts.
- Papadaki, E., Mérette, M., Lan, Y., and Hernandez, J., (2004), "Towards Deeper Canada-US Integration : A Computable General Equilibrium Investigation", International Trade Canada, memo.
- Perroni, C. and Whalley, J. (1996), "How severe is Global Retaliation Risk Under Increasing Regionalism?", *American Economic Review*, Papers and Proceedings of the AEA, 57-61.
- Tapp, S. (2005), "Understanding Rules of Origin: A Critical Review of the Literature", memo, Department of Finance-Canada.

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. The model is fully documented in Georges (2005).

A.1.1 Overall presentation

The world economy J , consists of seven countries/regions composing two blocks: Canada, USA, Mexico, ($NAFTA \in J$), Latin America, Mercosur, Europe, and the Rest of the World ($NONNAFTA \in J$). All countries are fully modelled. Each country has eight sectors of production, all perfectly competitive. These sectors are agriculture, food processing, resources sectors, textiles and clothing, manufactures, automotives, machinery and equipment, and services. Trade flows among countries is organised through an Armington system discussed below.

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 maximising 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. The household who effectively owns firms (by owning primary factors, namely labour and 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. 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 (see Abel and Blanchard 1993).

Sectors of activity are identified by indices $s, sd \in S$. Countries are identified by indices $i, j \in J$; $J = NAFTA \cup NONNAFTA$. Finally, the time-horizon is infinite and $v = 0, \dots, T, \dots$, 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 . Notation of main symbols used in the paper is given in Table A1.

A.1.2 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 1-3):

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

$$(2) \quad C_{j,v} = A_{j,s} \prod_s (c_{j,s,v})^{\rho_{j,s}} \quad ; \sum_s \rho_{j,s} = 1; s \in S,$$

$$(3) \quad c_{j,s,v} = \left[\sum_i \delta_{i,j,s} (c_{i,j,s,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}} \right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}} \quad ; i, j \in J; J = NAFTA \cup NONNAFTA.$$

$$(4) \quad I_{j,v} = A_{j,s}^* \prod_s (i_{j,s,v})^{\omega_{j,s}} \quad ; \sum_s \omega_{j,s} = 1; s \in S,$$

$$(5) \quad i_{j,s,v} = \left[\sum_i \beta_{i,j,s} (i_{i,j,s,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}} \right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}} \quad ; i, j \in J; J = NAFTA \cup NONNAFTA.$$

$$(6) \quad \underbrace{F_{j,v+1} - F_{j,v}}_{\text{Foreign Asset Accumulation (net foreign investment)}} + \underbrace{PI_{j,v} I_{j,v}}_{\text{Domestic investment spending}} = \underbrace{\rho_v F_{j,v} + w_{j,v} L_{j,v} + r_{j,v} K_{j,v} + G_{j,v}}_{\text{Revenue (GNP)}} - \underbrace{PC_{j,v} C_{j,v}}_{\text{Consumption spending}} \quad \underbrace{\hspace{10em}}_{\text{Saving}}$$

$$(7) \quad K_{j,v+1} - K_{j,v} = I_{j,v} \phi_j - \delta_j K_{j,v}$$

$$(8) \quad PC_{j,v} C_{j,v} = \sum_s P c_{j,s,v} c_{j,s,v}$$

$$(9) \quad P c_{j,s,v} c_{j,s,v} = \sum_i P_{i,j,s,v} (1 + \tau_{i,j,s,v}) c_{i,j,s,v}$$

$$(10) \quad PI_{j,v} I_{j,v} = \sum_s P i_{j,s,v} i_{j,s,v}$$

$$(11) \quad P i_{j,s,v} i_{j,s,v} = \sum_i P_{i,j,s,v} (1 + \tau_{i,j,s,v}) i_{i,j,s,v}$$

In the first level [equation (1)], 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 (2)], 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 (3)], 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 (6-11). The consumer is assumed to have perfect foresight, that is, he knows the sequence of prices $\{w_{j,v}, r_{j,v}, \rho_v, PC_{j,v}, PI_{j,v}\}$ over the time horizon $[0, \infty)$ where the prices are respectively the rental prices of labour and capital, the world interest rate, and some composite indexes of consumption and investment good prices. Consider an arbitrary path for these prices. This sequence leads 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 income of the household in the budget constraint (6) is itself generated by these prices 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).

Given a sequence of incomes, the household decides how much to consume and save. The household must decide on his sequence for final consumption spending $\{PC_{j,v}, C_{j,v}\}$ and saving (borrowing). This leads, at each period v , to an increment in the stock of capital services through spending on an investment good composite $PI_{j,v}, I_{j,v}$ as shown in

(6) and (7), or to an accumulation of foreign assets $F_{j,v}$ (or an issuance of foreign debt).⁹ The parameter ϕ_j in (7) 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 7) own 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 (4) and (5) permit in each period, to allocate total physical investment $I_{j,v}$ between different sectors and countries, in a two-stage process parallel to (2) and (3).¹⁰

To recap, the first level inter-temporal consumption/saving decision is thus a problem of maximising (1) subject to (6) and (7). 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 (2) subject to (8), and (3) subject to (9) where $P_{i,j,s,v}$ is the price of goods 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 (4) subject to (10) and (5) subject to (11), where $Pi_{j,s,v}$ and $PI_{j,v}$ are composite index price. Figure A1 represents schematically the choice of Canada’s representative household in a simplified three-country three-sector model.

A.1.3 Firms

All sectors of activity sd are assumed to be perfectly competitive industries. The representative firm of country j sector sd operates with a Cobb-Douglas constant return to scale technology, combining 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 $Q_{j,sd,v}$ [equation (12)]. Intermediate inputs are introduced in the production function in a way similar to that of consumption goods in households’ preferences: competitively produced goods from different

⁹ At each period the gross marginal revenue from 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 would increase to $r_{j,v}\phi_j$.

¹⁰ I assume that (4) and (5) are part of the preferences system of the representative household. However, this can alternatively be viewed as done by an unspecified agent.

geographical origins enter as imperfect substitutes (the Armington specification) [equation (15)]. Therefore, as shown in Figure A2 for a simplified three-sector three-country model, the representative Canadian firm in the agriculture sector $sd=agc$ needs to choose first, capital, labour and intermediary goods of different sectors (conditional factor demands), and then it needs to choose for *each* intermediary good of type s from which regions it purchases them.

The assumption of constant returns to scale technology implies that the cost function is linear in the level of output and given by $TC(\mathbf{w}, Q) = v(\mathbf{w}, 1) \cdot Q$, where \mathbf{w} is the vector of input prices, and $v(\mathbf{w}, 1)$ is the unit cost function. In this case, both the average cost and the marginal cost equal the unit cost v . Therefore, marginal cost pricing implies that:

$$(12) \quad P_{j,s,v} = v_{j,s,v}.$$

Input demands results from minimizing the total cost of production, that is:

$$(13) \quad \underset{L_{j,sd,v}, K_{j,sd,v}, X_{j,s,sd,v}, X_{i,j,s,sd,v}}{\text{Min}} \quad v_{j,sd,v} Q_{j,sd,v} = w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_s P x_{j,s,sd,v} X_{j,s,sd,v}$$

subject to:

$$(14) \quad Q_{j,sd,v} = B_{j,sd} (L_{j,sd,v})^{\alpha_{L,j,sd}} (K_{j,sd,v})^{\alpha_{K,j,sd}} \prod_s (X_{j,s,sd,v})^{\alpha_{X,j,sd}}$$

$$(15) \quad X_{j,s,sd,v} = \left[\sum_i \eta_{i,j,s,sd} (X_{i,j,s,sd,v})^{\frac{\sigma_{j,s}-1}{\sigma_{j,s}}} \right]^{\frac{\sigma_{j,s}}{\sigma_{j,s}-1}}$$

$$(16) \quad \sum_s P x_{j,s,sd,v} X_{j,s,sd,v} = \sum_{i \in \text{Nafta}} \sum_s P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v} + \sum_{i \notin \text{Nafta}} \sum_s P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v}$$

$$(17a) \quad \frac{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_{i \in \text{Nafta}} \sum_s P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v}}{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_s P x_{j,s,sd,v} X_{j,s,sd,v}} \geq A_{j,sd,v}; \quad 0 < A_{j,sd,v} \leq 0$$

or,

$$(17b) \quad \frac{w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v}}{\sum_{i \notin \text{Nafta}} \sum_s P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v}} \geq A_{j,sd,v}^*$$

