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Antoine Bouet
CATT/UPPA and CEPII

Jean-Christophe Bureau
Institute for International Integration Studies, Trinity College Dublin

Yvan Decreux
CEPII

Sébastien Jean
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Antoine BOUET (CATT/UPPA and CEPII)
Jean-Christophe BUREAU (IIIS, Trinity College Dublin and INAPG)
Yvan DECREUX (CEPII)
Sébastien JEAN (CEPII)

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Contact: J.Christophe BUREAU,The Institute for International Integration Studies, The Sutherland Centre, Arts Building Trinity College Dublin, Dublin 2, Ireland Tel: +353 1 608 31 96, Email: *bureauj@tcd.ie*

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Abstract: An applied general equilibrium model is used to assess the impact of multilateral trade liberalization in agriculture, with particular emphasis on developing countries. We use original data, and the model includes some specific features such as a dual labor market. Applied tariffs, including those under preferential regimes and regional agreements, are taken into account at the detailed product level, together with the corresponding bound tariffs on which countries negotiate. The various types of farm support are detailed, and several groups of developing countries are distinguished. Simulations give a contrasted picture of the benefits developing countries would draw from the Doha development round. The results suggest that previous studies that have neglected preferential agreements and the binding overhang (in tariffs as well as domestic support), and have treated developed countries with a high level of aggregation have been excessively optimistic about the actual benefits of multilateral trade liberalization. Regions like sub-Saharan Africa are more likely to suffer from the erosion of existing preferences. The main gainers of the Doha round are likely to be developed countries and Cairns group members.

Keywords: CGE model, Doha Round, agriculture, tariff preferences, domestic support.

J.E.L. Classification: F12, F13, D58, Q17.

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Introduction

The agricultural sector has been one of the most contentious issues in the multilateral trade negotiations that have been taking place since 1999. Discussions on agriculture have delayed the conclusion of the so-called "Doha Round" of negotiations under the auspices of the World Trade Organization (WTO), launched by the 2001 Ministerial Declaration. After 13 major meetings, some 45 proposals and submissions from 127 countries, members failed to agree on numerical targets, formulas and other "modalities" on the agricultural sector before the scheduled deadlines. It is only in July 2004 that an agreement was found on some general principles. However, crucial technical aspects, such as the exact degree of tariff reduction (bands and thresholds) and the level of cuts in distorting farm support have been left to future negotiation.

During these long drawn out negotiations, developing countries (hereafter DCs) have emerged as a significant political force. They built a united front to oppose an agreement during the 2003 Ministerial Cancun meeting. Since then, they have vehemently criticized the farm policies and agricultural tariffs in developed countries. During the year 2004, DCs have extracted some concessions from developed countries, namely the (conditional) ending of European Union (EU) export subsidies, and the promise that significant cuts will take place for highly protective tariffs. They also secured agreement that issues of particular interest for them, like cotton, would be examined.

Several assessments of the effect of an agricultural agreement in the Doha Round have been published during the last years. Most simulations with Applied General Equilibrium (AGE) models have concluded that developing countries would reap large benefits from agricultural trade liberalization. The World Bank, in particular, makes a strong case for the large gains that developing countries would draw from an agreement on agriculture. However, we believe that there are several reasons why many AGE simulations have been excessively optimistic in this area, and that general conclusions might have been drawn on the basis of models that rely on insufficiently detailed data. In this article, we assess the impact of the Doha agreement, with a particular focus on three aspects that are, in our opinion, the weak points of most existing models: (i) a precise measurement of protection, including trade preferences, regional agreements, and the gap between applied and bound protection, at a disaggregated product level; (ii) a precise accounting of the complex effects of the various types of domestic support; (iii) a distinction between the various groups of DCs.

We first explain why we believe that many assessments of multilateral negotiations using AGE models have lead to questionable conclusions regarding the effect of an agricultural agreement on DCs. We then describe the main features of our model. We focus on the differences with other models, on experiment design, and on the baseline assumptions. We describe the data, in particular our original treatment of tariff protection. In a second part of the article, we present the results of our simulations of the August 2004 agreement, using figures from the last draft compromise available for issues still under negotiation. We then provide some explanations for the results and undertake some sensitivity analysis. Introducing better protection data, accounting for quota rents, distinguishing the multiple forms of agricultural support, and using a

careful measurement of the actual impact of posted liberalization lead to conclusions that differ from the ones often reached by AGE modelers, regarding the impact of agricultural trade liberalization on DCs.

AGE models and WTO negotiations

AGE models were extensively used to assess the impact of trade negotiations during the Uruguay Round, with a particular effort by researchers working in international organizations, like the Organization for Economic Co-operation and Development (hereafter OECD). The consequences of the Round for developing countries were given particular attention (Goldin and Knudsen; Martin and Winters). The Global Trade Analysis Project (GTAP) made possible a dramatic expansion of AGE-based approaches (Hertel). For several years, AGE models have been at the core of the economic assessments of the Doha Round negotiations (see Beghin, Roland-Host and Van der Mensbrugghe; Diao, Somwaru and Roe; Francois, van Meijl and van Tongeren; Frandsen et al. for example).

Obviously, not all models lead to similar results regarding the effect of a WTO agreement. However, most simulations conducted with AGE models suggest that DCs will be major gainers under a Doha agreement (see Hertel, Hoekman and Martin; Goldin, Knudsen and van der Mensbrugghe, for example). According to some simulations, DCs would reap two thirds of the 500 billion USD gains generated by ambitious trade liberalization in the agricultural sector (The World Bank). We believe that several limitations of the models used mean these conclusions must be questioned.

Acknowledging DCs diversity. First, general conclusions about DCs as a whole could be misleading, and the impact of the Doha Round on these countries is likely to be uneven. With the ending of export subsidies and a decrease in tariffs and production enhancing subsidies, world agricultural prices are likely to go up. Higher prices and better access to agricultural markets in developed countries should benefit DCs, whose comparative advantages often lie in agriculture. However, not all DCs are net exporters of agricultural products. Not all net food-importing countries have the capacity to increase significantly their production, should unfair competition and subsidies be eliminated in OECD countries. In such cases, trade liberalization will mainly increase the food import bill. A multilateral agreement on agriculture will also have contrasted effects because some DCs export products subject to a high level of distorting support or to tariff peaks in OECD countries or in India and China (sugar, beef, cotton, groundnuts). Other DCs export products whose markets are much less distorted (coffee, cocoa, fish) and will gain less.

Erosion of preferences and trade diversion. The preferences granted either under preferential regimes linked to economic development criteria (e.g. the General System of Preferences or GSP, or the specific regimes offered to Least Developed Countries – LDCs- by most OECD countries) or on a geographical basis (e.g. the EU Lomé/Cotonou agreements, the US Africa Growth Opportunity Act, the Caribbean Basin Economic Recovery Act) are of considerable importance for some countries (see OECD). This is particularly the case for some small and highly specialized economies, which have developed specific agricultural sectors under a preferential access to the EU or US market. The ending of these preferences, or even the erosion of the preferential margins which would follow a multilateral decrease in tariffs, may have a significant negative impact. Some DCs might lose some markets to the benefit of developed countries such

as Australia or New Zealand, or other DCs such as Brazil. To our knowledge, however, no AGE assessment of multilateral liberalization has so far fully accounted for preferential regimes (the recent work on Africa by Achterbosch,, Ben Hamouda,, Osakwe and van Tongeren, 2004, is an exception). Due to the difficulty of gathering the relevant information, only a few agreements are generally accounted for.

Posted vs. actual liberalization. Many AGE models rely on crude assumptions on the level of protection and domestic support. It is often ignored that many countries apply tariffs that are only a fraction of their bound tariffs (often one third of the level of bound tariffs in DCs, see Gibson et al.). As multilateral tariff reductions are made on the basis of bound tariffs, the actual impact of a tariff cut will often be overestimated.[1] Reductions in farm support are negotiated on the basis of a maximum Aggregate Measure of Support (AMS), an indicator that combines estimates of the production distorting support paid by taxpayers and consumers. In the EU, for example, the actual AMS as notified to the WTO, is only a fraction of the ceiling on which countries negotiate reductions, and the recent EU policy reforms will soon reduce the actual AMS to a very small figure. That is, cuts in distorting support decided during the Doha Round will result in only a small change in the actual level of EU support. Again, ignoring the gap between the figures used in the negotiation and the actual figures can lead to misleading results.[2]

In the present article, we attempt to improve on existing models by addressing these issues. The model that we use shares some general features of other AGE models (e.g. some recent versions of the GTAP model including imperfect competition, or the LINKAGE model, see Hertel or Van der Mensbrugghe, respectively). It contains some specific aspects, such as product differentiation and increasing returns to scale in some sectors, endogenous land supply in some countries and a dual labor market in developing countries. Agricultural policies (including output quotas, market price support measures, and expenditure ceilings) are explicitly modeled, and consistency is ensured between intervention prices, export subsidies and tariffs. However, the major improvements are in the area of data on protection, a precise representation of the various forms of farm support, and scenarios that account for the existing gap between negotiated trade liberalization and actual changes.

