Simulating trade policy reforms at the detailed level: some practical solutions

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Abstract:

Complex trade policies, mixing different tools applied at heterogeneous level on specific products, are not compatible with abrupt quantitative economic models. The present paper proposes a pragmatic modelling solution for solving this issue. It allows to use the most disaggregated information available *i.e.* trade and protection data in a standard framework, here the GTAP model and database.

On the theoretical aspect, we open the black box of the standard Armington approach applied in an aggregated framework. We separate the bundle effect of an aggregated trade flow composed of different specific products (such as different HS6 lines), and the real geographical specificities of varieties. Moreover, we look at the issue of zero-trade flows that are usually badly treated in CGE models.

Using GTAPAgr model, we apply our disaggregation strategy to the dairy sector with a simple and illustrative case with two sub-products. The role of taking into account heterogeneous structure of trade and protection and the possibility of exclusion of some producers, *i.e.* trade flows going to zero, is demonstrated.

Keywords: trade policy, disaggregation, flexible functional forms

JEL Classification:

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Introduction

Trade policy instruments are extensively used by governments around the world in order to reach domestic objectives. These policies commonly have some adverse international impacts and thus are negotiated bilaterally or multilaterally under the auspices of the World Trade Organisation (WTO). To facilitate these negotiations, economic simulation models are very useful because they allow to evaluate the market and welfare impacts of different negotiation outcomes. Many alternative approaches to measuring the effects of trade agreements are presently available and, without doubt, they offer valuable insights. However, as far as we are aware of, all simulation models currently used in the policy debates suffer from crude hypothesis regarding trade policy modelling, so that their relevance can still be improved.

The modelling hypothesis that we attempt to address in this paper result from the lack of information concerning domestic variables in comparison to the data on trade policies and trade flows. Statistics on domestic production, demand, stocks and price are generally available with much less detail than trade variables. For example, one may easily know from international trade database the volumes and values of imports and exports of different kind of cheeses over several periods for many countries but country productions, consumptions, prices of these different cheese are typically unavailable or use is limited by confidentiality rules. This obviously hampers the evaluation of the impacts of trade policy reforms on the domestic economies. Practice so far consists in developing only aggregated models where the number of goods is constrained by the availability of domestic statistics.

Consequently data on trade flows and policy are necessarily aggregated and whatever the method of aggregation is, it involves loss of information and therefore this reduces the relevance of simulation models for trade policy analysis. Moreover some policy instruments are not easy to aggregate and one may think, as an example, to the aggregation of two tariff quotas where only one is initially binding. This first aggregation issue is not specific to one particular modelling approach; it equally applies to partial equilibrium (PE) and computable general equilibrium (CGE) models. From an empirical standpoint, this issue is likely to be more severe to the last because they usually operate on very aggregated products but theoretically the PE models also have to deal with it.

Another harmful consequence of the aggregate modelling following the lack of domestic statistics relative to trade data is that trade flows are generally modelled with the so-called “Armington” specification which assumes that products are differentiated by place of production (Armington, 1969). This product differentiation is usually captured by Constant Elasticity of Substitution (CES) functions. As can be expected, trade policy evaluations critically hinge upon the values of these elasticities (see, for example, McDaniel and Balistreri, 2003) which are calibrated to econometric estimates. It is also no surprise that the now numerous econometric studies provide very wide ranges of estimates for these elasticities of substitution (and price elasticities of import demand functions) (see, for example, Erkel Rousse and Mirza, 2002). Without completely undermining the credibility of trade policy analysis, this lack of consensus regarding these “trade” elasticities clearly downgrades their significance. This issue of sound econometric supports for calibration is not specific to trade elasticities; it also applies to other elasticities specified in simulation models (production and demand elasticities). Nevertheless the issue is made worse for trade elasticities because they compound two dimensions, namely the substitutability among different types of products from a given source and the substitutability among different sources for a given type of product. Indeed, the way that Armington assumption is usually handled is a source of great confusion and of misleading assessment. At an aggregated level, it mixes real geographical specificities (a French red wine and an Australian one have their own specificities) and diversity in the bundle of specific products exported by a country (the “beverage” sector exports from France and Australia have not the same composition in terms of wine, beer, …). Intuition suggests that the substitutability is greater among detailed products and there is indeed econometric evidence supporting this view (Panagaryia et al., 2001). However, for such goods like cheese or even wheat, the hypothesis of homogeneity across different sources of imports is still contradicted by econometric studies using very detailed trade statistics (the 6 digit level of the Harmonised System of nomenclature for goods). Working with an aggregate model and therefore aggregate elasticities of substitution among products again involves a loss of information and is prejudicial to the quality of trade policy analysis. Moreover, the “CES Armington” specification has long been criticized as being too restrictive (see, for example, Brown, 1987). These critics mostly focus on the lack of price and income flexibility of the CES type import demand functions as well as it does not allow to represent zero trade flows arising from prohibitive import protection (see, for instance, Kuiper and van Tongeren, 2006).

Our purpose in this paper is to propose some practical solutions to the modelling issues raised above. In an ideal world, one may want to get some detailed figures for domestic variables at a level comparable to trade data. This solution does not seem to us really feasible in the medium term, indeed even in the long run. We prefer to suggest practical solutions that can be readily implemented with currently available data. In fact, we propose to combine in a same model detailed trade data with aggregated domestic data in order to be able to directly model trade policy instruments (without aggregating) and examine their effects on domestic economies. More precisely, we maintain the modelling of a substitutability possibility between aggregate trade flows and domestic variables. Then we explode the aggregate trade flows into detailed trade flows and assume other substitutability possibilities at this stage. We finally suggest to model detailed trade flows by maintaining the “Armington” insights of differentiation of detailed products by source of production and by using a more flexible functional form than the CES one. We justify to keep the Armington differentiation of products by place of production because there is statistical and econometric evidence that, even at the finest level of available trade data, products are not homogenous and the law of one price does not hold. For instance, Christou et al. (2005) estimate the finite degree of differentiation among disaggregated cheeses coming from main producing countries around the world as perceived by the Japanese consumers. Regarding the choice of the functional form, we suggest to rely on the quasi homothetic version of the Normalised Quadratic Expenditure System (NQES) presented in Ryan and Wales (1999).[2] This form is appropriate for our purpose because it is flexible at the second order and satisfies concavity conditions globally. Admittedly, it may violate the monotonicity condition, that is that the import demand may become negative (see McKitrick, 1998 or Perroni and Rutherford, 1998). In fact this apparent drawback is turned round and exploited in this paper to model zero trade flows by relying on the theory of household behaviour under rationing (see, for example, Neary and Roberts, 1980). Technically, this means that our model must allow regime switches (where relevant prices for modelling the trade flows are no longer the tariff-corrected world prices but instead virtual prices when these flows become null) and in that respect, we

[2] This form is also labelled the Symmetric Generalised McFadden (SGMF) to acknowledge the contribution of McFadden.

adopt complementarity modelling (Rutherford, 1995). Here lies our main methodological contribution in this paper.