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

Figure A1. Choice of Canada's representative household

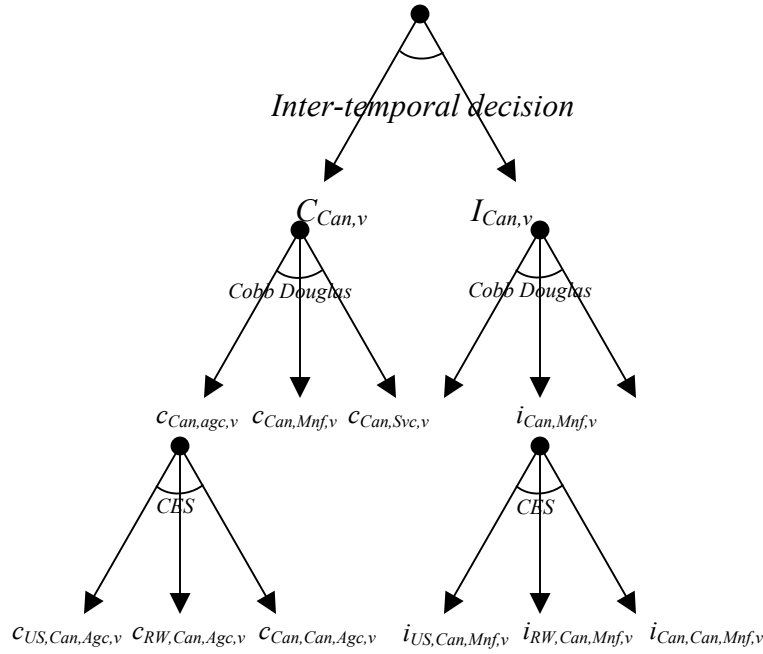
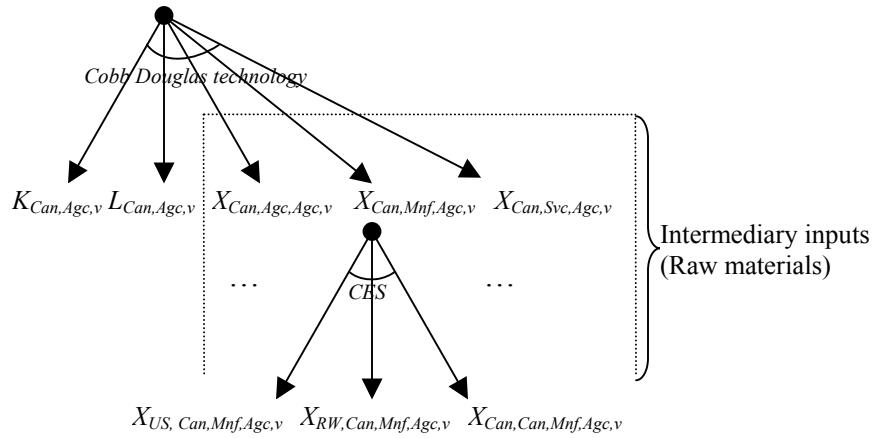


Figure A2. Choice of a Canadian representative firm in sector Agc, time v



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

and where $\eta_{i,j,s}$ are distribution parameters in the CES function, $\sigma_{j,s}$ are Armington substitution elasticities, and $X_{i,j,s,sd,v}$ represents the demand for intermediary good s produced in country j and used by the representative firm operating in sector sd of country j . The last term in equation (13) is the cost of intermediary goods used in the production process of good s of country j . This cost can be decomposed into the cost of material inputs originating from NAFTA and non-NAFTA countries as shown in (16) where $Px_{j,s,sd,v}$ is a price index that represents the minimum spending by the firm sd of country j on intermediary good s from both NAFTA and non-NAFTA origins in order to reach a composite index of raw materials of type s : $X_{j,s,sd,v} = 1$.

ROO appear in the minimisation problem of the firm under either equation (17a) or (17b). *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 $j \in \text{NAFTA}$. In (17a), the value content is expressed as the ratio of the sectoral value added in country j plus the value of raw materials 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. This rule 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 $i \notin \text{NAFTA}$ 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 (17a) will be discussed here.

Although equation (17a) is written as an inequality, I will assume that the ROO is strictly binding. It is clear that there is heterogeneous behavior among firms of a particular sector. Some firms may distort their behavior to obtain preferential treatment and others may not (and this is discussed at large in the Appendix 2). However, it is assumed here that the “representative” firm in a sector is a “composite” of several types of firms. In other words, instead of modeling heterogeneous behavior, the key insight that is proposed is to shift emphasis by considering that NAFTA ROO pushed the economy towards the currently *observed* values of A_{sd} for each sector sd and that this move increased the unit cost of production by a specific percentage θ_{sd} as discussed in Section 2 (main text).

Thus, in the case of equation (17a), instead of debating whether the left hand side (l.h.s.) member of the equation is or not above an institutionally given A_{sd} in sector sd , I claim

that the l.h.s. term *determines* the level of A_{sd} . In other words, I suppose that NAFTA ROO pushed the economy to the level of A_{sd} currently observed by the l.h.s. of the equation. From there, I proceed to examine the CGE impact of removing the ROO in all sectors sd .

A.1.4 General equilibrium

A competitive general equilibrium is a consumption and production allocation, supported by a vector of prices $(p_{j,sd,v}, w_{j,v}, r_{j,v}, \rho_v)$, $sd \in S$, $j \in J$, such that households maximise their utility at given prices and with income generated by those prices in combination with total endowments (Section A.1.2), firms minimize their cost (Section A.1.3), and supply equals demand in each markets: good, labour, capital, and world financial markets [equations (18)-(21)]:

$$(18) \quad Q_{j,s,v} = \sum_{i \in J} \left(\underbrace{c_{j,i,s,v} + i_{j,i,s,v} + \sum_{sd} X_{j,i,s,sd,v}}_{q_{j,i,s,v}} \right)$$

$$(19) \quad \bar{L}_j = L_{j,v} = \sum_s L_{j,s,v}$$

$$(20) \quad K_{j,v} = \sum_s K_{j,s,v}$$

$$(21) \quad \sum_{i \in J} \left(\underbrace{w_{i,v} L_{i,v} + r_{i,v} K_{i,v} + G_{i,v} - PC_{i,v} C_{i,v} - PI_{i,v} I_{i,v}}_{NX_{i,v}} + \rho_v F_{i,v} \right) = \sum_{i \in J} (F_{i,v+1} - F_{i,v}) = 0$$

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

$$(22) \quad G_{i,v} = \sum_s \sum_j c_{j,i,s,v} \tau_{j,i,s,v} P_{j,s,v} + \sum_s \sum_j i_{j,i,s,v} \tau_{j,i,s,v} P_{j,s,v} + \sum_s \sum_j \sum_{sd} X_{j,i,s,sd,v} \tau_{j,i,s,v} P_{j,s,v}$$

The good market equilibrium condition [equation (18)] 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 (22). 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 (19) assumes that labor supply is exogenously given at \bar{L}_j . Equation (21) 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 (21) 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 (21) 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 (21). Endogenous changes in the world interest rate ρ_v will bring about this equality.¹¹ A 2-country – 2-sector flow chart of the model is given at the end of the paper.

Observe that 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.

A.1.5 Calibration issues – subsidy and penalty from the presence of a ROO

The model has been calibrated to a base-year data set. I used the multi-country multi-sector database GTAP-5 (1997). The calibration procedure is described step-by-step in Georges (2005). The calibration consists in choosing the parameters of the model (that is the preference parameters underlying the nested utility function, the technology parameters, the initial endowments, and the initial policy instruments: tariff and ROO) so that the general equilibrium variables (prices and quantities) computed by the model, given these fitted parameters, are those observed in the database or social accounting matrix for a specific year referred as the benchmark year.¹² Once parameters have been chosen in this way, the modeler can simulate changes in economic policy by changing policy instruments (*e.g.*, lowering tariffs rates or eliminating ROO) and observe the impact of the policy on general equilibrium variables (prices and quantities).

Calibration of the technology parameters of the model is made difficult because of the introduction of ROO. It requires the joint determination of the distortion parameters [the Lagrange parameters associated with constraints (17a) or (17b)] and the technology parameters: $\alpha_{L_{j,sd}}; \alpha_{K_{j,sd}}; \alpha_{X_{j,s,sd}}; \eta_{i,j,s,sd}; B_{j,sd}$ for $s, sd \in S$; for $i, j \in NAFTA$; and for $i, j \in NONNAFTA$. Care must be taken to distinguish ROO-constrained NAFTA

¹¹ 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 (18)-(20) are in equilibrium then (21) is automatically in equilibrium so that (21) can actually be left out of the model.

¹² This procedure is equivalent to switching the model from a forward-looking solution procedure (solving the model for future values) to a backward-looking mode (solving the model for historical periods) to recover the set of parameter estimates consistent with the data observed in a particular year.

countries versus unconstrained non-NAFTA countries. This section briefly describes the procedure used for NAFTA countries.

