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The suspension of agricultural multilateral trade negotiations: does the European Union hold all responsibility?

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Abstract:

The present round of multilateral trade negotiations is still stalemated over agricultural trade. The European Union is urged on by its trading partners to open its agricultural markets. Economic evaluations of trade liberalisation scenarios unanimously conclude that a substantial opening of agricultural markets is required for a successful (welfare improving) Doha round. In this paper we perform new evaluations to precisely identify the contributions of the European farm policy and to examine the robustness of these evaluations to the representation of this complex policy. Using the common approach our first simulations show that the EU has a major responsibility in delivering developing countries significant gains. On the other hand, when we conduct the same experiments with a more relevant calibration and modelling of the European farm policy instruments, the gains that these developing countries may reap from the EU liberalisation are considerably reduced. Accordingly the current charge against the EU is simply inopportune.

Keywords: World Trade Negotiations, Common Agricultural Policy, Policy Modelling

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Introduction

Even if agricultural negotiations started one year before the official launch of the Doha Round in 2001, the current World Trade Organisation (WTO) talks are still stalemated over agricultural trade. Negotiations have even been suspended in July 2006 by WTO Director Pascal Lamy considering that the positions on agriculture were too distant for an agreement to emerge, independently of discussions on other subjects. In fact three key issues remained unsettled at that period: the level of reduction of i) tariffs on industrial products, ii) tariffs on agricultural products and finally iii) agricultural domestic subsidies. Pascal Lamy clarified further the current negotiation difficulties by suggesting that this triangle of issues corresponds to a triangle of members: “The European Union (EU) needs to do more on agricultural tariffs; the United States (US) needs to do more on reducing agricultural subsidies and the G-20 group of countries needs to do more on industrial tariffs”. This presentation thus puts huge responsibility on both the US and the EU for the failure to achieve up to now a successful development round initially promised to developing countries, and especially least developed countries.

Economic evaluations of the gains of a successful Doha round provide here valuable inputs to illuminate this agricultural trade policy debate. With different data sources and economic models these evaluations unanimously conclude that most of the gains will come from a reduction of tariffs on agricultural products (Diao et al., 2001; Hoekman et al., 2004; Hertel and Keeney, 2006; Anderson et al., 2006). Most recent estimates suggest that the potential contribution to global economic gains from removing agricultural domestic subsidies is less than one-tenth of that from removing agricultural tariffs. A complete liberalisation of agricultural trade is obviously not a realistic scenario discussed at the WTO but the relative importance of the market access still remains with a scenario defined as a same proportional reduction of agricultural tariffs, domestic subsidies and export subsidies (Tangerman, 2005 or OECD, 2006). This importance of the market access pillar can be explained by the fact that export subsidies are quite modest in value terms and that domestic instruments are less trade distorting than tariffs and other market access instruments.

There is also a significant consensus in the economic literature on the fact that agricultural tariffs and domestic subsidy ceiling must be cut substantially before some genuine reductions of trade distortions do occur. This reflects the present gaps between applied tariffs and subsidies and binding commitments. Moreover allowing a small percent of tariff lines to be treated as sensitive and thus subject to lesser cuts will considerably shrink the welfare gains of a successful Doha round (Jean et al., 2006).

Combining these economic assessments with the political context leads to mainly blame the EU which conditionally offers to reduce its agricultural subsidies and tariffs if a significant number of tariff lines can be designed as sensitive. Moreover these evaluations minimize the progress made by the EU with the recent CAP reforms (2003-2006) which mainly try to reduce export subsidies and reshape domestic support (from blue to green box). The European Commission (EC) obviously raises several arguments to justify its position on agricultural trade. In particular it argues that these economic evaluations imperfectly capture the complex nature of EU agricultural policy and its recent developments. Accordingly they incorrectly measure the relative

contributions of market access and domestic subsidies (EC, 2006).¹ More specifically she mentions an analysis conducted by the US Department of Agriculture (Diao et al., 2001) showing much less importance of these market access instruments (54% instead of 93% in the recent ones). However, as pointed out by Martin and Anderson (2007), these figures correspond to the price impacts and not the welfare impacts ; the EC does not compare like with like. This US study indeed concludes like others that market access opening is critical for welfare gains to bear out. To the defence of the EC analysis it must be recognized that the relative ranking of price and welfare effects of policy instruments is theoretically disturbing (see annex 1).

In this context the objectives of this paper are twofold: first to measure the real contributions of EU subsidies and tariffs on global welfare gains expected from a full agricultural trade liberalisation, second to test the sensitivity of these welfare effects to the modelling and data assumptions used to represent the complex EU Common Agricultural Policy (CAP).

With respect to the first objective, recent economic evaluations overwhelmingly use the last Global Trade Analysis Project (GTAP 6) database calibrated on the year 2001. They focus on the impacts of agricultural liberalisation in developed countries on the welfare of developing countries (due to the development-focused round). To our surprise we have not been able to find a recent study disentangling the impacts of the agricultural policies of each major developed country.² Hence the relative importance of the market access pillar obtained in available economic analysis can not be attributed to the EU only but may be the results of market protection of other developed countries as well (like those of the G-10 group of net food importers with heavily protected agricultural sectors). It is thus highly critical to figure out the contributions of main participants and not to stick to the oversimplified presentation made by the WTO director Pascal Lamy. In this paper we will give a careful look at the agricultural policy of three major developed players , namely the EU, the US and Japan.

Such distinction across countries has been done in previous studies using the former GTAP 5 database calibrated on the year 1997 (Diao et al., 2001, Tokarick, 2005). Unfortunately comparisons of model results reveal that the initial database critically influences outcomes (for instance, Bouët, 2006). As an example, Yu and Jensen (2006) found using the GTAP 5 database that removing EU export subsidies decreases the world welfare by one billion dollars while Hertel and Keeney (2006) found the opposite result of a very similar experiment (removing all export subsidies) with the GTAP 6 database. Such large difference reflects the evolution of market conditions and policies between 1997 and 2001 as well as a better representation of these agricultural policies in the database. In particular there is wide recognition that the last GTAP 6 database substantially improves on the measurement of market access instruments thanks to the MacMap database developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and the International Trade Centre (ITC) (Bouët et al., 2006). This last version now includes non-reciprocal trade preferences in protection data and thus allows a better analysis of the issues of preference erosion. Given the trade preferences granted by the EU and greatly discussed in trade talks, it is thus important to use this last database when assessing the effects of its agricultural policy.

¹ On the agricultural talks, the EU also points out that other countries uses market access instruments or indirect export subsidies. The highly debated issue of trade preferences erosion is mentioned as well. More generally the EU claims that a balanced agreement on agricultural and non agricultural trade policy instruments is needed.

² Winters (2005) analyses the impact of a complete dismantling of the CAP but only reports few results and does not identify the contribution of the different negotiation pillars.

With respect to the second objective, the agricultural policies around the world are so complex that a global modelling inevitably involves some simplifying modelling assumptions. Modellers then rely on sensitivity analysis to check the robustness of their results. To date Valenzuela et al. (2006) show that the welfare gains of a complete free trade scenario (including non agricultural products) simulated with the GTAP framework are only sensitive to the so-called Armington trade elasticities and are nearly independent on macro-economic closures and on functional specifications in agricultural markets. This is not really unexpected because welfare effects critically depends on the size of initial distortions which in turn depend on the unitary level of policy instruments and the price elasticities directly relevant to the associated economic flows (Gohin, 2006a). On the other hand the modelling of the way agricultural policy instruments operate as well as the exact level of these policy instruments have not been tested so far. In this paper we investigate the calibration and representation of EU CAP instruments in the GTAP framework as they have already been challenged on many grounds.

From the policy arena, the EC (2006) argues that this global trade model does not adequately represent the mechanics of EU domestic support prices which have been reduced during the last decade (and hence underscore the domestic support pillar) and furthermore does not correctly measure trade protection by wrong definition of products (and hence overvalues the need to substantially cut tariffs). On the academic front there are also many published researches which question the way the CAP is represented in the GTAP framework. In particular Lips and Rieder (2005) and Frandsen et al. (2003) demonstrate the substantial bearings of the EU milk and sugar production quotas which are not identified in the standard version of the GTAP database and model. Van Meijl and van Tongeren (2002) also modify the way EU support prices are modelled in this framework while Gohin (2006b) calls into question the modelling of the direct payments which have been progressively increased to compensate for price support decreases. In this paper we will progressively introduce these alternative specifications in order to check the robustness of the impacts of EU agricultural policy instruments. In addition we will pay particular attention to data involving EU agriculture. As recognized by data builders themselves, the GTAP 6 dataset relies on assumptions which may significantly influence policy measurement. In particular Bouët et al. (2006) acknowledge the difficulty to aggregate detailed trade policy instruments to the product level definition of the GTAP dataset. We will explore here the consequences of some methodological choice (the “reference-group” concept to compute ad valorem equivalents of all market access instruments) to build these protection data.

With respect to our first objective and using an empirical framework very close to the GTAP-AGR model, our simulations reveal that the EU agricultural policy has major impact on the welfare gains that developing countries may reap from a successful Doha Round. Moreover a major cut of EU agricultural tariffs is needed for these welfare gains to materialize while the removal of EU agricultural subsidies has more limited and negative welfare impacts on these developing countries. Full removal of Japanese tariffs also has limited impacts on their welfare. However this scenario generates the largest global welfare effects but they are mainly harvested by Japan itself. This is in sharp contrast to the EU market access liberalisation which reduces EU welfare. This difference is explained by the fact that the EU is a much larger player in agricultural markets than Japan and hence can optimally impose import tariffs to benefit from terms of trade gains. On the other hand tariffs imposed by Japan do not impose a burden on other exporters due to its small shares in world productions and demands (in particular in the rice market). Finally the dismantling of US agricultural policy instruments decreases developing countries welfare due to a deterioration of their terms of trade and is even world welfare decreasing. All these

results obtained with the standard GTAP framework thus confirm the predominant role the EU has in the current Doha round.

However when conducted with a more relevant calibration and modelling of the CAP instruments, simulation figures significantly change. Specifically when we introduce EU agricultural production control measures, model alternatively the working of the support price regime and direct payments, correct the initial level of policy instruments and the bias in trade elasticities, two main results emerge. Firstly the impact of the EU farm policy on developing countries is considerably reduced. Secondly the relative contributions of export competition and domestic support pillars greatly expand to the detriment of the EU market access pillar. These alternative results then suggest that the EU conditional offer at the WTO and the recent CAP reforms are far from being insignificant. They also imply that the EU must not be charged of the full responsibility of the current deadlock of trade talks. On the other hand economic modellers bear a major responsibility in correctly fuelling the policy debate by improving the representation of complex agricultural policies.

This paper is organised as follows. In a first section we briefly present the GTAP-AGR framework which is the main economic toolkit for evaluating Doha round scenarios. In a second section we use this framework to assess the impacts of successively removing export competition, domestic support and market access measures of three main players, the EU, the US and Japan. This will allow tackling our first objective. In a third section we detail the results obtained in case of EU liberalisation in order to understand them and reveal critical modelling assumptions. In a fourth section we present our modifications to the database and model equations to better represent the extent and working of the CAP. We then simulate the same experiments and contrast these new results with the standard framework. Section five concludes.

1. The GTAP-AGR framework

a. The starting point: the GTAP framework

The GTAP framework consists of a detailed database representing the world economic flows (incomes, productions, demands, imports and exports of many products in many regions) and a Computable General Equilibrium (CGE) model which explains these flows and allows simulating policy scenarios. There are many variants of the original GTAP model described in Hertel (1997) which basically converge on the same conclusions regarding Doha simulations (Valenzuela et al., 2006).³ Here we rely on (a copy of)⁴ the GTAP-AGR version explained in Keeney and Hertel (2005) because it includes the most detailed specification of

³ This includes the “Carnegie” model, the Mirage model of the CEPII, the Linkage model of the World Bank, the GTAPEM model of the OECD. These models diverge on some assumptions such as endogenous technical changes, imperfect competition, specification of the labour markets in developing countries.

