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# Toward a North American Security Perimeter? Assessing the Trade and FDI Impacts of Liberalizing 9/11 Security Measures

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***Abstract***

*This paper examines, for the first time, the trade and FDI impacts of a North American Security Perimeter that would liberalize the post 9/11 security measures at the Canada-US border. First, the study estimates econometrically the impact of post 9/11 security measures on bilateral (US-Canada) trade flows using a gravity model. Second, using these econometric estimates together with a three-region nine-sector general equilibrium model, we compute sectoral tariff rates "equivalent" to the 9/11 security measures. Finally, we assess the (general equilibrium) impacts on trade and FDI of a change of security paradigm toward a North American Security Perimeter. The paper shows that the economic opportunity gains occurring to Canada and the US from the liberalization of the 9/11 security measures amount to US$20 billion annually. This figure, once added to the direct administrative costs of the post 9/11 security measures, warrants serious consideration in policy discussions of a North American Security Perimeter.*

**Key words:** *Foreign Direct Investment; Trade Flows; Post 9/11 Security Measures; North American Security Perimeter; Gravity Model; General Equilibrium Modelling.*

**JEL Classification**: F1, F2, F5, C2, C6.

***Résumé***

*Cet article examine les impacts commerciaux et d'investissement direct étranger (IDE) d'un périmètre de sécurité Nord-Américain qui libéraliserait les mesures de sécurité qui furent introduites à la frontière Canado-américaine à partir du 11 Septembre 2001 (9/11). Dans un premier temps, l'étude estime économétriquement l'impact des mesures post 9/11 sur les flux commerciaux bilatéraux (US-Canada) en utilisant un modèle de gravité. L'étude utilise ensuite ces estimations économétriques conjointement avec un modèle d'équilibre général à 3 régions et à 9 secteurs afin de calculer les tarifs sectoriels équivalents aux mesures de sécurités 9/11. Finalement, nous évaluons les impacts (en équilibre général) sur le commerce et l'IDE d'un changement de paradigme de sécurité en faveur d'un Périmètre de Sécurité Nord-Américain. Cet article estime que les gains (d'opportunité) économiques pour le Canada et les États-Unis résultants de la libéralisation des mesures de sécurité 9/11 sont de 20 milliards de US$ annuellement. Ce montant, lorsque cumulé aux coûts administratifs directs des mesures de sécurité 9/11, devrait susciter des discussions politiques sérieuses sur la mise en œuvre d'un tel Périmètre de Sécurité Nord-Américain.*

**Mots clés:** *Investissement direct étranger; Flux commerciaux; Mesures de sécurité Post 9/11; Périmètre de Sécurité Nord-Américain; Modèle de Gravité; Modélisation en Équilibre Général.*

**Classification JEL**: F1, F2, F5, C2, C6.

## 1. Introduction

According to Clarkson (2008), "North American border-security relations have oscillated between two dominant visions". The first views the Canada-US border as a formal frontier "requiring levels of autonomous policing commensurate with the policy priorities and security issues of the time" (Clarkson, 2008). The second view relocates the border to the North American perimeter, within which the two national spaces "must be defended against common external threats and which require some level of joint monitoring" (Clarkson, 2008). Although the two dominant visions do "coexist" at any one point in time, the recent Canada-US declaration on a "Shared Vision for Perimeter Security and Economic Competitiveness" might be viewed as an attempt to lean toward the second model, after 10 years of strong predominance of the first view following the September 11, 2001 (9/11) terrorists attacks, and the enhanced measures imposed at the Canada-US border to "secure" the movement of goods and people.[1]

Such a change of vision might be vital for Canada's economic prosperity and this paper assesses its potential impact on trade and FDI flows. As a very open economy highly dependent on trade with the US, Canada should indeed debate and evaluate all measures that could alleviate the current burden of the Canada-US border. Existing measures such as trusted shipper and trusted traveller programs were introduced in order to mitigate the additional post 9/11 burden at the border.[2] However, these programs have not been very successful mitigating measures due to the high (fixed) cost of participation

[1] For a description of the "Shared Vision", see backgrounders released on February 4, 2011 and available on the Prime Minister of Canada website at: http://pm.gc.ca/eng/media.asp?category=5&featureId=6&pageId=48&id=3933.

[2] Some of these programs are, among others: Free and Secure Trade (FAST), NEXUS, Customs-Trade Partnership Against Terrorism (C-TPAT), Partners in Protection (PIP) and Customs Self Assessment (CSA).

and the limited benefits.[3] Even when taking these programs into account, many economists continue to claim that post 9/11 security measures have contributed to a "thickening" of the Canada-US border and a slowing, if not a reversal, of the North American economic integration and trade flows (e.g., Goldfarb and Robson, 2003; Grady, 2009; Globerman and Storer, 2008, 2009; Nguyen and Wigle, 2011).

Other economists (e.g., Goldfarb, 2007; Moens and Cust, 2008; Burt, 2009) have played down the effects on trade flows but nevertheless concede the increasing costs of trading across the border – direct costs of complying with border security policies and indirect costs such as a change in the way some companies trade cross-border, setting up "*just-in-case*" warehouses on the US side of the border for activities that used to depend on "*just in time*" processes. If export volumes of individual firms have not declined yet, then companies must have absorbed these extra costs for a while, reducing their profit margins.[4] In a competitive environment, small increases in trade costs combined with the existence of close substitutes in the US and other markets may eventually give an incentive for firms to stop production in Canada and locate in the (larger) US market, thus avoiding the border entirely.[5] Even firms operating on a worldwide scale might have been more reluctant to invest in Canada as they perceived a high likelihood of considerable delays in their supply chains when crossing the Canada-US border. In such a case, 9/11 border security measures might have diverted foreign direct investment (FDI)

[3] See for example the Canadian Chamber for Commerce at http://www.chamber.ca/index.php/en/policy-and-advocacy/C191/ and in particular: http://www.chamber.ca/images/uploads/Proposed_resolutions/2011/11-Canada-US.pdf.

[4] Alternatively, increased trade costs might have little impacts on export to the US if Canadian firms are able to pass forward these extra costs to the US customers. This would be the case if Canadian goods have little substitutes in the US or the rest of the world.

[5] When trade cost vary, each exporter may change the size of its exports (the intensive margin), but the set of exporters may vary as well (the extensive margin).

away from Canada in favor of the US, generating both regional and sectoral reallocation of resources.

There is currently no study that simultaneously gauges the trade and FDI impacts of the 9/11 security measures, let alone the impacts of a change of paradigm towards a North American Security Perimeter. This paper provides a step toward filling this gap. First, the study estimates econometrically the impact of post 9/11 security measures on bilateral and sectoral trade flows using a gravity model. Second, using these econometric estimates together with a three-region nine-sector computable general equilibrium (CGE) model, we generate sectoral tariff rates "equivalent" to the security measures and gauge the (general equilibrium) impacts on trade and FDI of an alternative security paradigm, the North American Security Perimeter, that would liberalize the post 9/11 security measures and decongest the Canada-US border.

The study does not focus on the specifics of the security measures that must be swapped from the Canada-US border to the North-American Perimeter. We simply assume that a North American Security Perimeter could be designed so as to liberalise the security measures introduced post 9/11 at the Canada-US border. Our study does not gauge the impacts of other possible measures recently announced by the joint declaration on the "Canada-US North American Perimeter Security" such as the harmonisation of product safety and quality regulations. Neither does it try to estimate the North American "security gains" or the "sovereignty erosion" in terms of intelligence data sharing, joint law enforcement and migration procedures, and pre-screening of offshore imports and travellers.[6] Finally, a North American Security Perimeter is not a proposal for a North

[6] According to the "Shared Vision" declaration, some of these aspects will be examined by two groups, the "Beyond the Border" Working Group and the Canada-US Regulatory Co-operation Council.

American Customs Union, although it could possibly renew calls in favour of this union and facilitate its implementation.[7]

The rest of the paper is as follows. Section 2 provides our econometric estimates of the impacts of post 9/11 security measures on export performance. Section 3 describes the general equilibrium model that we have built for this study. Section 4 reports the general equilibrium impacts on trade and FDI flows of liberalizing post 9/11 border security measures and Section 5 concludes. Appendix 1 provides the equations of the model and Appendix 2 describes parameters and data sets used for calibrating the model.

## 2. Econometric Estimates of 9/11 Security Measures on Export Performance

The post 9/11 border security measures have implied longer and less predictable waiting times for shipments crossing the Canada-US border. This clearly must have increased transport costs (e.g., drivers hours, fuels, cost of higher inventory levels in warehouses located on the other side of the border, costs of additional drivers or additional trucks to maintain "just in time" delivery, etc.). Various estimates from different studies reported in Moens and Cust (2008) suggest that these costs amount to a modest 2 to 3 percent of total trade. However, as suggested by Globerman and Storer (2009), this might be a gross underestimation because bilateral exports have been discouraged so that the reported cost estimates might be lower than would otherwise have been reported had bilateral exports maintained their pre 9/11 growth trajectory. In other words, it might be more appropriate to gauge the impact of post 9/11 security measures by focusing directly on the export performance of both countries.

[7] See Georges (2010) and Georges and Mérette (2010) for an analysis of the net benefit of such a customs union, including the elimination of NAFTA rules of origin and the associated political difficulties.

Several studies have used gravity-type econometric tools to provide quantitative estimates of the impact of the 9/11 thickening of the Canada-US border on exports flows both at sectoral and global levels (Globerman and Storer, 2008, 2009; Burt, 2009; Grady, 2009). These studies have focused on the impact of US security measures on the Canadian export performance. However, the extent of the cross-border supply chain and trade in intermediary goods between Canada and the US also warrants the study of the impact of post 9/11 Canadian security measures on US export performance.

The export of goods from country *i* to country *j* depends on demand factors in *j* and supply factors in *i*. In the following, we specify the simplest possible relationship able to capture the main interdependence between these factors in order to test whether that relationship changed after 9/11 by adding a dummy variable. The particular relationship used specifies that constant dollar export of a specific sector of country *i* is a function of country *j's* real GDP, which proxies *j's* real income (*j's* demand factors), the relative prices converted to a common currency using the exchange rate, and a capacity utilisation rate in country *i*. The hypothesis is that the higher the utilisation rate, the more active would be the firms of country *i* in seeking to export to *j* (*i*'s supply factors). The relation is specified in logarithms, with a constant term and a dummy variable for 9/11 as:

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where *E* is the year-*t* export of sector *s* by country *i* to country *j* (in constant dollar), *S*(*j*/*i*) is the nominal exchange rate (the number of units of currency *j* for one unit of currency *i*), *CUR* is the time-*t* capacity utilisation rate of sector *s* in country *i*, *D*911 is a dummy variable that takes a value of "0" before 9/11 and "1" thereafter. Data are annual, from

1997 to 2010. This implies that in 2001 *D*911 is set equal to "1/3" reflecting the part of that year after September 11. Finally, ε is a random disturbance term.

