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# Modelling Non-Tariff Barriers as an Exporter Cost

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## Abstract

Non-tariff measures (NTMs) are a prominent feature of many recent free trade agreement (FTA) negotiations, including the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the Canada-EU FTA. The implementation of NTMs within computable general equilibrium (CGE) models has been relatively simple to date, with modelers generally incorporating NTMs as tariff equivalents via export or import taxes or as import-augmenting technological (or iceberg) change. Our study compares and contrasts a new method with the traditional mechanisms used. The new methodology, introduced here, provides a mechanism for adjusting exporters' production costs directly, henceforth referred to as the export cost method.

We find that the choice of mechanism can have important consequences for estimates of the impact of changes in NTMs, with mechanisms that raise productivity leading to larger changes in real GDP than those that treat NTMs as associated with economic rents that can be modelled using trade taxes. We find some similarities between the two productivity methods – the iceberg method and new export cost method – however, further analysis reveals that the two approaches elicit very different changes in real GDP and prices; and that there are clear differences between how the iceberg and export cost methods allocate the gains between the importing and exporting countries. Careful consideration of the NTMs being investigated, the estimates being utilized, and the model mechanisms being used, would improve analysis by CGE modelers.

**Keywords:** non-tariff measures, iceberg costs, tariffs, export subsidies, export costs, computable general equilibrium models

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# 1 Introduction

Reducing the potential barriers to trade that non-tariff measures (NTMs) can create has been a prominent feature of many recent free trade agreement (FTA) negotiations, including the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the Canada-EU FTA. Measuring and assessing the impact of these NTMs, however, is fraught with difficulties. In addition to the challenging nature of econometrically estimating the impact of NTMs, the techniques used to implement them within a CGE framework generally fail to reflect the diverse and complex nature of NTMs and their impacts. For instance, sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) regulations may raise costs for exporters and importers, who must comply with the additional regulations, while also raising consumer confidence in the quality and safety of those imports, thereby raising demand.<sup>3</sup>

The traditional mechanisms used in computable general equilibrium (CGE) models to address NTMs have been relatively simple to date, with modelers generally incorporating them as tariff equivalents via export or import taxes or as import-augmenting technological (or iceberg) change, depending on the modeler's judgment of the extent to which rents and costs matter and how rents are distributed between importers and exporters. None of these mechanisms capture the impact on exporter costs directly, instead they work indirectly through trade costs and rents, which could lead to misleading results.

The iceberg method was first introduced by Samuelson (1954) in a simple two-by-two theoretical exposition, whereby "value melts away" during transit, causing the quantity arriving in the importing market to be lower than the quantity of goods that left the dock in the exporting country. Hence, the costs of producing the exported commodity are only indirectly reduced when NTMs reduce, with less required to be shipped to meet demand in the importing country. The use of the iceberg approach for applied policy analysis has been widely criticized (see Balistreri and Hillberry (2001), Ottaviano and Thisse (2003), McCann (2005), Fugazza and Maur (2008) and Walmsley and Minor (2015)), with some researchers questioning the validity of implementing reductions in NTMs as simple, and sometimes large, increases in the value of imports that arrive at the destination port – the benefits of which accrue to the importing country. The import tax method, on the other hand, assumes that NTMs create economic rents which form a price wedge between the c.i.f and market price of the imported good that accrue to the importing country. The export tax method is similar, although the rents accrue to the exporting country. Imperfect competition is often used to explain the existence of these rents from NTMs.

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<sup>3</sup> The potential demand side implications of NTMs are not discussed in this paper, those interested in this area are referred to Walmsley and Minor (2015).

Our study proposes a new modelling mechanism that can more appropriately capture the impacts of NTMs on exporters' production costs. We model a range of scenarios that reduce NTMs, comparing the results of this new export cost method with those obtained using traditional approaches of import augmenting iceberg costs, as well as import and export tax methods.

The export cost method for modelling NTMs is included in an augmented version of the Global Trade Analysis Project (GTAP) model. We illustrate and compare the impact of using alternative modelling mechanisms in an application that assesses the impact of reductions in NTMs by members of the Association of Southeast Asian Nations (ASEAN). We draw on new econometric estimates of the effects on trade of different types of NTMs in this region (Webb et al. 2018). These new estimates allow us to explore the impacts of the alternative modelling mechanisms.

Section 2 of this paper outlines the different modelling mechanisms for NTMs, including the new exporter cost mechanism. In section 3 we introduce the policy scenarios modelled. We then turn in section 4 to explore the implications of using different modelling mechanisms to capture the changes in NTMs modelled. Finally, we present the conclusions of our findings, including discussing implications for future research.

## 2 Modelling NTMs

Before examining each of the mechanisms for modelling NTMs, we review the mechanism by which demand for imports is modelled in trade models in general and in the GTAP model in particular. Demand for imports ( $Q_{r,s}$ ) is modelled using the familiar Armington CES demand function, obtained from maximizing utility ( $U_{r,s} = [\sum_{r=1}^n (Q_{r,s})^{-\rho}]^{-\frac{1}{\rho}}$ ) subject to a budget constraint ( $X_s = [\sum_{r=1}^n P_{r,s} \cdot Q_{r,s}]$ ) and illustrated in Armington (1969).<sup>4</sup> This gives:

$$Q_{r,s} = Q_s \cdot \left[ \frac{P_{r,s}}{P_s} \right]^{-\sigma} \quad (1)^5$$

Which in GTAP is given by:

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<sup>4</sup>  $\rho$  is a substitution parameter. It is related to the elasticity of substitution ( $\sigma$ ) between goods from different countries  $r$ , ( $\sigma = \frac{1}{1+\rho}$ ).

<sup>5</sup> Which is equivalent to:  $X_{r,s} = X_s \cdot \left[ \frac{P_{r,s}}{P_s} \right]^{1-\sigma}$ , where  $X$  represents imports in value terms.

$$QXS_{i,r,s} = QIM_{i,s} \cdot \left[ \frac{PMS_{i,r,s}}{PIM_{i,s}} \right]^{-ESUBM_i} \quad (2)^6$$

Where:  $r$  is the source country (where there are  $n$  countries,  $r \in 1 \dots n$ );

$s$  the importing country ( $s \in 1 \dots n$ ) (and in GTAP equation (2)  $i$  represents the commodity (where there are  $m$  commodities,  $i \in 1 \dots m$ ));

$P_{r,s}$  (or  $PMS_{i,r,s}$  in GTAP) is the price of the good from country  $r$ ;

$P_s$  (or  $PIM_{i,s}$  in GTAP) is the composite price of imports in country  $s$ ;

$\sigma$  (or  $ESUBM_i$  in equation (2)<sup>7</sup>) is the elasticity of substitution between goods from different countries  $r$ ;

$Q_{r,s}$  is the demand for goods from country  $r$  by country  $s$  (or  $QXS_{i,r,s}$  in GTAP); and

$Q_s$  is the demand for imported goods by country  $s$  (or  $QIM_{i,s}$  in GTAP).

In proportionate changes this demand function for imports is:

$$\widehat{QXS}_{i,r,s} = \widehat{QIM}_{i,s} - ESUBM_i (\widehat{PMS}_{i,r,s} - \widehat{PIM}_{i,s}) \quad (3)$$

Where:  $\widehat{\cdot}$  (and lower case in the GTAP model) represents the percent change in the variable.

In the following subsections, we outline the five methods used to model NTMs – iceberg costs, the two trade taxes and the export cost method – as modifications to this Armington specification.