⁴ In fact we start from the GTAPinGAMS version developed by Rutherford (1998) which differs from the standard GTAP model on two main points. First is the macro-economic closure (balance of saving-investment and public budget) but as Valenzuela et al. (2006) demonstrate, this has very few impacts on trade simulation results. Second is the representation of household preferences with a Cobb Douglas function rather a Constant Difference of Elasticities (CDE) demand system. This difference has much more consequences in terms of price elasticities and accordingly we change this specification towards a Linear Expenditure System (LES) calibrated with the CDE income elasticities. On this “LES GTAPinGAMS” version, we then introduce all changes explained in Keeney and Hertel to get this copy of the GTAP-AGR version. Implementation of the alternative modelling of CAP instruments is easier with the GAMS software.

agriculture. Below we briefly report the main characteristics of this model and the way agricultural policies are represented.

The GTAP-AGR CGE model adopts most of the simple assumptions of the standard GTAP model: perfect competition, constant returns to scale technologies, static behaviour with no risk consideration, focus on real sphere of economies (no money). Functional forms to represent production technologies, household preferences over goods and sources (domestic/imports as well as over different exporting regions) and factor mobility across production sectors (land, labour and capital) are mostly of the Constant Elasticity of Substitution (CES) / Transformation (CET) type with elasticities ranging from 0 to infinity. In particular imports are modelled according to the highly disputed CES-based Armington specification which assumes that goods are differentiated by sources.

b. Specificities of the GTAP-AGR version

Most differences between the standard GTAP and the GTAP-AGR model lie in the values of some transformation elasticities (agricultural primary factors are less mobile) and in the nesting of CES for the description of agricultural production technologies (substitution possibilities between inputs are higher and more differentiated across couples of inputs). In a very general way these changes allow a better calibration of the price elasticities of agricultural supplies and thus representation of the “farm problem” (Gardner, 1992).

If the standard GTAP model can be run for any commodity aggregation ranging from 1 to 57 and any number of regions up to 85 using the version 6 GTAP database, the GTAP-AGR version has been defined so far on 29 aggregate commodities and 23 aggregate regions due to available information on the aforementioned elasticities. In the present paper we even reduce the number of aggregate countries to 10 because we are not interested in the impacts on each developing country: we only distinguish “major” developing players in agricultural markets (China, India and the couple Argentina/Brazil). As is well known, the aggregation level matters for the simulation of trade reform because the more aggregated the model is, the more tariff peaks are diluted in the aggregation process. However our 10 region version is sufficient enough to reach our objectives because we get very similar global effects as with the 23 version (see below).

c. Agricultural policy modelling

In terms of agricultural policy instruments discussed at the WTO, the GTAP-AGR framework explicitly models some instruments pertaining to the three pillars of the negotiations. As far as the export competition pillar is concerned, direct export subsidies are simply introduced as a wedge between domestic and fab export prices. Their levels are calibrated with the export subsidies notified at the WTO for the 2001 base period. As far as the domestic support pillar is concerned, direct subsidies paid by the taxpayers of the amber, blue and green box are also introduced as price wedges in the output supply, intermediate input demand and primary factor demand functions. Their levels are calibrated using the OECD’s Producer Support Estimates (PSE) and transparent classification criteria. As far as the market access pillar is concerned, all measures pertaining to one given trade flow are represented into a single ad valorem tariff which is included as a difference between the cif import and the domestic market prices. The levels of import tariffs are sourced from the MacMap database maintained by the CEPII with many additional assumptions required to i) deal with non tariff barriers, ii) convert specific tariffs

into ad valorem ones and finally iii) aggregate HS 6 digit tariff lines to the product level definition of GTAP-AGR.

If far from perfect, one should begin to acknowledge the formidable task in compiling all these information with input-output tables into a CGE consistent format (balanced Social Accounting Matrix). Above all the transparency in the database building and model implementation gives one the opportunity to test that framework. But before running simulations with this standard framework, some first comments on agricultural policy modelling are already noticeable.

Firstly it is a well known fact that the EU is the main user of direct export subsidies while other developed countries may use more indirect measures to promote their exports (export credits, state trading, foreign aid, rules of origin, etc.). The sole inclusion of direct export subsidies thus biases the evaluation against both the EU and the relative importance of the export competition pillar. On the other hand the modelling of other export instruments is far from simple and will not be done in this paper focusing on the EU farm policy.

Secondly this standard framework does not recognize the different supply control measures European farmers face (set aside obligations on arable crops, production quotas on sugar and milk, beef premiums quotas) as well as attached environmental conditions to direct payments. If the latter are quite difficult to represent in global models, the former have already been studied and may have significant impacts on results. This will be considered latter in the paper.

Thirdly the modelling of market access instruments is finally kept to a minimum with only one ad valorem tariff equivalent of all measures. Even if this is perfectly calibrated at the initial point, this misses the intricate working of the tariff rate quotas which play a significant role in agricultural market access and trade talks. Again this may have significant impacts on trade reform results and will be considered latter in the paper.

2. The contributions of developed countries with the standard GTAP-AGR framework

a. Definition of experiments

The structure of the GTAP-AGR framework is such that it is possible to successively simulate the effects of removing instruments of each pillar. Two initial remarks are in order here. Firstly that possibility does not mean that there are no interactions between all instruments. Unfortunately authors usually ignore these interactions when reporting their results because they simply sum the impacts obtained with the removal of each instrument. If this is simpler for the headlines, policy makers are puzzled by the absence of cumulative effects (EC, 2006). In the results below, we report the impacts of each pillar as well as the impacts of all pillars considered simultaneously. Secondly that possibility suggests that one country may grant export subsidies without the need to protect its own market from re-exportation of these quantities. Again this may puzzled (EU) policy makers who deliver export subsidies to tariff protected goods only. In fact the Armington trade specification technically allows this possibility because imported goods are supposed to be different from exported goods. But this may not correspond to the working of EU support price regimes (EC, 2006). This will be discussed lengthier in section four.

For this section we run 22 experiments which combine four agricultural policy changes (removal of export competition measures, domestic support measures, market access measures and all instruments) and five countries or group of countries (all developed countries, the EU, the US, Japan and these three developed countries). The two last experiments assume full removal of the EU (respectively Japanese) agricultural policy and allows two GTAP products as sensitive where tariff reduction is assumed to be null (beef and sugar in the EU, rice and sugar in Japan). These experiments illustrate the issue of sensitive products which are often blamed for emptying the Doha round.

b. Global effects

Welfare effects measured with the equivalent variation are provided in table 1. The first row reports the results obtained by Hertel and Keeney and the results of our comparable scenario are in the second row. Focusing on the global impacts on the world, developed and developing groups, it appears that we are able to reproduce previous results. The distribution of effects across developing countries is however slightly different because we do not have the same regional aggregation and above all because we do not implement their pre-reform scenario (textiles and apparel trade liberalisation, newly acceding WTO members, including China). More significant are the differences on the relative contribution of each pillar. At the world level, Hertel and Keeney find that the share of the export competition pillar in welfare gains amounts to 2.2%, the domestic support pillar to 5.9% and the market access pillar to 91.9%. Our respective numbers are 1%, 11.3% and 86%. Possible explanations are the different regional aggregation, the specification of final demand preferences and the way contributions are computed. In our results the sum of contributions does not equal one due to interactions between the different instruments. If our results tend to put a slightly greater emphasis on the domestic support pillar, this is still less than the GTAPEM model where a contribution of 21.5% is computed (OECD, 2006). But the general message that the market access pillar is critical remains in all cases.

If the ‘contrasting fortunes’ of developing countries in the present Doha round have been extensively analysed in the economic literature, there are much less discussion on the differentiated impacts on developed countries. Our results show that Japan (as a net food importer) will loose from an agreement restricted to export and domestic subsidies. More surprising is the absence of effects on the EU welfare of a liberalisation of market access instruments in all developed countries. As will become apparent later, the EU is a large country on the world market and may benefit from an optimal tariff. Equally surprising is the distribution of welfare gains across developed countries. The economic literature has already stressed that developed countries will reap most of the welfare gains of the liberalisation of their own agricultural policies and this result does not lessen the urgent need to proceed to this liberalisation (for instance, Tangerman, 2005). Our results additionally show that this is indeed Japan who will reap most these gains (50% of world welfare gains and 62% of developed countries’ gains).

From this first group of experiments only, it might be tempting to conclude that the EU position on agricultural talks is internally legitimate: ~~she~~ it mainly gains from the removal of export and domestic subsidies and does not have much to expect from the market access pillar. Accordingly the EU conditional offer to partially open its market access does not cost her in terms of missing welfare gains while satisfying its farm sector. The debate on the market access pillar may be viewed mainly in the interest of Japan and developing countries. However this domestic justification must ignore the negative effects on developing countries of these subsidies, which is unlikely to hold given the development focused round and EU rhetoric positions. Moreover this first group of

experiments does not reveal the potential EU offensive interest in the market access liberalisation of other different developed countries in comparison to its own liberalisation. Let's thus turn to the identification of the impacts of each farm policy.

c. Effects of different agricultural policies

Without surprise dismantling the EU, US and Japanese agricultural policies generates most of the global welfare gains (97.5%) because other developed countries have limited subsidies/tariffs and/or are much smaller countries on the agricultural world markets. Among these three major players, it appears that the elimination of the Japanese agricultural policy contributes to 63% of total welfare gains, followed by the EU CAP (32%) while global welfare slightly decrease with the elimination of the (2001) US farm bill. Most important is the result that developing countries as a group enjoy most of their welfare gains when the EU removes the CAP (81%) and to a much lesser extent when the Japan removes its agricultural policy (23%). This group loses from the US farm bill elimination including all domestic subsidies (one leg of the "Lamy triangle of issues"). As expected these developing countries' gains mainly materialize when EU import protections are removed while they suffer from the suppression of EU export subsidies. According to these new simulation results with the standard GTAP-AGR framework, the EU has thus great responsibility in delivering developing countries welfare gains from the agricultural trade talks. If agricultural market access opening is not relevant for the EU welfare, it is highly critical for developing countries' ones.

The responsibility of the EU appears even greater in the current WTO impasse when we introduce sensitive products which are explicit in the conditional EU offer. Even if our scenario is rather crude (~~not~~ no tariff reductions on EU beef and sugar products), it clearly illustrates that there is the danger for the developing countries that they will not benefit at all from the round.⁵ Allowing the EU to select two sensitive GTAP products decreases developing countries welfare gains by 67%. Allowing Japan to equally define two GTAP products as sensitive also considerably decreases the welfare gains of developing countries (by 80%) but in absolute terms this is less dramatic (less than 2 billion US dollars instead of 5.5 billion US dollars).

On the basis of the results discussed so far, the political message would be that the EU bears major responsibility in current impasse of agricultural trade talks because it does not want to fully open its agricultural markets. The reduction of EU domestic subsidy is certainly meaningful (33% of world welfare gain of a complete CAP dismantling) but for the EU mainly. Japan has a much more limited responsibility in the sense that its import tariffs mainly penalize its consumers and to a fewer extent developing countries. Finally these countries have no gains to expect from a US liberalisation of domestic subsidies and thus the US can not be charge of the current deadlock. The worst scenario for developing countries would even be that the Doha round concludes with a removal of direct export subsidies only, which is to date the only concrete (but conditional) achievement !