Solving the simple inter-temporal problem described in Section A.1.3 for a firm sd of a country $j \in NAFTA$ will lead to conditional demand for factors of production (equations 23-27) and unit cost of production (equation 28):

$$(23) \quad L_{j,sd,v} = \frac{\alpha_{L_{j,sd}}^{roo} v_{j,sd,v}^{roo} Q_{j,sd,v}}{w_{j,v} (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))}$$

$$(24) \quad K_{j,sd,v} = \frac{\alpha_{K_{j,sd}}^{roo} v_{j,sd,v}^{roo} Q_{j,sd,v}}{r_{j,v} (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))}$$

$$(25) \quad X_{j,s,sd,v} = \frac{\alpha_{X_{j,s,sd}}^{roo} v_{j,sd,v}^{roo} Q_{j,sd,v}}{Px_{j,s,sd,v}^{roo}} \quad \text{for } s \in S$$

$$(26) \quad X_{i,j,s,sd,v} = (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} \left[\frac{Px_{j,s,sd,v}^{roo}}{P_{i,s,v} (1 + \tau_{i,j,s}) (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))} \right]^{\sigma_{j,s}} X_{j,s,sd,v}$$

for $i \in NAFTA$

$$(27) \quad X_{i,j,s,sd,v} = (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} \left[\frac{Px_{j,s,sd,v}^{roo}}{P_{i,s,v} (1 + \tau_{i,j,s}) (1 + \mu_{j,sd,v} A_{j,sd,v})} \right]^{\sigma_{j,s}} X_{j,s,sd,v} \quad \text{for } i \notin NAFTA$$

$$(28) \quad v_{j,sd,v}^{roo} = \frac{1}{B_{j,sd}^{roo}} \left(\frac{w_{j,v} (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))}{\alpha_{L_{j,sd}}^{roo}} \right)^{\alpha_{L_{j,sd}}^{roo}} \left(\frac{r_{j,v} (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))}{\alpha_{K_{j,sd}}^{roo}} \right)^{\alpha_{K_{j,sd}}^{roo}} \prod_s \left(\frac{Px_{j,s,sd,v}^{roo}}{\alpha_{X_{j,s,sd}}^{roo}} \right)^{\alpha_{X_{j,s,sd}}^{roo}}$$

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

$$(29) \quad Px_{j,s,sd,v}^{roo} = \left\{ \begin{array}{l} \sum_{i \in NAFTA} (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} [P_{i,s,v} (1 + \tau_{i,j,s}) (1 - \mu_{j,sd,v} (1 - A_{j,sd,v}))]^{\sigma_{j,s}} \\ + \sum_{i \notin NAFTA} (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} [P_{i,s,v} (1 + \tau_{i,j,s}) (1 + \mu_{j,sd,v} A_{j,sd,v})]^{\sigma_{j,s}} \end{array} \right\}^{\frac{1}{1 - \sigma_{j,s}}}$$

Observe that a superscript “roo” has been added to emphasize the presence of ROO in the benchmark data set and that $\mu_{j,sd,v}$, the Lagrange parameter associated to the ROO constraint (17a), is the ROO distortion parameter (each sector sd of each country $j \in NAFTA$ is faced with such a distortion). Observe from conditional demand functions that the solution suggests that NAFTA firm sd receives a subsidy $\mu_{j,sd,v} (1 - A_{j,sd,v})$ for the use of labor, capital, and the materials purchased within NAFTA, but pays a penalty ($\mu_{j,sd,v} A_{j,sd,v}$) for the use of intermediary goods purchased outside NAFTA.

Calibrating the technology parameters requires solving simultaneously equations (23) to (27) and (14), by feeding the “variables” with data observed in a given year v for

$L_{j,sd}; K_{j,sd}; X_{j,s,sd}; X_{i,j,s,sd}; Q_{j,sd}$ to obtain a set of “parameter” values:

$\alpha_{L_{j,sd}}^{roo}; \alpha_{K_{j,sd}}^{roo}; \alpha_{X_{j,s,sd}}^{roo}; \eta_{i,j,s,sd}^{roo}; B_{j,sd}^{roo}; \mu_{j,sd}$ consistent with the observed data. Clearly, there are more parameters to fit than equations, so that the $(j \times sd)$ parameters $\mu_{j,sd}$, cannot be calibrated.¹³ Additional $(j \times sd)$ equations must be introduced that link (for each sector of every NAFTA country) the unit cost of production with ROO and the unit cost if they were removed (*ceteris paribus*):

$$(30) \quad v_{j,sd}^{roo} = v_{j,sd} (1 + \theta_{j,sd})$$

where:

$$(31) \quad v_{j,sd,v} = \frac{1}{B_{j,sd}^{roo}} \left(\frac{w_{j,v}}{\alpha_{L_{j,sd}}^{roo}} \right)^{\alpha_{L_{j,sd}}^{roo}} \left(\frac{r_{j,v}}{\alpha_{K_{j,sd}}^{roo}} \right)^{\alpha_{K_{j,sd}}^{roo}} \prod_s \left(\frac{Px_{j,s,sd,v}}{\alpha_{X_{j,s,sd}}^{roo}} \right)^{\alpha_{X_{j,s,sd}}^{roo}}$$

and:

$$(32) \quad Px_{j,s,sd,v} = \left\{ \begin{array}{l} \sum_{i \in \text{Nafta}} (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} [P_{i,s,v} (1 + \tau_{i,j,s})]^{1-\sigma_{j,s}} \\ + \sum_{i \notin \text{Nafta}} (\eta_{i,j,s,sd}^{roo})^{\sigma_{j,s}} [P_{i,s,v} (1 + \tau_{i,j,s})]^{1-\sigma_{j,s}} \end{array} \right\}^{\frac{1}{1-\sigma_{j,s}}}$$

and $\theta_{j,sd}$, (given in Table 1, main text), is an external parameter that reflects by how much the unit cost of production increases due to the introduction of ROO. The additional set of $(j \times sd)$ equations (30) now permits to calibrate the set of distortion parameters $\mu_{j,sd}$.

It is important to stress the difference between the proposed calibration procedure and the typical procedure that would be used by a CGE modeler that uses a NAFTA benchmark data set but who does not account for the distortion in the behaviors of firms. He would solve a set of equations similar to (23) to (27) and (14), but where $\mu_{j,sd,v}$ would vanish, feeding the “variables” with the same data that I used in a specific year v for $L_{j,sd}; K_{j,sd}; X_{j,s,sd}; X_{i,j,s,sd}; Q_{j,sd}$ and obtain a solution for the technological parameters that should clearly be different from the one that I derived earlier. To emphasize the difference I introduce a superscript “o” so that the solution obtained is effectively:

$$\alpha_{L_{j,sd}}^o; \alpha_{K_{j,sd}}^o; \alpha_{X_{j,s,sd}}^o; \eta_{i,j,s,sd}^o; B_{j,sd}^o.$$

¹³ Recall that the numbers of countries $j \in \text{NAFTA}$ is 3, and the numbers of sectors $sd \in S$ is 8. Thus, there are $j \times sd = 24$ distortion parameters to calibrate and we need 24 additional equations to do this.

Figure A4 shows these two procedures. Case 1 reflects the traditional benchmarking of CGE trade models when analyzing free trade zones in that ROO are not considered (even when they exist). Although NAFTA ROO entail a distortion in the behaviors of firms, which is present in the benchmark data set, modelers under Case 1 simply do not account for this distortion. Case 2 corrects the calibration procedure by explicitly accounting for the existence of distortions in the behavior of firms as they are truly embodied in the benchmark data set. Thus, Case 2 highlights the calibration mistake under case 1 as it is typical done by CGE modelers when “forgetting” about ROO in NAFTA models.

Figures A4a, A4b, and A4c illustrate the demand for labor, capital and for an intermediary good s from NAFTA origin, by a firm of country $j \in \text{NAFTA}$ operating in sector sd and at time v . Figure A4d represents the demand by that same firm for an intermediary good s from nonNAFTA origin used in the production process of good sd . Points 1 and 2 in these graphs refer to the two procedures just described. Using Figure A4a as an example, wage earners in sector sd of country j receive wage income for a total value given by the area under (*i.e.*, to the south-west of) point 1. This value is observed in a Social Accounting Matrix and must be taken *per se*. Calibration procedure 1 would chose $\alpha_{L_j, sd}^{\circ}$ so that the demand function for labour passes through point 1.

Under procedure 2, it is assumed that firm j receives an implicit subsidy on its wage bill whose magnitude is equal to the difference between areas under points 1 and 2.¹⁴

Where does the subsidy come from? It comes from the distortion introduced by the ROO constraint that induces firms to hire “too much” NAFTA input, including domestic labour, in order to get preferential treatment, as discussed in Section 2 (main text). If the firm truly had to pay the wage rate $w_{j, sd}$, then it would hire less labour (as given by point 3). It only hires the quantity of labour $L_{j, sd, v}$ given by point 2 because it receives an implicit subsidy on the wage rate given by: $\mu_{j, sd, v}(1-A_{j, sd, v})$.