The solution package we advocate is not completely new; for instance, Anderson (1985) already underlines that disaggregation is strongly indicated for tax incidence problems. To the best of our knowledge, this challenge has not been seriously tackled by trade economists so far because it does not come without costs. However these costs are now relatively much more bearable than two decades ago. This package first supposes to get a consistent picture of trade flows and trade policy instruments. Fortunately, the MacMaps database maintained at CEPII (Laborde et al., 2006) offers this picture and is regularly updated to take into account the incessant evolution of trade policy instruments. Second, it obviously expands the dimension of the simulation model and may encounter computational limits of our computers. We foresee that this will not be a serious problem in the near future because of the rapid development of computing capacities, also because there already exists large simulation models (let's think of CGE model developed at the household level) and finally because it is of the responsibility of the modeller to choose its own disaggregation according to the problem at hand. Full disaggregation of all trade flows is not necessarily useful to examine sectoral issues. Third, the implementation of this solution package requires new elasticities for the calibration of all parameters and they are not necessarily available. However our solution package relies only on available statistics and thus econometric estimation of relevant parameters is not prevented. In addition, thank to the greater access to trade database and to the increasing capability of our computers, wide econometric estimations of trade functions is now possible (see, for instance, Kee et al., 2004).

The solutions we propose in this paper are fully consistent with the micro economic theory and differ from other presently conducted researches that adopt ad hoc assumptions. The current state of the art is summarised in the first section of this paper. In a second section, we detail the implementation of our solution package in the context of the GTAP (Global Trade Analysis Project) CGE model (Hertel, 1997). As mentioned earlier, the issues addressed in the paper are relevant to both PE and CGE models. Therefore, this presentation in a CGE model must not be interpreted as a unique solution for CGE modellers. The main advantage to focus on a CGE model is that they better allow welfare analysis (see, for example, Gohin and Moschini, 2006). This presentation will be progressive, where we first explain the usual trade specification in the GTAP framework, then move to explain the introduction of detailed trade flows and we finally discuss the specification of these trade flows with the NQES. In a third section, we perform some illustrative experiments to give a flavour of the relevance of our solutions. Finally section four concludes by suggesting future research directions.

1. Review of the state of the art.

1.1. The aggregation issue of trade policy instruments

If disaggregation has been recommended for a long time and has been adopted in sector/country focused CGE/PE models, the simulation economic models currently used to assess multilateral trade negotiations are still too much aggregated in comparison to the technical details of trade negotiations. This does not mean that nothing has been done by trade economists in that respect. For instance, global CGE models currently used rely on the GTAP database which is much more disaggregated in terms of product and countries that CGE models used ten years ago (for example, the RUNS and WALRAS models of the OECD). In the same vein, sector focused PE models are also much more disaggregated (compare, for example, in the agricultural context, the current coverage of the ATPSM model of the FAO to the previous MTM model of the OECD). But it remains that some forms of aggregation of trade flows and trade policy instruments are still required to simulate the impacts of some trade proposals.

Many aggregation procedures have been employed so far. Focusing first on the case where only ad valorem tariffs are used by governments, current procedures range from the very simple unweighted average (like in the PEATSIM model focused on agricultural sectors, see Abler and Blandford, 2006) to the use of sophisticated theoretical index of protection, typically the Trade Restrictiveness Index (TRI) explained in Anderson and Neary (1996) and its Mercantilist version (MTRI) explained in Anderson and Neary (2003). Other tariff aggregators include the simple trade weighted average tariffs and the "reference group" approach developed at CEPII and used in the GTAP framework (Bouët et al., 2004). As expected, the choice of a particular tariff aggregator has significance influence on results and depends on the objective of the study (see, for example, Bach and Martin, 2001). More recently, Manole and Martin (2005) test different tariff aggregators on real data and find that the welfare gains to a complete trade liberalization may increase by a factor of thirty in cases like Indonesia and Thailand. Moreover, losing information about tariff heterogeneity generally reduces the assessed gains of liberalization and can lead to misleading results about trade reactions. Indeed, Anderson and Neary (2004) demonstrates that a reduction in tariff deviation leads to an increase of welfare but not a straightforward impact on trade flows.

This aggregation issue is made worse when multiple trade policy instruments are used by governments. For instance, agricultural trade protection heavily relies on specific tariffs and tariff quotas. Anderson and Neary (1992) shows how to handle these quotas (by relying on the virtual prices associated to the binding) but it is clear that the resulting protection aggregator is harder to derive as one has to maintain the quantity restriction in the aggregation procedure and also has to make assumptions regarding the distribution of quota rents (see, for example, Anderson, 1998).

Faced with these difficulties, the practice so far has been mainly to conduct the evaluation of trade scenario with sensitivity analysis regarding the protection aggregator. More recently, Grant et al. (2006) adopt a very different strategy, very similar in spirit to our solution. They also propose to disaggregate trade flows but in a different setting. More specifically, they propose a "top-down bottom-up" approach where they combine an aggregated (top down) CGE model with some disaggregated (bottom up) PE models. This approach has been initially developed in the context of energy demand and supply modelling and is fully explained in Böhringer and Rutherford (B&R) (2005). Compared to our proposition to simultaneously include aggregate and disaggregated variables in a same (CGE) setting, this "top-down bottom-up" approach is very likely to be easier to solve when many discontinuities and regime switches are allowed in the modelling. However, on the B&R' own testimony, this computation property is not the main determinant for choosing their approach. Rather they justify it as being more compact and easier to formally implement. We fully agree with this statement but still adopt the other modelling strategy on the following grounds. First B&R neither said that our strategy is infeasible and in fact we will prove by this paper that it is indeed feasible. Second, when implemented in a CGE model, the potential sources of error when implementing the codes are easily checked in virtue of the Walras Law. Third, and more importantly in our view, our modelling strategy is fully consistent from a microeconomic viewpoint while the “top-down bottom up” strategy relies on “ad hoc” iterative (or decomposition) procedures. For instance, as far as we understand their decomposition, their bottom-up PE model of energy supply is represented by a quadratic programming problem where producers determine their supply given energy prices determined by the top-down CGE model and also given an estimate of price elasticity of demand. B&R argue that it is crucial to take into account, by this elasticity, of the response of market demand to changes in energy prices. However it seems to us that then producers behave like monopolists, which is a very different assumption from the CGE model where all economic agents are assumed to be price takers.

At this stage, we admit that these theoretical differences between the two approaches to model disaggregated trade flows may indeed result in very limited empirical differences; a empirical comparison between them is left for future research. Our solution also differ from the one developed by Grant et al. (2006) on the use of flexible functional forms. They still specify CES and CET functions for aggregated and detailed flows while we advocate the use of the NQES for more flexibility and dealing with the zeroes. We now turn to briefly discuss the issue of functional forms to specify trade flows.