⁵ There is presently great confusion on the treatment of sensitive products (number, level of tariff reductions, level of quota expansion). By keeping initial tariffs, one may think that we overstate the true impacts of these sensitive products because some tariff reductions will occur as well as tariff quotas expansion. But we only define two GTAP products and moreover the difference between bound and applied tariffs may lead to small reduction of applied tariffs. Our purpose with this experiment is mainly illustrative to show the potential substantial impacts of these sensitive products as this has already been demonstrated (Jean et al., 2006). Our main contribution here is to illustrate the impacts on developing countries welfare gains of sensitive product selection by different developed countries.

d. First qualifications

Given the strong political incidences of these figures, a more careful analysis is recommended. The focus here is on the impacts of US and Japan agricultural policies because the EU case will be analysis in length later. As already acknowledged, these results show that the small global benefits of tighter export disciplines almost exclusively come from the EU side because other export promotion measures are not introduced in the modelling framework. Equally disputable is the welfare decreasing effect of removing US export subsidies. The welfare decomposition reveals that this has nothing to do with (curious/Armington based) terms of trade effects on non agricultural products as those discussed in Tangermann (2005). In fact US export subsidies are initially concentrated on dairy products and their elimination decreases US dairy exports. They are then partly substituted by increased EU exports which benefit from fixed unitary subsidy in the standard GTAP-AGR framework. Thus the “US distortion” is replaced by an “EU distortion” which explains part of the EU and global welfare decrease of this scenario. Even if these figures are of small magnitude, they reveal an incorrect modelling of EU support price regime which would have reduced unitary export subsidy in the present case. There is a second reason for this negative global welfare effect which also questions another assumption in the modelling of agricultural policy instruments. The elimination of US dairy export subsidy leads to a slight rise of world prices registered at all borders. The fixed ad valorem tariff equivalents of all market access measures then apply to this increased world prices. Accordingly the unitary protection level on dairy products increases and given their already high initial level, they finally create more distortion effects. These results again demonstrate that the standard GTAP-AGR framework does not recognize the true nature of agricultural protection with a majority of specific tariffs. Basically these mechanisms apply everywhere and we discuss them here because they are the main explanations of these figures. Obviously this discussion is not sufficient to alter the previous political message. On the other hand it suggests that it may be worth to test the framework with other agricultural policy modelling when we simulate the removal of CAP instruments.

The US are pressed in the current trade talks to decrease their domestic subsidies. However the simulations with the GTAP-AGR framework show that the EU agricultural domestic subsidies have much more global impacts than the US ones. In fact that the removal of US agricultural domestic subsidies is world welfare decreasing is again surprising. The two previous explanations still prevail and even are supplemented by another one of the same nature. Specifically the removal of US agricultural domestic subsidies leads to US production and export decreases which are partially compensated by production increases in other countries. In the case of the EU, this means that coupled agricultural domestic subsidies (on output and inputs) are larger and hence more distortionary. This does not recognize that since 1992 total direct payments to EU arable crops farmers for instance are independent of market conditions. Even if the focus of the paper is on the EU CAP, we mention that the same modelling of the US farm internal instruments with fixed unitary output/input subsidies does not recognize their true “countercyclical” natures as well. On this domestic support pillar, it is funny to note that it is not in the interest of the EU total welfare that the US stops the farm bill. This is so because the US domestically subsidizes the arable crop sectors and the EU is a net importer of these products (imports of oilseeds/oilmeals/cotton outweigh exports of cereals). In such a case the charge by the EU on the US internal support is a manifestation of the EU farm sector interests.

Regarding the market access pillar, it is worth noting that the limited impacts of the Japanese farm policy on developing countries was not expected due to the very huge Japanese import tariff ad valorem equivalents (more than 600% on some products). In fact rice protection explains 90% of total Japanese farm policy effects. Japanese rice production represents a small share of world production while Japanese rice demand is price (and income) inelastic. Accordingly the burden imposed on exporting countries by the high import tariff is finally quite limited (a result consistent with Lee and Sumner, 2006). Still China is the main winner of a Japanese trade liberalisation and this country must even push more for a Japanese trade opening than an EU one. This is even more evident with the simulation where Japan is allowed to select rice as a sensitive product. In that case Chinese welfare gains decrease by 92.5% (this result is consistent with those suggesting a capping on import tariffs like Jean et al., 2006).

Also initially unexpected is the fact that suppressing US import tariffs have limited effects even on the sugar and milk sectors. A quick look at the initial database suffices to understand this result. US initial import tariffs on sugar and milk products are quite low (25% and 18% respectively on the average), at least compared to the EU ones (38% and 110% respectively). These levels are nevertheless in contradiction with the ones from the OECD PSE database. According to this latter, the consumer Nominal Protection Coefficients (NPC) amount to 2.4 for the EU sugar sector and 2.9 for the US one.⁶ In the case of the milk sector, the figures are 1.4 for the EU and 1.8 for the US. Later in this paper we check whether the EU market protection is overestimated in the initial GTAP 6 database. Whether the US protection data are underestimated or not is left for another research.

3. Impacts of and on the European Union agricultural sectors

So far the analysis has been conducted at the aggregate farm level without considering the different agricultural sectors and markets. In this section we go deeper in the analysis of CAP effects by simulating the effects of policy instruments of main agricultural sectors (arable crops, sugar, dairy and beef) and analysing the effects on EU corresponding markets. This section has two main purposes. One is to better understand previous EU results.⁷ The second is to go deeper in the analysis on the way the modelling of CAP instruments affects the results.

a. The contributions of the different Common Market Organisations

We first analyse the welfare consequences of each pillar on 6 major sectors. Results are reported in table 2. Full liberalisation of the EU arable crops increases world welfare by 1.3 billion dollars and developing countries one by 0.3 billion dollars only. As expected the removal of the corresponding export subsidies has limited effects due to their small amounts. The removal of arable crops direct payments is more world welfare improving (0.9 billion dollars). However this welfare gain is very limited with respect to the shock because EU arable crops farmers initially receive 17 billion euros of direct payments. This result is absolutely not original. The OECD analysis (2006) also reveals a very huge transfer efficiency of these payments using the GTAPEM model. In

⁶ The consumer NPC measures the ratio between the domestic price paid by consumers and the border price. It is thus an indicator of the protection given by the market access instruments. Figures above pertain to the year 2001 and are roughly similar when we take the average over the 1999-2003 years to account for world market price volatility (as well exchange rates).

⁷ We fully agree with Tangermann here that “it is desirable that the results of analysis based on CGE models are presented and explained in more detail”.

very general terms, the main reason is that these direct payments are rather uniform across farm sectors and above all total land is fixed. Accordingly they work as a subsidy to a fixed factor and thus do not alter input allocations and market equilibriums. These results suggest that the decoupling introduced in the 2003 CAP reform does not greatly reduce CAP distortions as intended by EU authorities. However Gohin (2006b) challenges this approach which implicitly assumes that these payments are already capitalized in land values. This implicit assumption is contradicted by observed statistics on land values and rental rates. Assuming another working of these subsidies (as a mix of labour, capital and land subsidies), the author is then able to show that their removal has significant impacts on land allocations and product market equilibriums. In the fourth section we will explore the consequences of this alternative. Finally the import protection on arable crops markets has again a limited welfare effect. As expected the elimination of rice (coarse grains) import tariffs benefits to China (the US and Brazil/Argentina respectively).

The impacts of EU sugar policy instruments are even more troubling. Firstly their export subsidies have nearly no effects. Secondly current EU sugar import tariffs marginally penalize Brazil and Argentina while significantly hurting the welfare of our other developing countries group (which includes preference receiving ACP countries). A quick look at the initial database allows understanding these two results. EU sugar export subsidies are low in the database (172 millions dollars) while EC statistics report that they amount to 1 billion euros in 2001 (averaging 1.2 billions euros over 2000-2002). Such large difference comes from i) the very bad statistics on sugar trade that needed to be reconciled (Gehlhar, 2006) and ii) the very intricate EU sugar policy. On this last point the EU reports much lower export subsidies to the WTO because one significant part of them is paid for the re-exportation of ACP sugar.

Now why doesn't Brazil reap most of the gains of EU market access opening? A combination of two factors explains this troubling result. According to the GTAP 6 database, Brazil sugar is heavily taxed by the EU (175%) but ACP sugar too (117%). If the first figure is not unexpected, the latter is. Where does it come from? Bouët et al. (2006) explains the conversion of all market access instruments into one ad valorem tariff equivalent. When doing this process, they notably use a reference group concept to convert specific tariffs into ad valorem ones with an "unbiased" world price. Basically they consider that bilateral unit values should not be used during this conversion process because they are endogenous and/or badly measured. They propose to use different, more robust and exogenous, world prices defined on reference groups. As these authors recognize themselves, this methodology is not perfect and in the EU sugar case is quite misleading. To explain it, let's simplify for a while by ignoring the additional issue of binding/no-binding tariff rate quotas. ACP sugar exports to the EU are subject to lower (in the average) specific tariffs and these countries are able to capture quota rents. The corresponding bilateral trade values are much higher than the unit values of sugar traded among other countries. But these ACP specific tariffs are divided by a reference group price which is much lower than the "rent-included" bilateral value. Accordingly this conversion overestimates the ad valorem equivalent of the specific tariff for these countries. That overestimated tariff is then applied to the true bilateral values in the GTAP 6 database. This implies that ACP sugar is sold on the EU market at a price much higher than the intervention EU sugar price. To summarise up to this point, the ad valorem tariff equivalent of the specific tariff is computed with one given price and is introduced in the database with another price.

In fact the import protection measure is even more complex due to the tariff rate quotas. This policy instrument introduces a discontinuity in the marginal tariff which is not acknowledged with one ad valorem tariff equivalent. So far this issue is resolved by maximizing the tariff in the sense that out of quotas tariffs are assumed when imports approach the quota level. This assumption is correct in a simulation which will lead to an increase of these imports. But when we remove that instrument, the marginal tariff is not the out of quota tariff but the (often significantly) smaller in quota tariff. This is the second reason which explains why EU tariffs on ACP sugar are so high. More generally this problem of measuring the true protection level of multiple trade instruments applies not only to the EU sugar case but to other products as well. In the section four below, we will propose one way to tackle this issue.

The second factor which explains why Brazil does not gain much with EU sugar market opening is more discussed in the economic literature. It relates to the CES Armington trade modelling with limited substitution elasticities which tends to fix exporter shares. To illustrate this point, let's assume two exporters to one given country. Their shares change as follows:

$$\hat{s}_i = (\sigma - 1)(1 - s_i)(\hat{p}_j - \hat{p}_i)$$

with s the initial share, p the tariff inclusive import price and σ the elasticity of substitution. In the GTAP-AGR framework, this elasticity equals 5.4, the initial share of Brazil is only 2%. If we furthermore assume that export prices are unchanged for simplicity, then removing all EU import tariffs increase Brazil share in EU imports by 38.8%, so that they only represent 3% at the end of the simulation! This issue has long been discussed in the literature ; it nevertheless exhibits significant virtues as it has resisted decades of criticism (for instance, Brown, 1987, Valenzuela et al., 2006). In the context of the GTAP-AGR framework this assumption is nevertheless the only viable option in the short run (for a long run option, see Gohin and Laborde, 2006) and one immediate solution would consist in increasing substitution elasticities for “homogeneous” goods. This will be explored in section four.

EU liberalisation of dairy markets generates very limited welfare effects (only 2% of complete EU CAP liberalisation) while the milk market price support represents 22.5% of total market price support according to the OECD PSE in 2001. Again these results suggest that the 2003 CAP reform on dairy will bring limited effects and can be partly explained by the modelling of market access instruments (unawareness of specific tariffs, EU support price regime), the CES-based Armington trade modelling and the calibration of EU market protection. Another reason is a “composition” effect. The GTAP 6 database defines two dairy products, milk at the farm level and dairy products at the industry level. The latter is obviously an aggregate made of heterogeneous products: butter is a homogenous product and cheeses are highly differentiated. The shares of these different products in total dairy production vary by countries. Accordingly the country share in world milk production may be quite different from the country share in world dairy production. For instance according to the GTAP 6 database, EU milk production represents 22.5% of initial milk productions (in value terms) and EU dairy production 36.1%. By contrast, China shares are 1.7% and 0.5% respectively while India ones are 13.1% and 1.5%. If the values and shares of milk production by countries are very similar to those from FAO statistics, there are no comparable statistics for dairy products. These figures suggest that processing industries are protected in developed countries, a fact which is consistent with the tariff escalating issue. When we add this very huge share of EU in world dairy production to the Armington modelling of trade (milk is not traded), the

limited welfare effects of removing EU dairy policy appear reasonable. As Anderson (1985) illustrated a long time ago, the product disaggregation would be certainly valuable on this sector. Works are underway to tackle this issue (Grant et al., 2007; Gohin and Laborde, 2006) and in this paper we will keep the initial product definition.