## 2.1 Iceberg Method

The most commonly employed approach for modelling trade facilitation, and other NTMs, in the GTAP model is through the iceberg cost variable,  $\tau_r$  or  $AMS_{i,r,s}$  in GTAP. The iceberg method was first elaborated by Samuelson (1954) in a simple two-by-two theoretical exposition, whereby “value melts away” during transit. Notably, Samuelson’s approach reduced the quantity arriving in the importing market  $\left[ \frac{q_{r,s}}{\tau_{r,s}} \right]$ , in contrast to that which left the dock in the

exporting country. Hence the utility function becomes:  $U_{r,s} = \left[ \sum_{r=1}^n \left( \frac{q_{r,s}}{\tau_{r,s}} \right)^{-\rho} \right]^{-\frac{1}{\rho}}$ , and budget

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<sup>6</sup> There are two levels of armington equations (nests) in the GTAP model – this is the second. The first determines demand for domestic and imported commodities to determine  $QIM_{i,s}$ .

<sup>7</sup> ESUBM in the GTAP model.

constraint:  $X_s = \left[ \sum_{r=1}^n P_{r,s} \cdot \tau_{r,s} \cdot \frac{Q_{r,s}}{\tau_{r,s}} \right]$ , since the price has risen to  $P_{r,s}$ ,  $\tau_{r,s}$  and the quantity is now  $\left[ \frac{Q_{r,s}}{\tau_{r,s}} \right]$ ; thereby ensuring that the same amount  $X_s$  is paid to the exporter for these goods. Demand for imports is therefore given by:

$$\frac{Q_{r,s}}{\tau_{r,s}} = Q_s \cdot \left[ \frac{P_{r,s} \cdot \tau_{r,s}}{P_s} \right]^{-\sigma} \quad (4)$$

Where:  $P_s$  is the composite price of imports in country  $s$ , inclusive of iceberg costs.

In GTAP notation equation (4) is given by:

$$\frac{QXS_{i,r,s}}{AMS_{i,r,s}} = QIM_{i,s} \cdot \left[ \frac{PMS_{i,r,s} \cdot AMS_{i,r,s}}{PIM_{i,s}} \right]^{-ESUBM_i} \quad (5)$$

or in percent changes as shown in the GTAP model:

$$\widehat{QXS}_{i,r,s} = \widehat{QIM}_{i,s} + \widehat{AMS}_{i,r,s} - ESUBM_i (\widehat{PMS}_{i,r,s} - \widehat{AMS}_{i,r,s} - \widehat{PIM}_{i,s}) \quad (6)$$

Where:  $\widehat{AMS}_{i,r,s}$  is the percent change in the iceberg cost of import augmenting iceberg cost of good  $i$  from region  $r$  to region  $s$ ; and

Hertel, Walmsley and Itakura (2001) state that *AMS* has two effects on trade within the Armington structure:

- $AMS_{i,r,s}$  reduces the importer's price causing substitution towards that good and an increase in quantity demanded;<sup>8</sup> and
- $AMS_{i,r,s}$  reduces the amount that needs to be imported to satisfy a given level of demand.

These two effects work in opposite directions, although, in practice, the first effect is larger than the second due to the fact that the price effects are multiplied by an elasticity which is greater than one. Model users, therefore, observe the desired result—the demand for imports rises as a result of lowering the NTM. An important outcome of the second effect, is that the calculated or "algebraic" quantity observed by the importer is changed in direct proportion to the size of the NTM.<sup>9</sup>

Importantly, this second effect, is a productivity shock applied entirely to the importing agents. Importing firms and final consumers reduce their orders with exporters in foreign markets, but

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8 Note that the exporter's price is not directly impacted by AMS, but rather through CGE effects such as resource costs. For this reason, the importers adjusted price is sometimes referred to as the "perceived or effective price".

9 The term "algebraic quantity" was first referenced by Samuelson (1954).

still receive the same amount of imports. The argument put forth to explain this direct change in the quantity imported versus the quantity originally exported is that there is potential for less spoilage, theft, breakage or loss in shipment. From a firm's perspective, the increased quantity of goods imported is equivalent to a technological change to the importing firm, akin to a reduction in the production costs. While this explanation may find some basis in a firm's supply chain, the role of a productivity shock for households and government is difficult to reconcile. It is important to note here that a commonly used explanation for the productivity shock on government and households is that it can be interpreted as a change in quality. However, this explanation is inconsistent with the impacts on real GDP that the productivity shock creates.

This stylized shock has implications the modeler must consider. First, it breaks the equivalence of quantities in the model. For example, assuming a positive AMS shock, the quantity imported will be higher than the quantity exported.<sup>10</sup> This raises a problem for the model user when deciding which variable to enumerate when reporting results of "real trade" volumes. Second, it has the effect of raising real GDP in the importing country, since there is the equivalent of a technological change shock that allows all agents (firms, households and government) to satisfy an initial demand with less imports (as seen from the exporter's perspective).<sup>11</sup>

## 2.2 Trade Taxes

NTMs are often modelled as tariff equivalents via import ( $T_{r,s}^M$ ) or export taxes.<sup>12</sup> Import and export taxes are modelled as a wedge between the world and market prices in the importing and exporting countries. Demand for imports with import taxes is therefore given by:

$$Q_{r,s} = Q_s \cdot \left[ \frac{P_{r,s} \cdot (1 + T_{r,s}^M)}{P_s} \right]^{-\sigma} \quad (7)$$

Where:  $P_s$  is the composite price of imports in country  $s$ , inclusive of import taxes.

In GTAP notation,  $TMS_{i,r,s}$  is defined as the power of the tariff or one plus the tariff rate. Hence (7) in GTAP notation is:

$$QXS_{i,r,s} = QIM_{i,s} \cdot \left[ \frac{PCIF_{i,r,s} \cdot TMS_{i,r,s}}{PIM_{i,s}} \right]^{-ESUBM_i} \quad (8)$$

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<sup>10</sup> When aggregated appropriately using the same shares.

<sup>11</sup> One might argue that this break in the equivalence of quantities between imports and exports could also be viewed as a productivity shock on exporting firms – reducing the exporter's production costs. While this may be a very reasonable explanation of how some NTMs affect an economy, the productivity gains from the AMS shock are allocated to the importer, not the exporter. The allocation of these productivity gains to the exporter or the importer is likely to significantly affect the allocation of the gains from the removal of the NTM across countries (see Mundell (1968) for further discussion of how the allocation of the iceberg cost between importer and exporter can impact the results).

<sup>12</sup>  $T_{r,s}^M$  represents 1 plus the tariff rate.

In the model these import taxes and import taxes enter the model as linking the free on board (FOB) and cost, insurance and freight (CIF) prices to the price of imports in the importing country ( $PMS_{i,r,s}$ ).