1.2. The «CES Argminton » representation of trade flows

Even if it has been criticized for decades now, the CES Armington representation of trade flows is still often used in CGE models and is more systematically implemented in PE models which distinguish import and export flows in place of implicit price transmission functions (see, for instance, the ATPSM model of the FAO). The standard specification (adopted in the GTAP framework as well as in other global CGE models) assumes a nested structure where consumers first arbitrate between domestic products and an aggregate of imports (according to a first CES function) and then substitute between different sources of imports (according to a second CES function). In a very highly synthetic way, this specification has been criticized for being not flexible in terms of price and income responses, for giving strong (if not absurd) terms of trade effects and finally for not allowing zero trade flows.

The first simple solution has been to increase the calibrated values of the elasticities of substitution on the basis that long run elasticities are larger than short run ones (evidence reflected by econometric estimation) but this does not tackle the flexibility issue. In that respect, several solutions has been proposed. The “simplest” one is to develop more elaborated nesting structure. The two stage structure described above is by definition more flexible than a one stage but still maintains strong restriction on substitution possibilities between different sources of imports. Consequently, some have developed three stage nesting structure with CES functions at all stages (see, for instance, Bchir et al., 2002). Again this increase the flexibility in terms of price responses but is still constraining when many countries are specified in the model.

Another route to cope with these difficulties has been to rely on more flexible functional forms. For instance, Hanslow (2001) suggests to use the CRESH (Constant Ratio Elasticity of Substitution Homothetic) function, Robinson et al. (1993) the AIDS (Almost Ideal Demand System) and finally Gohin (2005) the use of the latent separability notion (where substitution between goods operate over different groups rather than on only one group as with the weak separability). All these flexible functional forms are by definition more flexible than the nested CES representation but does not allow to tackle zero trade flows.

To our knowledge, this last issue has been resolved in three papers, if we exclude those assuming imperfect competition (which is not prevalent in all sectors). The first solution proposed by Gohin et al. (2006) applies to a one country CGE model where the authors assume the existence of two kinds of imports, one which is imperfectly substitute to domestic production and the other is a perfect substitute. The law of one price holds for the latter and in this case, complete specialisation (with possibly zero trade flows) is allowed. This solution is adequate in a single country CGE model and can be easily applied to single country PE models but has not been implemented in a multiple country models. The second solution proposed by Witzke et al. (2005) is to specify Linear Expenditure System (LES) where the minimal consumptions are negative. In a different context (estimation of gravity model), this solution has also been advanced (Tchamourlisky, 2002). The main difficulties with this second solution are that the interpretation of negative minimal consumption is not evident (is it indeed positive exports?) and that the LES is not completely flexible in terms of price response. Finally Kuiper and van Tongeren (2006) suggest to maintain CES functions in the modelling but to modify distributional parameters of these CES functions according to the results of gravity model estimation. Like the iterative procedure of B&R described above, this last solution does seem to us to suffer from theoretical inconsistencies. In that case, the authors make first simulations with the gravity equations but as been clearly stated by Anderson and van Wincoop (2004), the gravity models are useful to reveal trade costs and substitutions among goods; they are much less appropriate for simulation.

2. A CGE model with detailed trade flows and policy instruments

We now present our solution to finely model trade policy. We start this section by giving the usual equations to represent trade flows and policies. Without being new, it allows us to progressively introduce notations as well as to highlight our differences. Then we present how we manage the introduction of detailed trade flows and policies with some CES functions. This intermediate version of the model will allow us to replicate Grant et al. (2006) and, above all, reveal the relevance of the NQES functional form introduced in the final solution. We finally detail the implementation of this NQES and how we handle corner solutions.

2.1. Starting point

As we have in mind to apply our trade modelling solution to the GTAP framework, it is useful to adopt its notations and structure as the starting point. We again stress that this solution is not specific to CGE models. In the whole text, variables with a “a” upper script represent aggregated variables and those with a “d” are relevant to detailed trade flows. Let’s start with the demand side. To simplify without loss of generality, let’s assume a representative consumer who allocate his income across different aggregated goods so as to maximise utility. This program defines marshallian demand functions which depend on consumer prices of aggregated goods and total expenditure:

$$XC_{i,r}^{a} = XC_{i,r}^{a}\left(PC_{r}^{a}, R_{r}\right) \quad (1)$$

where products are indexed by i and j, countries by r and s, XC denotes domestic consumption, PC is the vector of consumer prices in country r and finally R the income of that representative consumer. We do not impose particular structure to the functional form; we only assume that it is globally regular.

Then this consumer arbitrates between domestic good and imports according to a CES function. The cost minimisation program gives[3]:

$$M^a_{i,r} = M^a_{i,r}\left(PD^a_{i,r}, PM^a_{i,r}, XC^a_{i,r}\right) \tag{2}$$

$$DD^a_{i,r} = DD^a_{i,r}\left(PD^a_{i,r}, PM^a_{i,r}, XC^a_{i,r}\right) \tag{3}$$

$$PC^a_{i,r} = PC^a_{i,r}\left(PD^a_{i,r}, PM^a_{i,r}\right) \tag{4}$$

Equation (2) defines the aggregate flows of import of good i in region r $M^a_{i,r}$ from all sources in terms of the domestic price $PD^a_{i,r}$, a index of import prices (defined latter) $PM^a_{i,r}$ and the total (marshallian) demand. Similarly equation (3) defines the demand for domestic goods with the same arguments. Finally equation (4) is the dual to the CES sub-utility function which defines consumer price of good i (here we abstract from consumption taxes to keep notations simple).

Finally, this consumer arbitrates between different sources of imports. In the same manner, we have:

$$M^a_{i,s,r} = M^a_{i,s,r}\left(PM^a_{i,s,r}, M^a_{i,r}\right) \tag{5}$$

$$PM^a_{i,r} = PM^a_{i,r}\left(PM^a_{i,s,r}\right) \tag{6}$$

where $M^a_{i,s,r}$ is the quantity of good i imported in region r from the producers in region s, $PM^a_{i,s,r}$ the corresponding price at the import side. The latter is defined by :

$$PM^a_{i,s,r} = \left(PY^a_{i,s}.\left(1 + tx^a_{i,s,r}\right) + tau^a_{i,s,r}.PT\right).\left(1 + tm^a_{i,s,r}\right) \tag{7}$$

where $PY^a_{i,s}$ is the export price for producers in region s, $tx^a_{i,s,r}$ the export tax/subsidy, $tau^a_{i,s,r}$ the unit transport coefficient which is multiplied by the international transport price PT and finally $tm^a_{i,s,r}$ is the ad valorem tariff applied by region r on imports of good i from region s.

In order to complete the presentation of the trade blocks, one has to specify the export supply function in all regions. If one assumes perfect substitutability at the production side (or, equivalently that producers do not differentiate between selling on the domestic market and exporting), then this export supply function is implicitly determined by equating the export price to the producer price. In that case, the market clearing condition (that domestic production equals domestic demand plus exports) determines this producer/export price :

$$Y^a_{i,s} = DD^a_{i,s} + \sum_r M^a_{i,s,r} \tag{8}$$

[3] In order to lighten the presentation, the CES functions and parameters are not explicitly written in equations; they are available for example in Perroni and Rutherford (1998).