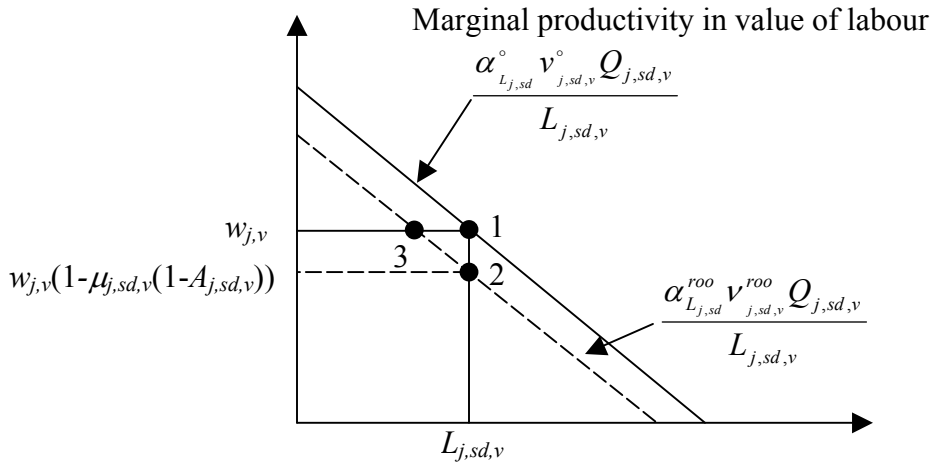
The implicit subsidy received by firm sd of country j on labor, capital, and all intermediary goods s from NAFTA origin (comparing points 1 and 2 in parts a-c of Figure A4) is:

¹⁴ Relative to the typical approach (case 1), calibrating the benchmark data set when taking into account the presence of rules of origins (case 2) suggests that the marginal productivity in values of labor, capital, and NAFTA intermediaries decrease while it increases for nonNAFTA intermediaries. Mathematically, this means that the share and distribution parameters $\alpha_{L_j, sd}^{RoO}$, $\alpha_{K_j, sd}^{RoO}$, and $\eta_{i \in \text{Nafta}, j, s, sd}^{RoO}$ are smaller and

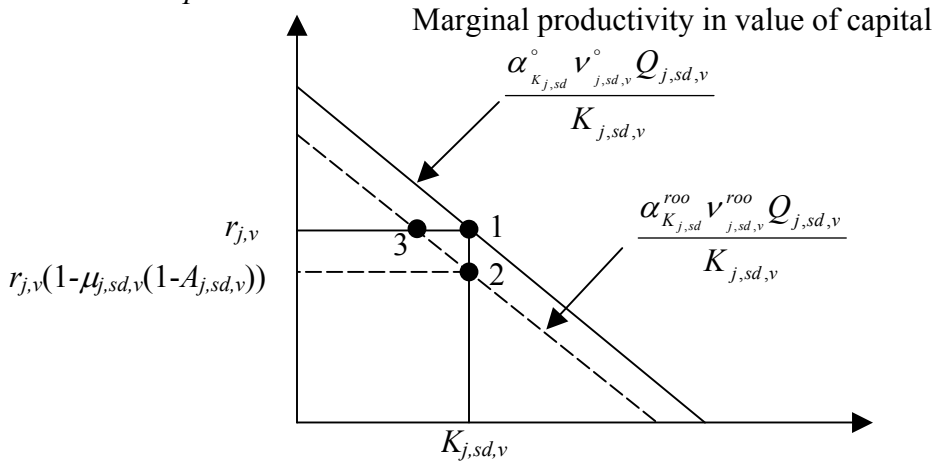
$\eta_{i \notin \text{Nafta}, j, s, sd}^{RoO}$ are larger under case 2 than their typical calibrated values under case 1. This follows from an examination of FOC. FOCs derived under the ROO assumption include an additional parameter $\mu_{j, sd, v}$ that represents the Lagrange parameter associated with the ROO constraint. A positive value for this parameter is necessary for the constraint to be binding and sufficient for the implication given above on the calibrated parameters.

Figure A4 Two distinct calibration procedures

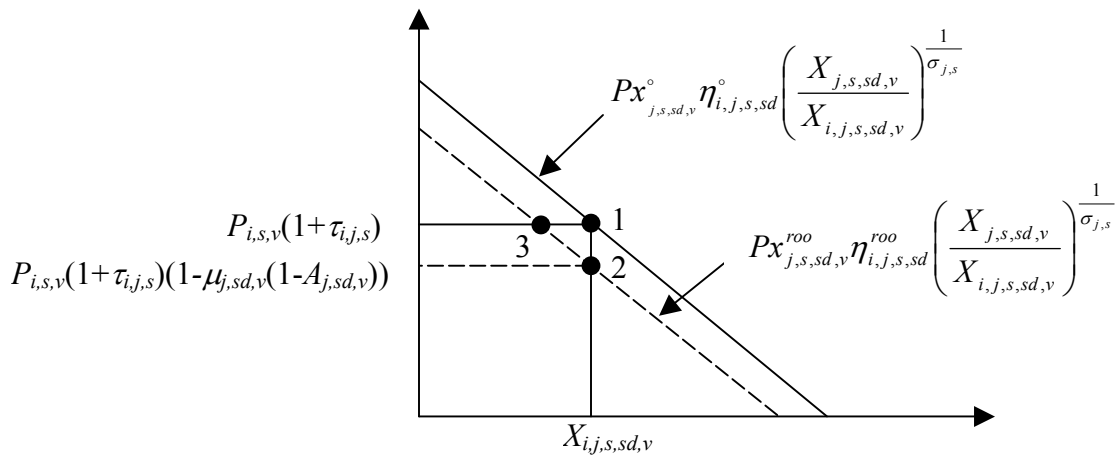
A4.a Labor market



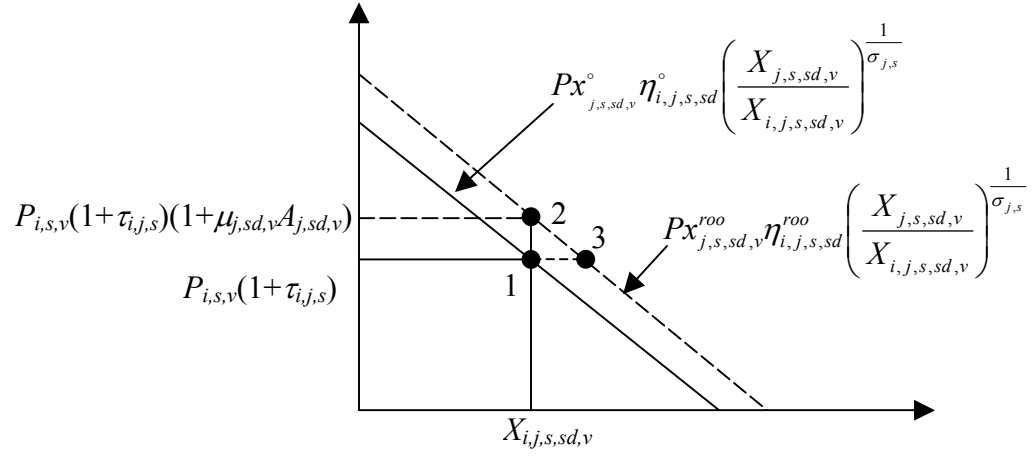
A4.b Capital market



A4.c Intermediary goods of NAFTA origin



5.d Intermediary good s on nonNAFTA origin



$$\begin{aligned}
(33) \quad \text{Subsidy}_{j,sd,v} &= w_{j,v} \mu_{j,sd,v} (1 - A_{j,sd,v}) L_{j,sd,v} + r_{j,v} \mu_{j,sd,v} (1 - A_{j,sd,v}) K_{j,sd,v} + \\
&\quad \sum_s \sum_{i \in \text{Nafta}} P_{i,s,v} (1 + \tau_{i,j,s}) \mu_{j,sd,v} (1 - A_{j,sd,v}) X_{i,j,s,sd,v} \\
&= \mu_{j,sd,v} (1 - A_{j,sd,v}) \left(w_{j,v} L_{j,sd,v} + r_{j,v} K_{j,sd,v} + \sum_s \sum_{i \in \text{Nafta}} P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v} \right)
\end{aligned}$$

The penalty for the purchase by firm sd of country j of all intermediary goods s originating from countries that do not belong to NAFTA is (Figure 5d):

$$\begin{aligned}
(34) \quad \text{Penalty}_{j,sd,v} &= \sum_s \sum_{i \notin \text{Nafta}} P_{i,s,v} (1 + \tau_{i,j,s}) (\mu_{j,sd,v} A_{j,sd,v}) X_{i,j,s,sd,v} \\
&= (\mu_{j,sd,v} A_{j,sd,v}) \sum_s \sum_{i \notin \text{Nafta}} P_{i,s,v} (1 + \tau_{i,j,s}) X_{i,j,s,sd,v}
\end{aligned}$$

Recall that firm sd of country j is assumed to fulfill exactly the constraint (29a), and substituting (16) into (17a):

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

it follows that:

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

Substituting the values for subsidies and penalties derived in (44) and (45) into (47), we finally obtain that the subsidy is equal to the penalty:

$$\begin{aligned}
\frac{\text{Subsidy}_{j,sd,v}}{\mu_{j,sd,v}} &= \frac{\text{Penalty}_{j,sd,v}}{\mu_{j,sd,v}} \Rightarrow \\
\text{Subsidy}_{j,sd,v} &= \text{Penalty}_{j,sd,v} \Rightarrow \\
\sum_{sd} \text{Subsidy}_{j,sd,v} &= \sum_{sd} \text{Penalty}_{j,sd,v} \Rightarrow \\
\text{Subsidy}_{j,v} &= \text{Penalty}_{j,v}
\end{aligned}$$

In conclusion, for each sectors, and thus for the country j as a whole, the penalty and subsidy proceeds exactly offset each other. This ensures that sectoral production values are indeed those observed in the social accounting matrix.