In percent changes as shown in the GTAP model:

$$\widehat{pms}_{i,r,s} = \widehat{pcif}_{i,r,s} + \widehat{tms}_{i,r,s} \quad (9)$$

$$\widehat{pfoob}_{i,r,s} = \widehat{pm}_{i,r} - \widehat{txs}_{i,r,s} \quad (10)$$

Where:  $\widehat{pcif}_{i,r,s}$  is the CIF price of commodity  $i$ , imported from region  $r$  by region  $s$ ;

$\widehat{tms}_{i,r,s}$  is one plus the tariff rate applied on commodity  $i$ , imported from region  $r$  by region  $s$ ;

$\widehat{pfoob}_{i,r,s}$  is the FOB price of commodity  $i$ , imported from region  $r$  by regions;<sup>13</sup>

$\widehat{pm}_{i,r}$  is the price of commodity  $i$  from region  $r$  (cost plus any output taxes); and

$\widehat{txs}_{i,r,s}$  is one minus the export tax rate applied on commodity  $i$ , imported from region  $r$  by region  $s$ .<sup>14</sup>

Note the difference between this and the iceberg cost is that tariffs do not reduce the quantity and hence the second effect, noted by Hertel, Walmsley and Itakura (2001) is not present. Moreover, revenue from these trade taxes accrues to the regional household of the importing or exporting country depending on whether the import or export tax is used, respectively. These 'tax' variables often serve a dual purpose to reflect the existence of economic rents that accrue to either the exporter or importer; perhaps due to imperfect competition. The choice of whether to use export or import taxes therefore depends on whether these rents are believed to accrue to the importing or exporting region.

## 2.3 Exporter costs

The final method, introduced here, is a new method for implementing NTMs. This method recognizes that many NTMs raise the costs of production of the exporting firm.

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<sup>13</sup> The difference between the CIF and FOB prices is the cost of transportation of the good from the exporting country to the importing country. Hence  $\widehat{pms}_{i,r,s} = (1 - S_{i,r,s}^T)(\widehat{pm}_{i,r} - \widehat{txs}_{i,r,s}) + \widehat{tms}_{i,r,s} + S_{i,r,s}^T(\widehat{ptrans}_{i,r,s})$ , where  $S_{i,r,s}^T$  is the share of transport costs in the CIF price and  $\widehat{ptrans}_{i,r,s}$  is the price of the transportation. Hence taxes on exports also directly impact the price of the imported good ( $\widehat{pms}_{i,r,s}$ ), although the impact is diluted, depending on the importance of transportation costs.

<sup>14</sup> We have defined the export tax rate the same way as that used in the GTAP model. In GTAP model, the export tax is defined relative to the FOB price, such that  $PM_{i,r,s} = PFOB_{i,r} \times [1 - TXSR_{i,r,s}]$ .

In order to model the impact of the NTM directly on exporter costs we introduce a new variable into the model,  $AXS_{i,r,s}$ , that represents the productivity of sector  $i$  firms located in region  $r$  that export to region  $s$ . Since the GTAP Data Base does not distinguish between firms that export goods and those that supply to the domestic market there are two options. First, we could separate the production of goods for domestic sales and for production into its component parts, as in Akgul, Villoria and Hertel (2016) and Lakatos and Fukui (2012); or second, the change in exporter costs can be appropriately weighted and applied to the productivity of all firms in sector  $i$  and region  $r$ . The second method is adopted for simplicity, although the two methods are equivalent when the cost structure (i.e., the input-output (IO) cost shares) of firms that export and those that sell goods domestically are identical, and they face the same input prices and production taxes.<sup>15</sup> Note however, that although the data are not separated, exports and domestic goods no longer have the same market price so one can no longer simply sum the quantities using market shares as is done in GTAP.<sup>16</sup> In this case (for a non-margin commodity):

$$VOM_{i,r} = \sum_s VXMD_{i,r,s} + VDM_{i,r} \quad (11)$$

Which is equivalent to:

$$PM_{i,r} \cdot QO_{i,r} = \sum_s PMX_{i,r,s} \cdot QXS_{i,r,s} + PMD_{i,r} \cdot QDS_{i,r} \quad (12)$$

Where:  $VOM_{i,r}$  is the value of output at market prices of commodity  $i$  in region  $r$ ;

$VXMD_{i,r,s}$  is the value of exports of commodity  $i$  from region  $r$  to regions  $s$ , at market prices; and

$VDM_{i,r}$  is the value of domestic sales of commodity  $i$  in region  $r$  at market prices.

$PMX_{i,r,s}$  is the price of the exported commodity  $i$  from region  $r$  to region  $s$ ;

$QXS_{i,r,s}$  is the quantity of the exported commodity  $i$  from region  $r$  to region  $s$  (as in GTAP);

$PMD_{i,r}$  is the price of the commodity  $i$  sold on the domestic market in region  $r$ ;

$QDS_{i,r}$  is the price of the commodity  $i$  sold on the domestic market in region  $r$ ;

$PM_{i,r}$  is an average market price of commodity  $i$  in region  $r$ ; and

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15 While cost structure may differ, we have no better data than to assume that they are identical. We assume that productivity shock to exporting firms ( $axs$ ) applies equally across all intermediate and factor inputs and therefore does not alter the cost structure of the exporting firms relative to firms producing for domestic sales. Domestic firms and exporting firms also face the same factor prices. In future work, this could be incorporated into a model where exporting firms are disaggregated, and heterogeneous firms could also be considered.

16 In GTAP:  $VOM_{i,r} = \sum_s VXMD_{i,r,s} + VDM_{i,r}$ , hence:  $PM_{i,r} \cdot QO_{i,r} = \sum_s PM_{i,r} \cdot QXS_{i,r,s} + PM_{i,r} \cdot QDS_{i,r}$

$QO_{i,r}$  is the quantity of commodity  $i$  produced in region  $r$  (as in GTAP).

$PMX_{i,r,s}$  and  $PMD_{i,r}$  are both derived from the zero profits equation ( $PZ_{i,r}$ ) for the production of the good and the productivity pertaining to exported ( $AXS_{i,r,s}$ ) and domestically supplied  $ADS_{i,r}$  goods and the power of the production tax (one plus the tax rate ( $1 + \tau_0$ ) or  $TO_{i,r}$  in GTAP):

$$PMX_{i,r,s} = \frac{PZ_{i,r}}{AXS_{i,r,s}} \cdot (1 + \tau_0) = \frac{PZ_{i,r}}{AXS_{i,r,s}} \cdot TO_{i,r} \quad (13)$$

$$PMD_{i,r} = \frac{PZ_{i,r}}{ADS_{i,r}} \cdot TO_{i,r} \quad (14)$$

Substituting equations (13) and (14) into (12), we can derive the relationship between production ( $QO_{i,r}$ ), exports ( $QXS_{i,r,s}$ ) and domestically supplied ( $QDS_{i,r}$ ) goods:

$$\frac{PZ_{i,r}}{AS_{i,r}} \cdot (1 + \tau) \cdot QO_{i,r} = \sum_s \left( \frac{PZ_{i,r}}{AS_{i,r}} \cdot AS_{i,r} \cdot (1 + \tau) \cdot \frac{QXS_{i,r,s}}{AXS_{i,r,s}} \right) + \frac{PZ_{i,r}}{AS_{i,r}} \cdot AS_{i,r} \cdot (1 + \tau) \cdot \frac{QDS_{i,r}}{ADS_{i,r}} \quad (15)$$

Where:  $AS_{i,r}$  is an average of the productivities on domestic and exported goods applied to total production.