This approach is the one currently specified in the GTAP model applying the « rule of two » : the elasticity of substitution at the second allocation level (across different sources of imports) is twice the elasticity at the upper allocation level (between domestic and aggregate imports). Other global CGE models (Mirage from CEPII, Linkage from the World Bank) also rely on very similar representation. As in apparent in previous equations, this approach can be implemented in a PE context. Its main advantage is the relative simplicity to implement it thanks to the use of homothetic CES functions. However trade policy instruments are reduced to ad valorem export and import taxes/subsidies. Other trade policy instruments (like quotas) are usually not represented in this kind of model because they are defined at more detailed level than domestic variables. The heterogeneity of tariffs across detailed products is also absent in this approach. Thus, when looking at a trade liberalisation shock, current strategies consist in implementing tariff cutting formulas at the detailed level (HS6 level, see for instance, Bchir et al., 2006), then aggregate the new tariffs with some "ad hoc" weights and finally implementing the final aggregate level in the aggregate (PE or CGE) model. This procedure is very likely to prevent the real assessment of impacts due to high heterogeneity of tariffs and to examine for example harmonizing formula of tariffs.

2.2. Introducing detailed trade flows and policy instruments

In this intermediate step, we introduce detailed trade flows but maintain simple CES functions to model arbitrages. As will become apparent later, this allows to limit the number of equations to be changed and consequently to progressively present our solution. This intermediate step requires to replace equations (5) to (8) and introduces 5 new equations.

We start at the demand side and we suppose, like Grant et al (2006), that the representative consumer does substitute between different sub-categories of an aggregate imported product, before deciding the sources of these imports and after deciding the amount of domestic good and total imports (equations 1 to 4 are unchanged). Figure 1 displays the demand tree shows the different steps of the consumer's choices. In practice, this consumer also arbitrates between different sub-categories of an aggregate domestic product but we have no data to identify this behaviour. To keep things simple, we assume that this substitutability between sub-categories on imports is governed by a CES function. In that case, we have:

$$M_{ii,r}^{d} = M_{ii,r}^{d}\left(PM_{ii,r}^{d}, M_{i,r}^{a}\right) \tag{5'}$$

$$PM_{i,r}^{a} = PM_{i,r}^{a}\left(PM_{ii,r}^{d}\right) \tag{6'}$$

where *ii* is the index of detailed products belonging to the aggregated category *i*, $M_{ii,r}^{d}$ the total imports of detailed products ii in region r, $PM_{ii,r}^{d}$ the corresponding price vector. Equation (5') expresses the imports of detailed products in terms of their prices and total demand for imports of the aggregate category which is determined by equation (2). Consequently, the composite import price used in the first budgeting stage is modified as explained in equation (6'): this aggregate composite import price now depends on detailed composite import prices.

Once this consumer has decided the total imports of each detailed product, he then determines the sources of these imports. We assume that this arbitrage is governed through a CES function, with the elasticity of substitution possibly equal to infinity to cope with homogenous detailed products across sources. The consumer cost minimization program leads to the following new equations:

$$M_{ii,s,r}^{d} = M_{ii,s,r}^{d}\left(PM_{ii,s,r}^{d}, M_{ii,r}^{d}\right) \tag{9}$$

$$PM_{ii,r}^{d} = PM_{ii,r}^{d}\left(PM_{ii,s,r}^{d}\right) \tag{10}$$

The two equations are very similar to equations (5) and (6), the only difference being the index of products. We now apply the Armington on detailed products rather than aggregate ones. In order to simplify the presentation, let's suppose for a while that at the disaggregated level we have only ad valorem tariff. In that case, we have the following:

$$PM_{ii,s,r}^{d} = \left(PY_{ii,s}^{d}.\left(1+tx_{ii,s,r}^{d}\right)+tau_{ii,s,r}^{d}.PT\right).\left(1+tm_{ii,s,r}^{d}\right) \tag{7'}$$

This equation is very similar to 7 expect that the export price, unit transport coefficient and above all trade policy instruments are now expressed in terms of detailed products. It is thus possible to directly simulate real policy packages and not aggregate and convert scenarios to the level of domestic variables.

Previous equations define the behaviour of consumers with respect to aggregate and detailed products. We now have to deal with the supply side and in particular how detailed products are supplied. Consistent with the previous assumptions of the behaviour of producers, we will assume that these producers do not arbitrate when allocating their detailed products across destinations. In other words, we still maintain that perfect competition holds and no pricing to market strategy occurs. In that case, the export price of the detailed products is implicitly determined by the following equation:

$$X_{ii,s}^{d} = \sum_{r} M_{ii,s,r}^{d} \tag{11}$$

where $X_{ii,s}^{d}$ is total export of the sub-category ii by the producers in region s.

On the other hand, we assume like Grant et al. that these producers do arbitrate when choosing the composition of their exports. That decision is represented by a revenue maximisation program subject to a Constant Elasticity of Transformation (CET) constraint. Solving this program leads to the following new equations:

$$X_{ii,s}^{d} = X_{ii,s}^{d}\left(PY_{ii,s}^{d}, X_{i,s}^{a}\right) \tag{12}$$

$$PY_{i,s}^{a} = PY_{i,s}^{a}\left(PY_{ii,s}^{d}\right) \tag{13}$$

Equation (12) expresses the export supply function in terms of detailed export price and the total amount of export of aggregate products by region s. The latter is implicitly determined by equation (13) where we assume that the composite export price is equal to the producer price. This equation 13 is also dual to the CET function defining aggregate exports in terms of exports of detailed products. In other words, we also maintain that, at the aggregate level of products, producers do not arbitrate between selling on the domestic market and selling on the export markets. The equilibrium condition (8) is nevertheless modified as:

$$Y_{i,s}^{a} = DD_{i,s}^{a} + X_{i,s}^{a} \tag{8'}$$

These changes are sufficient to implement disaggregated trade flows and policy instruments in an aggregated PE model where import/export tax receipts/subsidy expenditures have no feedback effects. On the other hand, in the context of CGE modelling, the changes as well as the determination of transport costs need to be taken into account but this does not pose serious modelling difficulties.