Model and data

Main characteristics of the model. The model used in this article is a multi-sector, multi-region general equilibrium model. While sharing basic features with the MIRAGE model (described in Bchir et al.), it has been developed specifically to assess the consequences of agricultural trade liberalization. The model distinguishes 30 sectors (including 23 agricultural and food sectors) and 11 country groups. In particular, large agricultural exporters (developing members of the Cairns group) and sub-Saharan Africa are distinguished. All agricultural sectors are perfectly competitive, but industrial (including food) sectors and services are not. Imperfect competition is

[1] Another source of overstatement of actual liberalization is the overstatement of initial protection, when not yet implemented commitments (such as those under the URAA for DCs, or those under the accession package for newly-acceded WTO members) are not taken into account, as is usually the case.

[2] Note that in addition, modelers do not always make allowance for blue box exemptions and *de minimis* payments when modeling cuts in support.

represented with an oligopolistic framework *à la* Cournot. It accounts for horizontal product differentiation linked to varieties, but also to geographical origin (nested Armington – Dixit-Stiglitz utility function). Some degree of vertical product differentiation is introduced in industrial sectors, by distinguishing two quality ranges, according to the country of origin of the product. (This is not the case, however, for agricultural commodities).

Although MIRAGE is a dynamic and sequential model, here, we present only static comparative simulations. The impact of some of our contributions (e.g. applied tariffs, detailed farm policy instruments, actual reductions, etc.) should appear more clearly than with a dynamic version which would have taken us further away from a *ceteris paribus* comparison with other studies. Capital stock is assumed to be perfectly mobile across sectors and we ignore foreign direct investment. In terms of macro-economic closure, investment is savings-driven, and the current balance is assumed to be exogenous. In the simulations presented here, we also ignore the possible impact of trade policy on economy-wide capital stock (through income or the rate of return to capital in the dynamic version of the model). Land supply behaves as an isoelastic function of the real return to land (van der Mensbrugghe). Regions are accordingly classified either as land-constrained or not, and different values of supply elasticities are assumed.[3] Land mobility across agricultural sector is assumed to be imperfect.

All developing countries are assumed to have dual economies, with an urban market that is distinct from a "traditional" market in rural areas (Lewis; Harris and Todaro). The modern sector (industry and services) pays an efficiency wage to unskilled workers, above their marginal productivity. It is thus faced with a totally elastic supply of unskilled labor. The primary sector (i.e., agriculture), in contrast, pays a competitive wage. The supply of unskilled labor available for the primary sector is set as a residual, once the "modern" sector has set its unskilled labor employment level. The specification provides a simple way to account for a hidden unemployment in developing countries, and to depart from the standard assumption of balanced labor markets used in AGE models, in spite of its obvious inappropriateness in the DCs case. In all countries, labor is imperfectly mobile between agricultural activities and other sectors, and substitution is represented by a Constant Elasticity of Transformation function.

Some original contributions to the modeling of agricultural trade liberalization. While the general architecture of the model remains relatively standard, compared to recent efforts in AGE modeling (with the exception, of the dual labor market assumption), we introduce some major improvements in the data and the treatment of agricultural policies. As in many other models, we use the GTAP database for accounting matrices, trade costs and non-farm policies (Dimaranan and MacDougall). However, our protection data and data on farm support rely on original work. Here, tariff protection relies on applied tariffs. A special database was developed in collaboration with the International Trade Commission (ITC), the MAcMap dataset.[4] The exact methodology is described in Bouët et al., 2004. MAcMap provides *ad valorem* tariffs, and estimates of the *ad*

[3] The values of the elasticities are similar to those used in the LINKAGE model, i.e. 0.25 for land constrained countries and 1 for other countries. We thank Dominique van der Mensbrugghe for providing us information and advice on this point. The transformation elasticity of land mobility across sectors is set to 0.5.

[4] The MacMap data on protection developed for this article will be used in future versions of the GTAP database (version 6). These data have been reviewed carefully by the 28 institutions members of the GTAP Consortium. They have identified many errors in earlier versions and their suggestions have improved dramatically the data used in this paper. We acknowledge the considerable contribution of GTAP consortium members and researchers in Purdue University.

valorem equivalents of specific tariffs and tariff quotas (based on the in or out of quota tariff, depending on which one is binding). Tariff quota rents are also computed, for those quotas that are filled, and are assumed to be kept by exporters[5]. The information is put together at the bilateral level, for 163 countries with 208 partners. All preferential agreements, including those of the EU, are taken into account. This information was put together at the six-digit level of the Harmonized System (HS) of classification (hereafter HS6), i.e. for 5,111 goods. The aggregation procedure uses weights based on the exports of each partner country to a reference group of countries which the importer belongs to, in order to avoid the well-known endogeneity bias that affects import-weighted average tariffs.[6] The bilateral matrices at the HS6 level make it possible to account for country specific aggregate tariffs, and for country specific aggregate tariff reductions. A change in the EU vector of bound tariffs, for example, will have a different impact on different countries because not all products are eligible to the same preferences. In addition, a given multilateral reduction in a bound tariff will result in a different change in the applied tariff across countries, because, for each product, the margin between bound and applied tariffs differs.

Another contribution is the data for agriculture in OECD countries. Here we build on existing work on the modeling of agricultural policy (Frandsen, Gerfeldt and Jensen; Burfisher, Robinson and Thierfelder) and we developed a precise representation of EU, US, Canadian and Japanese farm support. Information on farm policies at a very detailed level is used so as to take into account the actual effect of each payment. Subsidies are introduced as price wedges, either on output, on variable inputs, on land or on capital. Market price support is explicitly modeled, through the combination of tariffs and of export subsidies. The WTO ceilings cap the corresponding export subsidies, and reaching the ceiling entails an endogenous adjustment of the market price that can be supported. Production quotas are also explicitly modeled, and originate rents. Some of the (semi-decoupled) EU direct payments are treated as subsidies to the animal capital. Some others are treated as subsidies to land. The fully decoupled ones are treated as a return to self-employed labor and have therefore an indirect effect on production, by pulling some of the primary factor into the sector, reflecting that no payment is fully decoupled in agriculture. Set-aside is taken into account in the US and the EU, and modeled as a negative shock on the productivity of land (Bach and Frandsen). The original information is mainly based on the data compiled by the OECD for the calculation of the Producer support estimates (Additional data for non-standard commodities were provided by the OECD Secretariat and national sources). The effect of the EU enlargement, of a full implementation of the Agenda 2000 reform in the EU including the June 2003 Mid Term Review reforms, and of the 2002 US Farm Security and Rural Investment (FSRI) Act in the US, are taken into account.

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[5] This assumption is an extreme one, but in the absence of precise information on the sharing of the rent, it seemed more appropriate for a set of large quotas (EU sugar and bananas) than the other extreme assumption, that rents are captured by the importer. Note that there are cases where the method of administrating TRQs (e.g. auction) makes this assumption is hardly defendable. More generally, in the case of certain preferences (e.g. GSP), it is not clear that exporters get the benefits because of the way import licences are administered.

[6] Because of the negative correlation between tariffs and imports, trade weighted average tariffs underestimate true measures of protection (see Anderson and Neary). The bias is obvious for the Canadian dairy sector or the Japanese rice sector, where prohibitive tariffs result in a zero weight, leading to a very small aggregate tariff. The use of imports of a reference group of countries avoids endogeneity bias and provides a better approximation of theoretically consistent tariffs. (Note however, while the MAcMap dataset on protection is the basis for the future GTAP data, aggregation in GTAP 6 will not use a reference group but simple trade weighted aggregation. One reason for this decision by the Consortium is that many users do not focus on precise measurement of protection but need to maintain a direct link between tariffs and tariffs revenues to remain consistent with national accounting).

Experiment design. We established both a baseline and a trade liberalization scenario that is used to shock the baseline equilibrium. While it is intended to represent a mid-term reference point which the changes brought about by a Doha agreement can be compared to, the baseline is a somewhat fictitious situation. It corresponds to the situation as it was in 2001 (the last year for which the required data were available), but assuming that the EU enlargement has taken place and that the EU and US recent changes in farm policies are fully implemented. This avoids using forecast data originating from other models, while making it possible to account for the recent changes in agricultural policies. Such changes are important since, in the EU, they introduce some budget caps that restrict market intervention and therefore on price support. In brief, the baseline equilibrium is obtained as a result of pre-experiment simulation where the raw data (MAcMap_HS6 for protection including the EU Everything but arms initiative and the US Africa Growth Opportunity Act; GTAP version 5.3 for other data), is shocked by assuming that the 2003 US farm policy and the 2006 EU farm policy are in place; the Uruguay Round Agreement on Agriculture commitments are fully implemented by DCs; newly acceded WTO members (among which China) enter the WTO and implements the corresponding commitments made in terms of bound protection; and the Multi-Fiber Arrangement is phased out. This baseline is the reference point to which our scenario of agricultural trade liberalization will be compared.