In proportionate changes:

$$\begin{aligned} \widehat{pZ}_{i,r} - \widehat{as}_{i,r} + \widehat{to}_{i,r} + \widehat{qd}_{i,r} \\ = \sum_s \frac{VXMD_{i,r,s}}{VOM_{i,r}} \cdot (\widehat{pZ}_{i,r} - \widehat{as}_{i,r} + \widehat{to}_{i,r} + \widehat{as}_{i,r} + \widehat{qxs}_{i,r,s} - \widehat{axs}_{i,r,s}) \\ + \frac{VDM_{i,r}}{VOM_{i,r}} \cdot (\widehat{pZ}_{i,r} - \widehat{as}_{i,r} + \widehat{to}_{i,r} + \widehat{as}_{i,r} + \widehat{qds}_{i,r} - \widehat{ads}_{i,r}) \\ \widehat{qd}_{i,r} - \widehat{as}_{i,r} = \sum_s \frac{VXMD_{i,r,s}}{VOM_{i,r}} \cdot (\widehat{qxs}_{i,r,s} - \widehat{axs}_{i,r,s}) + \frac{VDM_{i,r}}{VOM_{i,r}} \cdot (\widehat{qds}_{i,r} - \widehat{ads}_{i,r}) \end{aligned} \quad (16)$$

Since there is no way of separately identifying  $\widehat{qd}_{i,r}$  and  $\widehat{as}_{i,r}$ , we redefine  $\widehat{qd}_{i,r}$  to be inclusive of the average productivity  $\widehat{as}_{i,r}$ . Similarly,  $\widehat{ps}_{i,r}$  in GTAP is redefined as the zero profits price  $\widehat{pZ}_{i,r}$ .

$$\widehat{ps}_{j,r} = \sum_e \frac{VFA_{e,j,r}}{VOA_{j,r}} (\widehat{pfe}_{e,j,r}) + \sum_i \frac{VFA_{i,j,r}}{VOA_{j,r}} (\widehat{pfi}_{i,j,r}) \quad (17)$$

Where:  $\widehat{ps}_{i,r}$  is the price of producing the average good  $i$  by sector  $i$  in region  $r$ . Note that it differs from the price in GTAP because it now includes the average productivity of domestic and exported goods ( $\widehat{as}_{i,r}$ ).

$VFA_{e,j,r}$  is the value of factor endowment  $e$  used in production of commodity  $j$  in region  $r$ ;

$VFA_{i,j,r}$  is the value of intermediate input  $i$  used in production of commodity  $j$  in region  $r$ ;

$VOA_{j,r}$  is the value of output of commodity  $j$  produced in region  $r$ ;

$\widehat{pfe}_{e,j,r}$  is the value of price of factor endowment  $e$  used in production of commodity  $j$  in region  $r$ ; and

$\widehat{pf}_{i,j,r}$  is the price of intermediate input  $i$  used in production of commodity  $j$  in region  $r$ .

Firms demand for intermediates  $\widehat{qf}_{j,i,s}$  and value added  $\widehat{qva}_{i,s}$  in the production of the good  $i$  then change by  $\widehat{qo}_{i,r}$  (inclusive of the average productivity), since a Leontief production function is assumed at this level.

$$\widehat{qva}_{i,s} = \widehat{qo}_{i,s} \quad (18)$$

$$\widehat{qf}_{j,i,s} = \widehat{qo}_{i,s} \quad (19)$$

In proportionate changes the market price of the exported good is given by (derived from equation (13)):

$$\widehat{pmx}_{i,r,s} = \widehat{ps}_{i,r} - \widehat{axs}_{i,r,s} - \widehat{to}_{i,r} \quad (20);$$

and the market price of domestically sold good (equation (14)):

$$\widehat{pmd}_{i,r,s} = \widehat{ps}_{i,r} - \widehat{ads}_{i,r} - \widehat{to}_{i,r} \quad (21)$$

For purposes of reporting changes in sectoral production we define a sectoral quantity index,  $\widehat{qo\_index}_{i,r}$  which is the weighted sum of the amounts produced from export ( $\widehat{qxs}_{i,r,s}$ ) and the domestic market ( $\widehat{qds}_{i,r}$ ):

$$\widehat{qo\_index}_{i,r} = \sum_s \frac{VXMD_{i,r,s}}{VOM_{i,r}} (\widehat{qxs}_{i,r,s}) + \frac{VDM_{i,r}}{VOM_{i,r}} (\widehat{qds}_{i,r}) \quad (22)^{17}$$

The exporter price  $PMX_{i,r,s}$  is then linked to the FOB price through the export subsidies and to the market price in the importing region  $PMS_{i,r,s}$  through the same mechanisms described in section 2.2 (replacing equation 10):

$$\widehat{pfoob}_{i,r,s} = \widehat{pmx}_{i,r,s} - \widehat{txs}_{i,r,s} \quad (23)$$

The exporter cost method is most closely related to the iceberg method, since a shock to  $AMS_{i,r,s}$  reduces demand for exports and hence production ( $QO_{i,s}$ ), through the second effect elaborated on by Hertel, Walmsley and Itakura (2001). This in turn reduces demand for intermediates and value added (equations 14 and 15), as does a shock to exporter costs ( $AXS_{i,s}$ ). An important

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<sup>17</sup> Note this is the equation for non-margin commodities.

difference between the two methods is that the productivity gains are captured by the exporting country, rather than the importing country, under the new exporter costs method. These is an important distinction which addresses the issue raised about the iceberg cost method in applied policy analysis.

## 3 Methodology

In order to compare and contrast the different methods for capturing the impact of NTMs in trade models, outlined above, we examine the impact of a reduction in NTMs by 6 of the ASEAN countries on each other. Since our aim is to compare the methods for implementing NTMs, we focus only on changes to merchandise trade NTMs, we do not model any other policy reform in the region.

The widely used standard GTAP model (Hertel, 1997), long considered the benchmark for analysis of trade agreements, is used for this analysis. We adapt the model to incorporate the new method for examining NTMs through a change in exporter costs. The traditional mechanisms of trade taxes and iceberg costs are already incorporated into the GTAP model. The four mechanisms examined are:

- Mechanism 1: AMS: iceberg costs
- Mechanism 2: AXS: exporter costs
- Mechanism 3: TMS: import taxes
- Mechanism 4: TXS: export taxes

Mechanisms 1 and 2 are referred to as productivity methods, since they involve adjusting a productivity variable in the model; while Mechanisms 3 and 4 are referred to as trade tax methods, given the use of trade taxes to represent rents. The mechanisms can also be divided according to whether they impact importers (import orientated) or exporters (export orientated): Mechanisms 1 and 3 are similar to the extent that they both impact importers directly; while Mechanisms 2 and 4 impact exporters.

The database used for the analysis is based on the GTAP 9.2 Data Base (Aguiar, Narayanan and McDougall, 2016), with production, trade and protection calibrated for all regions to the base year of 2011. The full GTAP Data Base of 141 regions and 57 sectors is aggregated to 15 regions and 7 sectors, as shown in Appendix I.

Gravity models are usually used to estimate the changes in trade due to NTMs. These changes in the trade are then converted into ad valorem equivalents using elasticities of substitution. This approach assumes that NTMs can be represented as trade costs. However, since we are

comparing several mechanisms that do not all apply the shock directly to trade costs, we have chosen not to use the ad valorem equivalents of trade costs obtained from econometric studies. Instead, we follow Webb et al. (2017) and Webb et al. (2018) in using the econometric estimates of the changes in trade as our shocks, allowing the model to calibrate the relevant ad valorem equivalent of the mechanism being used to model the NTM. For our purposes, this calibration approach takes into account the fact that an ad valorem equivalent on trade costs applied on production costs is unlikely to impact trade in the same way as if the same ad valorem equivalent was applied directly to trade costs, due to the additional taxes and transportation margins that are imposed on the good between the price paid by the importer and the price received by the exporter. By ensuring that the change in trade estimated by the gravity model is met in all four mechanisms, we improve the comparison of the impacts of the mechanisms. We calibrate the iceberg costs to the exported quantities, rather than the imported quantities, after taking account of the melting of the iceberg. This is consistent with the way in which the gravity model estimates the iceberg cost.