The OLS estimation results are provided in Table 1 (Canada's export performance to the US) and Table 2 (US export performance in Canada) for the nine available categories (or sectors) of exports and for total exports.[8] The *p*-values are given in italics below each parameter estimates. For our purpose, the most interesting results from Tables 1 and 2 are the parameter estimates of the *D*911 dummy variable. For example, we see in Table 1 that the real volume of export of the Canadian Automotive (AUTO) sector to the US has been reduced by 8.4% as a consequence of the post 9/11 US security measures. The High Tech (TECH), Transport (TRAN), and Textile and Clothing (TEXT) sectors have also been affected deeply (respectively -10.2%, -8.3%, and -12.3%). The probability values suggest that these parameters are statistically significant. This is not the case for the other sectors (AGRI, RESO, FOOD, MANU, and SERV) where the parameters are not significant at traditional values. The specification for US exports to Canada is given in Table 2. Here, we omitted the US *CUR* variable because Canada is a much smaller market for the US.

Comparing the parameter estimates for the *D*911 dummy variable in Tables 1 and 2, we observe that the negative impact of security measures has been stronger for US exports into Canada than for Canadian export to the US. This might be explained by more elastic US (versus Canadian) sectoral export supply curves. In other words, US export firms might be able to pass forward the extra cost associated with (Canadian) border measures to Canadian customers. On the other hand, Canadian export firms might rather compete against each other and accept a reduction in the price they receive for selling

[8] Sectors are defined in Appendix 2, Table A1.b.

products to US customers in order to mitigate any negative impact on their US market share after the introduction of US security measures. Hence, real Canadian export to the US might fall by less than real US exports to Canada for a given increase in border costs.

**Table 1: Regression results for Canada's real export performance to the US**

| | Total | AGRI | RESO | FOOD | TEXT | MANU | AUTO | TECH | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|
| C | 5.876 | 2.596 | -3.067 | 6.903 | 2.563 | 6.804 | 11.866 | 7.479 | 0.747 | 5.520 |
| | *0.016*** | *0.558* | *0.707* | *0.004** | *0.059*** | *0.006** | *0** | *0** | *0.81* | *0.018*** |
| Log of US Real GDP | -0.044 | 0.400 | -0.792 | 1.650 | 0.724 | 0.205 | 0.260 | 0.366 | 0.958 | 0.500 |
| | *0.887* | *0.464* | *0.566* | *0.001** | *0.006** | *0.511* | *0.238* | *0.18* | *0.126* | *0.121* |
| Rel. Cost (t-1) | 0.108 | 1.049 | -0.468 | 0.188 | -0.343 | 0.080 | -0.517 | -0.337 | 0.614 | 0.156 |
| | *0.624* | *0.051*** | *0.718* | *0.151* | *0.068**** | *0.785* | *0.058**** | *0.033*** | *0.138* | *0.366* |
| Exports (t-1) | 0.708 | 0.631 | 1.306 | 0.118 | 0.503 | 0.595 | 0.381 | 0.492 | 0.448 | 0.486 |
| | *0.001** | *0.015*** | *0.041** | *0.547* | *0** | *0.001** | *0.002** | *0** | *0.085**** | *0.024*** |
| D911 | 0.007 | -0.072 | -0.208 | -0.030 | -0.123 | 0.007 | -0.084 | -0.102 | -0.028 | -0.083 |
| | *0.874* | *0.459* | *0.557* | *0.571* | *0.006** | *0.868* | *0.069**** | *0.02*** | *0.747* | *0.026*** |
| CUR (Can) | 0.0280 | 0.0263 | 0.0383 | -0.0273 | 0.0192 | 0.0183 | 0.0126 | 0.0165 | 0.0282 | 0.0157 |
| | *0.002** | *0.166* | *0.122* | *0.004** | *0.007** | *0.029*** | *0.002** | *0** | *0.052**** | *0.019*** |
| R-Square | 0.96 | 0.68 | 0.88 | 0.98 | 0.99 | 0.95 | 0.97 | 0.98 | 0.90 | 0.96 |

*Note: *= significant at 1%, **=significant at 5%, ***=significant at 10%.*

**Table 2: Regression results for the US real export performance to Canada**

| | Total | AGRI | RESO | FOOD | TEXT | MANU | AUTO | TECH | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|
| C | -6.329 | 2.481 | -32.350 | -4.886 | 6.671 | -12.210 | -2.190 | -1.924 | -14.598 | -5.065 |
| | *0.106* | *0.628* | *0.057**** | *0.03*** | *0.158* | *0.001** | *0.693* | *0.627* | *0.026*** | *0.095**** |
| Log of Can Real GDP | 0.968 | 0.384 | 1.774 | 0.401 | 0.193 | 1.033 | 0.763 | 0.702 | 1.354 | 1.017 |
| | *0** | *0.017*** | *0.022*** | *0.002** | *0.252* | *0** | *0.005** | *0** | *0** | *0** |
| Rel. Cost (t-1) | 0.796 | 0.115 | 0.080 | 0.022 | 0.515 | 0.765 | 1.109 | 0.729 | 0.002 | 0.125 |
| | *0** | *0.468* | *0.887* | *0.780* | *0.043*** | *0** | *0.001** | *0.001** | *0.994* | *0.299* |
| Exports (t-1) | 0.209 | 0.395 | 0.250 | 0.730 | 0.445 | 0.339 | 0.226 | 0.284 | -0.022 | -0.029 |
| | *0.151* | *0.107* | *0.310* | *0** | *0.011*** | *0.002** | *0.147* | *0.031*** | *0.898* | *0.854* |
| D911 | -0.218 | 0.072 | -0.030 | -0.028 | -0.199 | -0.185 | -0.169 | -0.333 | -0.127 | -0.132 |
| | *0.003** | *0.359* | *0.886* | *0.376* | *0.015*** | *0.001** | *0.067**** | *0** | *0.186* | *0.007** |
| R-Square | 0.92 | 0.95 | 0.92 | 0.99 | 0.90 | 0.97 | 0.79 | 0.84 | 0.94 | 0.97 |

*Note: *= significant at 1%, **=significant at 5%, ***=significant at 10%.*

The existing econometric analyses of the impact of the 9/11 security measures on export performance typically stop here. In our study we use these estimates to gauge the general equilibrium impact of liberalising the Canada-US security measures. To do this we need a general equilibrium model. Section 3 briefly describes the model developed for this paper while Section 4 focuses on the simulation results.

## 3. Description of the CGE-FDI Model

This section presents a multi-region multi-sector static general equilibrium model that features production activities and consumption in each region as well as the flow of investment among regions. The representative household in each region decides on the allocation of its total spending among different commodities and on the allocation of its wealth (capital) among different activities. A peculiar characteristic of the model is the distinction between the activities of domestic- and foreign-owned firms at the microeconomic level, both in terms of demand and production characteristics, inspired by similar approaches by Petri (1997) and Verikios and Zhang (2001). Figure 1 provides a graphical representation of the model while Appendix 1 gives the equations of the model.

### *3.1 Capital Allocation*

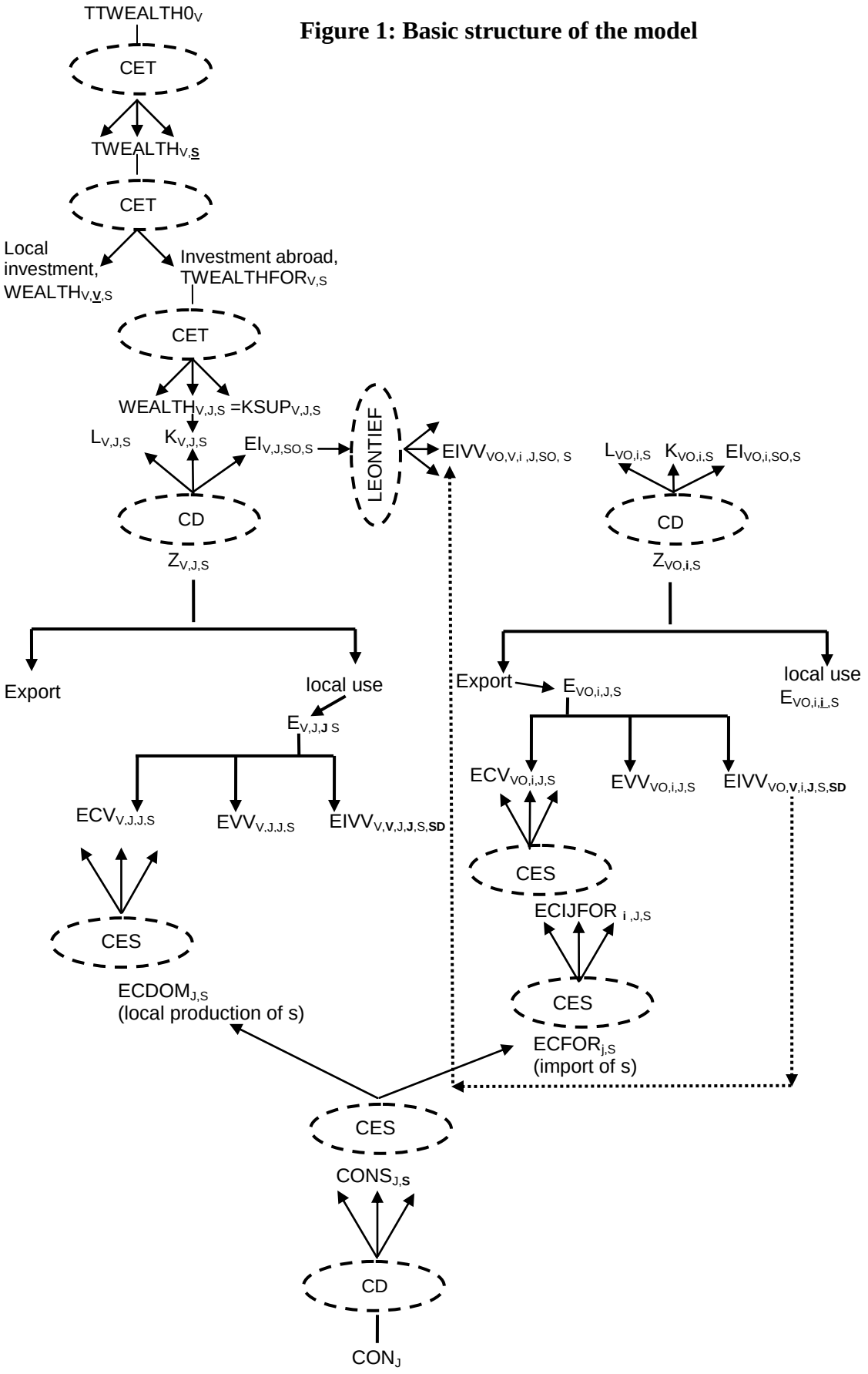
A key feature of the model is the determination of FDI investment, or more broadly the regional allocation of wealth. The investment decision is modeled in an optimizing framework that allocates wealth to the highest return activities, but also takes into account investor preferences (or bias) for a particular mix of instruments (portfolio approach to investment decision). The parameters that account for these preferences are calibrated from initial capital stock data, much the same way as the parameters of consumer preferences are calibrated from observed demand.