WTO countries agreed on liberalizing agricultural trade in August 2004 (WTO, 2004). However, the agreement leaves many technical issues to further negotiations. The only precise commitment is the ending of export subsidies on a date that is not specified. In the area of market access, there is a commitment to using a tiered formula, with deeper cuts in higher tariffs and "flexibilities" for sensitive products. However, the number of bands, the thresholds for defining the bands and the tariff reduction in each band remain under negotiation. In the domestic support area, an element of harmonization will in principle be introduced, meaning that higher levels of permitted trade-distorting support policies will be subject to deeper cuts. Thus, there is little precise information on what will be the actual technical modalities, and at this point, a scenario must be elaborated. The last proposal in the Doha round containing precise commitments is the draft compromise of March 2003 (WTO, 2003). It failed to attract a consensus. Later proposals such as the one discussed in the 2003 Cancun ministerial meeting may take better into account the evolution in negotiating positions but contain no precise quantification. In addition, if one analyzes the various country proposals submitted between 2001 and 2003, the technical provisions included in WTO (2003) appear close to the center of gravity of country proposals regarding domestic support, tariff bands and tariff reductions. In our scenario, we therefore use the March 2003 proposal to fill the grey areas that have been left by the August 2004 Decision on technical aspects, such as cuts in tariffs and reduction in the AMS ceiling. The tariff bands and reductions that are used in the scenario range from a 40% cut for small tariffs (those less than 15% *ad valorem*) to a 60% cut in high tariffs (those larger than 90%, see WTO, 2003). We assumed that the reduction in tariffs will be less constraining for developing countries, along the lines of the March 2003 proposal, and consistent with the principle of Special and Differential Treatment (SDT) outlined in the August 2004 declaration. Our scenario also includes the end of export subsidies and a cut of 55% in the various elements of support linked to output and inputs. [7]

[7] Here, we considered that "distorting" support included support coupled to production, as measured by the AMS and blue box payments. We also included payments notified by the US under the "*de minimis* clause" (this clause states that some payments do not have to be counted against the AMS if they amount to a small fraction of the value of production, but in the recent years, it was used by the US which would have otherwise exceeded the AMS ceiling).

Initial protection patterns. In the baseline, the thirty matrices of 11x11 average tariffs are constructed on the basis of applied tariffs, i.e. taking into account the gap that may exist between bound and actual most favored nation tariffs, tariff quotas, free trade areas and preferential regimes. Average tariffs for an aggregate of all sectors are presented in table 1. The figures refer to the average tariff imposed by the importer (column) to each supplier (row). The last row indicates the average agricultural protection by importing zone and the last column the average tariff faced by the supplier's aggregate exports.

[Insert table 1]

Table 1 shows that the agricultural sector is very protected in some countries, even when preferential regimes are taken into account. For example, the average tariff on agricultural goods imposed by EFTA countries is 47.7%, the one imposed by the EU is 16.7%. Note that the EU figure is smaller than the one that is found in most studies (e.g. Gibson et al.) and the present GTAP database. The reason is that the EU grants significant preferences to sub-Saharan Africa, EFTA and Mediterranean countries. These preferences result in a much lower average EU tariff applied to sub-Saharan exports (6.7%) than to the exports originating from the developed members of the Cairns group (25.9%). US preferences, including the North American Free Trade Agreement, and non-reciprocal preferences (the GSP) are also taken into account. Figures in table 1 show that there are some significant preferential margins, which would be eroded by a multilateral reduction in bound tariffs.

Sub-Saharan Africa faces the lowest level of protection against its agro-food exports (10.2%). Agricultural exports from the developed members of the Cairns group, for instance, are subject to a much higher average tariff (21.2%). The differences between these two figures reflect both the existence of preferences granted to African countries, and the composition of exports: Cairns group countries indeed export products that face high tariffs in OECD countries (such as beef, sugar or dairy), while sub-Saharan Africa exports large amounts of coffee, cocoa, and flowers, that face lower tariffs.

Broadly speaking, protection is often considerable in the sugar, meat, cereal and dairy sectors.[8] The highest duties are the ones imposed on rice by the group of Asian developed countries. It is noteworthy that there is sometimes a significant degree of protection of the processing sector: trade in fibers are nearly free, while trade on processed cotton and apparels face high tariffs in many countries.

The Doha agreement scenario: effects on protection. In our scenario, the cuts for the different tariff bands described in WTO (2003) are applied to the bound tariffs. But in the changes applied to our baseline matrices of tariffs, the new level of bound tariffs only becomes the applied tariff if the new bound level is lower than the initial applied tariff. The procedure is applied to all bilateral tariffs at the HS6 level. The new vectors of tariffs obtained are then aggregated in the model classification. The *ad valorem* equivalent of bound duties at the HS6 level was constructed, using each country's consolidated tariff schedule, in a way consistent with that used for measuring applied protection in MAcMap.[9] This computation of resulting applied tariff cuts thus contrasts with existing studies by making it possible to take into account the gap between

[8] Protection data at the sector level are available from the authors upon request.

[9] We used data kindly provided by John Wainio and Paul Gibson, from the Economic Research Service of the USDA to complement the MAcMap data on bound tariffs.

bound and applied tariffs at a detailed level, while also allowing the harmonizing effect of the formula to be accurately reflected. In addition, out-of-quota tariff cuts are reflected in lowered TRQ rents.

Table 2 shows the resulting changes in applied tariffs (change in percentage points) imposed by each group on imports of agricultural and food products from each partner group. The last line indicates the change in average protection in each group of importing countries. The last column shows the changes in market access faced by each group of exporting countries. For example, our Doha agreement scenario leads to a reduction of 2.9 percentage points in applied agricultural tariffs of EFTA, of 7.1 points in the EU25, and of 0.8 points in the US. While initial tariffs were also high, SDT and the fact that there was a very large degree of so-called "binding overhang" (i.e. bound tariffs were higher than applied tariffs) result in limited changes for DCs. In table 2, the last column shows that sub-Saharan countries is one of the regions that benefits least from the opening of markets, both because of its export structure (cocoa, coffee face low tariffs) and because of the preferential regimes. The average tariff faced by sub-Saharan agricultural exports only decreases by 2.2 percentage points. By contrast, the cut amounts to 4.6 percentage points for developing members of the Cairns group. This suggests that, among DCs, multilateral liberalization opens markets for Argentina and Brazil exports more than for Mediterranean and African countries. Moreover, table 2 shows that the greatest beneficiaries, from a mercantilistic point of view, are developed countries. The developed members of the Cairns group face an average tariff that decreases by 6.4 percentage points. The tariff cuts for EU and US exports also exceed the cuts for DCs, in percentage points. Despite a very high initial protection, applying the March 2003 formula does not entail a large openness of EFTA due to a binding overhang phenomenon.

[Insert table 2 and table 3]

Table 3 shows changes in the average tariff protection faced by each country group's exports by sector, in percentage points. A tiered formula cut in import duties would result in large market access improvements in rice (Developed Asia) and sugar (EU, Developed Asia).

Simulation results

The simulation consists of a shock to the baseline using our Doha Agreement scenario, i.e. the changes in tariffs described in the previous section, as well as the suppression of export subsidies and the cut in trade distorting domestic support. The model ensures consistency between various policies. In some cases, this requires making endogenous changes in policy variables. For example, the suppression of export subsidies and the cut in tariffs make some EU intervention price levels unsustainable (leading to unrealistic levels of inventories and exceeding the EU agricultural budget constraint agreed upon in 2003). In such a case of unbalanced domestic markets, the intervention price, which normally acts as a floor price for the producer in the model, is assumed to be adjusted by EU authorities, and becomes an endogenous variable. In the case of tariff rate quotas, the rent associated with the gap between the in and out-of-quota tariffs is positive only if the quota is filled by calculated imports.

The combination of changes to the three pillars, domestic support, border protection and export competition, leads to a consistent scenario. In the following tables, the figures correspond to an assessment of the effects of the three pillars independently, and the last column the combination

of the three, i.e. the changes brought by a Doha agreement to a mid-term reference situation represented by our baseline.