The estimates of changes in trade due to ASEAN NTMs are obtained from Webb et al. (2018). We follow Webb et al. (2018) in taking a relatively conservative approach: we only consider NTMs that have a statistically significant negative effect on the level of imports at the 90% level and we assume that only 20 percent of NTMs can be removed, given the various public policy objectives that they target.<sup>18</sup>

The calibration is done at the commodity and importer level. That means that for each of the four mechanisms, a separate calibration simulation is undertaken for each of the six ASEAN importing countries and five commodities to obtain the econometrically estimated change in quantity – i.e., 6 (goods commodities, Table A1, Appendix I)  $\times$  6 (regions, Table A2, Appendix I)  $\times$  4 (mechanisms) simulations.

Once calibrated, we undertake a single simulation for each mechanism to remove the calibrated NTMs on all commodities in all six ASEAN simultaneously (i.e., 4 simulations). We also use subtotals to examine separately the impact of Vietnam's liberalization of NTMs on imports from other ASEAN member countries alone, to see how each of the mechanisms allocates the gains to the importer or exporters. By focusing on one importing country, the differences between the mechanisms and how they allocate the gains from NTMs across importers and exporters become more apparent. We choose Vietnam because of it has high NTMs on goods and gains relative to the other ASEAN countries.

Note that the implementation of the trade taxes methodology also requires that the NTM ad valorem equivalents be incorporated into the tariff and export taxes in the underlying data using Altertax (see Malcom, 1998) before being removed in the NTM liberalization simulation.

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<sup>18</sup> See Webb et al. (2018) for further details and discussion of the NTM measures used.

Altertax is known to alter the data,<sup>19</sup> which is likely to impact our comparison, however the taxes must be incorporated in order to get accurate estimates of welfare. The need to include the estimates of the NTMs in the import and export taxes, and the consequent impact on these flows, is a weakness of the trade taxes approach.

## 4 Results and Analysis

### 4.1 Calibration Results

Table 1 shows the calibrated changes in each of the four mechanisms required to obtain the gravity estimates of the change due to NTMs by importer and commodity. The calibrated changes in all four mechanism are relatively close in absolute terms. The differences in absolute terms are to be expected given that the mechanisms enter the equations in slightly different places and would therefore be impacted by slightly different share weights. Moreover, the export mechanisms, and in particular the AXS or exporter cost method, impact the model further away from the importer's sourcing decision (i.e., the Armington equation) and hence slightly larger shocks are required to achieve the same change in quantity imported. The signs are also as expected given how each mechanism is incorporated into the model; for instance, the negative on TMS represents the removal of an import tariff or importer rent and the positive value of the TXS shocks represents the removal of an export tax or exporter rent.

Table 1 also shows that the largest NTMs are on plant and animal products; although Vietnam and the Philippines also have large NTMs on wood products and other manufactures. The NTMs on plant products by Singapore and the Philippines stand out as being significantly larger than the other importing countries (Table 1), although when aggregated across commodities (Table 2), the average for Singapore is relatively low due to the fact that these commodities represent a small share of their imports. The Philippines and Vietnam have the largest shocks.

The differences between the mechanisms for the shocks by importer (columns I to IV, Table 2) are fairly similar, although there are considerable differences across importing countries, with Malaysia, Vietnam and the Philippines experiencing the largest reductions in NTMs. The reductions for the Philippines are almost twice the size of the next highest, Vietnam.

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<sup>19</sup> We use the Altertax facility as outlined in Malcom (1998). The Altertax facility allows the tax rates in the GTAP Data Base to be altered with minimal changes to the IO shares. Unfortunately, while Altertax minimizes the changes in the IO shares, the trade data may adjust significantly, where the required change in tax rates is large. Caution is recommended.

**Table 1: Calibrated change in NTM mechanisms by commodity and importer (percent)**

	<b>Singapore</b>	<b>Thailand</b>	<b>Malaysia</b>	<b>Vietnam</b>	<b>Philippines</b>	<b>Indonesia</b>
A M S : I C E B E R G M E T H O D						
Plant Products	3.77	0.79	1.64	1.30	4.34	0.60
Animal Products	1.86	0.13	0.35	0.12	0.15	0.15
Wood Products	0.02	0.08	0.00	0.61	0.38	0.03
Textiles, Leather & Wearing Apparel	0.00	0.00	0.01	0.05	0.01	0.01
Machinery & Equipment	0.02	0.03	0.02	0.13	0.06	0.09
Other Manufactures	0.03	0.02	0.03	0.19	0.24	0.01
A X S : E X P O R T E R C O S T M E T H O D						
Plant Products	4.24	0.86	1.86	1.47	4.58	0.67
Animal Products	1.98	0.14	0.38	0.14	0.17	0.17
Wood Products	0.02	0.09	0.01	0.70	0.44	0.04
Textiles, Leather & Wearing Apparel	0.00	0.00	0.01	0.06	0.01	0.01
Machinery & Equipment	0.02	0.04	0.02	0.13	0.06	0.09
Other Manufactures	0.03	0.02	0.04	0.20	0.27	0.01
T M S : I M P O R T T A X M E T H O D						
Plant Products	-3.46	-0.75	-1.59	-1.23	-3.94	-0.59
Animal Products	-1.77	-0.13	-0.34	-0.12	-0.15	-0.15
Wood Products	-0.02	-0.08	0.00	-0.59	-0.37	-0.03
Textiles, Leather & Wearing Apparel	0.00	0.00	-0.01	-0.05	-0.01	-0.01
Machinery & Equipment	-0.02	-0.03	-0.02	-0.12	-0.06	-0.09
Other Manufactures	-0.03	-0.02	-0.03	-0.19	-0.24	-0.01
T X S : E X P O R T T A X M E T H O D						
Plant Products	4.01	0.83	1.83	1.40	4.27	0.66
Animal Products	1.91	0.14	0.37	0.13	0.16	0.16
Wood Products	0.02	0.09	0.01	0.69	0.43	0.04
Textiles, Leather & Wearing Apparel	0.00	0.00	0.01	0.06	0.01	0.01
Machinery & Equipment	0.02	0.04	0.02	0.13	0.06	0.09
Other Manufactures	0.03	0.02	0.04	0.20	0.27	0.01

Source: authors' calculations

When aggregated from the export side to give the average NTMs imposed on exports by country (columns V to VI, Table 2), the NTMs for the Philippines as an exporter are considerably lower than those found for the Philippines as an importer (0.06 as opposed to 0.5); while those for Indonesia are higher. This means that the Philippines imposes higher NTMs on imports from ASEAN members, than it faces on its exports to ASEAN countries. This is due to the fact that the Philippines does not send a large share of its exports to other ASEAN countries, and those countries and commodities it does export have relatively low NTMs. Indonesia, on the other hand, exports more to ASEAN and in particular to Malaysia, which has relatively high NTMs; while it imposes relatively small NTMs on its imports from ASEAN countries (Table 1).

Hence its shock as an exporter (around 0.18) is larger than that provided when it is considered an importer (around 0.09).