Appendix 2 On heterogeneous firm behavior and revealed shortcomings

On heterogeneous firm behavior

Krueger (1995) reports 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. This point suggests a specific rationality in the behavior of NAFTA firms. If the unit cost of production rises to v_{sd}^{rule} when a perfectly competitive firm with constant returns to scale technology distorts its behavior in order to comply with ROO, it is because its export price to another NAFTA country is such that:¹⁵

$$(36) \quad v_{sd}^{rule} (1 + \tau_{sd}^{Pref}) < v_{sd} (1 + \tau_{sd}^{MFN})$$

where τ_{sd}^{Pref} is the preferential tariff imposed by the NAFTA destination country on good sd and τ_{sd}^{MFN} is the most favor nation tariff (*i.e.*, the tariff imposed by the NAFTA destination country on a non preferential basis).¹⁶ Table 1 below classifies different cases. Suppose first that $\tau_{sd}^{Pref} < \tau_{sd}^{MFN}$, which is a natural a priori since τ^{Pref} is a preferential tariff. Consider first the scenario described above, that fulfilling ROO increases the unit cost of production so that: $v_{sd}^{rule} > v_{sd}$ [equation (10) in main text]. Then, the NAFTA firm would distort its behavior in order to fulfill ROO and apply for preferential treatment only if (36) was verified (type-1 firm). Otherwise, it would rather not distort behavior and pay the MFN tariff (type-2 firm).

Some firms, however could potentially face the case where $v_{sd}^{rule} = v_{sd}$. This could only be true if compliance costs – paper work and proving origin – were virtually zero. However, the truly interesting point in this case is that this would reveal the possibility that equation (5) were not binding – the optimal production process of those firms would already fully satisfy the ROO *before* its introduction, so that they can apply for

¹⁵ The constant returns to scale assumption implies that the unit cost of production v , is equal to both the average and the marginal cost. The perfect competition assumption implies pricing at marginal cost, v .

¹⁶ Instead of a minimizing cost approach, Krueger (1993) uses a profit maximizing approach, and shows that a final good NAFTA producer fulfills ROO and imports materials from NAFTA if the value added generated with this method of production exceeds the value added of the alternative method when importing materials from cheaper world source. The condition is thus that, say, the Mexican car assembler can sell cars in the U.S. at a price, net of tariff, higher than if the car was deemed non-originating, and this clearly must (more than) offset the higher cost for intermediary materials. She demonstrates that the higher the effective protection in the United States for a given final good, the more it pays the Mexican producers to buy intermediary goods from the U.S., so that the ROO basically extent the U.S. protection to other members of the FTA.

preferential treatment without distorting their behavior (type-3 firm). Table 1 makes clear that only type-1 firm distorts its behavior to fulfill ROO, whereas only firms of type 1 and 3 ask for preferential treatment when exporting to other NAFTA countries.

Table 1 Making sense of NAFTA firms behaviors

		$\tau_{sd}^{Pref} < \tau_{sd}^{MNF}$	$\tau_{sd}^{Pref} = \tau_{sd}^{MNF}$
$v_{sd}^{rule} > v_{sd}$ ($\theta_{sd} > 0$)	$v_{sd}^{rule} (1 + \tau_{sd}^{Pref}) < v_{sd} (1 + \tau_{sd}^{MNF})$	Pref. treatment distortionary behavior Type-1	MFN no distortion Type-4
	$v_{sd}^{rule} (1 + \tau_{sd}^{Pref}) \geq v_{sd} (1 + \tau_{sd}^{MNF})$	MFN no distortion Type-2	
$v_{sd}^{rule} = v_{sd}$ ($\theta_{sd} = 0$)		Pref. treatment no distortion Type-3	

It was initially supposed in Table 1 that $\tau_{sd}^{Pref} < \tau_{sd}^{MNF}$. The last column in Table 1 illustrates the case where $\tau_{sd}^{Pref} = \tau_{sd}^{MNF}$. This case is relevant because rounds of multilateral trade liberalization have been lowering MFN tariff rates. Consequently, the difference between NAFTA and MFN tariff rates has been declining to virtually vanish in some sectors. In this case there is no incentive for NAFTA firms to distort their behavior to obtain a “so-called” preferential tariff (type-4 firm). Note also that the external (*i.e.*, MFN) tariff of each NAFTA countries with respect to the rest of the world would also converge together towards these preferential tariff rates. Recalling the definition of trade deflection as the attempt by a non member to take advantage of the differential in the external tariff of FTA members, then it follows that trade deflection would *de facto* disappear, and with it the economic rationale for the preferential ROO itself.¹⁷

Suppose that an FTA (with $\tau_{sd}^{Pref} < \tau_{sd}^{MNF}$) is created between two countries that also agree on lax (not much restrictive) ROO [so that A is small in equation (5) in main text]. The probability density for type-3 firms will be large. This type of firms satisfies the ROO with their current production methods so that they typically apply for the preferential tariff but without distorting their behavior. If more restrictive ROO are introduced progressively (A increases), then the probability that a firm be of type-1 increases, eventually outnumbering type-3 firms. They distort their behavior, but do it because (36) holds. Finally, if A is pushed sufficiently high, most firms will now be of type-2. There is no further reason for distorting behavior because (36) does not hold anymore, and these firms will not request preferential treatment. For example, with respect to NAFTA, Estevadeordal and Miller (2002) and Estevadeordal and Suominen (2004) attribute the

¹⁷ Mirus and Hoffmann (2004) estimate the potential cost saving for Alberta’s exporters of eliminating ROO on sectors that reach sufficient tariff convergence.

fall in utilization rates (of the preferential tariff) to the tightening of ROO relative to what they were under its predecessor, the US-Canada FTA.¹⁸ It is important to stress the point that beyond a certain level of restrictiveness, firms stop distorting their behavior, but ROO remain costly because firms (and consumers) do not reap the benefits associated with a FTA (bilateral trade is done at MFN tariffs). Actually, as shown by Krishna (2005), at that point welfare might well be inferior to a pre-FTA arrangement (the member governments lose the pre-FTA tariff revenues while households do not even get lower consumption prices). This analysis shows that by increasing ROO's restrictiveness A , a relevant middle *range* $[A, \bar{A}]$ emerges, over which ROO imply distortionary behavior (*i.e.*, the firm is of type-1) so that the magnitude of distortion is not a monotonic transformation of restrictiveness. This has been discussed in the theoretical literature on ROO [*e.g.*, Grossman (1981), Krishna and Krueger (1985), Krishna and Ju (1998)].

Revealed shortcomings

A critical value θ_{sd}^p for a firm sd can be obtained by substituting the value of θ_{sd} given in (10 in the main text) (how much unit cost of production has increased in producing good sd because of compliance/distortion costs of ROO) into (36) to obtain:

$$(37) \quad \theta_{sd}^p = \frac{t_{sd}^{MFN} - t_{sd}^{Pref}}{1 + t_{sd}^{Pref}}$$

which is often referred to as the tariff preference. Clearly, for a specific firm, if $\theta_{sd} \geq \theta_{sd}^p$ then it would rather not apply for preferential treatment (firm is of type 2 or possibly 4). If all that is observed is the behaviour of the firm (not applying) and the tariff preference θ_{sd}^p , then θ_{sd}^p must be a *lower* bound estimate of the ROO cost. If $\theta_{sd} < \theta_{sd}^p$, then the firm would apply for the preferential treatment (firm is of type 1 or possibly 3) and θ_{sd}^p is an *upper* bound estimate for the ROO cost.

The revealed preference literature [Cadot et al. (2002), and Goldfarb (2002) and Kunimoto and Sawchuk (2004) for the Canadian case] extends this reasoning from a firm level to a sector level so that if all firms in a particular sector sd apply for preferential treatment, then the *aggregated* θ_{sd}^p gives an upper bound on the sectoral ROO costs, and if none applies this must be a lower bound estimate. One problem with this approach is that firms' utilization rates of the tariff preference are never 100% or 0%, and that each firm faces a specific θ_{sd}^p associated with its good, not the aggregated θ_{sd}^p computed as a

¹⁸ According to Goldfarb (2003), in 2002, 55% of total value of U.S. imports from Canada entered under the NAFTA regime and 45% entered at MFN rates. The author notes that, at first glance, the NAFTA utilization rate (55%) might seem low but since one-third of all U.S. MFN tariffs are zero, there is no incentive for those goods to enter under NAFTA (type-4 firms), so that the 55% is representative of firms of types 1 and 3 while 45% is representative of types 2 and 4. Goldfarb also notices a large inter-sectoral difference in NAFTA utilization rates. For example, Canada has high utilization rates for textiles and apparels (95%), but very low rates for pulp and paper (26%) and chemicals (32%).