The EU liberalisation of the beef sector gives most of the welfare effects in each pillar. This sector includes beef, veal and sheep meats. Beef export subsidies are for instance much lower than dairy ones but still generate more welfare effects. This is so because the EU is less important on this world market and other countries are less dependent on EU beef for their consumption. Thus other developing countries certainly suffer from an increase of EU beef prices (net of subsidy) but they can easily import from other countries (US, Australia and New Zealand). The suppression of EU beef domestic subsidy also leads to significant global welfare gains that are mainly harvested by the EU. These subsidies are lower than arable crops ones (9.6 billion dollars compared to 17 billions). The GTAP-AGR framework thus suggests that they are more distorting. In fact they are modelled as a capital subsidy and capital is perfectly mobile across farm sectors and imperfectly mobile between farm and non farm sectors. By contrast land is imperfectly mobile across farm sectors and not mobile at all with non agricultural sectors. Accordingly beef domestic subsidies attract more resources in the sector while arable crops ones do not. The production distorting effect of this capital subsidy is on the other hand limited by the production technology which assumes that capital, labour, land and feed ingredients are net substitutes. Such specification implies in particular that farmers use technologies intensive in capital (sucking cows) and extensive in land, labour and feed ingredients. Unfortunately this does not recognize that the CAP limits the number of animals per hectare. Moreover the numbers of animals eligible to the payments are also limited. Gohin (2006b) shows that modelling the latter constraint substantially challenges the results. Again we will consider one alternative modelling in section four. Opening the EU beef market is the most useful option for developing countries according to the GTAP-AGR. If the gains of Brazil and Argentina are not unexpected, the welfare effect on India is more curious because the EU did not import at all from this region according to EU trade statistics (COMEXT). The GTAP 6 database and its protection data explain this effect. At the initial point, India beef is supposed to be taxed by more than 200% compared to less than 90% for Brazil and Argentina. At the other extreme, New Zealand (included in Other developed) loses from this scenario because it mainly exports sheep meat under a tariff rate quota with very limited in quota tariffs. In relative terms the protection faced by New Zealand decreases less and hence the welfare loss. The interaction between the three pillars is here empirically important. When we sum the world welfare effects of all pillars, we get an increase of 10.6 billions dollars compared to 9.3 billion dollars in case of a simultaneous removal of all instruments.

The liberalisation of EU other animal sectors (pork/poultry meats) leads to limited welfare effects at the global level and is always negative for the EU. In fact the level of price instruments (unitary export subsidy at 5.4% and average import tariff at 18%) are low compared to other agricultural sectors and the EU share in world production value is considerable (32%) compared to physical quantities (19% for pork and 13% for poultry meat). Accordingly the EU can increase its welfare by exploiting terms of trade. This again comes from the Armington specification of trade.⁸

⁸ The Armington specification also allows explaining the 32% share in production value. In other words, this share can not be computed as one plus ad valorem tariff (18%) times the quantity share (between 19% and 13%).

Initial levels of trade policy instruments are also limited in the fruits and vegetables sector (the average ad valorem tariff is 18%). The other developing countries still gain 0.8 billion dollars in the elimination of EU import protection. Like on other products, the unique ad valorem tariff imperfectly captures the protection given by the tariff rate quotas applied to some fruits (bananas). EU imports represent a significant share of EU consumption in this sector compared to other CAP-supported ones (23% compared to 3% on dairy products for instance).

b. The effects on EU markets

In this subsection we analyse the impacts on EU markets of each pillar. In order to save space, table 3 reports the impacts of removing first export competition measures on all EU agricultural sectors, second domestic subsidies, third import tariffs and finally all instruments. In this table, we also report the initial values of domestic production, consumption, total EU exports and total EU imports. In CGE models price are usually calibrated to one and thus these values initially correspond to quantities. The import values include the tariffs while the export ones represent the domestic values before export subsidies.

Before analysing the impacts two remarks on these initial values are in order. Firstly the trade values are considerable. For instance, EU wheat exports represent 39% of domestic production and imports 37% of consumption. This is so because trade values include EU intra-trade. Self imports are usually maintained during the GTAP country aggregation process. Accordingly trade between EU members is supposed to be exports/imports and these quantities are introduced in the lower Armington nest. Netting out these self imports have been discussed in the GTAP context (see the frequently asked questions on the gtap website) and as will be see later, this has a significant impact on welfare effects. Secondly these initial data suggest that the EU is a net importer of sugar in 2001. If we remove EU intra trade, exports account for only 2.3% of EU sugar productions. As already underlined, this low figure comes from the difficulty to resolve trade statistics over all countries (Gehlhar, 2006). Unfortunately this is likely to bias downward the influence of the export competition pillar on this sector. We will examine this issue in section four.

As expected EU agricultural productions and exports generally decrease following the removal of CAP instruments while imports increase. More surprising are the small negative effects on EU total consumption of agricultural products. For instance EU dairy consumption decreases by 0.9% when the EU dairy producer price decreases by 2.8% in the full liberalisation experiment. In fact the EU final consumptions of food products marginally expand (1% in case of dairy products) and intermediate consumption decreases by a much larger extent.

Impacts on producer prices are also quite limited. This is quite usual with CGE models with constant returns to scale production technologies and significant degree of mobility of inputs across sectors. However these results clearly show that the standard GTAP-AGR model does not include production quotas. For instance, in the milk sector, it is very unlikely that a 0.5% reduction of milk producer price will translate to a 5% decrease of EU milk production because the vast majority of studies on the EU milk sector conclude to the existence of significant quota rents (Lips and Rieder, 2005 for instance). We will introduce these quotas in section four.

The impact of removing domestic support measures on the oilseed producer price is an exception with a 30% increase. The reason is that the oilseed output subsidy is large in the initial GTAP database and corresponds to the olive oil subsidy granted in Spain, Greece and Italy.

The last two columns of table 3 reports the impacts on land use and yields for major crops activities. The removal of domestic support measures has very strong impacts on land uses and yields per hectare. However econometric evidence so far does not support such results. For instance, Sckokai and Anton (2005) were unable to find significant effects of arable crops direct payments on yields. One possible explanation is that the GTAP-AGR framework is based on large substitution possibilities between land and other inputs. As Gohin (2006b) empirically shows, the way the arable crop direct payments are modelled also has a substantial bearing on the yield impacts. In section four, we will examine this issue. This is important per se and also when we will consider the EU set aside obligation. One may anticipate that in the GTAP-AGR framework removing the set aside obligation will have very limited market effects because additional cultivated lands will be compensated by large yield decreases.

The last result we want to underline is the decrease of EU imports when the EU removes export subsidies. Figures in table 3 are admittedly small due to EU intra-trade. But imports originating from non-EU countries decrease more significantly. As the EC (2006) underline, this does not reflect the EU market price support regime where imports are subject to tariff rate quotas and the EC simultaneously reduces import tariffs and intervention price in order to maintain preferences. We examine in the forthcoming section another modelling of imports and the EU market price support regime as was already done by van Meijl and von Tongeren (2002) for instance.

4. Sensitivity analysis to the modelling of the CAP

In the previous sections, we raise several comments on the way the CAP is modelled in the GTAPAGR framework. The purpose of this section is to measure the extent to which these modelling choices influence the results. We successively consider i) the issue concerning the measurements of market protection and export support (for sugar), ii) the introduction of production control measures, iii) the acknowledgment of tariff rate quotas, iv) the interaction of EU trade policy instruments due to the intervention price regime and v) the modelling of direct payments. Below we will focus the analysis on four main sectors (arable crops, beef, dairy and sugar) where there are sufficient published researches to support our sensitivity analysis. Before proceeding, we consider the issue of EU self imports in order to conduct the subsequent analysis on EU external trade and not EU total trade.

a. Self-imports

The GTAP database distinguishes 87 countries among which all 15 EU members (in 2001) appear. When the EU15 aggregate is built, the EU intra-trade flows must be considered, as this must be done for other country aggregation. The basic modelling option explicitly maintains these flows, notably because import values are higher than export values due to the additional transport costs. This modelling choice has already been discussed in the GTAP group and like Rutherford (2006) we remove them and affect the associated linked transport costs directly in the expenditure of domestic consumers.

The comparison of the first two rows of Table 4 illustrates the significant impact of the EU intra-trade modelling choice. When we remove all CAP instruments on the four main sectors (arable crops, beef, dairy and sugar), world welfare increases by 14.3 billion dollars with the standard approach and by 11.9 billion dollars with the new treatment of EU intra-trade. In fact the major difference resides in the effect of market access instruments. World welfare gains decrease from 9.3 to 6.7 billion US dollars. This reduction is mostly supported by the EU and the couple Brazil-Argentina. The logic of these results is rather simple. In the standard modelling, the self imports are (CES) nested with imports from outside the EU in the second-stage Armington trade modelling. The resulting import composite then substitutes with domestic product in the first-stage Armington trade modelling. The substitution elasticities in the second nest are twice those of the first nest. When we remove EU intra-trade, we basically introduce these flows in the domestic demand. Accordingly the substitution facilities between non EU imports and domestic products are lower in the alternative. By extension welfare effects are lower because these trade elasticities have very huge impacts on welfare effects of trade liberalisation (Valenzuela et al., 2006). These effects are quantitatively important in the beef sector where there is significant EU intra-trade, hence the significant reduction of welfare gains by the couple Brazil-Argentina. In the rest of the paper, we keep this alternative modelling of self imports, so that EU import price elasticities are on a level playing field.

b. Protection data and export subsidies

The impacts of policy instruments obviously depend on their initial amount. In the initial database we underline that the values of sugar exports and sugar export subsidies are considerably lower than statistics from EU sources. We also question the conversion of specific tariffs into ad valorem ones when there are simultaneously tariff rate quotas and that EU CIF import prices are significantly higher than other CIF prices.

Correcting data of CGE-supporting Social Accounting Matrix (SAM) is not a trivial task because market equilibrium must always be satisfied. In case of the sugar export values, we proceed as follows. We first increase the export values of sugar from the EU to the ROW aggregate by 1206 million US dollars based on COMTRADE values. We decrease by the same amount the value of EU sugar private consumption. In order to maintain the same EU final expenditures and trade figures over all agricultural products, we assume the opposite changes for the “other foods” product (exports are decreased and private consumption is increased). These first changes ensure that the EU SAM is still balanced. Again opposite changes need to be done for the SAM of the ROW country. As far as the sugar export subsidies are concerned, we increase their amount by 753 millions US dollars based on FEOGA expenditures. We decrease by a similar amount the EU private consumption of sugar.

As far as the protection data are concerned, we focus on the sugar and beef sectors because they generate most of the welfare effects. As said earlier, the conversion of specific tariffs is done with a reference group price (Bouët et al., 2006) and the resulting ad valorem tariff is applied on the much higher bilateral price in case of the sugar exported from the ROW country to the EU. In this paragraph, we assume that the true marginal tariff (in fact the out of quota tariff) is correctly computed and then we simply scale back the ad valorem tariff to reflect the difference between the reference group price and the bilateral price. In practical terms we reduce the ad valorem tariff imposed by the EU on ACP sugar from 114% in the initial database to 44.5%. This represents a 829 US millions dollars reduction on import tariffs which are compensated by a similar reduction of EU private consumption of sugar in order to balance the SAM for the EU.

We perform the same computations in order to correct the import tariff imposed by the EU on beef from Brazil/Argentina: we scale back the ad valorem tariff by 66%, from 88% to 56%. In the same way, the ad valorem tariff imposed by the EU on beef from the ROW country is reduced from 53% to 35%. Finally we suppress the ad valorem tariff imposed by the EU on India beef because there have been absolutely no trade flows between these two entities for many years.