Total or aggregate physical wealth (assets) of the representative household of nationality $v$ (nationals of $v$) is assumed fixed (at $TTWealth0_v$). Aggregate wealth, however, is allocated across all sectors $s$ and all countries/regions $j$ – see top of Figure 1. The allocation is done such as to maximize returns on wealth; changes in relative returns bring about changes in the composition of the portfolio. We use a three-level nested

constant elasticity of transformation (CET) function to represent the allocation of aggregate wealth. With finite elasticities of transformation, capital is less than perfectly mobile across sectors and regions. At the first level, aggregate wealth of nationals of *v* is allocated to physical capital across different sectors *s* as a function of the relative rate of returns on capital invested in various sectors (equation 1). At the second level, physical capital of nationals of *v* in sector *s* is allocated between domestic investment, that is, capital supplied to the "nationality-corresponding" country *v* as represented by $WEALTH_{v,v,s}$ in Figure 1 and equation 4, and investment abroad from *v*'s perspective, represented by an aggregate stock of capital abroad ($TWEALTHFOR_{v,s}$) invested in all foreign countries *j* ($j \neq v$) – equation 3.[9] Finally, at the third level, the stock of capital abroad must be allocated among subsidiaries located in specific countries *j* ($WEALTH_{v,j,s}$ with $j \neq v$, in equation 6). This represents the supply of capital available for a firm located in country *j* – equation 32 – (i.e., there is no cross-ownership across different nationalities).

[9] As this is a *multi*-country *multi*-sector model with *multi*-national firms, we have sets of elements defined over countries, sectors, and nationalities of companies. We use indices to refer to such elements. For example, *i* and *j* are indices corresponding to countries; *v* and *vo* are indices related to nationalities, and *s*, *so* and *sd* are indices referring to sectors. Because nationality ultimately corresponds to a country, index *v* refers to the same elements as *i* and *j*. The need for different indices over a same set of elements arises from binary relations between two or more elements of the same set. For example $E_{v,i,j}$ may express an export by a multinational of country *v* located in country *i*, to country *j*.

**Figure 1: Basic structure of the model**



At each step, a revenue-maximizing rule is used to determine the allocation of the index of physical capital into each of its components. Basically, the relative supply of capital in two competing destinations within a nest depends on their relative returns ($R_{v,j,s}$). The higher the relative return in one destination the higher the share of physical capital in that destination. The net return to physical capital in a given sector/destination takes into account the tax rate $CTAX_{v,j,s}$, imposed by country *j* on foreign capital originating from nationals of *v*. A relative change in tax rates on foreign versus domestic capital will affect both the net sectoral returns on assets abroad $RWFOR_{v,s}$ and overall $RTW_{v,s}$ (equations 7 and 5), and the allocation of assets abroad $WEALTH_{v,j,s}$, and domestically $WEALTH_{v,v,s}$, (equations 6 and 4).[10]

*3.2 Household consumption demand*

In each region *j*, the representative household derives income from labour, net returns to capital invested in the domestic economy and abroad, and (because household and governments accounts are consolidated), tariff revenue collected by the government and tax revenue perceived on capital incomes accruing to domestic and foreign subsidiaries located in *j* (equation 35). The representative household does not value leisure so that the supply of labour in each region is fixed.

We assume that the representative household cares about the nationality *and* the place of production of the good produced in a given sector. To account for this differentiation, we represent its preferences by a series of nested utility functions as illustrated at the bottom of Figure 1. At the first level, total utility or aggregate

[10] In this model version domestic capital revenues are not taxed and there is no policy change in the capital tax imposed on foreign investment. The parameter *CTAX* was originally introduced in the model to capture existing restrictions to FDI as an equivalent tax. Any change in these restrictions would translate into a change in relative returns and thus into a change in FDI. See Mérette, Georges, and Dissou (2008).

consumption ($CON_j$ in equation 8) is a Cobb-Douglas index of consumption of different sectoral goods *s* ($CONS_{j,s}$). At the second level, consumption of good *s* is a CES aggregate of the index of goods produced domestically in *j* (including those produced by foreign-nationality subsidiaries located in *j*), $ECDOM_{j,s}$ in equation 10, and of the index of those produced in foreign countries and imported, $ECFOR_{j,s}$ in equation 11. At the third level, consumption by the representative of household of *j* is another CES aggregate of good *s* produced by subsidiaries of all nationalities *v* and located in *j* ($ECV_{v,j,j,s}$ in equation 13) including production by firms of domestic nationality *v=j* ($ECV_{j,j,j,s}$). In another nest, the index of imported good *s* is a CES aggregate of imported goods from geographical origin *i*, ($ECIJFOR_{i,j,s}$ in equation 15) – the Armington assumption. Finally, in the fifth nest, the import into *j* of good *s* from a specific country *i* is a CES aggregate of goods produced by subsidiaries of different nationalities *v* located in *i*, $ECV_{v,i,j,s}$ in equation 17.

Utility maximization, subject to a multi-step budgeting process in which the representative household minimizes expenditures, allows the derivation of the demand for each commodity within each nest. The ratio of the demand for two competing goods within a nest is inversely related to their relative prices (see equations 8, 10, 11, 13, 15 and 17) where price indices are given by (9), (12), (14), (16) and (18).

*3.3 Investment demand*

Final demand is made of household demand and investment demand. Aggregate investment demand in country *j* ($INV_j$ ) (not shown in Figure 1) is a Cobb-Douglas index of different investment goods *s* produced by different subsidiaries *v*, ($INVVS_{v,j,s}$ in

equation 19). The second (CES) level uses the Armington assumption to allocate this investment spending across all countries *i* ($EVV_{v,i,j,s}$ in equation 21).

*3.4 Supply side*

In each country *j*, the representative firm of nationality *v*, operating in sector *sd* (or *s*), combines local labour, capital (of ownership *v*) and intermediate inputs to produce an output using a constant-returns-to-scale technology (center of Figure 1). The firm operates in a competitive setting where it considers factor and output prices as given. It determines the optimal level of output by maximizing profits and using a marginal-cost pricing rule (equation 23) where $\nu_{v,j,sd}$ is the unit (average and marginal) cost. We assume that the production function is a Cobb-Douglas function of capital, labour and the index of intermediate inputs. Because of the constant-returns-to-scale property of the technology, the cost function is linear in output and thus the marginal cost is equal to average cost and is independent of the level of production (equation 27). It follows that the optimal level of inputs can be determined from a cost-minimization rule (equations 24, 25, 26). At each node of the technology representation, the demand for each input increases with the price of the good produced ($PV_{v,j,sd}$) and decreases with its own factor price ($W_j$, $R_{v,j,sd}$, and $PCI_{v,j,s,sd}$). Finally, the aggregate intermediate input *s* used in sector *sd* by a firm of nationality *v* located in *j*, $EI_{v,j,s,sd}$, is a multi-level Leontief function of goods produced by subsidiaries of different nationality *vo* and located in different countries *i*, $EIVV_{vo,v,i,j,s,sd}$, all complements in the aggregation index $EI_{v,j,s,sd}$ (Figure 1 and equation 28).

*3.5 Equilibrium and stationary state conditions*

A general equilibrium of this model economy is represented by a set of endogenous real and nominal variables such that all economic agents maximize their objective functions while respecting their budget constraints, and all factor and good markets clear. In particular, in each region *j*: 1.The wage rate adjusts so as to equate total demand for (local) labour with the total fixed supply of labour (equation 30); 2.The return to physical capital should adjust such as to equate the supply of capital for subsidiary *v* located in country *j* in sector *sd* with the demand for capital in the same sector, by the same subsidiary *v* in country *j*, (equation 31);[11] and: 3.Good prices should adjust such as to equalize the supply of each good produced in sector *s* by subsidiary *vo* located in country *j* to total demand for consumption, investment and intermediate uses, by domestic and foreign agents from all countries *i*, (equation 34). $E_{vo,j,i,s}$ can be viewed as the export of a good *s* by a firm of nationality *vo* located in *j* to country *i* (equation 33).[12]

In stationary state, investment equals depreciation of the stock of capital (equation 36).[13] Also the current account $CA_j$ must be equal to zero for all countries *j*, so that national saving equals investment (equation 37).[14]

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[11] Note that equation (32) implies no cross-ownership of a firm (across nationalities).

[12] When *i=j*, this represents domestic use.

[13] SCR is a scaling factor that converts "units" of the investment good into "units" of services of capital.

[14] We define GNP as $REV_j^{\bullet} = REV_j + ESC \times DET_j$, which adds to the revenue $REV_j$ defined in equation (35), a calibrated scaling term $ESC \times DET_j$ that remains exogenous in our model. The presence of this term can be explained as follows. The model does not include financial bonds and therefore "model wealth" represents *physical* capital only. In the real data set, of course, there is also a *financial* wealth $DET_j$, invested in domestic and foreign bonds and generating financial interest revenues. The scaling term above represents financial interest revenues observed in the data but which is not modeled here and therefore remains constant (at its calibrated value). Implicit in the scaling term is the assumption of perfect *financial* capital mobility across countries. This implies both a unique world financial interest rate *ESC* (equal to the rate of time preference) and the irrelevance of the allocation of financial wealth $DET_j$ into domestic and foreign bonds. On the other hand, our model assumes imperfect substitution between domestic and foreign physical capital. This implies distinct returns (and thus the use of an index *j* in $RTTW_j$ and in all other composite returns in equations 1-7), and an explicit allocation of physical wealth $TTWEALTH_j$ into domestic and foreign physical capital (e.g. equation 35). Finally, there is no reallocation of total wealth

## 4. Simulation Results

The objective of Section 4 is to provide a general equilibrium analysis (*i.e.*, to describe the general ramifications throughout the economy) of the potential economic benefits for North America of a continental security perimeter that would improve the flows of goods by decongesting the Canada-US border. In order to facilitate the interpretation of the results we propose two experiments. In the first scenario, we assume that US alone removes US imposed 9/11 security measures at the Canada-US border. In Scenario 2, we assume a joint removal of US and Canada 9/11 security measures. This last experiment may roughly approximate the economic impact of the 2011 joint proposal for a "North-American Security Perimeter" that liberalises the post 9/11 security measures at the Canada-US border.