(weighted or non-weighted) average of specific tariff preferences. Goldfarb notes for example that although the tariff preference is as large as 10.2% in textiles and apparel, utilization rates are not 100%, suggesting that some firms (of type 2) might find complying with ROO for textiles and clothing very costly.¹⁹ Although this could be true, this might as well be false. If a firm faces a specific θ_{sd}^p lower than the aggregate θ_{sd}^p , then it might decide not to apply for preferential treatment. By looking at the aggregate θ_{sd}^p , we would wrongly infer that the cost of ROO must be high for that firm.²⁰ Furthermore, firms within a specific sector not only face possibly heterogeneous tariff preferences, they might potentially face heterogeneous compliance/distortionary costs.

Appendix 3 Intertemporal issues and trade balance

Income, Investment, and Consumption spending

Figure 1.1 illustrates that the removal of ROO leads to a lower nominal GDP in Canada both during the transition period and at the new steady state. To understand the changes in the nominal GDP, we must look at the components of the GDP. The removal of ROO induces Canadian (and more generally NAFTA) firms to substitute from capital and labour into intermediary inputs originating from the rest of the world. This tends to lower the total remuneration of capital and labour and thus GDP within NAFTA countries while having the opposite effect in the Rest of the World.

The representative household which has perfect foresight of the time path of wage and rental prices, realises that the lower demand for capital push its rental price down, which suggests that he should place less of its saving into domestic physical capital and more into world financial market. This implies that investment spending on physical capital will fall within NAFTA countries and increase in the ROW relative to what it would have been otherwise, as is shown in Figure 1. Only results for Canada are reported. Graphs for the USA and Mexico are similar, while graphs for other countries are mirror images.

The *level* of consumption spending is determined by the time path of *net* GDP, $w_{j,v}L_{j,v} + r_{j,v}K_{j,v} + G_{j,v} - PI_{j,v}I_{j,v}$, (*i.e.*, GDP – investment spending) which is itself determined by the path of investment and by the initial stock of foreign assets. Figure 2.1 shows for Canada the time path for *net* GDP versus consumption spending (in shock minus control). The vertical distance between the two paths automatically gives the trade balance.

¹⁹ The restrictiveness index of Estevadeordal and Suominen is indeed the highest for this sector (6.9 on a maximum of 7), which may corroborate the difficulty for some firms in this sector to comply with the ROO.

²⁰ Thus, the fact that some firms do not apply for ROO even if the aggregate tariff preference is in the order of 10% does not reveal that the true cost of ROO, θ_{sd} , exceeds 10% for those firms. On the other hand, if a firm faces a specific θ_{sd}^p higher than the aggregate θ_{sd}^p , then it might decide to apply for preferential treatment, so that we would wrongly infer, from the firm's application, that the cost of ROO is low.

First, note the smooth profile for consumption spending in Figure 2.1. The Euler equation provides the Keynes-Ramsey rule according to which consumption increases, remains constant, or decreases depending on whether the marginal product of capital net of depreciation and capital gains/losses (ρ) exceeds, is equal to, or is less than the rate of time preference (ψ). Thus, the higher the marginal productivity of capital relative to the rate of time preference, the more it pays to depress the current level of consumption in order to enjoy higher consumption later. Thus if initially the marginal product of capital is high, consumption will be increasing over time along its optimal path.

Consumption spending profile is constant on the optimal path in Figure 2.1 because I assume that the (net) marginal product of capital is always equal to the rate of time preference, an important benchmark case that is often studied in the literature (see Blanchard and Fischer (p.65)) and Obstfeld and Rogoff (1996, p.5).

However, the Keynes-Ramsey rule gives the rate of change in consumption spending along the optimal path (in my results, zero by assumption) but not the *level* of consumption spending along this path. To obtain this level, we need to integrate forward the constraints of accumulation of foreign assets (18) and stock of capital (19), and to impose steady state conditions. By doing this, we move from a dynamic to an intertemporal budget constraint to obtain in present value terms, [see Georges (2005)]:

$$\begin{aligned}
(38) \quad & 0 = (1 + \rho_0 \Delta_0) F_{j,0} \\
& + \Delta_0 [w_{j,0} L_{j,0} + r_{j,0} K_{j,0} + G_{j,0} - PC_{j,0} C_{j,0} - PI_{j,0} I_{j,0}] \\
& + \Delta_1 \frac{1}{(1 + \rho_1 \Delta_1)} [w_{j,1} L_{j,1} + r_{j,1} \{\phi_j \Delta_0 I_{j,0} + K_{j,0} (1 - \delta_j \Delta_0)\} + G_{j,1} - PC_{j,1} C_{j,1} - PI_{j,1} I_{j,1}] \\
& + \Delta_2 \frac{1}{(1 + \rho_1 \Delta_1)(1 + \rho_2 \Delta_2)} \left[w_{j,2} L_{j,2} + r_{j,2} \left\{ \phi_j \Delta_1 I_{j,1} + \phi_j (1 - \delta_j \Delta_1) \left[\Delta_0 I_{j,0} + \frac{K_{j,0}}{\phi_j} (1 - \delta_j \Delta_0) \right] \right\} \right. \\
& \quad \left. + G_{j,2} - PC_{j,2} C_{j,2} - PI_{j,2} I_{j,2} \right] \\
& + \dots \\
& + \frac{1}{(1 + \rho_1 \Delta_1)(1 + \rho_2 \Delta_2) \dots (1 + \rho_{T-1} \Delta_{T-1})} \frac{1}{\rho_T} \left[w_{j,T} L_{j,T} + r_{j,T} \left\{ \frac{\phi_j I_{j,T}}{\delta_j} \right\} + G_{j,T} - PC_{j,T} C_{j,T} - PI_{j,T} I_{j,T} \right]
\end{aligned}$$

where $v=T$ is the steady state, and Δ_v is period- v length. Observe from notation that any two periods do not need to be of equal length. This methodology is from Mercenier and Michel(***)

This equation shows that the *level* of the consumption spending path in country j , $PC_{j,v} C_{j,v}$ is determined by the path of *net* GDP, $w_{j,v} L_{j,v} + r_{j,v} K_{j,v} + G_{j,v} - PI_{j,v} I_{j,v}$, (*i.e.*, GDP – investment spending) which is itself determined by the time path of investment and by the initial stock of foreign assets, $F_{j,0}$. As already mentioned in Section 3, this calculation requires that the household plan the entire path of prices (wage, rental price of capital, etc.).

Coming back to Figure 2.1, the path for net GDP (in shock minus control) decreases over time (indeed in Figure 1.1, GDP progressively falls but investment falls at once and then recover somewhat). I now want to explain the change in the level of consumption in this figure due to the removal of ROO. The (constant) profile for consumption must, from the equation above, be such that the (change in the) present discounted value of *net* GDP minus the (change in the) present discounted value of consumption is zero, or equivalently that the present value of the (change in) current and future trade surpluses/deficit is zero. Graphically, the discounted values of the two areas formed by the dashed and continued profiles must be equal and opposite in signs; the level of consumption spending is determined by drawing a horizontal line such that the two defined areas are equal in present value terms.

In Figure 2.1 net GDP initially increases (from its pre-shock steady state level) and eventually falls over time below its pre-shock steady state. Accordingly, the net GDP profile starts above and eventually falls short of the consumption profile. Recalling that the vertical distance between these two profiles is equal to the trade balance, the initial excess increase of net GDP over consumption leads to foreign lending by Canada (and other NAFTA countries), or by running a current account surplus. Foreign assets accumulate during this phase. Eventually, net GDP lowers sufficiently so that trade balance moves towards a deficit. In the new steady state the current account must be balanced. The trade deficit is thus offset by interest receipt on foreign asset. The increase in interest received at the steady state means that Canada (and other NAFTA countries) accumulates foreign assets over the period following the removal of ROO. This improvement in net foreign asset position from its initial steady state reflects the decision to consume at a rate below the level of net GDP early in time for NAFTA countries.

Current Account and Components

To recap, Figure 3.1 shows the current account, trade balance and interest payments of Canada (in shock minus control). We observe the same pattern for other NAFTA countries and a mirror image for countries from the Rest of the World.

The current account is the summation of two components, the trade balance and the interest receipt/payment on foreign asset/debt. The current account also represents the difference between national saving and domestic investment in physical capital, so that a positive current account leads to an accumulation of foreign assets. At the steady state, the current account must return to zero, which reflects the fact that the process of accumulation of asset or debt comes to an end.