It comes as no surprise that different data lead to different results. The results with this new modification are reported in the third row of table 4. It appears that the removal of export subsidies is more welfare improving and essentially to the benefit of the EU. By contrast the removal of tariffs is less welfare enhancing, both for developed countries as well as for developing countries. At this stage the removal of EU tariffs is still the major welfare enhancing scenario for developing countries but the magnitude of the gains is considerably reduced, from 6.2 to 2.6 US billion dollars. In terms of world welfare, the contribution of the market access pillar relative to the whole CAP also decrease significantly, from 65% (9.3 / 14.3) to 32% (2.8/8.8).

c. Production quotas

The development of EU milk and sugar productions has been constrained for decades by production quotas which are not introduced in the GTAPAGR framework. However these production quotas are very important instruments of the EU milk and sugar policy. The main difficulty in introducing these instruments in the GTAPAGR framework is certainly not the modelling (see for instance Hertel and Tsigas, 1991) but to determine the level of the associated quota rents. Based on van Meijl and van Tongeren (2002), Frandsen et al. (2003) and Lips and Rieder (2005) we assume that the unit quota rents represent 20% of initial producer prices in both sectors. We simultaneously reduce the value of other factors of production used in these sectors (labour and capital) using their initial share. Our introduction of production quotas is made in a complementarity fashion, i.e. the quota regimes are endogenous.

The effects of introducing these production quotas on CAP impacts are provided in the fourth row of table 4. It appears that the main effect is to significantly reduce the world welfare gains of an export subsidy removal scenario from 1.7 to 0.9 billion US dollars. This reduction is mainly supported by the EU equivalent variation (from 2.4 to 1.7 billion US dollars), simply because price must significantly decrease in these two sectors before resource allocation (and hence welfare) changes. The impact of the market access pillar is also significantly reduced from 2.8 to 2 billion US dollars at the world level. Again the main welfare loser is the EU because these two farm sectors better resist liberalisation.

d. Tariff rate quotas

The protection of EU agricultural markets is characterised by the predominance of tariff rate quotas. Again if the modelling of such instrument is well known, its practical implementation is challenging. The main reason is that they are defined at tariff lines while economic models are usually defined on product aggregates due to availability of data (Gohin and Laborde, 2006). Accordingly the aggregation must acknowledge the discontinuity involved in the TRQ. Another important reason is that this instrument generates rents and their distribution between importers and exporters should be identified.

In the GTAPAGR framework, the default assumptions are to use the out of quota tariff when imports approach the quota level and to implicitly affect the quota rent to the importer. This last assumption is very crucial as it

implies that export prices by foreign countries to the EU are equal to their true production costs. Accordingly these foreign producers are not able to export the same quantities to the EU if their export prices slightly decrease. The assumption is supported by the analysis of Tangermann (2005) who concludes that importers in developed countries are likely to capture these rents. In this paper we will adopt this assumption but like the EC (2006) we suspect that additional works would be useful here on the measurement of true production costs. On the other hand we examine the assumption that the marginal tariff equals to the out of quota tariff when imports reach the quota level. Our concern can be simply explained in the sugar case. The application of the out of quota tariff to the bilateral cif import price between the ACP and the EU leads to a domestic price of imports much higher than the EU market price. These imports are in fact taxed at a much lower rate. In order to compute our true marginal tariff, we proceed as follows. We first compute the maximum entry price by multiplying the reference price with the initial ad valorem tariff rate. We then assume that the marginal tariff is given by the difference between this maximum entry price and the bilateral price. With these assumptions, the tariff rate imposed by the EU on ACP sugar becomes zero while the tariff rate on beef imported from Brazil/Argentina is reduced to 23.5%. We thus reduce again the level of tariff on the GTAP database to reflect the lower in quota tariff which applies on higher bilateral trade values.

The results of the new modification are reported in the fifth row of table 4. As expected, the world welfare effect of removing the EU tariff protection is again much lower (from 2 to 1.2 US billion dollars). The ROW country group now does not significantly benefit from this experiment. This critical impact of the TRQ in the assessment of global welfare effects of trade liberalization is also found in other recent studies (Decreux and Ramos, 2007).

e. The intervention price regime

So far we measure the impacts of each pillar independently of interactions between instruments thanks to the Armington trade modelling. The EC (2006) questions the absence of articulation between tariffs and export subsidies in the representation of EU price support regimes. In the academic literature, there is recognition that these two instruments are linked. Van Meijl and von Tongeren (2002) in particular assume that the reduction of market price support implies a simultaneous decrease of export subsidies and import tariffs. In the cereal sectors, these two policy instruments are made endogenous and are linked to the two exogenous intervention and threshold prices respectively. As the evolutions of the two latter are practically linked (due to the “155%” rule), it is thus clear that the removal of export subsidies is linked to a reduction of tariff. In other sectors (notably beef), these authors also assume that the reduction in support prices is reflected in exogenous lower import tariffs and exogenous lower export subsidies. Unfortunately the precise relationship is here unclear.

Regarding the EU support price regimes and the links between tariffs and export subsidies, our understanding is as follows. When the EU simultaneously grants export subsidies and imports significant quantities in one given market, the imports are preferential and motivated by historical relationship (butter) and/or as a development policy tool (sugar). Thus the EU wants to maintain these trade flows and will reduce, if necessary, the import tariffs in case of market changes. On this understanding we assume that the removal of export subsidies scenario should be accompanied by a reduction of tariff rates such that total imports are maintained in each export subsidising EU agricultural sector. The impacts of removing market access instruments should in that case be computed as the difference between the simultaneous removal of both instruments and the new export subsidy scenario.

The results of this new decomposition are given in the sixth row of table 4. The contribution of the export competition pillar now increases from 1.1 to 1.5 billion US dollars because we simultaneously reduce import tariffs on sugar (by 100%) and dairy products (by 24%). The additional welfare gain is mostly reaped by the EU and the couple Brazil/Argentina. By definition the contribution of the “remaining” market access pillar is lower. In the initial setting, the market access pillar contributes to 65% of world welfare gain generated by the EU CAP liberalisation. In our new setting, it only contributes to 14% and moreover the absolute level decreases by 90 % (from 9.3 to 1 US billion dollars). By contrast the contribution of the export competition pillar increases from 7% to 23%.

f. the modelling of direct payments

The fact that massive direct payments have limited welfare consequences puzzles many observers. Global models are criticized for their inability to represent the different channels (wealth, dynamic, efficiency effects) by which these direct payments influence country production and ultimately trade (for instance, Roberts and Gunning Trant, 2007). If these critics are theoretically justified, there is to date no published researches showing major impacts of the direct payments through these channels. On the other hand Gohin (2006b) questions the usual modelling of EU direct payments on currently available models and tests alternative specifications. The first point is that these models (including the GTAP-AGR framework) assume that arable crops direct payments are fully capitalized in land values. Comparison with land rental rates shows that this assumption is untenable. This author reconciles these figures by assuming that arable crops direct payments are partly land subsidies, partly labour/capital subsidies. The second point is that these models implicitly assume that beef direct payments are fully coupled and accordingly does not recognize the different constraints associated with these payments. Their introductions on the different categories of animals significantly alter the production and trade effects of EU beef direct payments.

In this last sensitivity analysis we basically implement the alternative specifications developed by Gohin (2006b) in the GTAP-AGR framework. As far as the arable crops sectors are concerned we reduce the initial level of land subsidies and introduce subsidies on labour and capital uses. We maintain the total level of direct payments but the distribution across factors is done according to the factors shares in the value-added. This implies that when we remove these direct payments, we remove land subsidies and the labour and capital subsidies as well. We also increase the land endowment (by 5%) to reflect the set aside policy linked to these direct payments. As far as the cattle sector is concerned, the GTAP-AGR product disaggregation is not sufficiently detailed to reproduce the different beef premiums and attached constraints. As underlined earlier, the initial modelling overstates the impacts of these payments by considering them as a capital subsidy (because capital is a substitute to other factors in the cattle production technology, including the more fixed land factor). In our alternative modelling, we consider that these direct payments are output subsidies. We also introduce a production quota to reflect the different constraints on suckling herds. Based on simulation results of Gohin (2006b) we assume that the associated quota rent is half the cattle direct premiums.

These last changes obviously significantly alter the welfare effects of the domestic support pillar. World welfare gains decrease from 4.9 to 3.9 US billion dollars. This reduction of welfare gain is mainly supported by the EU. In fact there are two opposite forces. The modifications made on the arable crops direct payments make them initially more distortionary because resource allocation of primary factors across sectors changes more

significantly. On the other hand the introduction of the beef premiums constraints makes them much less distortionary. The impacts of the two other pillars are slightly reduced.

Conclusion

The present round of multilateral trade negotiations is still stalemated over agricultural trade. The EU is pressed by its trading partners to open its agricultural markets. Economic evaluations of trade liberalisation scenarios unanimously conclude that substantial market opening are required for a successful (welfare improving) Doha round. In this paper we perform new evaluations to precisely identify the contributions of the CAP and to examine the robustness of these evaluations to the representation of this complex policy. Using standard approaches our first simulations show that the EU has a major responsibility in delivering developing countries significant gains. On the other hand, when we conduct the same experiments with a more relevant calibration and modelling of the CAP instruments, the potential gains and their distribution are significantly modified: world welfare gains decrease by 60% and the contribution of the market access pillar by 52% (from 65% to 13%). For developing countries, the reduction of their welfare gains due to a CAP dismantling is even more significant (92.5%).

We are quite reluctant to draw too general policy conclusions from these simulations because they are based on modelling assumptions which could be improved and we just demonstrate that available results are not really robust. In this paper we only modify some data measuring the support given by the CAP and the way these policy instruments are modelled. On the other hand we never modify the (CES-based) trade elasticities which are well known to have significant impacts.

But if political decisions are to be feed by available economic evaluations, our empirical analysis allows us to conclude that the current focus in the Doha round on EU agricultural market access is misplaced. This statement has already been expressed in general terms by Charlton and Stiglitz (2005) for instance. Our contribution in this paper is to empirically demonstrate this point by using and improving a widely used economic tool.

Table 1. Welfare impacts of agricultural liberalisation in developed countries (equivalent variation in income, 2001 \$US million)

Impacts on	EU15	US	Japan	Other developed	Total developed	Brazil-Argentina	China	India	Other developing	Total developing	World
Liberalisation in											
Hertel and Keeney											
Export subsidies					2554	99	-78	13	-1545	-1511	1043
Domestic support					2450	1152	-428	72	-437	359	2809
Market access					31811	4746	1141	409	5688	11984	43795
Total					36815	5997	635	494	3706	10832	47647
All developed											
Export subsidies	2469	-113	-536	370	2190	107	-103	18	-1721	-1699	489
Domestic support	4091	2184	-661	548	6161	751	-522	42	-1065	-794	5370
Market access	193	1613	24376	2537	28719	4479	2106	632	4980	12197	40919
Total	6829	3856	23246	3495	37426	5530	1748	834	2067	10179	47606
EU + US + Japan											
Export subsidies	2469	-113	-536	370	2190	107	-103	18	-1721	-1699	489
Domestic support	4130	2174	-637	485	6152	739	-513	37	-1016	-753	5400
Market access	295	786	24265	2336	27682	4461	2114	635	5081	12291	39974
Total	6750	3061	23149	3191	36151	5498	1765	831	2177	10271	46424
EU15											
Export subsidies	2479	-118	-510	353	2204	103	-95	18	-1689	-1663	542
Domestic support	4658	89	-81	191	4857	328	-87	-8	-54	179	5038
Market access	-363	356	-449	1075	619	4407	98	788	4226	9519	10141
Total	6139	298	-1084	1556	6909	5080	-133	951	2326	8224	15135
Total with sensitive pds	3550	369	-1016	1645	4548	1580	121	-14	1010	2697	7245
US											
Export subsidies	-21	2	-19	8	-30	1	-6	0	-26	-31	-61
Domestic support	-552	1991	-850	257	846	357	-438	39	-1040	-1082	-235
Market access	21	-551	19	182	-329	175	-5	-7	239	402	73
Total	-554	1431	-858	449	468	532	-444	31	-829	-710	-243
Japan											
Export subsidies	0	0	0	0	0	0	0	0	0	0	0
Domestic support	-16	21	310	24	339	8	9	3	43	63	402
Market access	859	995	24638	1130	27622	-111	2094	-168	549	2364	29988
Total	795	1012	24781	1155	27743	-99	2088	-164	479	2304	30048
Total with sensitive pds	4	1289	763	1038	3094	19	157	-26	320	470	3563