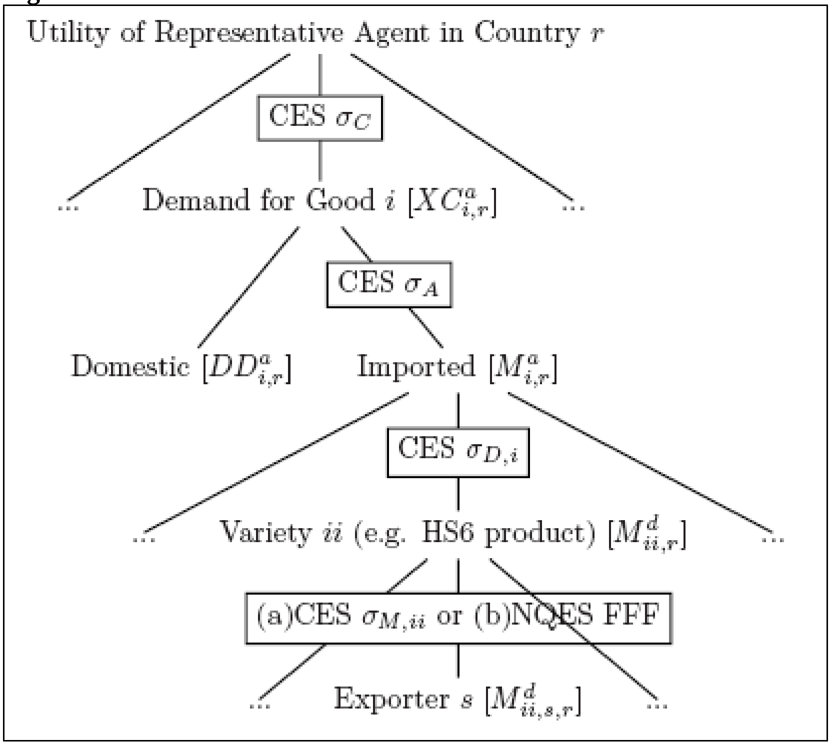
Up to now, we assume that market access instruments reduce to ad valorem tariffs. Let's consider now that the modeller has lot of information regarding other trade protection instruments and for instance has the information on the existence of tariff quotas at the HS6 level, the most detailed level existing with an international harmonization. In that case, it is not very difficult to implement them, except the usual issue of rent allocations. As an example, let suppose a tariff rate quota on the import of a given detailed product *ii* by region *r* from region *s*. With complementarity modelling, we have:

$$M_{ii,s,r}^{d} = M_{ii,s,r}^{d}\left(\tilde{PM}_{ii,s,r}^{d}, M_{ii,r}^{d}\right) \leq quota_{ii,s,r}^{d} \qquad (9')$$

$$\tilde{PM}_{ii,s,r}^{d} = \left(PY_{ii,s}^{d}.\left(1+tx_{ii,s,r}^{d}\right)+tau_{ii,s,r}^{d}.PT\right).\left(1+tm_{ii,s,r}^{d}\right)+rent_{ii,s,r}^{d} \qquad (7'')$$

where $rent_{ii,s,r}^{d}$ is the unit rent value linked to the quota and $\tilde{PM}_{ii,s,r}^{d}$ is the rent corrected import price. These two equations ensure regime switching: when the quota is binding, then the unit rent is positive and the import price is a shadow price. When the quota is not binding, then this unit rent is zero and the import price is a market price. In a CGE model, total rents must be allocated to the income of the some economic agents and here different sharing rules are possible. This difficulty is not attributable to the detailed modelling of trade flows. On the other hand, the detailed modelling must be seen as raising new interesting issues.

Figure 1 Demand structure with detailed trade flows



2.3. Implementing the NQES to cope with zero trade flows

The intermediate solution just presented is already an improvement compared to current modelling strategies of trade policies but also raises some new issues. In particular, at the detailed level, occurrence of zero trade values are very likely and there is widespread recognition that they must be taken seriously into account (see Romer, 1994, to mention just one widely cited paper). In a very general way, the literature on new goods and new flows has focused on an imperfect competition environment (with some fixed costs and/or preference for varieties) which may not relevant to all sectors/goods. We prefer to maintain perfect competition and focus on one flexible functional form which allows us to deal with zero values. We choose the Normalised Quadratic Expenditure System (NQES) as the representation of consumer preferences.[4] This system has already been used for modelling trade flows in some PE models (see, for instance, Winter and Frohberg, 2002) or in CGE models (see, for instance, McKitrick, 1998). This flexible expenditure system has not been extensively used in simulation models because it does not satisfy monotonicity conditions over all positive prices. On the other hand, it satisfies globally other theoretical conditions (concavity). Indeed, Perroni and Rutherford (1998) show that the monotonicity violation occurs when substitution elasticities are initially high. In our context, this is very likely to be the case as we want to model detailed economic flows, and thus one may expect significant substitution effects between products/sources.

This lack of global monotonicity is indeed a very important property in our context because we want to be able to model zero trade flows. To maintain theoretical consistency in the modelling framework, we rely on corner/rationing modelling where we assume that the relevant price is the market price as long as trade flows are

[4] To simplify the presentation, we focus on the demand side but the zero value can also be explained by a lack of supply. In that case, a symmetric analysis can be done using a Normalised Quadratic Revenue System.

positive, and the relevant price is a shadow price when the trade flows is negative. We thus adopt a complementarity modelling in the same way as the tariff quota described above. To the best of our knowledge, this solution has never been implemented in global simulation models while there are now numerous econometric studies dealing with individual data (and corner solutions) which apply this technique (famous papers are Woodland, 1983 and Lee and Pitt, 1986).

However, one must admit that the implementation of the flexible expenditure system is not immediate in the model because the resulting demands are not homothetic and thus stage budgeting process used so far is not theoretically possible. In that respect, we suggest to use the quasi homothetic version of the NQES, so that the nesting structure can still be solved.

Practically, the introduction of the quasi homothetic version of the NQES and the treatment of zero trade flows are made as follows. We start from the bottom of the nested structure and assume that the representative consumer minimizes the purchasing costs of imports of differentiated goods from different sources. The quasi homothetic version of the NQES which summarises this behaviour takes the following form:[5]

$$E\left(P^d_{ii,s,r}, M^d_{ii,r}\right) = A^d_{ii,r}\left(P^d_{ii,s,r}\right) + B^d_{ii,r}\left(P^d_{ii,s,r}\right).M^d_{ii,r} \qquad (14)$$

with $$A^d_{ii,r}\left(P^d_{ii,s,r}\right) = \sum_s \alpha^d_{ii,s,r}.P^d_{ii,s,r} \qquad (15)$$

and $$B^d_{ii,r}\left(P^d_{ii,s,r}\right) = \sum_s \beta^d_{ii,s,r}.P^d_{ii,s,r} + 0.5\frac{\sum_s \sum_{s'} \chi^d_{ii,s',s,r}.P^d_{ii,s,r}.P^d_{ii,s',r}}{\sum_s \delta^d_{ii,s,r}.P^d_{ii,s,r}} \qquad (16)$$

where the $\alpha, \beta, \chi, \delta$ are vectors of parameters to be calibrated. In order to identify them, the δ are assumed to be predetermined and following Perroni and Rutherford (1998), we use initial shares. Other parameters are then determined by the set of initial income and price elasticities as well as theoretical restrictions (see, for example, Ryan and Wales, 1999). Applying the Shephard lemma gives us the conditional detailed trade flows by source in terms of prices and total detailed imports:

$$M^d_{ii,s,r} = \alpha^d_{ii,s,r} + M^d_{i,r}.\left(\beta^d_{ii,s,r} + \frac{\sum_{s'} \chi^d_{ii,s',s,r}.P^d_{ii,s,r}}{\sum_{s'} \delta^d_{ii,s',r}.P^d_{ii,s',r}} - 0.5.\delta^d_{ii,s,r}.\frac{\sum_{s''}\sum_{s'} \chi^d_{ii,s',s'',r}.P^d_{ii,s'',r}.P^d_{ii,s',r}}{\left(\sum_{s'} \delta^d_{ii,s',r}.P^d_{ii,s',r}\right)^2}\right) \qquad (9'')$$