### 4.1 Scenario 1— Removing US post 9/11 security measures

In order to assess the economic impact of eliminating US security measures in a general equilibrium setting, we first need to estimate the tariffs rates that are "equivalent" to the post 9/11 border security measures (including the trusted trader programs) in terms of export impacts given in Table 1 by the parameter estimates of the *D*911 dummy variable. In other words, we try to answer the following (counterfactual) question: If the US government had imposed in the early 2000s a protectionist measure (in the form of a tariff barrier on Canadian goods and services) leading to a percent reduction in Canada's export as given in Table 1, what should have been the magnitude of the shock on the US-imposed tariffs? This is a very complex question and we answer it using the general equilibrium model described in Section 3, which we simulate. We shock the model by

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($TTWEALTH_j + DET_j$) between physical and financial wealth, that is, we assume physical and financial wealth to be perfect complements, insensitive to their relative returns, ($RTTW_j / ESC$).

imposing the *exogenous* percent change in sectoral real Canadian exports to the US econometrically estimated in Table 1. The model solves *endogenously* for the "equivalent" tariff rates necessary to absorb the trade shock.[15] As a caveat, if the sectoral parameter for the *D*9/11 dummy variable is not statistically different from 0 (at 10%) in Table 1, then the exogenous shock corresponding to this percent change in sectoral export is set equal to zero in our general equilibrium model.

**Table 3: Tariffs rates equivalent to the US-imposed border security measures (%)**

| | Sectors (S) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
| TEq(CAN,US,S) | 2.4 | 0.3 | 2.4 | 4.4 | 2.2 | 4.7 | 4.5 | 2.8 | 9.6 |

Table 3 provides the sectoral equivalent tariffs generated by this methodology. For example, the (general equilibrium) tariff equivalent to the post 9/11 US border security measures in the Textile, Automobile, or Service sectors are 4.4%, 4.5%, and 2.8% respectively suggesting that activities that depends more on *just in time* processes might have been more affected. These equivalent tariffs are quite significant, which suggests that the post 9/11 border security measures must have significantly eroded the cumulated trade impact of both the 1989 Can-US FTA and its successor, NAFTA. In fact, the US-imposed 9/11 security measures may have pushed Canada into a situation worse than the pre-FTA period because the sectoral tariff preferences obtained over time through both preferential agreements with the US were typically less (and sometime much less) than the tariffs equivalent to the security measures given in Table 3.[16]

[15] In terms of the model in Section 3, the percent change in $E_{v,can,us,s}$ is exogenously set equal to its estimate given in Table 1 (and assumed to be the same for all subsidiaries *v*) while the bilateral tariff $TAR_{v,can,us,s}$ can adjust endogenously to absorb the shock.

[16] The magnitude of these equivalent tariffs can also be compared to US tariffs imposed on Canada's goods and given in Table A3 of Appendix 2 (for example, 3.7% on the Food sector, which includes dairy products—see the explicit definition for Food and all other sectors in Table A1.b of Appendix 2).

The counterfactual proposal analysed in Scenario 1 is the elimination of US-imposed 9/11 security measures at the Canada-US border which, in our modeling strategy, corresponds to setting all sectoral equivalent tariffs of Table 3 to zero. The most direct impact of this liberalisation scenario is, of course, on Canadian exports to the US. The second row (CAN.CAN.US) in Table 4 indicates that firms of Canadian nationality located in Canada increase their export to the US by 10.2% in the Technology (TECH) sector. Exportations from Canada to the US also increase significantly in the Textile (TEXT, 12.3%), Automotive (AUTO, 8.4%), and Transportation (TRAN, 8.3%) sectors. Note that exports to the US of US and ROW subsidiaries located in Canada also rise correspondingly (11$^{th}$ and 20$^{th}$ rows in Table 4). In fact the numbers reported in rows 2, 11, and 20 correspond exactly to the econometric estimate reported in Table 1. In other words, scenario 1, by eliminating the equivalent tariff of the security measures given in Table 3, simulates a liberalisation scenario which eliminates the negative trade effect of the US-imposed 9/11 security measures as gauged in our econometric model. This should give some comfort with respect to our simulation strategy and model. The most important aspect of using a general equilibrium model, however, is that we are now in position to analyse many other impacts of this liberalisation scenario on Canadian, US, and ROW economies, which an econometric analysis is unable to provide.

**Table 4: Sectoral trade flows by nationality of firms - Impact of Scenario 1 (in %)[1]**

| Row # | Nationality | From: | To: | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CAN | CAN | CAN | 0.5 | 1.1 | 0.6 | 0.0 | 1.7 | 1.2 | 2.8 | 0.5 | 1.0 |
| 2 | CAN | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| 3 | CAN | CAN | ROW | -3.5 | -0.5 | -5.8 | -8.2 | -2.2 | -6.8 | -6.0 | -4.0 | -3.2 |
| 4 | CAN | US | CAN | 2.3 | 1.3 | 3.1 | 4.3 | 3.1 | 7.6 | 6.9 | 2.3 | 2.4 |
| 5 | CAN | US | US | -0.5 | -0.1 | -0.6 | -0.5 | -0.2 | -1.8 | -3.2 | -0.7 | -0.1 |
| 6 | CAN | US | ROW | -0.6 | 0.0 | -0.6 | -0.6 | -0.2 | -0.3 | -0.2 | -0.5 | -0.4 |
| 7 | CAN | ROW | CAN | 3.0 | 1.3 | 3.7 | 5.1 | 3.4 | 8.0 | 7.1 | 2.4 | 2.6 |
| 8 | CAN | ROW | US | -0.5 | 0.0 | -0.3 | -0.5 | -0.1 | -1.5 | -3.9 | -0.3 | -0.4 |
| 9 | CAN | ROW | ROW | -0.8 | -0.5 | -0.9 | -0.6 | -0.3 | 0.0 | -0.2 | -0.9 | -0.5 |
| 10 | US | CAN | CAN | 0.9 | 1.4 | 1.6 | 0.5 | 1.7 | -0.9 | 1.9 | 1.3 | 1.3 |
| 11 | US | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| 12 | US | CAN | ROW | -2.9 | -0.4 | -5.0 | -7.7 | -2.1 | -6.5 | -5.6 | -3.6 | -2.8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | US | US | CAN | 3.4 | 1.4 | 3.7 | 4.6 | 3.1 | 3.7 | 5.3 | 2.6 | 2.8 |
| 14 | US | US | US | 0.0 | 0.0 | 0.0 | -0.1 | 0.0 | -0.1 | -0.2 | 0.0 | 0.1 |
| 15 | US | US | ROW | 0.0 | 0.1 | 0.0 | -0.3 | -0.1 | -0.4 | -0.3 | -0.1 | -0.1 |
| 16 | US | ROW | CAN | 4.2 | 1.4 | 4.3 | 5.7 | 3.4 | 4.5 | 5.8 | 2.9 | 3.2 |
| 17 | US | ROW | US | 0.2 | 0.0 | 0.4 | 0.2 | 0.3 | 0.5 | -0.5 | 0.1 | 0.0 |
| 18 | US | ROW | ROW | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | 0.1 | 0.0 | -0.1 | -0.1 |
| 19 | ROW | CAN | CAN | 1.0 | 1.4 | 1.7 | 0.6 | 1.7 | -1.3 | 1.9 | 1.4 | 1.3 |
| 20 | ROW | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| 21 | ROW | CAN | ROW | -2.8 | -0.4 | -4.9 | -7.6 | -2.0 | -6.7 | -5.6 | -3.5 | -2.7 |
| 22 | ROW | US | CAN | 3.6 | 1.4 | 3.7 | 4.7 | 3.0 | 3.0 | 5.2 | 2.6 | 2.9 |
| 23 | ROW | US | US | 0.1 | 0.0 | 0.1 | -0.1 | 0.0 | -0.4 | -0.3 | 0.1 | 0.1 |
| 24 | ROW | US | ROW | 0.1 | 0.1 | 0.0 | -0.3 | -0.1 | -0.6 | -0.3 | -0.1 | 0.0 |
| 25 | ROW | ROW | CAN | 4.3 | 1.4 | 4.4 | 5.8 | 3.4 | 3.8 | 5.8 | 3.0 | 3.2 |
| 26 | ROW | ROW | US | 0.3 | 0.0 | 0.5 | 0.3 | 0.3 | 0.2 | -0.6 | 0.2 | 0.0 |
| 27 | ROW | ROW | ROW | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

1. Note: Domestic production for domestic use is also reported. For example CAN.CAN.CAN is the production of a firm of Canadian nationality located in Canada and "exported" to Canada (i.e., kept for domestic/Canadian consumption).

One interesting observation from Table 4 is that the elimination of the 9/11 US security measures at the Canada-US border generate more trade between Canada and the US at the expense of Canada (and to a lower extent US) trade with the ROW in most sectors as can be seen in rows 3, 12, 21 (and 6, 15, 24). This illustrates that US 9/11 security measures generated trade diversion in the sense that firms located in North America and especially in Canada reacted during the 2000s by diverting some of their exports to the ROW. Therefore, the liberalisation scenario of this section would help reverse this trade diversion. It is also worth observing that eliminating the US security measures stimulates Canadian imports from the US (see rows 4, 13, and 22) but also from the ROW (see rows 7, 16, and 25). Of course, this suggests that the sectoral production of firms located in Canada tends to increase (as illustrated in Table 5 and explained shortly), which requires more intermediary goods originating from all countries. This also suggests that the purchasing power of Canadian consumers has increased (as will be shown in Table 7). Incidentally, observe that the increase in Canadian imports is more balanced across sectors than for exports, highlighting income and relative price change effects. This shows the importance of a general equilibrium analysis for the issue at stake.