Table 2. Welfare impacts of liberalisation in EU agricultural sectors (equivalent variation in income, 2001 \$US million)

Liberalisation in EU15:	Impacts on										Total developed	Total developing	World
	EU15	US	Japan	Other developed	Total developed	Brazil-Argentina	China	India	Other developing	Total developing	World		
Arable Crops													
Export subsidies	326	-3	-35	56	344	18	-21	6	-293	-290	55		
Domestic support	633	69	-102	98	698	308	-101	8	-25	190	890		
Market access	39	107	-61	7	92	107	365	-24	-110	338	430		
Total	911	171	-202	159	1039	443	228	-5	-378	288	1328		
Sugar													
Export subsidies	116	-4	-19	4	97	14	-3	1	-53	-41	57		
Domestic support	7	0	0	0	7	0	0	0	2	2	8		
Market access	946	51	-28	13	982	105	-53	-3	1212	1261	2242		
Total	1086	46	-51	18	1099	122	-57	-2	1150	1213	2313		
Dairy													
Export subsidies	713	-108	-178	202	629	23	-54	-2	-498	-531	99		
Domestic support	155	-4	-8	19	162	-5	-3	-1	-30	-39	123		
Market access	-925	31	-245	1074	-65	31	-106	-17	413	321	255		
Total	-221	-73	-431	1307	581	55	-167	-20	-78	-210	370		
Beef													
Export subsidies	913	33	-40	60	966	17	-7	9	-237	-218	747		
Domestic support	3365	24	22	86	3497	47	12	-10	32	81	3578		
Market access	2220	-127	-20	-83	1990	3447	-213	822	254	4300	6300		
Total	4588	-111	-51	12	4438	3953	-237	983	125	4824	9261		
Other animals													
Export subsidies	-34	34	-159	38	-121	22	3	0	-160	-135	-255		
Domestic support	-34	4	-10	7	-33	2	0	-1	-3	-2	-34		
Market access	-1063	93	-58	35	-993	638	-78	2	746	1308	315		
Total	-1156	135	-229	82	-1168	666	-76	2	586	1178	9		
Fruits and vegetables													
Export subsidies	27	-6	-4	0	17	0	1	-1	-50	-50	-33		
Domestic support	-52	-1	-3	3	-53	2	1	-1	16	18	-34		
Market access	-812	-62	-37	6	-905	29	126	-12	839	982	76		
Total	-883	-70	-46	9	-990	32	129	-13	814	962	-29		

Table 3. Market impacts of liberalisation in EU agricultural sectors (initial values in million US dollars and impacts in %)

Impacts on :	Production	Consumption	Exports	Imports	Producer price	Land uses	Yields
Wheat	10272	9922	4004	3654	1		
Export subsidies	-5.1	-0.9	-12.9	-2.3	-1.3	-0.9	-4.2
Domestic support	-4.2	-0.3	-8.3	1.6	2.6	-22.3	18.2
Market access	4.4	-2.6	13.6	-4.6	-2.9	2.1	2.3
Full liberalisation	-6.0	-4.1	-10.5	-5.9	-1.9	-21.3	15.3
Other grains	11464	11024	3130	2690	1		
Export subsidies	-5.7	-1.1	-18.4	-1.5	-1.4	-1.2	-4.6
Domestic support	-1.5	-0.8	-3.0	-0.1	2.6	-21.0	19.2
Market access	-2.9	-3.4	0.8	-0.9	-3.7	-0.7	-2.2
Full liberalisation	-10.6	-5.5	-22.0	-2.9	-2.9	-22.3	11.7
Oilseeds	5665	9971	941	5247	1		
Export subsidies	1.3	-0.2	3.4	-1.2	-0.8	1.6	-0.3
Domestic support	-34.7	-3.3	-60.9	22.8	30.5	-23.7	-11.0
Market access	6.7	-2.1	19.5	-7.7	-3.1	2.8	3.8
Full liberalisation	-29.9	-6.1	-50.3	11.9	25.4	-19.6	-9.2
Sugar/Sugarbeet	19654	21981	1373	3700	1		
Export subsidies	-2.6	-0.8	-30.0	-1.6	-0.3	0.3	-2.3
Domestic support	0.5	0.1	2.3	-0.1	-0.7	15.5	-15.0
Market access	-38.6	-4.0	-49.3	235.7	-4.3	-12.0	-17.2
Full liberalisation	-41.1	-5.0	-88.4	227.0	-5.1	2.0	-33.1
Dairy products/ Milk	110546	106474	21527	17455	1		
Export subsidies	-5.0	-0.5	-24.1	-1.0	-0.5		
Domestic support	0.2	0.9	0.4	0	-0.1		
Market access	-6.6	-0.4	-13.6	23.7	-2.2		
Full liberalisation	-12.4	-0.9	-41.0	20.8	-2.8		
Beef/Cattle	61698	63513	7741	9556	1		
Export subsidies	-3.0	-0.2	-23.9	-1.1	-0.4		
Domestic support	-3.9	-1.2	-14.2	5.7	5.4		
Market access	-27.3	-0.2	-50.9	160.5	-3.1		
Full liberalisation	-35.4	-1.6	-86.3	181.5	1.5		

Other meats/animals	97376	96642	16792	16058	1
Export subsidies	-1.3	-0.2	-7.3	-0.6	-0.3
Domestic support	0.2	0.4	0.7	-0.2	-0.2
Market access	-4.6	-0.5	-9.9	15.0	-2.0
Full liberalisation	-5.7	-0.6	-17.2	13.1	-2.5
Fruits and vegetables	45718	57048	15999	27329	1
Export subsidies	0.5	0	0.5	-0.7	-1.0
Domestic support	4.1	0.6	6.6	-1.6	-4.6
Market access	-5.2	0.3	-7.9	4.5	-4.8
Full liberalisation	-0.4	0.8	-0.7	1.8	-10.0

Table 4. Sensitivity of welfare effects of removing EU agricultural policy instruments to modelling choices (equivalent variation in income, 2001 SUS million)

	EU15	US	Japan	Other developed	Total developed	Brazil-Argentina	China	India	Other developing	Total developing	World
Initial modelling											
Export subsidies	2115	-79	-277	327	2086	74	-87	14	-1098	-1097	989
Domestic support	4605	87	-74	189	4806	331	-89	-6	-55	180	4986
Market access	2425	60	-344	978	3118	3611	3	774	1775	6164	9282
Total	7881	25	-717	1421	8610	4345	-213	938	634	5704	14314
Self-imports											
Export subsidies	1871	-20	-274	354	1931	99	-71	21	-891	-841	1090
Domestic support	4354	98	-79	184	4557	291	-63	6	73	307	4865
Market access	1299	237	-138	376	1774	2512	185	496	1794	4988	6762
Total	6308	295	-503	892	6992	3194	22	633	1052	4901	11893
Data											
Export subsidies	2378	-1	-287	374	2465	154	-77	29	-811	-704	1761
Domestic support	4252	98	-79	184	4455	289	-63	6	71	303	4757
Market access	-231	186	-130	375	201	1793	239	-8	604	2627	2828
Total	5593	270	-498	902	6267	2440	71	33	-16	2528	8795
Production quotas											
Export subsidies	1713	0	-210	291	1794	96	-67	13	-957	-915	879
Domestic support	4509	96	-70	176	4711	280	-62	3	64	285	4996
Market access	-927	186	-60	280	-521	1715	254	-19	589	2539	2018
Total	5048	249	-395	736	5637	2241	91	7	-301	2038	7675
Tariff rate quotas											
Export subsidies	1950	1	-203	287	2035	87	-65	12	-958	-924	1112
Domestic support	4408	96	-70	176	4610	281	-62	3	63	285	4895
Market access	-274	187	-76	347	184	632	323	-20	61	996	1181
Total	5484	262	-386	792	6152	1031	168	4	-663	540	6693
Intervention regime											
Export subsidies	2186	6	-204	324	2312	292	-67	25	-1027	-777	1536
Market access	-261	173	-125	316	103	409	299	-21	170	857	959
Direct payments											
Export subsidies	1979	18	-181	277	2093	308	-68	23	-1011	-748	1345
Domestic support	3453	116	-148	244	3665	341	-83	18	-61	215	3879
Market access	-347	183	-113	301	24	323	290	-22	131	722	746
Total	4589	281	-474	870	5266	1073	144	16	-791	422	5709

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Annex 1: Relative ranking of price and welfare effects of domestic subsidies and tariffs

Our objective in this annex is to clarify the debate raised by the EC (2006) by comparing price and welfare effects in the same table. Indeed Diao et al. (2001) show that the increase of world prices is (roughly) equally explained by the market access instruments and other instruments. In the same the contribution of market access instruments to welfare gains are much higher than the other instruments. This ranking is theoretically curious, as the simple example illustrates. We consider a two country world with only the domestic country subsidizing its production or taxing imports. Like Anderson et al. (2006), we first use a graphical analysis and then an analytical approach.

Graphical approach

Introduction of domestic subsidies

Figure1 - Market impacts of the introduction of domestic subsidies

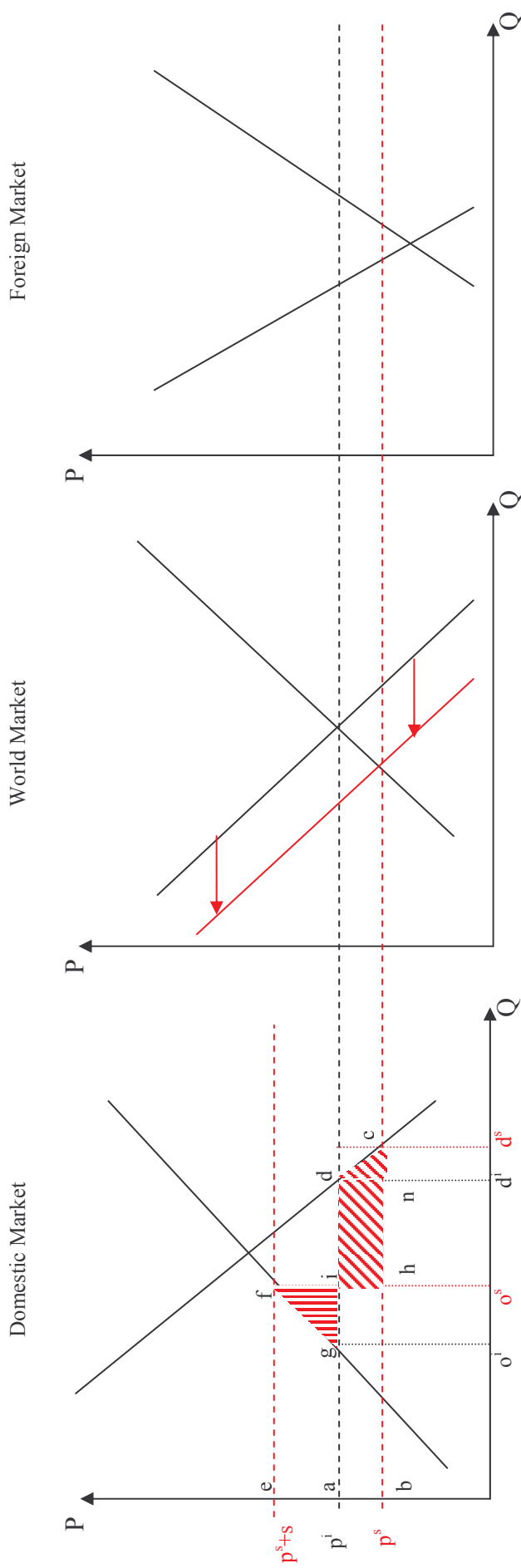


Figure1 graphically represents the impact on domestic, world and foreign markets of the introduction of domestic subsidies. The initial situation, before introducing subsidies, is represented in black and the changes induced by the introduction of subsidies is represented in red.