**Table 2: Weighted average of calibrated changes in NTM mechanisms aggregated by importer and by exporter for selected mechanisms (percent)**

	Shocks aggregated by importer			Shocks aggregated by exporter		
	I AMS	II AXS	III TMS	IV TXS	V AXS	VI TXS
Singapore	0.109	0.113	-0.102	0.106	0.057	0.056
Thailand	0.062	0.060	-0.060	0.059	0.161	0.153
Malaysia	0.154	0.156	-0.149	0.152	0.185	0.175
Vietnam	0.256	0.274	-0.248	0.265	0.244	0.226
Philippines	0.507	0.512	-0.471	0.473	0.062	0.06
Indonesia	0.088	0.092	-0.087	0.091	0.189	0.181

*Source: authors' calculations*

These differences between the shocks when the country is considered an importer, as opposed to an exporter, explain most of the difference between the final impacts of the four different mechanisms. It is therefore worthwhile separating the countries into two groups: a) Singapore, Vietnam and the Philippines, which impose higher NTMs on their imports, than their exports face in other ASEAN countries; and b) Thailand, Malaysia and Indonesia whose exports face higher NTMs, than they impose on imports from other ASEAN countries.

## 4.2 Macroeconomic impacts

An examination of the real GDP results reveals two important differences between the various mechanisms used. First, the methods that entail productivity improvements, AMS and AXS (columns I and II, Table 3), have a larger impact on real GDP than those methods which alter the rents or tax wedges, TMS and TXS (columns III and IV, Table 3). A productivity improvement directly increases the amount of product that can be produced or consumed with a given amount of resources; while a decrease in taxes merely improves the allocation of resources, thereby increasing the efficiency with which those resources are used. Since all four of the methods involve similarly sized shocks (Table 1 and Table 2), it is not surprising that the productivity methods, that directly impact productivity, yield a larger increase in total production or real GDP.

If we aggregate the changes in real GDP into an ASEAN total (total ASEAN row), we find little difference between the change in real GDP for ASEAN under the two productivity methods (columns I and II, Table 3). The export tax and import tax methods (columns II and IV, Table 3) also lead to similar changes in overall total ASEAN real GDP. The allocations across countries, however, differ considerably between methods.

This leads to our second finding: the allocation of the gains across regions differs significantly between the export and import methods (i.e., comparing Column I with II and Columns III with IV, Table 3). Moreover, these differences between the methods, reflect the differences seen in the weighted calibrated shocks shown in Table 2. For instance, the Philippines does not gain as much in terms of real GDP when an export orientated method is used (columns II and IV, Table 3), since the average shocks impacting the Philippines as an exporter are relatively small (Table 2); on the other hand, methods that assume the gains go to the importer (Columns I and III, Table 3) show the Philippines as a significant beneficiary of the liberalization of NTMs. Singapore and Vietnam show similar results, for the same reason: they impose higher NTMs on their imports than they face on their exports.

**Table 3: Impact on real GDP of ASEAN and Vietnam's liberalization of NTMs on goods from ASEAN using four alternative mechanisms (percent)**

	ASEAN reduces NTMs on imports from other ASEAN countries				Vietnam (only) reduces NTMs on imports from other ASEAN countries			
	I AMS	II AXS	III TMS	IV TXS	V AMS	VI AXS	VII TMS	VIII TXS
Singapore	0.13	0.08	0.02	0.02	0.00	0.02	0.00	0.00
Thailand	0.06	0.14	0.02	0.03	0.00	0.04	0.01	0.01
Malaysia	0.13	0.18	0.02	0.03	0.00	0.03	0.00	0.00
Vietnam	0.29	0.23	0.04	0.06	0.28	0.03	0.02	0.03
Philippines	0.25	0.07	0.07	0.05	0.00	0.01	0.00	0.00
Indonesia	0.03	0.05	0.00	0.01	0.00	0.01	0.00	0.00
Total ASEAN	0.10	0.10	0.02	0.02	0.02	0.02	0.00	0.00

*Source: authors' calculations*

The reverse is true for our second group of countries: Malaysia, Thailand and Indonesia. Malaysia, Thailand and Indonesia export a high share of their goods and services to ASEAN countries with higher NTMs, and therefore face higher NTMs on their exports than they impose on their imports. Hence when export mechanisms are used to model reduction in NTMs, Malaysia, Thailand and Indonesia obtain more of the gains, than under the import methods.

If we separate the liberalization of NTMs by Vietnam only (columns V to VIII, Table 3), you will notice that under the AMS method (Column V) all the increases in real GDP accrue to the importer, in this case Vietnam; while under the AXS method (column VI), the same total gains in real GDP are spread across all the ASEAN exporters of goods to Vietnam, as well as Vietnam.<sup>20</sup> This emphasizes the point made above, that under the AMS method the gains accrue to the importer (in this case, Vietnam), not the exporters.

<sup>20</sup> We chose Vietnam for explanatory purposes because the shocks as importer and exporter are quite closely matched.

Table 4 shows some of the results for other key macroeconomic variables. In general trade (exports and imports) rises under all methods. This is because a reduction in NTMs generally reduces the price of NTMs, which increases demand for traded goods. The fall in Vietnam's exports, and the lower change in exports for all ASEAN countries, under the AMS method reflects the iceberg effect – when NTMs are reduced, less goods must be exported for the importer to receive the same amount of imports. Hence although bilateral imports between two countries may rise, the amount that needs to be exported to fulfil that increase in imports is now lower, and hence the change in exports under the AMS method are lower than those obtained under the AXS method. It is this effect on exports which concerns many users of this iceberg approach.

Investment rises in all ASEAN countries, but most notably in Thailand, Malaysia, Vietnam and the Philippines, regardless of the mechanism used. Trade balances also decline as a result of the reduction in NTMs in these countries, as the expansion in investment is mostly funded by foreign savings. In general, the tax methods lead to smaller increases in income and hence savings than the productivity methods, which causes the increase in investment to be lower and/or the trade balance to fall even further under the tax methods, than under the productivity methods. In the case of the TMS method, for instance, global savings falls, causing investment to be lower and the changes in the trade balances to be lower (or more negative) across regions.

The terms of trade, the price of exports relative to imports, tend to rise as a result of the removal of NTMs as prices received for exports rise relative to imports. Those countries where the NTM shocks are larger when examined from the exporting point of view (Thailand, Malaysia and Indonesia, Table 2), experience a smaller increase in terms of trade when the export methods are used. This is because the export methods tend to reduce the price of exports of the exporting countries (Thailand, Malaysia and Indonesia) further than the import methods, lowering the terms of trade of these countries; which in turn lowers the price of imports of the other countries (Singapore and the Philippines) more, raising their terms of trade.

**Table 4: Impact of ASEAN liberalization of NTMs on goods from ASEAN on several macroeconomic variables using the four alternative mechanisms (percent)**

Exports	Imports	Investment	Terms of trade	Trade balance (US\$ millions)
<b>S I N G A P O R E</b>				
AMS	0.06	0.06	0.07	0.03
AXS	0.10	0.17	0.07	0.09
TMS	0.11	0.18	0.07	0.03
TXS	0.09	0.19	0.07	0.09
<b>T H A I L A N D</b>				
AMS	0.01	0.16	0.26	0.09
AXS	0.17	0.22	0.25	-0.02
TMS	0.04	0.23	0.27	0.11
TXS	0.15	0.21	0.22	-0.01
<b>M A L A Y S I A</b>				
AMS	0.09	0.20	0.27	0.06
AXS	0.28	0.35	0.27	0.03
TMS	0.19	0.35	0.26	0.08
TXS	0.24	0.35	0.24	0.04
<b>V I E T N A M</b>				
AMS	-0.11	0.38	0.92	0.14
AXS	0.15	0.65	0.90	0.15
TMS	0.23	0.57	0.75	0.13
TXS	0.15	0.62	0.82	0.16
<b>P H I L I P P I N E S</b>				
AMS	0.10	0.36	0.51	0.01
AXS	0.16	0.86	0.51	0.45
TMS	0.92	0.73	0.29	-0.12
TXS	0.18	0.87	0.51	0.45
<b>I N D O N E S I A</b>				
AMS	0.13	0.19	0.03	0.07
AXS	0.32	0.28	0.03	-0.04
TMS	0.20	0.30	0.03	0.08
TXS	0.28	0.27	0.02	-0.03

Source: authors' calculations

### 4.3 Welfare

The welfare results for the four alternative mechanisms are shown below in Table 5. A comparison of the results for the two productivity methods (AMS and AXS) reveals surprisingly similar results across regions, although an analysis of the decomposition (Table 6) suggests that there are important differences in where those welfare gains come from.