From this last equation, it appears that the conditional demand functions look like those derived from the LES ; it is tempting to interpret the α parameters as minimal consumptions because imports by source equal these parameters when total import of detailed products is null. But this form is indeed more complex because the term in parenthesis may be negative, in which case imports by source are lower than these α .

At the upper level, for each country and aggregate products, we minimize the sum over differentiated products of these expenditures subject to the CES functions. Consequently, equations (5’) et (6’) remains very similar in

[5] We explicit the structure of the NQES because it is less known.

spirit but they applies on different price indexes. That is, because the NQES is not homothetic, the price index is not straightforward. In fact we use the function B defined by equation (16) as the price indexes while the function A has not particular role at this stage. This is also the case when modelling the arbitrage between aggregate domestic products and aggregate imports. In other hand, at the upper level of the consumer utility tree, the marshallian demand function are replaced by:

$$XC_{i,r}^{a} = XC_{i,r}^{a}\left(PC_{r}^{a}, R_{r} - \sum_{ii} A_{ii,r}^{d}\left(PM_{ii,s,r}^{d}\right)\right) \qquad (1')$$

where total expenditures are reduced by the A functions.

Finally, as mentioned above, the great interest of moving from the CES to the NQES is to allow zero trade values. Three kind of zeros must be distinguished. The first corresponds to no preferences from household. In that only case does exist, then the CES representation performs as well as the NQES. The second corresponds to the case of zeros trade flows at the end of simulation. In that case, we have to modify the equation (9'') to impose the flows to be greater or equal to zero. This is done using complementarity modelling as we did for tariff quotas above; this implies the followings:

$$M_{ii,s,r}^{d} = M_{ii,s,r}^{d}\left(\tilde{PM}_{ii,s,r}^{d}, M_{ii,r}^{d}\right) \geq 0 \qquad (9'')$$

$$\tilde{PM}_{ii,s,r}^{d} = PM_{ii,s,r}^{d} - vrent_{ii,s,r}^{d} \qquad (17)$$

In equation (17) the $vrent_{ii,s,r}^{d}$ is a virtual price gap corresponding to the difference between the market price and the virtual price for the consumer. It is zero when imports flow is positive , it is positive when the import is null. This specification is easier to implement that the tariff rate quota above because there are no rents to allocate to households.

The third zero that may exists corresponds to initial zeros due to prohibiting protection but preferences for these imports do exist. This case is slightly more difficult to implement as it requires more outside parameters. That is, one needs the elasticities of the virtual prices with respect to other prices as well as the impacts of marginal increases of these imports on these virtual prices and other (initially positive) imports. Finally we need an initial estimate of the differences between market price and virtual prices. All these information are generally less available from econometric studies but can in theory be computed (Dong and Kaiser, 2003). Calibration of parameters then can be done by deriving unconstrained elasticities from constrained elasticities (see, for example, Neary and Roberts, 1980).

3. Illustration

In order to illustrate the feasibility and relevance of our solution to model trade policies, we implement it in the "agricultural version" of the GTAPinGAMS model (Rutherford, 2005). We choose the GAMS software as it is well designed for complementarity modelling. We first briefly describe this model and the assumptions made to move from the different versions of that model. Then we define illustrative policy experiments and analyse results.

3.1. Specifications

Our benchmark modelling framework is the GTAPAgr model as described in Keeney and Hertel (2005). This agricultural version of the GTAP model has been widely used now for assessing trade liberalisation scenarios. This model is initially implemented in GEMPACK and we develop a GAMS version in order to better tackle regime switches. The major point of departure of this GAMS version concerns the specification of the final demand system: we rely here on a LES rather than a CDE demand system because the former is less cumbersome to implement in a non linearised economic model. This drives no loss of generality for the illustrative purpose of this paper.

The main data source is GTAP v6 database and we consider a 26 sector/10 region product/country coverage which highlights food markets and participants. We will focus our attention on one GTAP sector, subject to wide variation in protection and diverse categories, namely dairy. Even if our methodology will allow for considering the 24 HS6 products belonging to this sector (and more generally more sectors simultaneously), we will just split the dairy sector in two products: cheese and rest of dairy products. In that respect, we need two kinds of information: data on import protection, export subsidies and transport cost in one hand, substitution/transformation elasticities on the other hand.

In the GTAPAgr model, the Armington substitution elasticity is fixed at 7.3. When implementing the intermediate CES version of the disaggregated model, we assume that the substitution elasticities across sources are equal to 6 for cheese and 8 for other dairy products. We also fix the substitution elasticity between cheese and other dairy products at the consumer side at the value of 0.8 and finally the transformation elasticity between these two products at the supply side at 2. We admit that these values, assumed to be the same in all countries, are quite arbitrary. Nevertheless they are in line with the 7.3 value adopted in the benchmark and also with information from PE models focused on agricultural sectors (like Peatsim explained in Abler and Blandford, 2006). We indeed assume that the aggregate of other dairy product (including mainly butter and milk powder) is a more homogeneous product than cheeses. Finally we assume that there are more flexibility at the supply side of the two dairy products than at the consumer.

When moving from the intermediate CES version to the NQES final one, we calibrate the parameters of this flexible functional system by maintaining these substitution elasticities. We thus keep homothetic preferences and regarding the zero issue, we assume that all initial zeros refer to no preferences for the associated variety. Nevertheless, null trade flows can occur as the result of the simulation.

In terms of data, we mainly rely on the MacMap-HS6 database developed at CEPII. This database is available at the HS6 level and we simply make trade weighted averages to define data for cheese. Data for other dairy products are simply taken as the difference between the initial GTAP database and the ones on cheese. We do not consider explicitly here import quotas because our illustrative disagregation of dairy product is still too aggregated. Before moving to experiments, it is useful to give a look to these data. Table 1 illustrates the great role of three countries in the world dairy markets: the major player is EU15 at both the import and export side because of the existence of export subsidies and the granting of minimum and current access. Another big exporter is the pair Australia and New Zealand (ANZ). Their share is however much more limited because the mainly export industrial dairy products. Finally our Rest of the World region is a significant importer.