World prices. The first expected impact of a multilateral liberalization is an increase in world prices. *Ceteris paribus*, removing protection should decrease export surpluses or increase import demand in protective countries and therefore push world prices up. So do cuts in production support and the removal of exports subsidies. Indeed, table 4 shows that world agricultural prices will increase. In the case of rice, cotton, and to a lesser extent oilseeds and cereals, the main source of the increase is the removal of domestic support. In the case of sugar, it is the ending of (EU) export subsidies. In the fruits and vegetable as well as in the beverage sector, the main source is the decrease in tariffs. Overall, the increase in world price is significant in the fibers sector (cotton), and significant in the rice and oilseed sector. In other cases, the increase in world prices is limited.[10]

[Insert table 4]

Quantities traded. Table 5 suggests that, overall, the quantities of agricultural products traded internationally will grow by some 6%. The main driving force is the decrease in tariffs. The suppression of export subsidies only has a limited effect. One reason is that EU export subsidies have already decreased dramatically since the late 1990s, and this was taken into account in the baseline. In some cases, such as the US (cotton) and the EU (sugar), the Doha agreement will result in a significant decrease in some exports after domestic or export subsidies are cut, but it is offset by an increase in the exports of some other products due to improved market access in third countries. This is not the case for EFTA countries. The decrease in tariffs results in a significant increase in exports of Cairns group countries and China. Mediterranean countries' exports of agricultural products also increase in spite of the erosion of their (very limited) preferential access to the EU (note, however, that they experience a fall in exports of non agricultural products such as garments). Sub Saharan Africa countries experience a smaller increase in exports than most other developing countries. This results mainly from the erosion of preferences on the EU's market. As a general rule, exports of the poorest countries (sub-Saharan Africa and South Asia, which includes most LDCs, plus India) increase significantly less than the average exports of the rest of the world.

[Insert table 5]

If we now focus on the effect of the Doha agreement on net trade, the increase in imports exceeds the increase in exports in the case of developed countries in Asia and Europe. The trade balance for agricultural products worsens in the case of Japan and Western Europe. The growth in imports also offsets the growth in exports in the case of China and South Asian countries. The trade balance of Cairns group countries, especially that of the developed members, increases a lot (imports grow by 3% and exports by 13%).

Terms of trade. Our Doha agreement agricultural scenario results in significant terms of trade variations. The Cairns group developing countries terms of trade improve. So do the terms of

[10] The case of sugar, whose world prices show a slight decrease following a reduction in tariffs reflects the way the we measured world prices, i.e. as import prices. Sugar is subject to a tariff quota in the EUTRQs: The decrease in out-of-quota tariffs lowers the rent, which is assumed to be kept by the exporting country and treated as an increase in import prices.

trade of sub-Saharan Africa. Among developing countries, the role of cotton appears significant in explaining changes in terms of trade. The cotton price is a major driving force of the improved terms of trade of sub-Saharan Africa, but also the deterioration of terms of trade in Mediterranean countries, which are large importers of cotton. This finding illustrates the importance of the cotton issue for DCs, and provides some justification for the specific negotiation on cotton, a commitment of WTO members in the July 2004 agreement.

Welfare. Table 6 shows the impact of a Doha agreement on agriculture in terms of welfare. Overall, the changes in welfare are small. Basically, the agreement on agriculture that was reached in August 2004 would lead to a mere 0.1 percent increase in world welfare. The fact that the actual outcome of the negotiations on technical modalities might differ from our scenario is unlikely to change the magnitude of this result. On the opposite, the fact that some "sensitive products", i.e. those where most of the existing distortions are concentrated, are likely to be excluded from the discipline, suggest that our small figure might even be optimistic.

[Insert table 6]

Countries that reduce their own domestic distortions are the main gainers in the agreement. This is clearly the case for the US (provided that the domestic support is reduced by as much as included in our scenario. It is also the case of the EU, of developed Asia and EFTA if the agreement on tariff cuts is close to the one we included in our scenario, that is if these countries do not make a large use of the provisions for "sensitive products" of the August 2004 Declaration. In all these cases, most gains are linked to an improved efficiency of resource allocation. The impact of ending export subsidies is quite small, again reflecting that the recent changes in the CAP have already led to a decrease in domestic price and a decrease in production. A second category of winners are those countries for which trade liberalization result in significant export opportunities. This is particularly the case of developed countries of the Cairns group, but the gains remain limited (welfare increases by 0.5%). For developing countries of the Cairns group, there is no change in welfare, overall. Note, however that this reflects contrasting effects between the agricultural sector (which gains) and other sectors, and between producers and consumers: the latter are adversely affected by higher food prices.[11] A decomposition of welfare gains also shows that the decrease of rents earned from TRQs and the relative shift of resources away from the (modern) industrial sector balance the benefits reaped from improved terms of trade and increased arable land usage.

A Doha agreement results in welfare losses for several groups of developing countries. Mediterranean countries suffer from the higher price of cotton caused by the reduction in US and EU domestic subsidies which affects their garment industry and, as net food importing countries, from the higher price of agricultural products. Because they already benefit from some (limited) preferential access to the EU market, the benefits they reap from the decrease in agricultural tariffs are not sufficient to offset the negative effects of higher world prices. Sub-Saharan African countries also experience a welfare loss as a consequence of a Doha agreement, in spite of a slight improvement in their terms-of-trade. This results from the combined effect of higher

[11] Note that our group of "developing members of the Cairns group" includes not only efficient agricultural exporters such as Brazil and Argentina, but also many Asian countries such as Malaysia, Indonesia, Philippines, etc. Welfare effects are also contrasted between the different members of the group.

prices for food imports, and from the extra competition faced by their exports due to preference erosion. The elimination of EU export subsidies is the major force driving welfare losses, but the decomposition of welfare changes shows that reduced TRQ rents contributes significantly to the welfare loss observed for sub-Saharan Africa. The actual effect of a future agreement may even be more negative than what is suggested by the figures in table 6. It is uncertain whether future negotiations will lead to a cut in US cotton subsidies by 55% as we assumed in this scenario, because of well-organized interest groups.

Impact on the agricultural sector. The global welfare effects hide contrasted effects between the farm sector and other sectors, especially in DCs. The effect on the farm sector can be seen through the changes in the returns to land and the changes in the return to agricultural labor. We focus here on the returns to workers that are specific to the agricultural sector.[12] Table 7 shows that trade liberalization in the agricultural sector has very significant consequences, especially for EU farmers. Indeed, the cut in domestic support, which is assumed to remain uncompensated by lump sum transfers or any other green-box type of subsidies in our scenario, has a very large effect on returns to land in the EU. The farm sector in developed Cairns group countries benefits from the agreement. This is also true in most developing countries, but in smaller proportions. Indeed, returns to land in sub-Saharan Africa only increase by 0.2% and returns to labor by 1.2%. The figures are respectively 0.6% and 1.4%in the developing members of the Cairns group.

[Insert table 7]

Comments and sensitivity analysis

A surprising result is the limited increase in trade and welfare resulting from a Doha agreement. Indeed, the gains in world welfare that we obtain are significantly smaller than those found by other authors. Another difference with most other studies is that we do not find that all countries gain from multilateral trade liberalization in agriculture. Some DCs, like sub-Saharan Africa experience some (slight) net losses, even though the farm sector enjoys some small benefits from trade liberalization. Such differences with a large body of the literature demand explanations and some sensitivity analysis.

One explanation for the small welfare gains resulting from the agreement is that the agricultural and food sector only represents a small proportion of the gross domestic product in many economies, and here, we simulated only the impact of the agricultural component of the Doha agreement. Other authors have focused on a larger agreement (e.g. Hertel, Hoekman and Martin; Francois, van Meijl, van Tongeren). They obtain significant gains in the textiles sector, for example, or gains linked to specific (and somewhat *ad hoc*) assumptions on trade facilitation or positive externalities of trade liberalization. Another explanation is that our scenario accounts only for the changes in tariffs and domestic support that result from actual changes in applied tariffs and policies. Because of data availability, most modelers apply the cuts in bound tariffs negotiated under the WTO as if they were made on applied tariffs. As a sensitivity analysis, we

[12] This excludes skilled workers, since this type of work is assumed to be perfectly mobile across sector. The imperfect mobility (and therefore the sector specificity) thus only concerns unskilled workers, but they contribute almost 90% of labor value added in the agricultural sector worldwide, and to more than 80% in the EU in the model, which relies for this aspect on the GTAP database.

ran our tariff cut scenario on the applied tariffs, rather than the bound tariffs. Under this alternative assumption, the subsequent increase in world agricultural exports is much higher (15.0% to be compared to 6.1% when the gap between applied and bound duties is taken into account) and the increase of agricultural exports of the Cairns developing countries is also larger than in table 5 (+21.5%, that is to say a USD 11.2 bln augmentation, while our result gives USD 5.7 bln).