**Table 5: Sectoral output - Impact of Scenario 1 (in %)**

| Row # | Nationality | Location | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CAN | CAN | -0.4 | 0.6 | 0.3 | 3.2 | 0.9 | 3.6 | 5.9 | 0.4 | 1.0 |
| 2 | CAN | US | -0.5 | -0.1 | -0.6 | -0.5 | -0.1 | -1.2 | -2.0 | -0.7 | -0.1 |
| 3 | CAN | ROW | -0.8 | -0.4 | -0.9 | -0.5 | -0.3 | -0.1 | -0.4 | -0.9 | -0.5 |
| 4 | US | CAN | 0.0 | 0.8 | 1.1 | 3.5 | 0.9 | 2.7 | 5.7 | 1.2 | 1.2 |
| 5 | US | US | 0.1 | 0.0 | 0.1 | -0.1 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 |
| 6 | US | ROW | -0.1 | -0.1 | -0.1 | 0.0 | 0.0 | 0.2 | 0.0 | -0.1 | -0.1 |
| 7 | ROW | CAN | 0.1 | 0.8 | 1.2 | 3.6 | 0.9 | 2.5 | 5.7 | 1.3 | 1.3 |
| 8 | ROW | US | 0.2 | 0.1 | 0.1 | -0.1 | 0.1 | -0.3 | 0.1 | 0.1 | 0.1 |
| 9 | ROW | ROW | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6: Physical capital stock - Impact of Scenario 1 (in %)**

| Row # | Nationality | Location | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CAN | CAN | -0.2 | 0.5 | 0.2 | 1.8 | 0.5 | 1.9 | 3.1 | 0.6 | 0.7 |
| 2 | CAN | US | -1.3 | -0.9 | -1.4 | -1.5 | -1.2 | -1.8 | -2.4 | -1.5 | -1.2 |
| 3 | CAN | ROW | -1.6 | -1.1 | -1.7 | -1.6 | -1.4 | -1.3 | -1.5 | -1.7 | -1.5 |
| 4 | US | CAN | 1.2 | 1.4 | 1.8 | 3.3 | 1.7 | 2.7 | 4.2 | 2.2 | 2.1 |
| 5 | US | US | 0.1 | 0.0 | 0.0 | -0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 |
| 6 | US | ROW | -0.2 | -0.1 | -0.2 | -0.2 | -0.2 | 0.0 | -0.2 | -0.2 | -0.2 |
| 7 | ROW | CAN | 1.3 | 1.5 | 2.0 | 3.4 | 1.8 | 2.7 | 4.4 | 2.4 | 2.3 |
| 8 | ROW | US | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.1 | 0.2 | 0.2 |
| 9 | ROW | ROW | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 7: Some aggregates - Impact of Scenario 1**

**Δ in millions of constant dollar; Other results in %**

| | Δ REV | Δ wage Income | Δ Cap Income | Δ CON | Δ TBAL | %Δ REV | %Δ CON | %Δ TBAL | %Δ TOT | %Δ W | %Δ RTTW | %Δ $R^a(i,i,s)$ | %Δ PCON |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 4861 | 4575 | -21 | 8881 | -5605 | 0.5 | 1.2 | -0.3 | 2.2 | 3.8 | 2.4 | 3.3 | 2.7 |
| US | 2263 | 2209 | -6 | 5487 | -4627 | 0.0 | 0.1 | 0.0 | -0.1 | 0.3 | 0.3 | 0.3 | 0.3 |

**Table 8: Percent point change in rate of returns on physical capital stock**

| Row # | Nationality | Location | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CAN | CAN | 2.3 | 2.9 | 2.7 | 3.9 | 2.9 | 4.0 | 4.9 | 3.0 | 3.1 |
| 2 | CAN | US | 1.4 | 1.8 | 1.3 | 1.4 | 1.5 | 1.0 | 0.6 | 1.3 | 1.6 |
| 3 | CAN | ROW | 1.2 | 1.6 | 1.1 | 1.2 | 1.4 | 1.4 | 1.3 | 1.1 | 1.3 |
| 4 | US | CAN | 1.1 | 1.3 | 1.6 | 2.6 | 1.5 | 2.2 | 3.3 | 1.9 | 1.8 |
| 5 | US | US | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 |
| 6 | US | ROW | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.1 | 0.2 |
| 7 | ROW | CAN | 1.0 | 1.1 | 1.5 | 2.5 | 1.3 | 1.9 | 3.2 | 1.7 | 1.7 |
| 8 | ROW | US | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.2 | 0.2 | 0.2 |
| 9 | ROW | ROW | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

As just mentioned, the production in Canada increases in almost all sectors (Table 5). This holds for Canadian firms (row 1) and for multinationals located in Canada (rows 4 and 7). This increase is mainly due to two effects. First, the liberalisation of the US security measures eliminates a distortion which allows a better re-allocation of resources across all sectors in North America. From this perspective alone, some sectors could gain at the expense of others. However, and this is the second effect, although labour supply is

fixed and immobile between countries in this model, the allocation of the stock of capital owned by Canadians and Foreigners is determined endogenously through FDI flows between countries. FDI inflows to Canada and Canadian dis-investment abroad would increase the stock of capital available for firms located in Canada and this would stimulate production in all Canadian sectors. Table 6 reports the changes in the sectoral stock of capital. The stock of capital in Canada (rows 1, 4, and 7) enlarges in almost all sectors. This implies that Canadian investors (row 1) but also foreign investors (FDI in rows 4 and 7) reallocate their wealth in favour of the Canadian region. With a more efficient reallocation of resources within Canada and the rise in Canadian exports to the US one may indeed expect that doing business in Canada becomes more appealing from the investors' point of view. Table 6 also reports that Canadian investment abroad (in both the US and the ROW) declines significantly (rows 2 and 3). This is consistent with results in Table 5 (rows 2 and 3) where Canadian multinationals located in the US and the ROW tend to reduce their activity. 9/11 security measures might have provided a rationale for Canadian firms to increase their activity directly in the US instead of exporting (as suggested in the introduction). With the elimination of the US security measures at the Canada-US border, some of these activities could be repatriated in Canada (rows 1 versus 2, Table 5). Furthermore, if exporting to the US becomes easier following the liberalization of US security measures, then, Canadian multinationals might want to export less to the ROW (row 3, Table 4) and invest and produce less directly in affiliates located in the ROW (row 3, Tables 5 and 6) as their products can now be more easily exported to the US and used there as intermediary goods in the production of US goods that are ultimately exported to the ROW. This is of course an indirect (and often-

mentioned) way for Canada to participate in the global value chain. The results in Tables 4, 5, and 6 suggest that Canadian exports to the US (which increase following the liberalisation of the US security measures) and Canadian investment in the US (which decreases) are substitutes, while Canadian exports to the ROW and Canadian investment (and production) into the ROW are complement (as they both decline).[17]

Finally, Table 7 reports the impact of eliminating the US security measures at the Canada-US border on aggregate indicators for Canada and the US. Revenue in Canada increases by 4.8 billion (in constant dollar) of which a large part is due to an increase in wage income (4.5 billion).[18] This increase is due to stronger economic activity by firms located in Canada (Table 5) which occurs, as seen before, through a better reallocation of resources and an increase in the physical capital stock available for firms located in Canada (Table 6). For a constant labour supply, this increases the labour productivity in Canada and leads to a higher wage rate (+3.8%). A proxy for the change in Canadians' purchasing power is obtained by subtracting, from the percent change in the wage rate, the percent change in the Canadian consumer price (% $\Delta$PCON = +2.7%, which reflects changes in prices of Canadian and foreign goods). The resulting 1.1 percent difference (3.8%-2.7%) is a proxy for the change in Canadians' purchasing power and this props up real consumption in Canada (% $\Delta$Con = 1.2%) on a permanent basis. Note finally the increase in the sectoral rental prices of capital in Canada (rows 1, 4, and 7 in Table 8).

[17] Looking at the other side, we also observe increases in US and ROW investments into, and export to, Canada, also suggesting complementarities.

[18] We are using a static model, so the increase in real GNP must be considered a lower bound of the long run impact. Indeed, in a dynamic set up, total wealth would also increase (instead of simply being reallocated across sectors and countries) and so would physical capital stock. Consequently, GNP would increase by more.

This reflects the stronger economic activity in Canada, which increases the productivity of capital and induces FDI flows (including reinvestment by Canadians) to Canada.[19]

Table 7 shows that the Canadian trade balance deteriorates by 5.6 billion. From the import side this is due to the fact that real Canadian consumption increases by 8.8 billion which leads to an increase in spending on foreign goods and thus an increase in imports. From the export side, the liberalisation of the US security measures at the Canada-US border induces Canada to export more to the US, but less to the ROW. Furthermore, liberalising US security measures is similar to removing a US tariff on Canadian goods (assumed in our model to be imperfect substitutes to US and ROW goods). This tends to increase the demand for and thus the price of Canadian goods, generating a terms of trade appreciation for Canada (+2.2% in Table 7). An appreciation means that for the same volume of import, Canada does not need to export as much as before, which also explains part of Canada's deterioration in its trade balance.

The change in revenue estimated above ($4.8 billion in constant dollar) gives the annual amount of money that Canada would gain if (post 9/11) US security measures were eliminated. This suggests that Canada could basically send a check of (up to) $4.8 billion (every year) to the US in exchange for an American decision to invest in an alternative approach that would permit the elimination of US border security measures. Americans themselves would also directly benefit from these measures ($2.2 billion in Table 7).

### 4.2 Scenario 2—The North American Security Perimeter

[19] Note that % $\Delta R^a(i,i,s)$ = 3.3% for Canada in Table 7. It is the increase in the production-weighted sum (over all sectors *s*) of the rates of return on domestic investment (investment by Canadians in Canada) (i.e., it is the production-weighted sum of the returns given in first row of Table 8).

In this section we assume a joint removal of US *and* Canadian 9/11 security measures. This scenario may roughly approximate the economic impact of a North American Security Perimeter that liberalises the post 9/11 security measures at the Canada-US border. Following the same strategy as in Section 4.1, we first compute the general equilibrium tariff rates that are equivalent to the US and Canadian security measures in terms of their export impact estimated in Tables 1 and 2. We do this by simulating the general equilibrium model in Section 3 and Table 9 gives these sectoral equivalent tariffs.[20] Then, we use our model to simulate the general equilibrium impacts on trade, FDI and aggregate measures (e.g., GNP, real consumption), of a change in security paradigm towards a North American Security Perimeter by setting these equivalent tariffs to zero. Tables 10-14 present the results. Due to space limitation we simply offer a few observations on the differences in results with respect to those obtained in Scenario 1 (liberalisation of US security measures only).