Initially p^i , which is the equilibrium price on world market, is higher than the equilibrium price on domestic market leading to a demand higher than supply. So, the domestic country is a net importer. The opposite phenomenon occurs in the foreign country which is then a net exporter.

When subsidies s are introduced in the domestic country, the producer receives a unitary price higher than p^i and thus produces more, this makes imports demand decrease, leading to a shift of demand on world market and a decrease in world price. As the new world price p^s is lower than p^i , domestic demand increase switching from d^i to d^s . The producer now receives p^s+s instead of p^i and the new supply o^s is higher than the initial supply o^i , as well.

So, the welfare gain of consumer, coming from the decrease in world price, is represented by the area $abcd$ on figure 1. The welfare gain of producer, coming from the subsidies introduction, is represented by $eagf$. Finally, the tax payer, who has to financed subsidies, loses welfare and this loss is represented by $ebhf$ rectangle on figure 1. The global welfare gain is thus represented by $ihcd$ (▨) and the global welfare loss by gif (▨). This can be expressed as follows :

$$\text{Welfare loss : } \frac{1}{2}(o^s - o^i)(p^s + s - p^i)$$

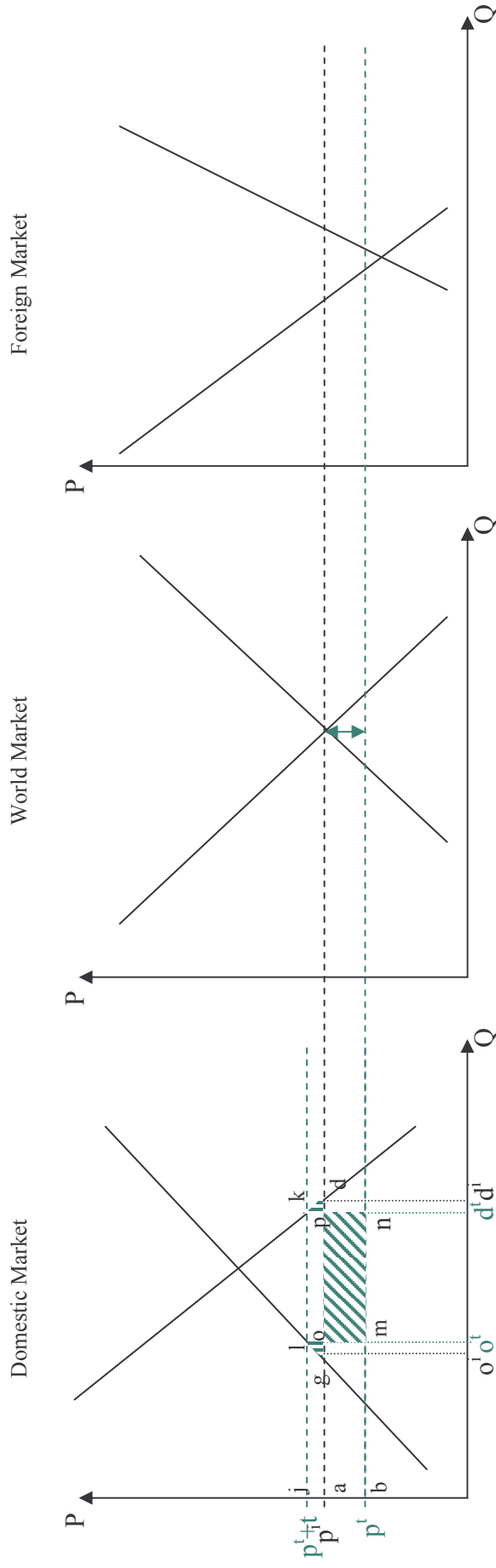
$$\text{Welfare gain : } (d^s - o^s)(p^i - p^s) - \frac{1}{2}(d^s - d^i)(p^i - p^s)$$

$$\Delta W^s = (d^s - o^s)(p^i - p^s) - \frac{1}{2}(d^s - d^i)(p^i - p^s) - \frac{1}{2}(o^s - o^i)(p^s + s - p^i)$$

$$\Delta W^s = \frac{1}{2}(p^i - p^s)(d^s - o^s + d^i - o^i) - \frac{1}{2}s(o^s - o^i)$$

Introduction of tariffs on imports

Figure2 - Market impacts of the introduction of tariffs on imports



We find in figure2 the graphical representation of introduction of tariffs on imports in domestic country. As previously the initial situation is represented in black and the final one in green.

The introduction of tariffs leads exporter to lower their price, so the world price falls from p^i to p^i . Domestic market is then set to the new world price plus tariffs t . Domestic consumer and producer thus face a new market price p^{i+t} higher than p^i : the former decreases his demand from d^i to d^i whereas the latter increases his supply from o^i to o^i . Therefore, welfare gains of producer is represented by area ajl and welfare loss of consumer by area knk . Furthermore, tax payer receives tariffs paid on imports and thus benefits from a welfare gain represented by rectangle $lmnk$. The global welfare gain is here represented by $omnp$ (hatched) and the global welfare loss by $gol + kpd$ (green). This can be expressed as follows :

$$\text{Welfare loss} : \frac{1}{2}(p^i + t - p^i)(o^i - o^i) + \frac{1}{2}(p^i + t - p^i)(d^i - d^i)$$

Welfare gain : $(p^i - p^j)(d^i - o^i)$

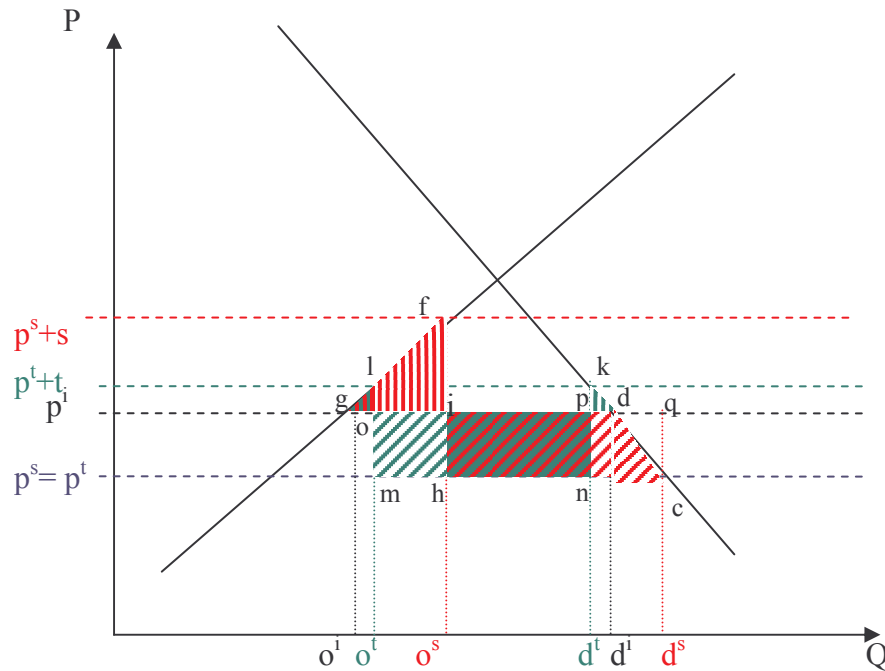
$$\Delta W^i = (p^i - p^j)(d^i - o^i) - \frac{1}{2}(p^i + t - p^j)(o^i - o^j) - \frac{1}{2}(p^i + t - p^j)(d^i - d^j)$$

$$\Delta W^i = (p^i - p^j)(d^i - o^i) - \frac{1}{2}(p^i - p^j + t)(o^i - o^j + d^i - d^j)$$

$$\Delta W^i = \frac{1}{2}(p^i - p^j)(d^i - o^i + d^i - o^i) - \frac{1}{2}t(d^i - d^j + o^i - o^j)$$

Comparison of welfare changes from both politics

Figure3 - Compared impacts of tariffs and subsidies on domestic market
Domestic Market



▤ : welfare loss ▨ : welfare gain

Figure3 summarizes results from figure1 and figure2 in order to compare welfare changes from both tariffs and subsidies introductions. Our objective is to know which politic leads to higher changes in welfare, world price being constant. Thus, as represented on the graph, we suppose that $p^s = p^t$. Moreover as changes in world prices are induced by changes in imports, we also have identical changes in imports.

We have :

$$\Delta W^s = \frac{1}{2}(p^i - p^s)(d^s - o^s + d^i - o^i) - \frac{1}{2}s(o^s - o^i)$$

and

$$\Delta W^t = \frac{1}{2}(p^i - p^t)(d^t - o^t + d^i - o^i) - \frac{1}{2}t(d^i - d^t + o^t - o^i)$$

World price (and thus imports) change is the same manner with domestic subsidies and tariffs introductions :

$$p^s = p^t \quad \text{and} \quad d^s - o^s = d^t - o^t .$$

Lets now suppose that demand and supply functions are such that : $D = c - eP$ and $O = a + bP$, with $a > 0, b > 0, c > 0$ and $e > 0$

This implies :

$$d^s - o^s = d^t - o^t$$

$$\Leftrightarrow c - dp^s - a - bp^s - bs = c - ep^t - et - a - bp^t - bt$$

$$\Leftrightarrow -bs = -et - bt$$

$$\Leftrightarrow s = \left(\frac{b+e}{b} \right) t$$

So :

$$\Delta W^t = \frac{1}{2} (p^i - p^s) (d^s - o^s + d^i - o^i) - \frac{1}{2} \frac{b}{b+e} s (o^s - o^i + d^i - d^s)$$

$$\Leftrightarrow \Delta W^t = \Delta W^s + \frac{1}{2} s (o^s - o^i) - \frac{1}{2} \frac{b}{b+e} s (o^s - o^i + d^i - d^s)$$

$$\Leftrightarrow 2(\Delta W^t - \Delta W^s) = s(o^s - o^i) \left(1 - \frac{b}{b+e} \right) + \frac{b}{b+e} s (d^s - d^i)$$

$$\Leftrightarrow 2(\Delta W^t - \Delta W^s) = \frac{ds}{b+e} (o^s - o^i) + \frac{bs}{b+e} (d^s - d^i)$$

$$\Leftrightarrow 2(\Delta W^t - \Delta W^s) = \frac{ds}{b+e} (a + bp^s + bs - a - bp^i) + \frac{bs}{b+e} (c - dp^s - c + dp^i)$$

$$\Leftrightarrow 2(\Delta W^t - \Delta W^s) = \frac{bes}{b+e} (p^s + s - p^i) + \frac{bes}{b+e} (p^i - p^s)$$

$$\Leftrightarrow 2(\Delta W^t - \Delta W^s) = \frac{bes^2}{b+e}$$

All coefficients are positive, thus : $\Delta W^t - \Delta W^s = \frac{1}{2} \frac{bes^2}{b+e} > 0 \Leftrightarrow \Delta W^t > \Delta W^s$

Analytical approach

Our objective here is to compare analytically the welfare changes coming from an introduction of subsidies with those coming from an introduction of tariffs.