The negative outcome found for sub-Saharan and Mediterranean countries as a result of implementing the Doha Agenda is among the striking features of the results. As mentioned above, a likely explanation for this finding is the erosion of the tariff preferences these countries enjoyed on their export market. In order to check for this explanation, we carried out an additional simulation of the Doha Agenda, where trade preferences are not taken into account in the baseline.[13] This simulation also highlights what difference covering exhaustively trade preferences makes on the assessed impact of multilateral liberalization. On average, the difference with the standard assessment is not large. However, agrofood exports of sub-Saharan African and Mediterranean countries increase substantially more under this scenario (+7.0% vs. +4.7% for sub-Saharan Africa when preferences are accounted for, and 13.4% vs. 8.8% for Mediterranean countries). More importantly, the impact on welfare is significantly improved for these two regions. In particular, the loss previously found for sub-Saharan African countries is changed for a slight gain (+0.06%) when preferences are not accounted for. This confirms that the erosion of preferences significantly harms sub-Saharan African and Mediterranean countries as a result of multilateral liberalization, in spite of the fairly limited liberalization actually delivered by the Harbinson proposal, as emphasized above.

A puzzling result is the small welfare changes for the Cairns group countries, even though these countries experience a significant increase in exports. Indeed, given the figures in table 6, it is surprising that the developed members of the Cairns group fight so hard for agricultural liberalization, which would barely bring them an increase in welfare corresponding to a few months of GDP growth. It is even more surprising that the Doha agreement results in no welfare gain for the developing countries of the Cairns group, since countries such as Brazil and Argentina are assumed to reap large benefits from agricultural trade liberalization. Because some of the results might be dependent of the model specification, the following sections provide some sensitivity analysis.

First, the Armington specification may underestimate the increase in imports of Cairns group products by the EU, following a decrease in EU domestic support. It is well known that the Armington assumption is questionable for agricultural products (Alston et al.), even though it remains used by most modelers because of its parsimony in parameters. Agricultural goods are often relatively homogenous and the Armington assumption tends to overestimate the degree of differentiation of goods according to their origin. Recent econometric estimates suggest that elasticities could be larger than the ones we used in the model (see Erkel-Rousse and Mirza). In order to assess the sensitivity of the results to the assumptions on the substitution between

[13] This is done by substituting, in the benchmark data, MFN duties to applied duties. However, five exceptions are made, to account for large agreements: the EU, NAFTA, ANZCERTA, the EU-EFTA Agreement and SACU are still taken into account. This ensures that the coverage of preferential regimes under this alternative simulation is exactly the same as in GTAP version 5 database, which has been so far the workhorse for the assessing the impact of multilateral liberalisation.

domestic products and imports, we modified the model's elasticities of substitution in the agricultural sector.[14] Doubling the value of the elasticities affects trade and welfare. World agrofood exports increase by almost 11% (rather than 6% in our results), with the same uneven distribution amongst zones: Developed countries exports of the Cairns group increase considerably (+20.2%), while the increase in exports of sub-Saharan Africa after trade liberalization is a modest 6.2%. Welfare increases are larger in economies where government intervention in agriculture generates large distortions (EU, Developed Asia). The welfare changes in sub-Saharan Africa is still negative (-0.04% instead of -0.03%).

Some unwanted consequences of our assumption of imperfect competition *à la* Dixit-Stiglitz and increasing returns to scale in industrial sectors have been documented (Francois and Roland-Holst). Francois, van Meijl and van Tongeren explain that they ran into a problem that also affects our results. When large agricultural producers expand their farm output, they draw resources from their industrial sectors, which contract. The presence of economies of scale in these sectors, and the "love of variety" effect linked to the Dixit-Stiglitz specification, implies the predicted contraction of these sectors leads to negative welfare effects. This could contribute to the low welfare gains in the developing members of the Cairns group, which were expected to draw larger gains from the Doha Round in our results. In order to assess how important this effect is, we ran the same simulation assuming perfect competition in all sectors. That is, the economies of scale and love of variety effects are eliminated. The changes in welfare and in other macroeconomic variables are indeed slightly affected by this assumption: for example, welfare in Cairns developing countries now increase by 0.04% while it increased by 0.01% under the imperfect competition assumption. The welfare gains are also larger for the developed member of the Cairns group (0.08% instead of 0.04%), and the small welfare loss for sub Saharan Africa (-0.01%) disappears under the perfect competition assumption. The changes are nevertheless very limited for these three groups of countries. The welfare changes in other countries remain practically the same under this alternative assumption.

Unlike most AGE models (with the exception of the LINKAGE model, the source of inspiration for our specification) we introduced some flexibility in land supply in some large countries, with a low population density. While we believe that an exogenous land assumption understates supply response, this assumption is important since it dampens world price effects. We ran a simulation under the assumption of exogenous land. The endogenous land assumption does not affect significantly the results, even if world prices increase by 2.5% (rather than 2.8% in our simulations). The impact is very minor on the world price of goods exported by DCs, and on DC welfare changes.

Another potential explanation for the difference in results with other studies is the dual labor market assumption for DCs. We ran the simulation relaxing this assumption. Under the dual market assumption, an expansion of the agricultural sector means that some resources are drawn into a less productive sector. Under the single market assumption, the welfare losses for Mediterranean and sub-Saharan African countries are smaller. The welfare gains for the developing members of the Cairns group are larger, but remain very limited (+0.3%). However, the difference remain very small compared to our basic simulation, a few percent of a percentage

[14] The source of the substitution elasticities is the GTAP database. Elasticities of substitution between domestic and imported goods range between 2 and 3.8, averaging 2.3, in agricultural sectors. Elasticities between imports of different origin are roughly twice this level. Note, however that when applied to small levels of imports, larger elasticities still lead to a small increase in trade flows.

point in the computed changes. That is, none of the specific modeling assumptions described in this section affects significantly our findings.

Conclusion

We used an AGE model to assess the effects of an agreement on agriculture in the Doha round of negotiations. Because the July 2004 framework agreement did not lead to a decision on the precise modalities of the cuts in tariffs and domestic support, we assumed that further negotiations will lead to modalities that we could approximate with the provisions included in the WTO draft compromise proposal of March 2003.

Our work includes significant innovations. Our data on applied protection rely on original work which assesses the protection arising from *ad valorem* tariffs, specific tariffs and tariff rate quotas at a highly disaggregated level (HS6 classification), taking into account all preferential agreements. Ad-valorem-equivalent bound duties, the ones subject to liberalization, are also estimated at the HS6 level. Domestic support in the EU and the US are represented through a variety of instruments, also using original and very detailed data on the various policy tools. The effect of the FSRI and the 2003 reform of the CAP are included, assuming full implementation in an enlarged EU. In establishing scenarios for simulation, we accounted for the fact that commitments on bound tariffs and AMS ceilings show only a remote connection with the changes in actual tariffs and policies, given the "binding overhang" that characterizes the tariff structure in many countries, and the gap between actual support and AMS ceilings. The tariff cuts are applied on some 5,000 different tariffs at the six-digit level before the new variables are aggregated consistently with our 30-sector and 11-country group model.

The results show very significant differences with most of the findings of other similar AGE models. Because the data that was developed for this project will be made available to a large public as part of the future version of the GTAP database (GTAP6), more refined assessments of the effect of the Doha negotiations by the large community of users of these data will be made possible. Our estimates of the impact of a Doha agreement on agriculture suggest much lower welfare gains than most other studies. In addition, we find that a large number of developing countries would actually experience a loss in welfare, a result that is seldom observed with AGE models. Cairns group countries would expand their agricultural output and exports. However, in terms of welfare, the main winners are developed countries that reduce their own distorting support. Negative consequences are nevertheless significant for the farm sector in the EU. They are more limited for developed Asia and the US.

Our results suggest that the erosion of existing preferences will be an important problem, especially for sub-Saharan Africa. African countries which benefit from preferential access to the EU and the US will face competition from Cairns group countries. Overall, sub-Saharan countries will experience a decrease in welfare, even under our optimistic assumption that US and EU cotton and tobacco subsidies will be reduced by a large amount. Overall, there will be a limited increase in world prices for agricultural products. However, this limited increase will negatively affect some net food importers and some cotton importers such as Mediterranean countries. Like sub-Saharan African countries, they will not gain on other grounds, because of the erosion of preferential margins and diminished rents on their quota-constrained exports to the EU.

A sensitivity analysis shows that these results are hardly affected by the various assumptions that make our model specific, compared to other AGE models (dual labor market, endogenous land supply, monopolistic competition, etc.). That is, the differences between our conclusions and those of most AGE modelers mainly come from the use of better data, namely on preferential tariffs, and more careful design of the actual effect of the posted reductions in tariff and farm support. In particular, our results suggest that better data would modify significantly the conclusions that are often drawn about the benefits of trade liberalization for developing countries. General conclusions that developing countries will reap most of the benefits from trade liberalization in agriculture do not seem to hold when one takes properly into account applied tariffs, the erosion of preferences, and trade diversion. Clearly, the effects on developing countries will be contrasted, and some group of countries such as sub-Saharan Africa are more likely to suffer than to benefit from a multilateral trade liberalization.