**Table 9: Tariffs equivalent to the US and Canadian border security measures (%)**

| | Sectors (S) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
| TEq(CAN,US,S) | 0.2 | -12.8 | 0.5 | 2.1 | -0.9 | -0.9 | -0.4 | 0.7 | 7.3 |
| TEq(US,CAN,S) | -0.8 | -11.3 | -0.9 | 4.9 | 16.2 | 21.8 | 9.7 | -1.5 | 8.1 |

**Table 10: Sectoral trade flows by nationality of firms - Impact of Scenario 2 (in %)[1]**

| Nationality | From: | To: | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | CAN | CAN | 2.1 | 1.2 | 1.9 | 2.0 | 4.3 | 4.4 | 4.4 | 1.1 | 2.1 |
| CAN | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| CAN | CAN | ROW | -0.6 | -0.1 | -1.8 | 0.2 | 0.6 | 11.3 | 9.6 | -1.5 | -0.6 |
| CAN | US | CAN | 0.0 | 0.0 | 0.0 | 19.9 | 18.5 | 33.3 | 16.9 | 0.0 | 13.2 |
| CAN | US | US | -0.1 | 0.0 | -0.2 | -0.8 | 0.1 | -2.1 | -3.4 | -0.2 | 0.2 |
| CAN | US | ROW | -1.3 | -0.2 | -1.9 | -2.3 | -0.9 | -3.3 | -2.7 | -1.3 | -1.0 |
| CAN | ROW | CAN | 4.9 | 1.4 | 4.6 | -0.1 | -0.3 | -9.2 | -6.7 | 2.8 | 0.4 |
| CAN | ROW | US | 0.7 | 0.0 | 1.4 | 1.5 | 1.4 | 1.3 | -1.2 | 0.5 | 0.4 |
| CAN | ROW | ROW | -0.7 | -0.4 | -0.7 | -0.5 | -0.3 | -0.3 | -0.3 | -0.8 | -0.5 |
| US | CAN | CAN | 2.3 | 1.3 | 2.3 | 2.0 | 3.3 | -12.9 | 0.0 | 1.4 | 2.0 |
| US | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| US | CAN | ROW | -0.3 | 0.0 | -1.5 | 0.5 | 0.8 | 14.3 | 10.6 | -1.3 | -0.4 |
| US | US | CAN | 0.0 | 0.0 | 0.0 | 19.9 | 18.5 | 33.3 | 16.9 | 0.0 | 13.2 |
| US | US | US | 0.1 | 0.0 | 0.1 | -0.5 | 0.2 | 0.1 | -0.2 | 0.0 | 0.2 |

[20] We will see that there will be a stronger demand for Canadian goods (relative to scenario 1) in part because US GDP and imports increase by more. Thus, Canadian tariff rates do not need to change as much as in Scenario 1 in order to generate percent changes in Canadian exports given in Table 1, and they might even fall in some sectors. In other words, these are *general equilibrium* tariffs.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| US | US | ROW | -1.1 | -0.2 | -1.7 | -2.3 | -0.9 | -2.5 | -2.5 | -1.1 | -0.9 |
| US | ROW | CAN | 5.3 | 1.5 | 4.8 | 0.0 | -1.5 | -28.0 | -10.8 | 3.0 | 0.5 |
| US | ROW | US | 1.0 | 0.0 | 1.7 | 1.8 | 1.6 | 3.5 | 2.4 | 0.7 | 0.5 |
| US | ROW | ROW | -0.4 | -0.2 | -0.5 | -0.3 | -0.2 | 0.7 | 0.1 | -0.5 | -0.3 |
| ROW | CAN | CAN | 2.5 | 1.4 | 2.7 | 2.6 | 4.3 | 8.0 | 4.9 | 1.8 | 2.4 |
| ROW | CAN | US | 0.0 | 0.0 | 0.0 | 12.3 | 0.0 | 10.2 | 8.4 | 0.0 | 8.3 |
| ROW | CAN | ROW | 0.0 | 0.0 | -1.1 | 0.8 | 0.8 | 11.4 | 10.1 | -1.1 | -0.2 |
| ROW | US | CAN | 0.0 | 0.0 | 0.0 | 19.9 | 18.5 | 33.3 | 16.9 | 0.0 | 13.2 |
| ROW | US | US | 0.4 | 0.1 | 0.4 | -0.5 | 0.2 | -1.8 | -1.2 | 0.4 | 0.3 |
| ROW | US | ROW | -0.8 | -0.1 | -1.5 | -2.1 | -0.8 | -3.2 | -2.7 | -1.0 | -0.7 |
| ROW | ROW | CAN | 5.9 | 1.5 | 5.1 | 0.3 | -0.4 | -5.3 | -6.4 | 3.2 | 0.8 |
| ROW | ROW | US | 1.4 | 0.0 | 2.0 | 2.1 | 1.7 | 1.8 | 1.4 | 0.9 | 0.7 |
| ROW | ROW | ROW | -0.1 | 0.0 | -0.1 | -0.1 | -0.1 | 0.0 | 0.0 | -0.1 | -0.1 |

1. Note: Domestic production for domestic use is also reported. For example CAN.CAN.CAN is the production of a firm of Canadian nationality located in Canada and "exported" to Canada (i.e., kept for domestic/Canadian consumption).

**Table 11: Sectoral output - Impact of Scenario 2 (in %)**

| Nationality | Location | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | CAN | 1.3 | 0.7 | 1.5 | 5.0 | 2.7 | 8.0 | 7.3 | 1.0 | 2.2 |
| CAN | US | -0.3 | 0.0 | -0.2 | -0.6 | 0.4 | -0.9 | -1.8 | -0.2 | 0.2 |
| CAN | ROW | -0.7 | -0.3 | -0.7 | -0.3 | -0.2 | -0.2 | -0.4 | -0.8 | -0.4 |
| US | CAN | 1.5 | 0.8 | 1.8 | 5.0 | 2.1 | 1.4 | 6.1 | 1.4 | 2.1 |
| US | US | -0.1 | 0.0 | 0.0 | -0.3 | 0.5 | 0.9 | 0.7 | 0.0 | 0.2 |
| US | ROW | -0.4 | -0.2 | -0.5 | -0.2 | -0.1 | 0.8 | 0.2 | -0.5 | -0.3 |
| ROW | CAN | 1.7 | 0.9 | 2.2 | 5.3 | 2.7 | 9.5 | 7.5 | 1.7 | 2.4 |
| ROW | US | 0.2 | 0.1 | 0.3 | -0.3 | 0.5 | -0.7 | -0.1 | 0.4 | 0.3 |
| ROW | ROW | -0.1 | 0.0 | -0.1 | 0.1 | 0.0 | 0.1 | 0.0 | -0.1 | -0.1 |

**Table 12: Physical capital stock - Impact of Scenario 2 (in %)**

| Nationality | Location | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | CAN | 0.2 | -0.2 | 0.5 | 2.0 | 0.5 | 1.9 | 1.7 | 0.4 | 0.7 |
| CAN | US | -0.4 | -0.2 | -0.4 | -0.7 | 0.0 | -0.9 | -1.4 | -0.4 | -0.2 |
| CAN | ROW | -1.3 | -0.8 | -1.4 | -1.2 | -1.0 | -1.0 | -1.2 | -1.3 | -1.2 |
| US | CAN | 0.7 | 0.1 | 1.1 | 2.5 | 0.5 | -1.5 | 1.4 | 1.0 | 1.1 |
| US | US | 0.0 | 0.1 | 0.1 | -0.2 | 0.4 | 0.6 | 0.4 | 0.1 | 0.2 |
| US | ROW | -0.8 | -0.5 | -0.8 | -0.6 | -0.6 | -0.1 | -0.4 | -0.8 | -0.7 |
| ROW | CAN | 1.3 | 0.6 | 1.9 | 3.3 | 1.4 | 3.8 | 2.8 | 1.8 | 1.9 |
| ROW | US | 0.7 | 0.6 | 0.8 | 0.5 | 1.0 | 0.2 | 0.5 | 0.9 | 0.9 |
| ROW | ROW | -0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |

**Table 13: Some aggregates - Impact of Scenario 2**

**Δ in millions of constant dollar. Other results in %**

| | Δ REV | Δ wage Income | Δ Cap Income | Δ CON | Δ TBAL | %Δ REV | %Δ CON | %Δ TBAL | %Δ TOT | %Δ W | %Δ RTTW | %Δ R(iis) | %Δ PCON |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 9366 | 9334 | -11 | 23627 | -24546 | 0.9 | 3.2 | -1.4 | -1.3 | 2.8 | 1.9 | 2.6 | 0.7 |
| US | 11259 | 10664 | -22 | 14107 | -6590 | 0.1 | 0.1 | 0.0 | 1.3 | 1.5 | 1.2 | 1.3 | 1.3 |

From an economic point of view we expect stronger results for Canada because Canadians will benefit from the removal of US security measures (as in Scenario 1), but also from the removal of their own Canadian-imposed security measures at the border. Indeed, US exporting firms routinely pass forward the extra cost resulting from the Canadian security measures to Canadian firms and consumers. Liberalising these security measures eliminates these costs, which makes US goods relatively cheaper. This forces a

better reallocation of resources within the Canadian economy. However, all firms located in Canada eventually produce more (compare rows 1, 4 and 7 in Table 5 with the same rows in Table 11). Although the increase in production is partly due to a reallocation of Canadian capital towards the Canadian economy, it is interesting to note that this reallocation is not as strong as in Scenario 1 (compare rows 1, 2, and 3 in Table 12 with the same rows in Table 6). Therefore, the stronger production increase (with respect to scenario 1) reveals a stronger increase in the demand for goods produced in Canada, itself propped up by a higher purchasing power of Canadians and Americans in comparison to Scenario 1. Table 13 illustrates the higher revenues for Canadians and Americans. Real Canadian GNP increases by 9.3 billion (annually) instead of 4.8 billion for Scenario 1 (Table 7) and real consumption spending increases by 3.3% (instead of 1.2%). Real US GNP increases by 11.3 billion (annually) instead of 2.2 billion in Scenario 1. Note that real consumption in the US would increase by 14 billion in this scenario. This appears to be a conservative assessment with respect to the study of Mueller and Stewart (2011) who estimate the deadweight losses and losses in US consumer welfare due to the enhanced 9/11 security measures to be 30 billion annually.