Table 1 Geographical breakdown and importance in world dairy markets

Code	Description	Share in Dairy World Exports	Share in Dairy World Imports
ANZ	Australia and New Zealand	14.00%	0.63%
Acceding	10 acceding countries to European Union	3.81%	1.85%
Amercent	Central America	0.65%	4.67%
Canada	Canada	1.07%	1.77%
EFTA	European Free Trade Association	1.85%	1.08%
EU15	European Union (15 members)	68.03%	50.63%
Japan	Japan	0.04%	4.22%
MERCOSUR	Mercosur countries	1.69%	0.91%
RoW	Rest of the world	6.07%	30.21%
USA	United States of America	2.78%	4.17%

Source: GTAP database

Because the EU15 is a significant player in world dairy markets, our experiments will focused on that region. We provide in table 2 the initial EU15 *ad-valorem* import tariffs and export subsidies by dairy products and partners. It appears that unitary export subsidies are rather uniform across destinations. Moreover, they are much more important for other dairy products than cheese. On the other hand, protection of the EU dairy market is quite heterogeneous with respect to products and regions. This partly reflects the complex trade policy of the EU where some countries are given tariff preferences through current access commitments and/or through regional trade agreements.

Table 2. Initial values of trade policy instruments applied by the EU15

	Ad valorem export subsidies			*Ad valorem* import tariffs		
	All dairy	Cheese	Other dairy	All dairy	Cheese	Other dairy
ANZ	23,5%	14,3%	34,2%	49,6%	38,2%	56,7%
RoW	23,5%	14,3%	25,0%	19,6%	67,3%	16,9%
Japan	23,5%	14,3%	33,5%	32,0%	42,3%	31,3%
Canada	23,5%	14,3%	39,3%	35,8%	40,8%	24,9%
US	23,5%	14,3%	38,2%	32,0%	43,5%	31,2%
Amercent	23,5%	14,3%	26,5%	14,6%	60,8%	13,9%
Mercosur	23,5%	14,3%	25,4%	32,7%	52,1%	32,4%
EFTA	23,5%	14,3%	35,8%	31,2%	38,5%	3,6%
Accessing	23,5%	14,3%	28,0%	40,4%	38,9%	41,1%

Source: GTAP and MacMap-HS6v1 database.

3.2. Experiment design and results

We perform one illustrative experiment to demonstrate the feasibility and relevance of our trade policy modelling approach. We assume that the EU is required to cut by half its export subsidies and import tariffs on dairy products but has some liberty to do it on the different dairy products. We therefore assume an unilateral experiment in order to identify the economic mechanisms at work in each version of the model ; in any case does this experiment intend to address current trade policy debates.

We examine this scenario first with the standard/aggregate GTAP model, then with the intermediate detailed model where we use CES functions and finally with the detailed NQES version. For the two latter, we have the possibility to implement this choc at the individual line level. In one case (symmetric choc), we assume that the 50% reduction of export subsidies and import tariff apply on both cheese and other dairy products. In the other case (asymmetric choc) we assume that import tariffs on cheese are reduced by 70% and export subsidies on other dairy products by 70% too. The reductions on import tariffs on other dairy products and exports subsidies on cheese are determined such the trade weighted average cut equal 50%.

Table 3. Impacts on dairy productions

	Initial level Millions $	Aggregated	Intermediate CES detailed		NQES detailed	
			Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	8852	15,6%	14,2%	12,4%	13,6%	13,4%
RoW	43031	4,3%	4,7%	4,6%	4,6%	4,6%
Japan	19667	0,8%	0,5%	0,5%	0,4%	0,4%
Canada	7439	2,7%	1,9%	1,7%	2,0%	1,9%
US	84438	0,7%	0,5%	0,5%	0,5%	0,5%
Amercent	7830	1,3%	1,4%	1,3%	1,4%	1,3%
Mercosur	12503	0,9%	1,0%	1,0%	1,2%	1,2%
EU15	110546	-5,9%	-5,3%	-4,9%	-5,1%	-4,9%
EFTA	5478	10,7%	2,4%	0,8%	2,9%	0,0%
Accessing	6759	12,9%	11,1%	9,4%	9,2%	8,8%

Without surprise, our experiment leads to a decline in EU15 production of dairy products, compensated by an increase in other countries, mainly the ANZ region. However the impacts differ quite significantly across modelling versions. The signs of the estimates never change but the magnitude is very sensitive in relative terms. For example, if we take the last of the asymmetric chock in the NQES version as the relevant estimates, it appears that the benefits of this experiment to the ANZ producers are overestimated by 17% (from 13.4% to 15.6%) ; the loss of EU15 producers are also overestimated by 21% (from 4.9% to 5.9%). The most dramatic impact is on the EFTA dairy production: it is nearly null in the last column while the first standard GTAPAgr model concludes to a 10.7% increase. There are also cases where moving from the left to the right involves greater impacts. For instance, the impact on Mercosur dairy production increases from 0.9% to 1.2% (a 30% increase in relative terms).

Results reported in this table 3 show that both the definition of a symmetric/asymmetric choc and the choice of the functional form to represent trade flows (and dealing or not with zero values) are important modelling factors. In order to best understand these results, let’s focus on the EFTA impacts. The great difference between the different version is mainly attributable to the impacts of their exports to the EU15 (cf. tables 4a and 5a).

EFTA countries export relatively more cheese than other dairy products to the EU15 and the former are more taxed than the latter. In the same time, the import tariff imposed by the EU15 on these other dairy products (3.6%) is far apart (and very low) from those to other countries (around 25%). As a consequence, our experiment leads to less tariff preference for these countries and their export to the EU15 decrease (by 4.2% in the symmetric CES case). The tariff imposed by the EU15 on EFTA exports of cheese is quite comparable to those imposed on other countries, so that the EFTA producers gain when the EU reduces its tariffs on cheese. But this own cheese positive effect is tempered by a contraction at the supply side, namely the “other dairy product” negative effect reduces the incentive for EFTA producers to export. So, at the end of the day, depending on elasticities and the definition of the experiments, cheese positive effects may just compensate other dairy product negative effect on EFTA total exports of dairy products to the EU15. For instance, in the symmetric CES case, these exports increase by 0.7% compared to 102.7% in the standard GTAPAgr modelling framework where cross markets effects are only implicitly taken into account.

Pursuing on this example, it clearly appears that the choice of the functional form does matter. For instance, when we adopt the NQES and the asymmetric choc, EFTA exports to the EU15 of other dairy products do vanish, leading to the smallest impact on EFTA production (0%). On the other hand, when we maintain CES functions, initial trade flows never vanish and this does keep eventually artificial flows and consequently softens production impacts (increase of EFTA production by 0.8%). Finally, as expected, the possibility to define symmetric as well as asymmetric shocks is very important. In the EU15 does not use this flexibility, then the estimated impact on EFTA production is 2.9% while it reduces to 0% in the asymmetric scenario.