Corrective measures are needed for possible losers, but the present Special and Differentiated Treament (SDT) provisions under the WTO cannot be considered as an adequate response. Eligibility to the SDT relies on self-declaration of countries, and the one-size-fits-all status of "developing" country does not account for the considerable differences between DCs (Korea and Haïti are examples). In addition, the SDT (under its present form) merely allow developing countries to opt out liberalization measures. Opting out is not an adequate response to the erosion of preferences for, say, African or Caribbean countries.

In order to make the results of a Doha Round more consistent with Pareto-improvement principles, more differentiation between developing countries should be allowed. In that sense, our findings are at odds with the idea that preferences should be as little discriminating as possible, an idea which is widely shared amongst economists (see IPC), and which is also at the core of the evolution of multilateral trade rules (e.g. the "Enabling clause" for the GSP, the need to be granted a waiver for other non reciprocal regimes).

The specific treatment mentioned for LDCs in the July 2004 Decision is consistent with extra differentiation across developing countries, but not all potential losers are LDCs. The 2004 decision of the WTO Appellate body on the EU drug-fighting related provisions of the GSP leaves a door open for further differentiation, under well-defined conditions. This might be a way to amend the SDT in a way that would reflect the growing heterogeneity of the developing countries. Clearly, introducing more differentiation between countries raises difficult issues. The risk exists that eligibility would be subject to questionable political conditions (already an issue in some US non-reciprocal preferential schemes), or that discrimination reflects arbitrary historical ties (an issue in EU preferences). More objective criteria would be preferable, and preferential treatments should be GSP-consistent rather than based on geography. Some elements of differentiation are already introduced in the EU and US GSP, in particular the EU system of graduation, which involves development indicators. While more assessment of the potential unwanted effects would be needed, there might be a source of inspiration for a revised modalities of the SDT, in spite of the likely opposition from the most advanced DCs.

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Table 1. Bilateral tariff, all agricultural products aggregate (%)

	EU 25	USA	Asia developed	EFTA	Cairns developed	Mediterranean	Sub-Saharan Africa	Cairns developing	China	South Asia	RoW	Average
EU 25		5.8	22.2	52.0	15.7	35.1	30.2	16.1	25.5	52.8	26.2	18.1
USA	16.2		28.9	57.9	5.1	23.3	18.9	13.2	27.4	45.4	12.7	18.8
Asia developed	12.5	3.7		17.9	6.2	32.2	31.4	17.3	25.8	51.6	24.8	16.0
EFTA	7.9	3.9	11.6		10.6	21.4	22.9	19.1	30.5	43.0	21.3	10.7
Cairns developed	25.9	3.4	24.9	79.8		37.4	14.7	11.8	16.9	42.6	18.7	21.2
Mediterranean	7.3	4.0	14.1	25.7	3.7		30.2	20.3	23.6	34.9	22.9	12.7
Sub-Saharan Africa	6.7	3.0	12.0	8.9	0.7	18.0		26.1	14.7	35.0	17.8	10.2
Cairns developing	18.3	3.8	24.0	34.7	5.9	28.9	27.9		29.3	65.0	23.0	20.8
China	13.5	5.1	21.7	36.7	8.7	36.2	26.0	19.6		46.5	29.2	16.3
South Asia	14.4	1.8	33.7	21.9	1.8	37.4	24.4	17.4	14.5		20.0	16.7
Rest of the World	15.1	2.1	17.4	25.8	2.6	32.5	25.1	19.7	22.9	45.6		15.1
Average	16.7	4.7	22.5	47.7	10.8	30.8	26.3	16.0	25.1	52.6	21.1	

Source: MacMap_HS6 and authors' calculation. Year 2001. Ad valorem equivalents.

Table 2. Impact of the tariff cut scenario on market access for agricultural products

	EU 25	USA	Asia developed	EFTA	Cairns developed	Mediterranean	Sub-Saharan Africa	Cairns developing	China	South Asia	RoW	Average
EU 25		-1.0	-6.2	-3.3	-2.3	-4.2	-0.4	-1.2	-10.4	-1.8	-1.0	-3.1
USA	-6.0		-6.5	-2.7	-1.1	-2.9	-0.2	-0.9	-10.4	-5.9	-0.4	-4.3
Asia developed	-4.6	-0.8		-2.9	-1.1	-2.5	-0.2	-0.6	-9.2	-0.3	-1.1	-3.0
EFTA	-2.5	-0.5	-1.4		-1.1	-2.7	-0.1	-0.5	-10.0	-0.2	-1.2	-1.9
Cairns developed	-12.1	-0.2	-6.7	-2.7		-3.8	-0.5	-1.0	-6.7	-4.7	-0.4	-6.4
Mediterranean	-2.9	-0.8	-3.5	-2.2	-0.9		-0.2	-1.0	-9.1	-1.8	-1.0	-2.6
Sub-Saharan Africa	-3.3	-0.1	-4.1	-0.7	-0.1	-1.1		-0.3	-5.1	-0.4	-1.1	-2.2
Cairns developing	-8.0	-0.7	-5.4	-1.9	-1.4	-2.6	-0.2		-10.1	-1.8	-0.6	-4.6
China	-4.5	-1.5	-5.9	-2.5	-2.7	-4.4	-0.7	-0.8		-7.3	-0.8	-3.6
South Asia	-7.0	-0.3	-9.7	-4.2	-0.2	-4.9	-0.3	-1.0	-3.8		-0.5	-3.9
Rest of the World	-6.6	-0.2	-5.0	-2.5	-0.5	-3.4	-0.7	-1.0	-8.5	-2.3		-4.2
Average	-7.1	-0.8	-5.9	-2.9	-1.8	-3.3	-0.3	-1.0	-9.4	-2.7	-0.7	

Source: MacMap_HS6 and authors' calculation. Year 2001.
In percentage points (i.e. the figures correspond to x-y if a tariff of x% is reduced and results in a y% tariff).

Table 3. Impact of the tariff cut scenario on market access by sector

	EU 25	USA	Asia developed	EFTA	Cairns developed	Mediterranean	Sub-Saharan Africa	Cairns developing	China	South Asia	RoW	Agriculture and food
Paddy rice	-30.5	-1.8	-81.3	0.0	0.0	-0.1	0.0	-0.1	0.0	-23.0	-0.2	-17.6
Processed rice	-82.2	-1.3	-66.5	0.0	0.0	-0.1	0.0	-0.1	0.0	-21.0	-0.2	-18.9
Coarse grains	-4.2	-0.4	-25.7	0.0	0.0	-0.7	0.0	-1.1	-7.5	-14.1	-0.6	-5.3
Wheat	-0.2	-1.0	-0.4	0.0	0.0	-1.2	0.0	-0.3	0.0	-28.5	-0.2	-1.2
Sugar	-76.9	0.0	-64.1	-26.6	-0.9	0.0	-0.3	-3.0	-0.1	0.0	-0.2	-20.6
Oilseeds	0.0	-1.3	-1.9	0.0	0.0	0.0	0.0	0.0	-36.1	0.0	-0.2	-4.6
Live animals	-17.6	0.0	-6.7	0.0	0.0	-6.5	0.0	-0.2	-2.0	0.0	-0.1	-6.3
Animal products	-1.8	-0.1	-3.4	-0.2	-1.1	-0.5	-0.1	-0.3	-3.1	0.0	-1.2	-1.5
Meat	-29.0	-0.1	-11.0	-0.3	-0.1	-25.0	-0.3	-2.0	-10.9	0.0	-0.2	-11.8
Meat products	-7.7	-1.6	-15.3	-6.1	-9.6	-17.0	-0.4	-2.6	-5.9	0.0	-0.2	-6.7
Dairy products	-18.3	-0.6	-4.7	-8.1	-1.6	-4.6	-0.6	0.0	-16.3	0.0	-1.3	-4.7
Fibers	0.0	0.0	0.0	0.0	0.0	-0.4	-0.2	-0.2	0.0	0.0	-0.1	-0.1
Fruits & vegetables	-7.6	-1.2	-5.4	-1.0	-0.5	-8.9	-2.0	-1.8	-8.0	0.0	-0.5	-4.2
Other crops	-0.8	-0.3	-0.7	-1.4	-0.4	-1.5	-0.4	-0.4	-9.0	0.0	-2.1	-1.1
Fats	-1.8	-1.4	-1.5	-3.8	-0.4	-0.5	0.0	0.0	-6.1	0.0	-0.2	-1.5
Beverages & Tobacco	-6.2	-0.2	-4.0	-3.6	-2.8	-5.2	-0.2	-3.2	-24.7	0.0	-3.4	-4.1
Food	-2.8	-1.0	-2.4	-2.2	-1.4	-2.6	-0.5	-0.6	-6.3	0.0	-0.1	-2.0
Total agrofood	-7.1	-0.8	-5.9	-2.9	-1.8	-3.3	-0.3	-1.0	-9.4	-2.7	-0.7	

Source: MacMap_HS6 and authors' calculation. Year 2001.
In percentage points (i.e. the figures correspond to x-y if a tariff of x% is reduced and results in a y% tariff).