**5. Conclusion**

The results of the study suggest that the economic gains for Canada of a North American Security Perimeter would be substantial. Trade flows (exports and imports) of goods would improve significantly, especially for sectors like textile, manufacturing, high technology, automotive and transports that are more dependent on *just in time* processes. But our study also suggests that economic gains would be important in terms of revenue and welfare. The annual amount of money Canada would gain if (post 9/11)

border delays were eliminated is estimated to be $9.3 billion. The equivalent amount for the US is $11.1 billion.

Cumulating the changes in GNP in US and Canada, the analysis suggests that the economic (opportunity) gains occurring to Canada and the US from the liberalization of the 9/11 security measures are large. Both countries could, together, gain up to US$20 billion annually if a North American Perimeter were implemented. This reflects the opportunity gains of eliminating the Canada-US enhanced security measures introduced post 9/11; this is not an estimate of the current direct (administrative) costs of these measures. In fact, according to Mueller and Stewart (2011), the direct cost of these enhanced security measures for US federal homeland security is about 50 billion per year.[21] If this estimate is correct, the equivalent cost for Canada is (at most) 5 billion per year, (i.e., 10% of the US cost).[22]

On this basis, Canada and the US should seriously examine the alternatives, including the long-discussed continental Security Perimeter which could correspond to a bilateral policy harmonisation and a pooling of sovereignty on security issues similar to that which exists among European Union members — where common visa and asylum policies, a shared information system, and standardized border procedures essentially provide a common security perimeter.

**Appendix 1 Equations of the CGE-FDI Model**

*1. Wealth/Capital allocation (from the perspective of nationals of country v)*

[21] And probably more according to them, if we add local and state expenditures.
[22] According to the federal government of Canada website the direct administrative cost is much lower, at around 1 billion per year since 2001. See:
http://www.canadainternational.gc.ca/washington/bilat_can/border_frontiere.aspx?lang=eng

(1) $TWEALTH_{v,s} = ETAW_{v,s}\left(\frac{RTW_{v,s}}{RTTW_{v}}\right)^{\sigma TTW_{v}} TTWEALTH\,0_{v}$

(2) $\left(RTTW_{v}\right)^{1+\sigma TTW_{v}} = \sum_{s} ETAW_{v,s}\left(RTW_{v,s}\right)^{1+\sigma TTW_{v}}$

(3) $TWEALTHFOR_{v,s} = ETAWFOR_{v,s}\left(\frac{RWFOR_{v,s}}{RTW_{v,s}}\right)^{\sigma TW_{v,s}} TWEALTH_{v,s}$

(4) $WEALTH_{v,v,s} = ETAWDOM_{v,s}\left(\frac{R_{v,v,s}}{RTW_{v,s}}\right)^{\sigma TW_{v,s}} TWEALTH_{v,s}$

(5) $\left(RTW_{v,s}\right)^{1+\sigma TW_{v,s}} = ETAWFOR_{v,s}\left(RWFOR_{v,s}\right)^{1+\sigma TW_{v,s}} + ETAWDOM_{v,s}\left(R_{v,v,s}\right)^{1+\sigma TW_{v,s}}$

(6) $WEALTH_{v,j,s} = ETAWW_{v,j,s}\left(\frac{R_{v,j,s}\left(1-CTAX_{v,j,s}\right)}{RWFOR_{v,s}}\right)^{\sigma W_{v,s}} TWEALTHFOR_{v,s} \qquad v \neq j$

(7) $\left(RWFOR_{v,s}\right)^{1+\sigma W_{v,s}} = \sum_{j,\,j\neq v} ETAWW_{v,j,s}\left[R_{v,j,s}\left(1-CTAX_{v,j,s}\right)\right]^{1+\sigma W_{v,s}}$

*2. Consumption demand (from the perspective of a representative household of country j)*

(8) $CONS_{j,s} = \frac{\rho_{j,s} CON_{j} PCON_{j}}{PCFC_{j,s}}$

(9) $Log\left(PCON_{j}\right) = \sum_{s} \rho_{j,s} \log\left(PCFC_{j,s}\right)$

(10) $ECDOM_{j,s} = ETADOMC_{j,s}\left[\frac{PCFC_{j,s}}{PDOM_{j,s}}\right]^{\sigma FORC_{j,s}} \underbrace{\frac{\rho_{j,s} PCON_{j} CON_{j}}{PCFC_{j,s}}}_{CONS_{j,s}}$

(11) $ECFOR_{j,s} = ETAFORC_{j,s}\left[\frac{PCFC_{j,s}}{PFOR_{j,s}}\right]^{\sigma FORC_{j,s}} \underbrace{\frac{\rho_{j,s} PCON_{j} CON_{j}}{PCFC_{j,s}}}_{CONS_{j,s}}$

(12) $\left(PCFC_{j,s}\right)^{1-\sigma FORC_{j,s}} = \left[ETADOMC_{j,s}\left(PDOM_{j,s}\right)^{1-\sigma FORC_{j,s}} + ETAFORC_{j,s}\left(PFOR_{j,s}\right)^{1-\sigma FORC_{j,s}}\right]$

(13) $ECV_{v,j,j,s} = ETADOMV_{v,j,j,s}\left[\frac{PDOM_{j,s}}{PV_{v,j,s}}\right]^{\sigma DOMV_{j,s}} ECDOM_{j,s}$

(14) $\left(PDOM_{j,s}\right)^{1-\sigma DOMV_{j,s}} = \sum_{v} ETADOMV_{v,j,j,s}\left(PV_{v,j,s}\right)^{1-\sigma DOMV_{j,s}}$

(15) $ECIJFOR_{i,j,s} = ETAFC_{i,j,s}\left[\frac{PFOR_{j,s}}{PIJ_{i,j,s}}\right]^{\sigma_{j,s}} ECFOR_{j,s}$

(16) $\left(PFOR_{j,s}\right)^{1-\sigma_{j,s}} = \sum_{i} ETAFC_{i,j,s}\left(PIJ_{i,j,s}\right)^{1-\sigma_{j,s}}$

(17) $$ECV_{v,i,j,s} = ETAFORV_{v,i,j,s}\left[\frac{PIJ_{i,j,s}}{PV_{v,i,s}\left(1+TAR_{v,i,j,s}\right)}\right]^{\sigma FORV_{j,s}} ECIJFOR_{i,j,s}$$

(18) $$\left(PIJ_{i,j,s}\right)^{1-\sigma FORV_{j,s}} = \sum_{v} ETAFORV_{v,i,j,s}\left(PV_{v,i,s}\left(1+TAR_{v,i,j,s}\right)\right)^{1-\sigma FORV_{j,s}}$$

*3. Investment demand*

(19) $$INVVS_{v,j,s} = \frac{\gamma_{v,j,s} INV_j PINV_j}{PCFV_{v,j,s}}$$

(20) $$\log PINV_j = \sum_{v}\sum_{s} GAM_{v,j,s} \log PCFV_{v,j,s}$$

(21) $$EVV_{v,i,j,s} = ETAFV_{v,i,j,s}\left[\frac{PCFV_{v,j,s}}{PV_{v,i,s}(1+TAR_{v,i,j,s})}\right]^{\sigma_{j,s}} \underbrace{\frac{\gamma_{v,j,s} INV_j PINV_j}{PCFV_{v,j,s}}}_{INVVS_{v,j,s}}$$

(22) $$\left(PCFV_{v,j,s}\right)^{1-\sigma_{j,s}} = \sum_{i} ETAFV_{v,i,j,s}\left[PV_{v,i,s}\left(1+TAR_{v,i,j,s}\right)^{1-\sigma_{j,s}}\right]$$

*4. Supply side (from the perspective of a firm located in country j)*

(23) $$PV_{v,j,sd} = \nu_{v,j,sd}$$

(24) $$L_{v,j,sd} = \frac{\alpha_{L\,v,j,sd} PV_{v,j,sd} Z_{v,j,sd}}{W_j}$$

(25) $$K_{v,j,sd} = \frac{\alpha_{K\,v,j,sd} PV_{v,j,sd} Z_{v,j,sd}}{R_{v,j,sd}}$$

(26) $$EI_{v,j,s,sd} = \frac{\alpha_{X\,v,j,s,sd} PV_{v,j,sd} Z_{v,j,sd}}{PCI_{v,j,s,sd}}$$

(27) $$\log PV_{v,j,sd} = \alpha_{L\,v,j,sd} \log\left(W_j\right) + \alpha_{K\,v,j,sd} \log\left(R_{v,j,sd}\right) + \sum_{s} \alpha_{X\,v,j,s,sd} \log\left(PCI_{v,j,s,sd}\right)$$

(28) $$EIVV_{vo,v,i,j,s,sd} = ETAII_{vo,v,i,j,s,sd} \underbrace{\frac{\alpha_{X\,v,j,s,sd} PV_{v,j,sd} Z_{v,j,sd}}{PCI_{v,j,s,sd}}}_{EI_{v,j,s,sd}}$$

(29) $$PCI_{v,j,s,sd} = \sum_{i}\sum_{vo} ETAII_{vo,v,i,j,s,sd} PV_{vo,i,s}\left(1+TAR_{vo,i,j,s}\right)$$

*5. Equilibrium conditions*

(30) $$\sum_{v}\sum_{sd} \frac{\alpha_{L\,v,j,sd} PV_{v,j,sd} Z_{v,j,sd}}{W_j} = LSUP0_j$$

$$(31)\quad \frac{\alpha_{Kv,j,sd} PV_{v,j,sd} Z_{v,j,sd}}{R_{v,j,sd}} = KSUP_{v,j,sd}$$

$$(32)\quad KSUP_{v,j,sd} = WEALTH_{v,j,sd}$$

$$(33)\quad E_{vo,j,i,s} = ECV_{vo,j,i,s} + EVV_{vo,j,i,s} + \sum_{sd}\sum_{v} EIVV_{vo,v,j,i,s,sd}$$

$$(34)\quad \underbrace{Z_{vo,j,s}}_{\substack{\text{Supply of goods by subsidiary } vo \\ \text{located in country } j}} = \underbrace{\sum_{i} E_{vo,j,i,s}}_{\substack{\text{Demand for good produced by subsidiary } vo \text{ located in country } j \\ \text{and expressed by all countries } i \text{ (including country } j)}}$$