Table 4a. Impacts on EU total imports of dairy products

	Initial level Millions $	Aggregated	Intermediate CES detailed**		NQES detailed**	
			Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	431	198,7%	179,4%	134,7%	90,9%	83,0%
RoW	162	61,9%	67,0%	65,3%	57,3%	54,8%
Japan	2	124,2%	140,0%	137,6%	91,1%	89,5%
Canada	38	144,6%	49,0%	15,3%	43,7%	18,0%
US	68	125,4%	131,4%	128,7%	87,5%	85,7%
Amercent	8	41,5%	51,3%	53,7%	47,3%	46,9%
Mercosur	8	129,1%	150,7%	154,0%	95,1%	94,8%
EU15	14988	-9,9%	-7,0%	-4,0%	-2,4%	-0,8%
EFTA	393	102,7%	0,7%	-32,4%	2,6%	-43,6%
Accessing	319	166,6%	139,6%	108,8%	86,0%	77,2%

** : Imports are available by source and products (see below) but not by source only. Accordingly we report trade weighted figures here only for understanding where differences are.

Table 4b. Impacts on EU imports of cheese

	Initial level Millions $	Intermediate CES detailed		NQES detailed	
		Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	165	23,8%	36,3%	22,5%	41,9%
RoW	9	79,1%	135,0%	70,5%	111,8%
Japan	0	52,6%	77,0%	48,1%	73,8%

Canada	26	26,2%	38,6%	30,4%	46,7%
US	4	40,2%	66,6%	38,8%	66,8%
Amercent	0	79,5%	145,9%	69,1%	113,1%
Mercosur	0	53,7%	97,6%	52,0%	89,0%
EFTA	239	3,9%	-1,1%	5,6%	-7,2%
Accessing	99	41,4%	49,7%	35,5%	51,1%

Table 4c. Impacts on EU imports of other dairy products

	Initial level	Intermediate CES detailed		NQES detailed	
	Millions $	Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	265	276,4%	196,1%	133,5%	108,6%
RoW	153	66,3%	61,3%	56,5%	51,6%
Japan	1	146,3%	141,9%	94,2%	90,6%
Canada	12	98,7%	-35,6%	72,9%	-44,4%
US	64	137,8%	133,0%	90,9%	87,1%
Amercent	8	50,9%	52,3%	47,0%	45,9%
Mercosur	8	152,5%	155,0%	95,9%	94,9%
EFTA	154	-4,2%	-81,0%	-2,1%	-100,0%
Accessing	219	184,1%	135,5%	108,8%	89,0%

Table 5a. Impacts on EU total exports of dairy products

	Initial level	Aggregated	Intermediate CES detailed**		NQES detailed**	
	Millions $		Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	59	-53,7%	-42,4%	-42,3%	-51,4%	-48,3%
RoW	4455	-53,0%	-54,4%	-55,0%	-62,9%	-64,1%
Japan	335	-55,5%	-51,6%	-51,3%	-63,7%	-60,5%
Canada	127	-55,2%	-45,6%	-44,2%	-49,5%	-46,0%
US	765	-52,8%	-46,4%	-45,5%	-52,3%	-48,9%
Amercent	203	-58,8%	-58,4%	-59,0%	-84,0%	-82,7%
Mercosur	63	-59,2%	-59,6%	-59,9%	-86,4%	-86,6%
EFTA	330	-35,9%	-38,8%	-42,5%	-34,9%	-38,1%
Accessing	201	-53,1%	-50,9%	-52,1%	-65,3%	-69,5%

** : Imports are available by source and products (see below) but not by source only. Accordingly we report trade weighted figures here only for understanding where differences are.

Table 5b. Impacts on EU exports of cheese

	Initial level	Intermediate CES detailed		NQES detailed	
	Millions $	Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	31	-10,8%	-5,7%	-9,4%	-3,5%
RoW	603	-29,5%	-24,1%	-28,9%	-24,4%
Japan	174	-28,9%	-22,9%	-29,9%	-23,8%
Canada	80	-22,0%	-16,6%	-20,0%	-14,3%
US	470	-24,3%	-18,9%	-22,3%	-16,9%

Amercent	49	-30,3%	-24,9%	-33,8%	-28,4%
Mercosur	10	-25,0%	-19,9%	-24,0%	-19,0%
EFTA	188	-25,1%	-25,6%	-26,0%	-28,0%
Accessing	65	-19,0%	-14,7%	-17,7%	-14,3%

Table 5c. Impacts on EU exports of other dairy products

	Initial level	Intermediate CES detailed		NQES detailed	
	Millions $	Symmetric	Asymmetric	Symmetric	Asymmetric
ANZ	27	-78,9%	-84,7%	-100,0%	-100,0%
RoW	3853	-58,3%	-59,8%	-68,2%	-70,3%
Japan	162	-76,1%	-81,8%	-100,0%	-100,0%
Canada	47	-86,0%	-91,2%	-100,0%	-100,0%
US	295	-81,8%	-88,0%	-100,0%	-100,0%
Amercent	154	-67,4%	-69,9%	-100,0%	-100,0%
Mercosur	53	-66,4%	-67,8%	-98,7%	-100,0%
EFTA	142	-56,9%	-64,9%	-46,6%	-51,5%
Accessing	136	-66,2%	-70,0%	-88,1%	-96,0%

Concluding comments

Complex trade policies, mixing different tools applied at heterogeneous level on specific products, are not compatible with abrupt quantitative economic models. The present paper proposes a pragmatic modelling solution for solving this issue. It allows to use the most disaggregated information available *i.e.* trade and protection data in a standard framework, here the GTAP model and database.

For the demand side, starting from the traditional Armington assumption, the imported aggregated sectoral good, is split in different sub-varieties (HS6 products) using a CES function. The final stage deals with the allocation of the demand for a given variety across alternative exporters. In a first approach, a standard CES function is applied, as in nested CES Armington structure. However, in a second proposal, we acknowledge zero trade flows by combining a not globally regular flexible functional form and corner solution modelling based on a NQES function. On the supply side, exporters are assumed to offer different varieties of an aggregated product, relying on CET function.

Using GTAPAgr model, we illustrate our innovative solution by applying it on one sector with a only two sub-product disagreggation, assuming homothetic demand system and only *ad-valorem* policy instruments for the sake of clarity and simplicity. Our methodology can however be applied to many sectors, with non homotheticicy and more complex policy instruments (including tariff rate quotas) as explained in the theoretical part of the paper. This is left for further applications. Our illustration proves the importance of taking into account detailed trade flows and heterogeneous structure of protection, but also, the tremendous impact of going beyond CES approach and to allow trade flows to disappear, reflecting the exclusion of the market of some producers, through the use of the NQES.

To be applied for real trade negotiation issues, the main requirement in data are twofold: exhaustive protection database, such as MacMapHS6 describing *ad-valorem* and specific tariffs but also Tariff Rate quotas, and new estimation of elasticities for more sophisticated demand system. This last point should lead to a closer interaction between simulation modellers with econometricians.

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