For instance, in the case of Singapore, Vietnam and the Philippines, we know from Table 2 that the shocks based on these countries as importers are larger than those where these countries are considered exporters, hence the AXS method has a smaller technological effect, but a larger terms of trade impact, while the AMS method has a larger productivity effect and lower terms of trade effect (Table 6). The reverse is true for Malaysia, Thailand and Indonesia, where the shocks are larger when examined from the exporters' point of view – hence the AXS method shows the larger productivity effect (Table 6).

**Table 5: Impact on welfare of ASEAN's liberalization of NTMs on imports from ASEAN countries using four alternative mechanisms (US\$ millions)**

	<b>AMS</b>	<b>AXS</b>	<b>TMS</b>	<b>TXS</b>
Singapore	429.3	431.9	141.2	265.5
Thailand	444.1	434.1	360.8	70.5
Malaysia	529.8	520.8	248.7	131.3
Vietnam	579.2	569.4	210.1	337.2
Philippines	565.1	564.7	50.3	526.3
Indonesia	350.4	343.2	213.6	-24.0

*Source: authors' calculations*

It is also interesting to note that the allocative efficiency effects are larger under the AXS method, than those obtained when using AMS methods. This is because the changes in trade are larger under the AXS method, due to the iceberg effect – less goods need to be exported to meet the importers demand for goods. Lower imports mean lower allocative efficiency effects on imports.

The welfare impacts of the TMS and TXS methodology are smaller than the productivity methods (Table 5), as was also found in the real GDP results. When comparing the TXS and TMS method however, there is no clear relationship between the differences in real GDP (Table 3) and welfare (Table 5). Singapore, Vietnam and the Philippines, all impose larger NTMs than they face, however the welfare impact using the TXS method is larger than that of the TMS method. This is the case across all elements of the welfare decomposition, although it is primarily the result of a higher gain in the terms of trade, which we have established is related to the price of imports falling more than the price of their exports rises due to larger importer shocks relative to exporter shocks (Table 2). The reverse is true for Malaysia, Thailand and Indonesia.



**Table 6: Decomposition of selected ASEAN members welfare due to ASEAN liberalization of NTMs on imports from ASEAN countries using the productivity mechanisms (US\$ millions)**

	Singapore		Thailand		Malaysia		Vietnam		Philippines		Indonesia	
	AMS	AXS	AMS	AXS	AMS	AXS	AMS	AXS	AMS	AXS	AMS	AXS
Allocative efficiency	39.9	39.8	54.4	78.4	25.6	49.2	48.6	67.1	60.3	104.4	32.1	40.4
Technological change	313.9	176.0	168.1	414.3	355.1	459.9	351.2	247.2	497.1	43.8	183.4	406.7
Terms of Trade	101.7	249.5	225.5	-54.4	161.3	25.9	140.5	215.0	2.6	409.8	140.7	-97.4
Capital goods	-26.2	-33.5	-3.8	-4.2	-12.1	-14.1	39.0	40.0	5.1	6.7	-5.8	-6.5
Total	429.3	431.9	444.1	434.1	529.8	520.8	579.2	569.4	565.1	564.7	350.4	343.2

Source: authors' calculations

To understand the welfare results further, we separate the impact of Vietnam reducing NTMs on its imports (columns I-IV, Table 7) and the impact of NTMs being reduced on Vietnamese exports (columns V-VIII, Table 7) on Vietnamese welfare.<sup>21</sup> As we saw in the case of real GDP, the AMS method allocates the productivity gain entirely to the importer), while the AXS method allocates it across exporting regions. This is most clearly seen when looking at the Vietnam only results – under the AMS method there is a large gain in welfare due to technological change of US\$351.2 million (column I, Table 7), while the AXS method shows zero technological gain here (column II, Table 7). When Vietnam is the exporter of goods on which NTMs are reduced (columns V to VIII, Table 7), it receives a welfare gain from technological change under the AXS method (column VI), and nothing under the AMS method.

Notice, however, that the terms of trade effect under the AXS method (column II, Table 7) is almost as large as the technological change effect under the AMS method (column I, Table 7). This is because, although Vietnam does not gain from the iceberg productivity effect under the AXS method, they do gain from the rise in the price received for their exports. Hence rather than receiving a productivity gain, importers receive a terms of trade gain (plus a little extra allocative efficiency) which is roughly equivalent in size to the iceberg productivity gain they would have achieved under the AMS method. Since the changes in the capital goods terms of trade are also similar between the AMS and AXS methods, the total change in welfare is also similar.

**Table 7: Decomposition of Vietnam's welfare due to liberalization of NTM using four alternative mechanisms (US\$ millions)**

	Vietnam (only) reduces NTMs on imports from other ASEAN countries				ASEAN reduces NTMs on imports from Vietnam (only)			
	I AMS	II AXS	III TMS	IV TXS	V AMS	VI AXS	VII TMS	VIII TXS
Allocative efficiency	24.2	41.6	29.9	42.5	26.4	27.6	33.9	45.1
Technological change	351.2	0.0	0.0	0.0	0.0	247.2	0.0	0.0
Terms of Trade	-7.6	325.7	-73.7	327.6	181.3	-76.2	227.9	-70.7
Capital goods	11.3	11.7	-8.9	11.9	32.6	31.7	40.8	27.0
Total	379.1	379.0	-52.7	381.9	240.3	230.3	302.6	1.5

Source: authors' calculations

When we examine Vietnam as an exporter (Table 7), there is a productivity gain/technology effect of US\$247.2 million that goes to Vietnam as the exporter under the AXS method (Table 7). This amount is smaller than the gain obtained as an importer based on the AMS approach (US\$351.2 million), because as we saw in Table 2, the shock when Vietnam is an exporter is smaller. This US\$247.2 million represents the productivity gain in the production of exports

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<sup>21</sup> Note the two numbers do not sum to the total change in welfare, since it does not take account of the indirect effects of the other ASEAN countries reducing NTMs on each other; this difference is small.

and is offset by a slight decline in the terms of trade. Similar terms of trade effect differences are seen between the TMS and TXS methods.

#### 4.4 Sectoral and factor impacts

Table 8 provides the changes in sectoral production as a result of the reduction in NTMs under the four alternative methods. The changes in sectoral production between the four methods are quite similar, with larger differences across methods occurring in plant and animal products, and between the TMS method and the other methods. Table 9 compares the productivity methods more closely and shows that the production changes tend to be lower under the AMS method than in the AXS method, even in countries where real GDP was lower, Singapore, Vietnam and the Philippines. This lower production, particularly in plant and Animal products is due to the iceberg effect. The changes in production shown in the TMS and TXS methods are significantly smaller than those under the productivity methods.