Table 4. Impact of the Doha Agreement scenario on world prices (import prices)

Sector	Initial share in world exports	Domestic support	Export subsidies	Tariffs	Doha agreement, 3 pillars
Paddy rice	0.6	8.2	0.1	1.3	9.4
Processed Rice	1.2	0.6	0.0	0.3	1.0
Coarse grains	3.6	2.6	0.1	0.5	3.1
Wheat	3.9	1.4	0.1	0.9	2.3
Sugar	2.7	0.2	5.6	-1.5	2.8
Oilseeds	5.7	9.1	0.0	0.5	9.7
Live animals	1.2	0.9	0.1	0.7	1.6
Animal products	3.4	0.6	0.0	0.1	0.8
Meat	4.0	0.6	0.1	0.5	1.2
Meat products	4.8	0.3	1.5	0.1	2.0
Dairy products	3.6	0.3	2.3	0.0	2.7
Fibers	3.6	25.6	0.0	0.2	26.0
Fruits & vegetable	8.3	0.1	0.2	0.5	0.8
Other crops	10.1	0.8	0.0	0.4	1.2
Fats	7.2	2.8	0.0	0.2	3.0
Beverages and Tobacco	11.0	0.1	0.5	0.3	0.3
Processed food	25.0	0.3	0.6	0.4	0.9
Total agrofood	100.0	2.1	0.5	0.3	2.8

Source: Authors' simulations. (*) World imports here refer to imports between the regions considered in the model. Imports between countries within the same region are not considered. ‘World price’ is a weighted average of the changes in each region’s import prices.

Table 5. Impacts of Doha agreement scenario on agrofood exports (% change)

	Initial level (Mn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha agreement, 3 pillars
EU 25	61 642	-1.9	-4.2	7.4	2.7
USA	69 969	-6.7	0.6	7.2	0.8
Asia developed	5 716	0.6	1.2	10.7	11.8
EFTA	6 428	2.4	-6.6	2.7	-3.8
Cairns developed	38 875	2.2	0.6	10.2	12.8
Mediterranean	8 304	2.0	-0.2	6.2	8.8
Cairns developing	54 934	2.7	-0.1	7.9	10.4
China	11 947	2.0	0.0	11.0	13.2
RoW	35 074	2.1	-0.5	5.5	6.8
South Asia	7 513	3.1	-0.4	3.3	6.4
SubSaharan Africa	12 420	3.3	-1.2	2.7	4.7
World	312 822	-0.5	-0.9	7.4	6.1
Richest countries	182 630	-2.6	-1.3	7.9	4.2
Developing countries	110 260	2.4	-0.2	7.3	9.4
Poorest countries	19 933	3.3	-0.9	2.9	5.4

Source: Authors' simulations.
Note: Initial levels are expressed in millions of US dollars. The figures refer to f.o.b. values.

Table 6. Impacts on welfare (% change)

	Initial GDP (Bn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha agreement, 3 pillars
EU 25	8 235	0.04	0.01	0.09	0.14
USA	7 952	0.05	0.00	0.00	0.05
Asia developed	5 233	-0.05	0.00	0.11	0.05
EFTA	408	-0.04	0.08	0.03	0.11
Cairns developed	1 092	-0.01	0.00	0.04	0.04
Mediterranean	454	-0.27	-0.07	0.16	-0.16
Cairns developing	2 012	-0.02	0.00	0.02	0.00
China	876	-0.21	0.00	0.38	0.15
RoW	2 026	-0.07	-0.06	0.01	-0.10
South Asia	527	-0.01	0.00	0.19	0.17
Sub-Saharan Africa	207	0.01	-0.08	0.03	-0.03
World	29 023	0.02	0.00	0.06	0.08
Richest countries	22 920	0.02	0.00	0.06	0.08
Developing countries	5 368	-0.09	-0.03	0.08	-0.03
Poorest countries	734	-0.01	-0.03	0.15	0.11

Source: Authors' simulations.

Table 7: Impacts on the real return to land and agricultural labor (% change)

	Land				Labor			
	Domestic support	Export subsidies	Tariffs	Doha	Domestic support	Export subsidies	Tariffs	Doha agreement 3 pillars
EU 25	-14.6	0.0	-0.4	-15.1	-0.5	0.0	-0.5	-1.1
USA	-0.4	0.0	0.2	-0.2	-2.2	0.0	0.6	-1.7
Asia Developed	0.5	0.0	-2.3	-1.8	0.3	0.0	-1.2	-0.8
EFTA	1.1	0.5	-0.5	1.1	0.3	-1.6	0.2	-1.5
Cairns Developed	-0.3	0.0	1.3	1.1	1.0	0.1	1.7	2.8
Mediterranean	0.7	0.0	0.0	0.8	0.0	-0.1	0.3	0.2
Cairns Developing	0.6	0.0	0.0	0.6	0.5	0.0	0.8	1.4
China	0.5	0.0	-0.3	0.3	-0.1	0.1	0.9	0.7
RoW	1.1	0.0	0.0	1.1	0.6	-0.2	0.7	1.1
South Asia	-0.1	0.0	0.0	-0.1	0.5	0.0	0.2	0.6
SubSaharan Africa	0.2	-0.1	0.0	0.2	1.1	-0.2	0.3	1.2

Source: Authors' simulations.

APPENDIX

Appendix I. The baseline and the scenario for the Doha Agreement simulation

Appendix II. Results and sensitivity analysis

Appendix III. Welfare decomposition

Appendix IV. Elements on the structure of the model

Appendix I. The baseline and the scenario for the Doha Agreement simulation

I.1. Sectoral aggregation

Table A1 shows the sectoral aggregation that is used in the agricultural version of the MIRAGE model. Table A1 also shows the type of competition that is assumed for each sector, i.e. perfect competition, or imperfect competition that is represented by both a Dixit-Stiglitz specification and a vertical differentiation in two categories of quality (see explanations below). The category of economic activity (agriculture, food, other primary, industry, services) is also shown, given that this distinction is used in some particular result aggregates. The sectors where there are subsidized exports in the baseline, or in which subsidized exports are possible in order to clear the domestic market, are also indicated. The last column specifies whether in developing countries, the corresponding sector is part of the "modern" sector (in which an efficient wage is paid) or the traditional one, under the assumption of a dual labor market.

The precise contents of each sector, regarding tariff lines, can be found in Dimaranan and McDougall (2002), as well as in the GTAP correspondence tables with the HS6 (see www.gtap.agecon.purdue.edu).

Table A1. Sectoral aggregation

Sector	Type of competition	Vertical differentiation	Aggregate	Possibility of subsidized exports	Traditional/ Modern in DCs
Paddy rice	Perfect	No	Agriculture	EU	Traditionnal
Processed rice	Imperfect	Yes	Food products		Modern
Coarse grainss	Perfect	No	Agriculture	EU	Traditionnal
Wheat	Perfect	No	Agriculture	EU	Traditionnal
Sugar	Perfect	No	Food products	EU	Modern
Oilseeds	Perfect	No	Agriculture		Traditionnal
Live animals	Perfect	No	Agriculture		Traditionnal
Animal products	Perfect	No	Agriculture		Traditionnal
Meat	Perfect	No	Food products	EU	Traditionnal
Meat products	Imperfect	Yes	Food products	EU/US	Modern
Dairy	Imperfect	Yes	Food products	EU/US	Traditionnal
Fibers	Perfect	No	Agriculture		Traditionnal
Vegetables and fruits	Perfect	Yes (Low)	Agriculture	EU	Traditionnal
Other crops	Perfect	Yes (Low)	Agriculture		Traditionnal
Fats	Imperfect	Yes (Low)	Food products		Traditionnal
Beverages and tobacco	Imperfect	Yes	Food products	EU	Modern
Processed food	Imperfect	Yes	Food products	EU	Modern
Forestry	Perfect	No	Agriculture		Traditionnal
Fishing	Perfect	No	Agriculture		Traditionnal
Primary	Perfect	No	Other primary		Modern
Wood products	Imperfect	Yes	Industry		Modern
Wool	Perfect	No	Agriculture		Traditionnal
Textiles	Imperfect	Yes	Industry		Modern
Clothing	Imperfect	Yes	Industry		Modern
Leather	Imperfect	Yes	Industry		Modern
Equipment	Imperfect	Yes	Industry		Modern
Chemicals	Imperfect	Yes	Industry		Modern
Other industry	Imperfect	Yes	Industry		Modern
Services	Imperfect	Yes	Services		Modern

In some sectors, an element of vertical differentiation is introduced (in addition to the horizontal differentiation introduced by the Dixit-Stiglitz specification). That is, we assume that there are two different qualities of products, depending on the level of development of the country of origin, in particular sectors. The elasticity of substitution is therefore lower between products originating from countries of different level of development, for the sectors indicated by "yes" in the third column of Table A1. This

intends to reflect that qualities differ between origins with a North/South approximation (case in industrial goods).