Initial situation :

$$\text{We have the demand function : } D(p) = c - ep \Leftrightarrow P^D(d) = \frac{c-d}{e}$$

$$\text{and the supply function : } O(p) = a + bp \Leftrightarrow P^O(o) = \frac{o-a}{b}$$

The initial welfare of consumer is thus :

$$W_C^i = \int_0^{d^i} P^D(y).dy - p^i d^i = \int_0^{d^i} \frac{c-y}{e}.dy - p^i d^i$$

$$W_C^i = \left[\frac{c}{e}y - \frac{y^2}{2e} \right]_0^{d^i} - p^i d^i = -\frac{1}{2e}d^{i2} + \left(\frac{c}{e} - p^i \right) d^i$$

$$W_C^i = -\frac{1}{2e}d^{i2} + (c - ep^i) \frac{d^i}{e} = -\frac{1}{2e}d^{i2} + \frac{1}{e}d^{i2}$$

$$\boxed{W_C^i = \frac{d^{i2}}{2e}}$$

$$\boxed{W_C^i = \frac{(c - ep^i)^2}{2e} = \frac{c^2 - 2cep^i + e^2 p^{i2}}{2e}}$$

The initial welfare of producer is :

$$W_P^i = p^i o^i - \int_0^{o^i} P^O(y).dy = p^i o^i - \int_0^{o^i} \frac{y-a}{b}.dy$$

$$W_P^i = p^i o^i - \left[\frac{y^2}{2b} - \frac{a}{b}y \right]_0^{o^i} = -\frac{o^{i2}}{2b} + \frac{o^i}{b}(bp^i + a)$$

$$\boxed{W_P^i = \frac{o^{i2}}{2b}}$$

$$\boxed{W_P^i = \frac{(a + bp^i)^2}{2b} = \frac{a^2 + 2abp^i + b^2 p^{i2}}{2b}}$$

The initial welfare of tax payer is null :

$$\boxed{W_T^i = 0}$$

The total welfare is thus equal to :

$$W^i = W_C^i + W_P^i + W_T^i$$

$$W^i = \frac{c^2 - 2cep^i + e^2 p^{i2}}{2e} + \frac{a^2 + 2abp^i + b^2 p^{i2}}{2b}$$

$$\boxed{W^i = \frac{bc^2 - 2bcep^i + be^2 p^{i2} + ea^2 + 2abep^i + eb^2 p^{i2}}{2eb}}$$

Introduction of subsidies :

We have the demand function : $D^s(p) = c - ep \Leftrightarrow P^{Ds}(d) = \frac{c-d}{e}$

and the supply function : $O^s(p) = a + bp + bs \Leftrightarrow P^{Os}(o) = \frac{o-a-bs}{b}$

The welfare of consumer is now :

$$W_C^s = \int_0^{d^s} P^{Ds}(y).dy - p^s d^s = \int_0^{d^s} \frac{c-y}{e}.dy - p^s d^s$$

$$\boxed{W_C^s = \frac{d^{s2}}{2e}}$$

$$W_C^s = \frac{(c - ep^s)^2}{2e}$$

$$\boxed{W_C^s = \frac{c^2 - 2cep^s + e^2 p^{s2}}{2e}}$$

The welfare of producer is :

$$W_P^s = p^s o^s - \int_0^{o^s} P^{Os}(y).dy = p^s o^s - \int_0^{o^s} \frac{y-a-bs}{b}.dy$$

$$W_P^s = p^s o^s - \left[\frac{y^2}{2b} - \frac{a+bs}{b}y \right]_0^{o^s} = \frac{o^s}{b}(o^s - a - bs) - \frac{o^{s2}}{2b} + \frac{o^s}{b}(a + bs)s$$

$$\boxed{W_P^s = \frac{o^{s2}}{2b}}$$

$$W_P^s = \frac{(a + bp^s + bs)^2}{2b} = \frac{(a + bp^s)^2 + b^2 s^2 + 2bs(a + bp^s)}{2b}$$

$$\boxed{W_P^s = \frac{a^2 + b^2 p^{s2} + 2abp^s + b^2 s^2 + 2abs + 2b^2 sp^s}{2b}}$$

The welfare of tax payer is :

$$\boxed{W_T^s = -so^s}$$

$$W_T^s = -s(a + bp^s + bs)$$

$$\boxed{W_T^s = -as - sbp^s - bs^2}$$

The total welfare is thus equal to :

$$W^s = W_C^s + W_P^s + W_T^s$$

$$W^s = \frac{bc^2 - 2bcep^s + be^2 p^{s^2} + a^2 e + b^2 ep^{s^2} + 2abep^s + b^2 es^2 + 2abes + 2b^2 esp^s - 2aebs - 2seb^2 p^s - 2eb^2 s^2}{2eb}$$

$$W^s = \frac{bc^2 - 2bcep^s + be^2 p^{s^2} + a^2 e + b^2 ep^{s^2} + 2abep^s - b^2 es^2}{2eb}$$

$$W^s = \frac{p^s (-2bce + 2abe) + p^{s^2} (be^2 + b^2 e) + bc^2 + a^2 e - b^2 es^2}{2eb}$$

Which leads to the welfare change induced by the introduction of subsidies :

$$\Delta W^s = W^s - W^i = \frac{p^s (-2bce + 2abe) + p^{s^2} (be^2 + b^2 e) + bc^2 + a^2 e + b^2 es^2 - bc^2 + 2bcep^i}{2eb}$$

$$- \frac{be^2 p^{i^2} + ea^2 + 2abep^i + eb^2 p^{i^2}}{2eb}$$

$$\Delta W^s = \frac{p^s (-2bce + 2abe) + p^{s^2} (be^2 + b^2 e) - b^2 es^2 - p^i (-2bce + 2abe) - p^{i^2} (be^2 + eb^2)}{2eb}$$

$$\Delta W^s = \frac{(p^i - p^s)(2c - 2a) + (p^{i^2} - p^{s^2})(-e - b) - bs^2}{2}$$

Introduction of tariffs :

We have the demand function : $D^t(p) = c - ep - te \Leftrightarrow P^{Dt}(d) = \frac{c-d}{e} - t$

and the supply function : $O^t(p) = a + bp + bt \Leftrightarrow P^{Ot}(o) = \frac{o-a}{b} - t$

The welfare of consumer is now :

$$W_C^t = \int_0^{d^t} P^{Dt}(y).dy - p^t d^t = \int_0^{d^t} \left(\frac{c-y}{e} - t \right).dy - p^t d^t$$

$$W_C^t = \left[\frac{cy}{e} - \frac{y^2}{2e} - ty \right]_0^{d^t} - p^t d^t = d^t \frac{c-te}{e} - \frac{d^{t^2}}{2e}$$

$$\boxed{W_C^t = \frac{d^{t^2}}{2e}}$$

$$W_C^t = \frac{(c - ep^t - te)^2}{2e} = \frac{(c - ep^t)^2 + e^2 t^2 - 2et(c - ep^t)}{2e}$$

$$\boxed{W_C^t = \frac{c^2 - 2cep^t + e^2 p^{t^2} + e^2 t^2 - 2etc + 2e^2 tp^t}{2e}}$$

The welfare of producer is :

$$W_P^t = p^t o^t - \int_0^{o^t} P^{O^t}(y) \cdot dy = p^t o^t - \int_0^{o^t} \frac{y - a - bt}{b} \cdot dy$$

$$\boxed{W_P^t = \frac{o^{t^2}}{2b}}$$

$$W_P^t = \frac{(a + bp^t + bt)^2}{2b} = \frac{(a + bp^t)^2 + b^2 t^2 + 2bt(a + bp^t)}{2b}$$

$$\boxed{W_P^t = \frac{a^2 + 2abp^t + b^2 p^{t^2} + b^2 t^2 + 2abt + 2b^2 tp^t}{2b}}$$

The welfare of tax payer is :

$$\boxed{W_T^t = t(d^t - o^t)}$$

$$W_T^t = t(c - ep^t - et - a - bp^t - bt)$$

$$\boxed{W_T^t = tc - etp^t - at - btp^t - et^2 - bt^2}$$

The total welfare is thus equal to :

$$W^t = W_C^t + W_P^t + W_T^t$$

$$W^t = \frac{c^2 - 2cep^t + e^2 p^{t^2} + e^2 t^2 - 2etc + 2e^2 tp^t}{2e} + \frac{a^2 + 2abp^t + b^2 p^{t^2} + b^2 t^2 + 2abt + 2b^2 tp^t}{2b} + tc - etp^t - at - btp^t - et^2 - bt^2$$

$$W^t = \frac{bc^2 - 2bcep^t + be^2 p^{t^2} - be^2 t^2 - 2betc + 2be^2 tp^t + a^2 e + 2abep^t + b^2 ep^{t^2} - b^2 et^2 + 2abet}{2eb} + \frac{2b^2 etp^t + 2ebtc - 2e^2 btp^t - 2aebt - 2eb^2 tp^t}{2eb}$$

$$\boxed{W^t = \frac{bc^2 - 2bcep^t + be^2 p^{t^2} - be^2 t^2 + a^2 e + 2abep^t + b^2 ep^{t^2} - b^2 et^2}{2eb}}$$

Which leads to the welfare change induced by the introduction of tariffs:

$$\Delta W^t = W^t - W^i = \frac{-2bcep^i + be^2 p^{i^2} - be^2 t^2 + a^2 e + 2abep^i + b^2 ep^{i^2} - b^2 et^2}{2eb}$$

$$- \frac{-2bcep^i + be^2 p^{i^2} + ea^2 + 2abep^i + eb^2 p^{i^2}}{2eb}$$

$$\Delta W^t = \frac{p^i(2bce - 2abe) - p^{i^2}(be^2 + eb^2) - p^t(2bce - 2abe) - p^{t^2}(-be^2 - b^2e) - t^2(be^2 + b^2e)}{2eb}$$

$$\boxed{\Delta W^t = \frac{(p^i - p^t)(2c - 2a) + (p^{i^2} - p^{t^2})(-e - b) - t^2(e + b)}{2}}$$

Comparison of the two politics :

We want to compare :

$$\Delta W^t = \frac{(p^i - p^t)(2c - 2a) + (p^{i^2} - p^{t^2} + t^2)(-e - b)}{2}$$

and

$$\Delta W^s = \frac{(p^i - p^s)(2c - 2a) + (p^{i^2} - p^{s^2})(-e - b) - bs^2}{2}$$

$$\Delta W^t - \Delta W^s = \frac{(p^i - p^t)(2c - 2a) + (p^{i^2} - p^{t^2} + t^2)(-e - b)}{2} - \frac{(p^i - p^s)(2c - 2a) + (p^{i^2} - p^{s^2})(-e - b) - bs^2}{2}$$

$$2(\Delta W^t - \Delta W^s) = (p^i - p^t)(2c - 2a) + (p^{i^2} - p^{t^2} + t^2)(-e - b) - (p^i - p^s)(2c - 2a) - (p^{i^2} - p^{s^2})(-e - b) + bs^2$$

$$2(\Delta W^t - \Delta W^s) = (p^s - p^t)(2c - 2a) + (p^{s^2} - p^{t^2} + t^2)(-e - b) + bs^2$$

And, as we have seen previously, we suppose that world price and imports are the same for both politics which

leads to $s = \left(\frac{b+e}{b}\right)t$ (see graphical approach for demonstration).

So :

$$2(\Delta W^t - \Delta W^s) = t^2(-e - b) + bs^2$$

$$2(\Delta W^t - \Delta W^s) = t^2(-e - b) + b\left(\frac{b+e}{b}\right)^2 t^2$$

$$2(\Delta W^t - \Delta W^s) = -t^2(b+e) + t^2\frac{(b+e)^2}{b}$$

$$2(\Delta W^t - \Delta W^s) = t^2(b+e)\left[-1 + \frac{(b+e)}{b}\right]$$

$$2(\Delta W^t - \Delta W^s) = \frac{et^2(b+e)}{b} > 0 \Leftrightarrow \Delta W^t > \Delta W^s$$

This result is the same than the one found with the graphical approach :

$$et^2 + \frac{e^2}{b}t^2 = e\left(\frac{b}{b+e}\right)^2 s^2 + \frac{e^2}{b}\left(\frac{b}{b+e}\right)^2 s^2 = \frac{eb^2 + e^2b}{(b+e)^2} s^2 = \frac{eb}{(b+e)} s^2.$$

With both the graphical and analytical methods, we show that the domestic welfare is greater with the tariff than with the subsidy. The foreign welfare is the same with the two instruments because they leads to the same world price. Accordingly the global welfare is greater with the tariff than with the subsidy. But we know that in this simple setting, the introduction of any instrument is welfare decreasing. The global welfare thus decreases less with the tariff than with the subsidy. Removing the tariff is finally less welfare improving than removing the subsidy at the world level.

Diao et al. (2001) found the opposite results. Our tentative explanation of this contradiction lies in the computation of world price effects. In the GTAP framework, prices are specific to each country due to the Armington assumption of product differentiation by country. Hence computing a world price index involves an aggregation procedure which may be not fully consistent with the GTAP framework.