Table 10 provides the real returns to factors of production under the four alternative methods. The table shows to the real returns to mobile factors generally rise more under the productivity methods than the tax methods, as production rises more than productivity and more than the tax method, leading to larger increases in the marginal products of those factors of production. On the other hand, land, which is specific to plant products and is greatly affected by the removal of large NTMs on plant products, experiences a larger rise in marginal product under the tax method, where its productivity remains unchanged.

**Table 8: Impact on Vietnam's sectoral production of ASEAN's liberalization of NTMs on goods from ASEAN countries using four alternative mechanisms (percent)**

	AMS	AXS	TMS	TXS
Plant Products	0.20	0.59	0.42	0.42
Animal Products	0.14	0.14	0.02	0.05
Wood Products	-1.12	-1.08	-0.98	-1.08
Textiles, Leather & Wearing Apparel	-0.55	-0.52	-0.41	-0.50
Machinery & Equipment	-0.19	-0.13	-0.03	-0.12
Other Manufactures	-0.59	-0.54	-0.46	-0.54
Services	0.29	0.29	0.13	0.18

*Source: authors' calculations*

**Table 9: Decomposition of other selected ASEAN members production due to ASEAN liberalization of NTMs on imports from ASEAN countries using the productivity mechanisms (US\$ millions)**

	Singapore		Thailand		Malaysia		Philippines		Indonesia	
	AMS	AXS	AMS	AXS	AMS	AXS	AMS	AXS	AMS	AXS
Plant Products	5.23	6.30	0.29	0.56	0.47	0.83	-0.74	-0.71	0.12	0.24
Animal Products	1.42	1.70	0.10	0.16	0.58	0.81	0.26	0.26	0.21	0.27
Wood Products	0.32	0.40	0.02	0.08	-0.02	0.04	-0.38	-0.37	-0.09	-0.07
Textiles, Leather & Wearing Apparel	0.82	0.85	-0.29	-0.26	-0.34	-0.30	-0.20	-0.20	-0.21	-0.20
Machinery & Equipment	-0.03	0.02	-0.10	-0.06	-0.25	-0.21	-0.25	-0.23	-0.18	-0.15
Other Manufacturers	0.08	0.11	-0.13	-0.09	-0.14	-0.10	-0.02	0.00	-0.09	-0.06
Services	-0.04	-0.04	0.00	0.00	0.02	0.03	0.16	0.16	0.02	0.02

*Source: authors' calculations*

**Table 10: Impact on Vietnam's real wages/returns of ASEAN's liberalization of NTMs on goods from ASEAN using the alternative mechanisms (percent)**

	<b>AMS</b>	<b>AXS</b>	<b>TMS</b>	<b>TXS</b>
Land	0.95	0.88	1.36	1.37
Office Managers and professionals	0.59	0.59	0.44	0.49
Technicians and associate professionals	0.55	0.55	0.42	0.47
Clerks	0.69	0.69	0.49	0.56
Service and shop workers	0.63	0.63	0.46	0.52
Agricultural and low skilled workers	0.42	0.41	0.47	0.47
Capital	0.47	0.48	0.37	0.40
Natural resources	0.04	0.05	0.03	0.01

*Source: authors' calculations*

## 5 Conclusions

Overall, we find that the choice of mechanism can have important consequences for estimates of the impact of the reduction in NTMs: more careful consideration of the NTMs being investigated, the estimates being utilized, and the CGE mechanisms being used, could improve analysis.

We find:

- In terms of real GDP, the productivity methods lead to much larger changes in real GDP than the tax methods across countries.
- The allocation of the gains to GDP depends on whether the NTM is applied to the exports or imports. If the shock is applied to exports, then the exporters gain; if applied to imports then the gains go to importers. The relative importance of NTMs on their imports versus their exports for each country determines how much of the global gain is allocated to them under the alternate methods. Hence in Singapore, Vietnam and the Philippines, the NTMs they apply to imports are higher than those faced by their exports and hence they gain more from the reduction of NTMs on their imports than from the reduction of NTMs on their exports.
- The terms of trade effects also differ across mechanisms depending on the relative importance of NTMs on a country's imports relative to their exports. Hence for Singapore, Vietnam and the Philippines, terms of trade effects tend to be larger when the export methods are used, because these mechanisms result in lower prices and

given imports are more important, the decline in price of imports outweighs the decline in exports and terms of trade rises.

- The welfare impacts for the AXS and AMS methods are very similar. Although the two methods allocate the productivity gains differently, the terms of trade effect offsets these differences leading to similar overall changes in welfare.
- The strange impact of the iceberg in the AMS method can be seen in the results for production, trade and the allocative efficiency effects. The iceberg effect tends to lead to lower changes in all of these, relative to the AXS method.

# Appendix I: Aggregation

**Table A 1: Sectoral aggregation**

No	Sectors modelled	Description	GTAP sectors*
1	Plant Products**	Crops and plant products	pdr wht gro v_f osd c_b ocr vol pcr sgr ofd b_t
2	Animal Products**	Livestock and animal products	ctl oap rmk fsh cmt omt mil
3	Wood Products**	Forestry, wood and paper products	frs lum ppp
4	Textiles, Leather & Wearing Apparel**	Textiles, leather and apparel	pfb wol tex wap lea
5	Machinery and Equipment**	Motor vehicles, machinery and equipment	mvh otn ele ome
6	Other Manufactures**	Extractive and other manufactured sectors	coa oil gas omn p_c crp nmm i_s nfm fmp omf
7	Services	Services	ely gdt wtr cns trd otp wtp atp cmn ofi isr obs ros osg dwe

\* See [www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp](http://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp) for details of the 57 GTAP sectors.

\*\* Goods commodities impacted by NTMs

**Table A 2: Regional aggregation**

No.	Country/region modelled	Original GTAP regions*	Aggregated regions for reporting
1	Singapore	sgp	ASEAN
2	Thailand	tha	ASEAN
3	Malaysia	mys	ASEAN
4	VietNam	vnm	ASEAN
5	Philippines	phl	ASEAN
6	Indonesia	idn	ASEAN
7	OtherASEAN	brn khm lao xse	Rest of Asia (includes some ASEAN countries, but not included in analysis)
8	NewZealand	nzl	Australasia
9	Australia	aus	Australasia
10	India	ind	Rest of Asia
11	Japan	jpn	Rest of Asia
12	Korea	kor	Rest of Asia
13	China	chn	China
14	US	usa	United States
15	ROW	xoc hkg mng twn xea bgd npl pak lka xsa can mex xna arg bol bra chl col ecu pry per ury ven xsm cri gtm hnd nic pan slv xca dom jam pri tto xcb aut bel cyp cze dnk est fin fra deu grc hun irl ita lva ltu lux mlt nld pol prt svk svn esp swe gbr che nor xef alb bgr blr hrv rou rus ukr xee xer kaz kgz xsu arm aze geo bhr irn isr jor kwt omn qat sau tur are xws egypt mar tun xnf ben bfa cmr civ gha gha nga sen tgo xwf xcf xac eth ken mdg mwi mus moz rwa tza uga zmb zwe xec bwa nam zaf xsc xtw	Rest of the world

\* See [www.gtap.agecon.purdue.edu/databases/regions.asp?Version=9.211](http://www.gtap.agecon.purdue.edu/databases/regions.asp?Version=9.211) for details of the GTAP countries and regions.

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