The removal of the rules of origin initially pushes NAFTA countries towards a surplus in trade balance and in the current account. Indeed, due to the removal of ROO, NAFTA firms lower their demand for physical capital (as they substitute away from capital to ROW intermediary goods). This lowers the rental price of capital within NAFTA, which induce households to place their saving into foreign financial market instead of funding NAFTA physical capital accumulation. This accumulation of ROW asset by NAFTA

households (or alternatively, a decline in foreign debt) will over time improve the net interest payment position of NAFTA countries (*i.e.*, either NAFTA countries receive more interest receipt from the ROW, or NAFTA interest payments to the ROW are lower). Eventually, in steady state, once the current account returns to zero, NAFTA countries have a more favourable net foreign asset position, which implies higher net interest receipt and which must be reflected into a steady state trade balance that deteriorates with respect to its pre-shock position.

Figure 1.1. GDP, and consumption and investment spending (Canada)

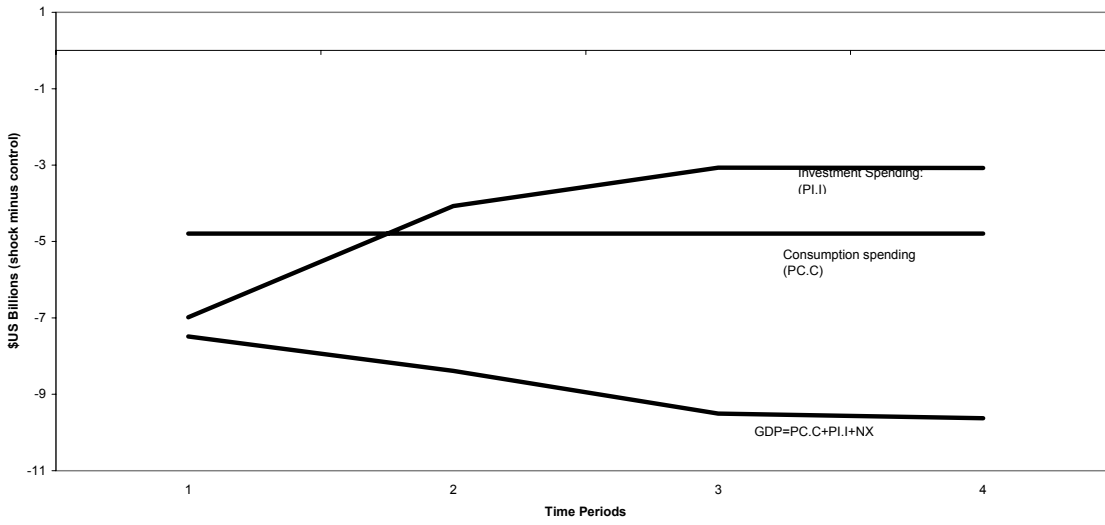


Figure 2.1. Consumption, net GDP, and trade balance (Canada)

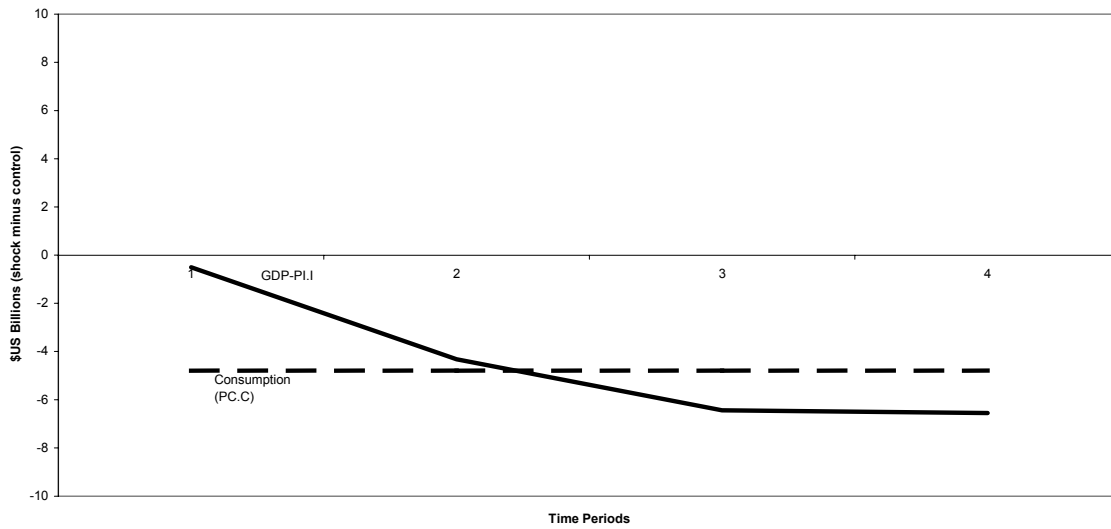


Figure 3.1. Current Account and Components (Canada)

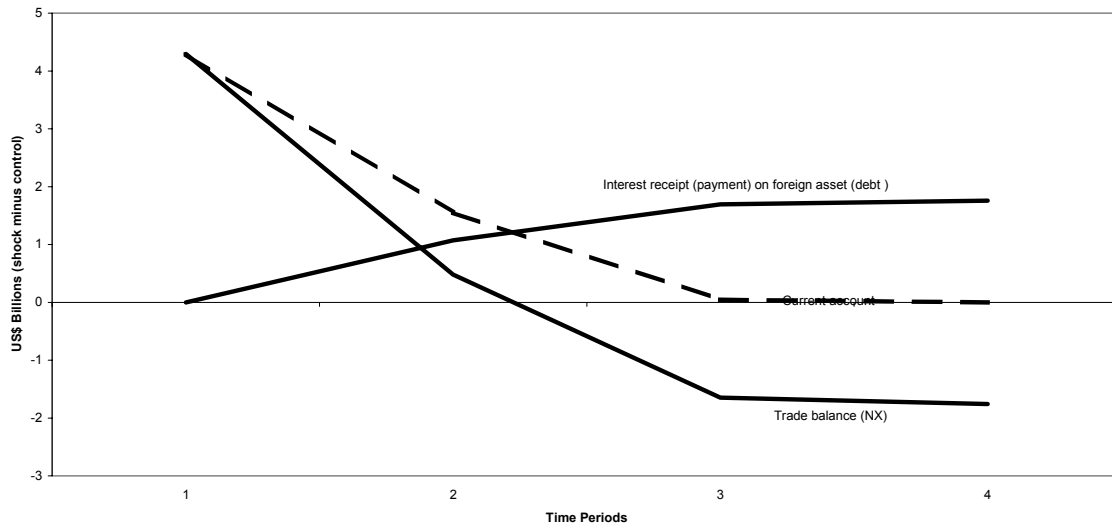


Table A1 Notation

Parameters (Static Part)	Meaning
$\rho_{i,s}$	Share par. in Cobb Douglas Utility Function
$\omega_{j,s}$	Share par. in Cobb Douglas Utility Function
$\sigma_{j,s}$	Elasticity of Substitution between goods (or intermediate inputs) S in country J
$(\delta_{i,j,s})^{\sigma_{j,s}}$	Distribution par. In CES function (exponent)
$(\beta_{i,j,s})^{\sigma_{j,s}}$	Distribution par. In CES function (exponent)
$(\eta_{i,j,s,sd})^{\sigma_{j,s}}$	Distribution par. In CES function (exponent)
$\alpha_{L_{j,sd}}$	Share par. in Cobb Douglas production function
$\alpha_{K_{j,sd}}$	Share par. in Cobb Douglas production function
$\alpha_{X_{j,s,sd}}$	Share par. in Cobb Douglas production function
$\tau_{i,j,s,v}$	TARiffs
Parameters (Dynamic Part)	
$1/\gamma (= \sigma)$	INTERtemporal SUBstitution
ψ	DiSCcount rate (ESCompte in French)
δ_i	DEPReciation rate
$\psi + \delta_i (= \phi_i)$	SCaling of R
Δ_v	Time Interval
Variables	
$c_{i,j,s,v}$	Bilateral Export flows of goods for final Consumption <i>Note: Sales to domestic market on diagonal (I=J)</i>
$P_{i,j,s,v}$	Price of output
$c_{i,s,v}$ (eq 2.3.1)	Country-origin composite of final consumption
$PC_{i,s,v}$	Price of Composite Final Consumption
$C_{j,v}$	Aggregate CONsumption
$PC_{j,v}$	Price of aggregate CONsumption
$i_{i,j,s,v}$	Bilateral Export flows of goods for investment <i>Note: Sales to domestic market on diagonal (I=J)</i>
$i_{j,s,v}$	Country-origin composite of final investment
$PI_{j,s,v}$	Price of Composite Final inVestment
$I_{j,v}$	Aggregate private INVestment
$PI_{j,v}$	Price of aggregate INVestment
$X_{i,j,s,sd,v}$	Bilateral Export flows of goods for InterM. Demands from S to SD <i>Note: Sales to domestic market on diagonal (I=J)</i>
$X_{j,s,sd,v}$	Country-origin composite of intermediate goods
$PX_{j,s,sd,v}$	Price of Composite Intermediate (from S to SD)
$\sum_s X_{j,s,sd,v}$	Aggregate intermediate good demand by firm SD of country I
$L_{j,sd,v}$	Labour demand by firm SD of country I
$w_{j,v}$	Wages
$K_{j,sd,v}$	Capital demand