*6. Revenue (GNP) equation (from the perspective of nationals of country j)*

$$(35)\quad \begin{aligned} REV_j = & \sum_{v}\sum_{sd} \alpha_{Lv,j,sd} PV_{v,j,sd} Z_{v,j,sd} + \sum_{v}\sum_{sd} R_{j,v,sd} WEALTH_{j,v,sd} (1 - CTAX_{j,v,sd}) \\ & + \sum_{vo}\sum_{sd}\sum_{i} E_{vo,i,j,sd} PV_{vo,i,sd} TAR_{vo,i,j,sd} + \sum_{v}\sum_{sd} R_{v,j,sd} WEALTH_{v,j,sd} CTAX_{v,j,sd} \end{aligned}$$

*7. Stationary state*

$$(36)\quad INV_j = \frac{\sum_{v}\sum_{s} DEPR_{j,v,s} KSUP_{j,v,s}}{SCR_j}$$

$$(37)\quad \underbrace{REV_j^{\bullet} - CON_j PCON_j}_{\text{Saving}_j} - INV_j PINV_j = CA_j = 0, \text{ where } REV_j^{\bullet} = REV_j + ESC \times DET_j$$

**Appendix 2 Data Sets and Parameters**

The aggregate variables and trade flows of the model were calibrated to the GTAP7 database (Dimaranan and McDougall, 2010). In Table A1 we provide the regional and sectoral aggregation mapping from GTAP to our model. The GTAP Armington elasticities and tariffs rates are also reported (Tables A2a/b and A3). Table A4 reports the FDI ownership ratios that we use to add and calibrate a nationality dimension to sectoral and regional production activities that were obtained from the GTAP database. To build this matrix, we have used the recent GTAP-FDI database (Lakatos and Walmsley, 2010; Boumellasa, Gouel and Laborde, 2007). In the second column, the number 0.998 for CAN.CAN.AGRI indicates that 99.80% of the capital stock in the

primary sector in Canada is owned by Canadian households. The numbers 0.001 for both US.CAN.AGRI and ROW.CAN.AGRI indicate that 0.1% of the capital stock in the primary sector in Canada belongs to American (rest-of-the-world) investors who invested in a US- (ROW-) owned firm located in Canada. Note that these three ratios sum to 100%. Finally, another parameter worth mentioning is the initial tax rate on foreign assets, CTAX, given in Table A5 for each of the nine sectors of the three regions. The rates were obtained from the OECD's FDI restrictiveness index study (Kalinova, Palerm, and Thomsen, 2010), based on the methodology of Golub (2003), whose methodology was itself largely inspired by Hardin and Holmes (1997).

**Table A1: Aggregation mapping from GTAP to Model**

| ***a. Regions of the Model*** | ***Regions/countries in GTAP database*** |
|---|---|
| Canada (CAN) | Canada |
| USA (US) | USA |
| Rest of the World (ROW) | Australia; New Zealand; Rest of Oceania; China; Hong Kong; Japan; Korea; Taiwan; Rest of East Asia; Cambodia; Indonesia; Lao People's Democratic Republic; Myanmar; Malaysia; Philippines; Singapore; Thailand; Viet Nam; Rest of Southeast Asia; Bangladesh; India; Pakistan; Sri Lanka; Rest of South Asia; Mexico; Rest of North America; Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Nicaragua; Panama; Rest of Central America; Caribbean; Austria; Belgium; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Slovakia; Slovenia; Spain; Sweden; United Kingdom; Switzerland; Norway; Rest of EFTA; Albania; Bulgaria; Belarus; Croatia; Romania; Russian Federation; Ukraine; Rest of Eastern Europe; Rest of Europe; Kazakhstan; Kyrgyztan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Iran, Islamic Republic of; Turkey; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa; Nigeria; Senegal; Rest of Western Africa; Central Africa; South Central Africa; Ethiopia; Madagascar; Malawi; Mauritius; Mozambique; Tanzania; Uganda ; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; South Africa; Rest of South African Customs Union. |

| ***b. Sectors of the Model*** | ***Sectors in GTAP database*** |
|---|---|
| Agriculture (AGRI) | Paddy rice; wheat; cereal grains nec; vegetables, fruit, nuts; oil seeds; sugar cane, sugar beet; plant-based fibers; crops nec; bovine cattle, sheep and goats, horses; animal products nec; raw milk; wool, silk-worm cocoons. |
| Resource (RESO) | Forestry; fishing; coal; oil; gas; minerals nec. |
| Food (FOOD) | Bovine cattle, sheep and goat meat products; meat products; vegetable oils and fats; dairy products; processed rice; sugar; food products nec; beverages and tobacco products. |
| Textile (TEXT) | Textiles; wearing apparel; leather products. |
| Manufacture (MANU) | Wood products; paper products, publishing; petroleum, coal products; |

| | |
|---|---|
| | petroleum, coal products; chemical, rubber, plastic products; mineral products nec; ferrous metals; metals nec; ferrous metals; metals nec; metal products; manufactures nec. |
| Automobile (AUTO) | Motor vehicles and parts; transport equipment nec. |
| High Tech (TECH) | Electronic equipment; machinery and equipment nec. |
| Services (SERV) | Electricity; gas manufacture, distribution; water; construction; trade; communication; financial services nec; insurance; business services nec; recreational and other services; public admin. and defence, education, health; ownership of dwellings. |
| Transport (TRAN) | Transport nec; water transport; air transport. |

*Source: Authors own classification based on GTAP7*

## Table A2: Elasticities

***Table A2.a*: Armington CES elasticities of substitution for domestic goods and composite imports ($\sigma FORC_{j,s}$)**

| | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|
| CAN | 2.4 | 5.1 | 2.4 | 3.8 | 3.1 | 4.2 | 3.1 | 1.9 | 1.9 |
| US | 2.4 | 5.1 | 2.4 | 3.8 | 3.1 | 4.2 | 3.1 | 1.9 | 1.9 |
| ROW | 2.4 | 5.1 | 2.4 | 3.8 | 3.1 | 4.2 | 3.1 | 1.9 | 1.9 |

*Source: Based on top parameters ESBD in GTAP7*

***Table A2.b*: Armington CES elasticities of substitution for regional (geographical) allocation of imports ($\sigma_{j,s}$)**

| | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|
| CAN | 4.9 | 11.8 | 4.9 | 7.6 | 6.5 | 8.4 | 6.3 | 3.9 | 3.8 |
| US | 4.9 | 11.8 | 4.9 | 7.6 | 6.5 | 8.4 | 6.3 | 3.9 | 3.8 |
| ROW | 4.9 | 11.8 | 4.9 | 7.6 | 6.5 | 8.4 | 6.3 | 3.9 | 3.8 |

*Source: Based on bottom parameters ESBM in GTAP7*

## Table A3: Bilateral Tariff (%)[1]

| Countries (i.j) | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|
| CAN.CAN | - | - | - | - | - | - | - | - | - |
| US.CAN | 1.2 | 0 | 15.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| ROW.CAN | 0.8 | 0 | 13.6 | 11.9 | 1.7 | 0.8 | 4.1 | 0 | 0 |
| CAN.US | 0.6 | 0 | 3.7 | 0 | 0 | 4.4 | 0 | 0 | 0 |
| US.US | - | - | - | - | - | - | - | - | - |
| ROW.US | 3.1 | 0.2 | 5.4 | 9.4 | 1.4 | 0.7 | 1.6 | 0 | 0 |
| CAN.ROW | 10.6 | 0.9 | 21.9 | 8.3 | 2.7 | 3.1 | 0 | 0 | 0 |
| US.ROW | 11.5 | 1.5 | 19.5 | 6.6 | 3.4 | 2.1 | 2.8 | 0 | 0 |
| ROW.ROW | - | - | - | - | - | - | - | - | - |

[1] Tariff imposed by country *j* on goods originating from country *i*

*Source: GTAP7*

## Table A4: FDI ownership ratio[1] (in proportion)

| Countries *v.i.* | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|
| CAN.CAN | 0.998 | 0.877 | 0.568 | 0.921 | 0.752 | 0.751 | 0.798 | 0.913 | 0.988 |
| US.CAN | 0.001 | 0.114 | 0.235 | 0.025 | 0.163 | 0.222 | 0.152 | 0.052 | 0.007 |
| ROW.CAN | 0.001 | 0.009 | 0.197 | 0.054 | 0.085 | 0.027 | 0.05 | 0.035 | 0.005 |
| CAN.US | 0.001 | 0.013 | 0.002 | 0.008 | 0.028 | 0.046 | 0.054 | 0.004 | 0.001 |
| US.US | 0.998 | 0.972 | 0.92 | 0.953 | 0.903 | 0.872 | 0.821 | 0.923 | 0.993 |
| ROW.US | 0.001 | 0.015 | 0.078 | 0.039 | 0.069 | 0.082 | 0.125 | 0.073 | 0.006 |
| CAN.ROW | 0.001 | 0.013 | 0.002 | 0.008 | 0.028 | 0.046 | 0.054 | 0.004 | 0.001 |
| US.ROW | 0.001 | 0.015 | 0.078 | 0.039 | 0.069 | 0.082 | 0.125 | 0.073 | 0.006 |
| ROW.ROW | 0.998 | 0.972 | 0.92 | 0.953 | 0.903 | 0.872 | 0.821 | 0.923 | 0.993 |

[1] *v* is the nationality of the owners of a firm operating in sector *s* of country *i*

*Source: Computation by the authors on the basis of the GTAP-FDI database (Lakatos and Walmsley, 2010; Boumellassa, Gouel and Laborde, 2007)*

**Table A5: Tax on foreign assets ($CTAX_{v,j,s}$)[1] (in proportion)**

| Countries *v.j.* | AGRI | RESO | FOOD | TEXT | MANU | TECH | AUTO | SERV | TRAN |
|---|---|---|---|---|---|---|---|---|---|
| CAN.CAN | - | - | - | - | - | - | - | - | - |
| US.CAN | 0.0 | 0.153 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.153 | 0.267 |
| ROW.CAN | 0.0 | 0.153 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.153 | 0.267 |
| CAN.US | 0.0 | 0.116 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.116 | 0.553 |
| US.US | - | - | - | - | - | - | - | - | - |
| ROW.US | 0.0 | 0.116 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.116 | 0.553 |
| CAN.ROW | 0.163 | 0.117 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.117 | 0.249 |
| US.ROW | 0.163 | 0.117 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.117 | 0.249 |
| ROW.ROW | 0.163 | 0.117 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.117 | 0.249 |

[1] Country *j* imposes a tax on foreign assets originating from nationals of country *v*

*Source: Kalinova, Palerm, and Thomsen (2010)*

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