$r_{i,v}$	Rental price of capital
$q_{i,j,s,v}$	Bilateral Export flows <i>Note: Sales to domestic market on diagonal (I=J)</i>
$Q_{i,s,v}$ ($= \sum_j q_{i,j,s,v}$)	Gross output of good S in country I (=Total demand of good S produced in country I)
$v_{i,sd,v}$ ($= P_{i,sd,v}$)	Variable unit cost of producing the gross output
L_i	Labour supply in country i
$K_{i,v}$	Private capital supply in country i at time v
$F_{i,v}$	Foreign asset (Foreign debt if negative)

Table 1 Country j inter-temporal problem (v to v+1) and first steps of intra-temporal problem (at v)

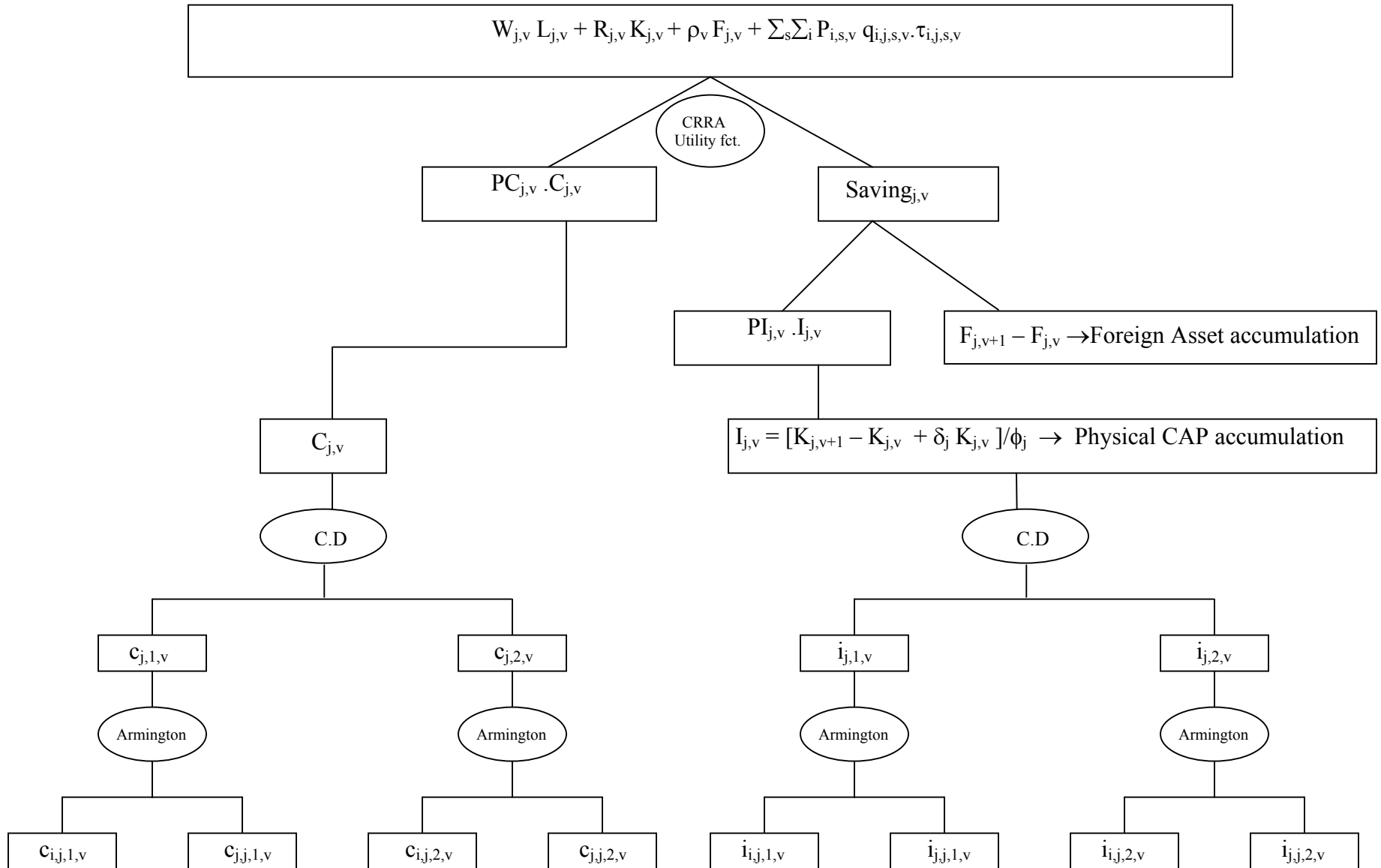


Table 2

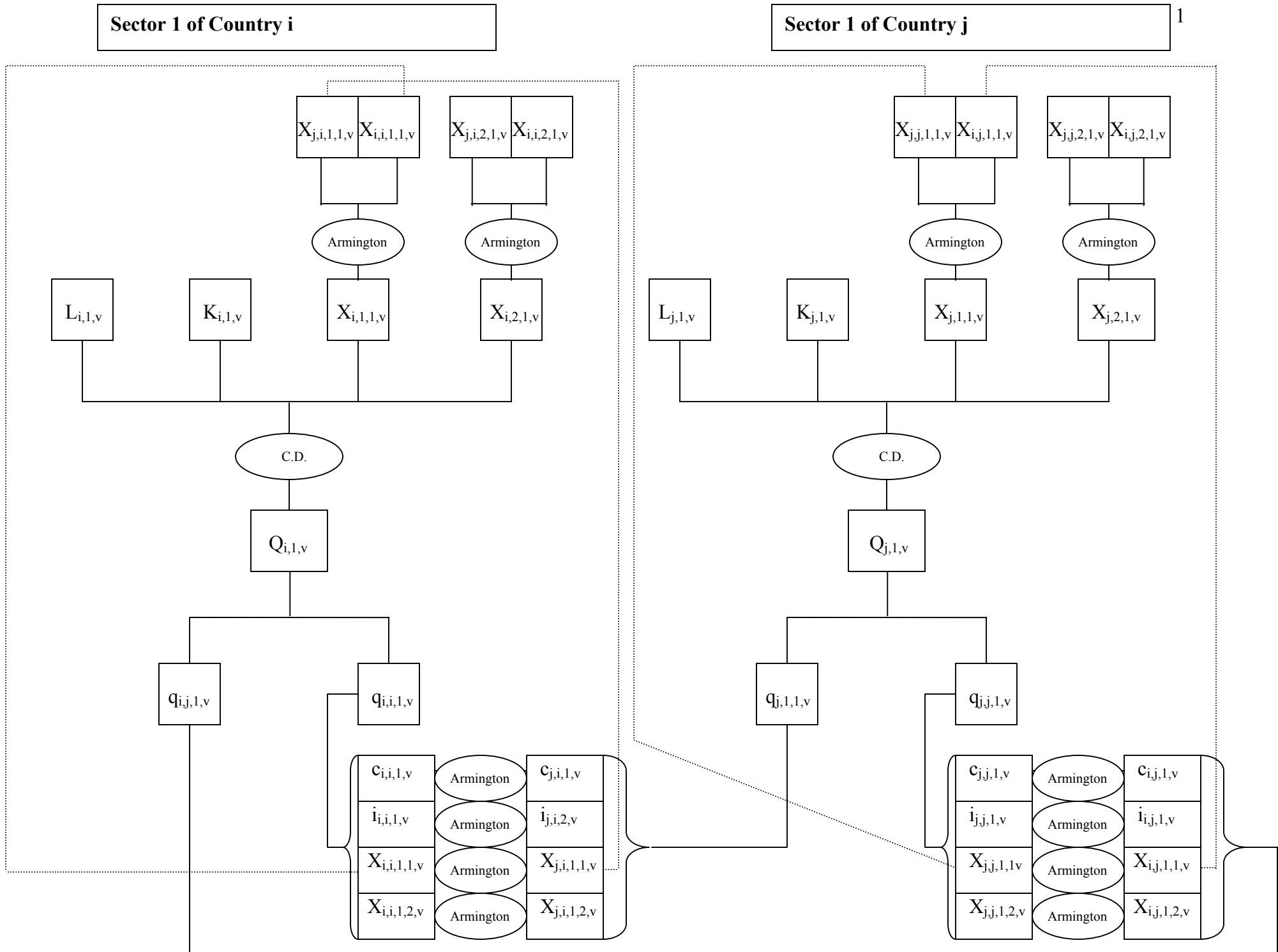


Table 3

Sector 2 of Country i

Sector 2 of Country j

2