In some sectors (indicated by "low"), elasticities of substitution are country group-specific and are set at low levels. The purpose is to take into account that the given aggregate (e.g. "Other crops") includes very different products according to the country group (e.g. cotton, cocoa, coffee). Indeed the use of undifferentiated elasticities of substitution would have unwanted effects (e.g. a cut in EU tobacco subsidies would generate extra imports of cocoa).

I.2. Country aggregation

Table A2 provides a list of the 11 country groups that are used in the aggregate model. Country groups with small/large arable land area are distinguished, since we assume different supply elasticities of agricultural land (see details in the article). Table A2 also provides a (crude) classification of the country groups in two categories (developed / developing) of countries, since some aggregate results are presented for developing countries.

Table A2: Country aggregates

Country group	Countries	Assumption on agricultural land available (for the endogenous land supply modelling)	Development
EU 25	European Union, enlarged to 25 countries	Small	Developed
USA	United States of America	Large	Developed
Developed Asia	Japan, South Korea	Small	Developed
EFTA	Switzerland, Norway, Iceland	Small	Developed
Developed countries of the Cairns group	Australia, Canada, New Zealand	Large	Developed
Mediterranean	Maghreb, Mashreq, Romania, Bulgaria, Turkey, Croatia	Small	Developing
Sub Saharan Africa	Africa, including islands close to Africa (Seychelles, Madagascar, Maurice) with the exception of Maghreb and Mashrek	Large	Developing
Developing countries of the Cairns group	All other Cairns group members, including Brazil, Argentina, Chile, Malaysia, Philipines, etc.	Large	Developing
China	China and Hong Kong	Large	Developing
South Asia	Bangladesh, India, Pakistan	Small	Developing
Rest of the worl (RoW)	Others	Small	Developing

I.3. The baseline

The baseline represents a fictitious mid-term reference point using the most recent data available as a benchmark. It is based on the situation in the year 2001, but some data come from the GTAP dataset and correspond to the year 1997 (namely non-agricultural data). In addition, we assumed that the EU enlargement had taken place, reflecting the 2005 situation. Finally, we assumed that the reforms of farm policies decided in 2002 in the US, in 1999 and in 2003 for the EU were fully implemented, while in reality, the transition period spans over several years in the case of the EU.

That is, the baseline provides a mid term reference points which the scenario of the Doha agreement is applied to, as a counterfactual situation, not a faithful representation of the present situation.

I.4. Data on protection

The protection data used in these simulations is the result of an original work, which led to the constitution of the MAcMap dataset. The methodology is further detailed in Bouët et al. (2004). These data will be included in the forthcoming version 6 of the GTAP dataset. It is noteworthy that, compared to the original

MAcMaps data, the data used in the present paper have has been dramatically improved following corrections and suggestions by several members of the GTAP consortium and researchers of Purdue University, and has benefited from additional input supplied by the Economic Research Service of the US Department of Agriculture, namely in the area of tariff-rate quotas.

The data originates from the source files of UNCTAD's TRAINS database, from countries notifications to the WTO (Consolidated Tariff Schedules), from the Agricultural Market Access Database -AMAD-, supplemented with data and from national custom information (reported to of UNCTAD, or directly to ITC). This information is completed by other relevant sources (administrations, statistical institutes, international organizations, websites of regional agreements, etc.). This combined information characterizes the trade policy applied by 163 countries to 208 exporting partners. It includes information on tariffs (ad valorem, specific, mixed, compound and antidumping duties), and tariff quotas.

This database brings three original contributions: (i) it covers all preferential agreements enforced in 2001; (ii) the calculation of *ad valorem* equivalent of specific tariffs (at the 6 digit level) accounts for exporters specialization in terms of product quality, which impacts the unit value of exports; (iii) the aggregation method used limits the extent of the endogeneity bias.

The exhaustive coverage of preferential agreements makes a sizeable difference with regards to other existing multilateral databases on protection, given the large coverage of such agreements. In particular, the data used in the model includes all EU preferential agreements, including the Lomé/Cotonou régime and the "Everything But Arms" (EBA) initiative. The information is not communicated to the various international organizations by the EU Commission, explaining why EU preferences are only partially included in databases such as UNCTAD's TRAINS, or not included at all (the IDB database of the WTO). Specific data from the TARIC (Tariff Intégré des Communautés Européennes) was used in order to complement international data sources.

Information on tariff rate quotas (TRQs) comes from AMAD, and from the WTO. Tariffs under TRQs come from different sources, including US International Trade Commission and TARIC. A marginal protection duty and a rent are calculated, taking into account the bilateral allocation of each quota, when applicable, and the fill rate of each quota. The marginal protection duty (sometimes called shadow tariff) is defined as the *ad valorem* tariff duty which, applied to the same product, would lead to the same level of import as the TRQ considered. This marginal protection rate is assumed to be equal to the inside-quota tariff rate (IQTR) if the quota is not filled (fill rate inferior to 90%), and to the outside-quota tariff rate (OQTR) as soon as the quota is filled (fill rate equal to 100%). In between (fill rate included between 90% and 100%), the quota is assumed to be filled (administration problems are likely to cause the quota not be exactly filled, even when the IQTR is not binding), but the OQTR is assumed to be prohibitive. In this case, without any better proxy, the marginal protection rate is approximated by the average of the IQTR and the OQTR.

The vertical specialization of countries along the quality ladder has been shown to be widespread, and closely correlated with countries factor endowment and technology (Fontagné et al., 1997; Schott, 2004). Given that specific tariffs have a more restrictive impact on unprocessed or low quality goods, these differences are worth taking into account. The method used here relies on reference groups. Built as a result of a hierarchical clustering analysis based on real Gross Domestic Product per capita (i.e. GDP expressed in purchasing power parities) and trade openness, each of the five groups gathers relatively similar countries in terms of export specialization. *Ad valorem* equivalents are then calculated based on the (weighted) median unit value of worldwide exports originating from the reference group the exporter belongs to (see Bouët et al. 2004 for details).

The aggregation methodology intends to reflect trade restrictiveness, and to limit the extent of the endogeneity bias. This bias arises when average tariffs are computed using bilateral imports as weighting scheme, since higher tariffs *ceteris paribus* lead to lower imports (Laird and Yeats, 1998). Instead,

average tariffs are computed here using exports of the exporting country toward the whole reference group of the importer, as weighting scheme across products and across exporters.

I.4. Farm support and policy variables

Sources. The different forms of farm support are expressed as a percentage of the sectoral output (or input) in 2001 and are then included the dataset so as to replace original GTAP data. For OECD countries, the farm support data relies on primary information from the OECD on the Producer Support Estimates (PSEs). A detailed classification of the various forms of payments was made, relying on the OECD "PSE Cookbook" so as to model the farm policies (OECD, 2003). Basic data from the PSE dataset was kindly provided by the Secretariat. For non-PSE commodities data, some data was provided by the OECD secretariat, and other data from national sources have been used (e.g. budget data for subsidies to cotton, tobacco, olive oil in the EU; data provided by the Economic Research Service of the USDA for US programs). For China, data from FAPRI (Food and Agricultural Research Institute) was used. Additional data was on EU agricultural payments was provided by Hans Grinsted Jensen, from FOI Copenhagen.

For non-OECD/China countries, the data that has been used for domestic agricultural policies have been limited to the instruments available in the standard 5.3 version of the GTAP dataset (see Dimaranan and McDougall, 2002).

Tax and subsidies instruments. Agricultural policies are represented by various types of taxes and subsidies for modeling purposes. We distinguish market price support, output subsidies, capital subsidies, variable input subsidies, land subsidies, and decoupled subsidies, in the sense that the latter do not target a particular agricultural sector. That is, for example, the EU Common agricultural policy is modeled by different price wedges and percentage subsidies, either on output, on variable inputs, on land or on capital. In addition, market price support is modeled through the combination of tariffs and of export subsidies. Regarding land set-aside, we assume that only a part of total land is available for production.

All subsidies (limited and unlimited) that are a function of the volume of output are treated as output subsidies. Capital subsidies include support of farm investment (e.g. national subsidies on interest charges given by some EU member states), and payments per head of cattle (e.g. beef premia in the EU[15]). Variable input subsidies include tax deductions (fuel in some countries), subsidies to particular inputs (e.g. cotton seeds in the EU). Direct payments per hectare that are based on reference yields (e.g. arable crops payments in the EU) are treated as land subsidies. Decoupled payments (payments to self-employed labor) include all payments that are conditional to input constraints, agri-environmental payments, and payments that are based on reference levels and not tied to land, input use or output.

With these assumptions, it is noteworthy that, for example, most of the EU support to the beef sector in 2001 is treated as a capital subsidy (more exactly to the capital specific in the live animals sector); most of the support to grains in the EU is treated as land subsidy (specific to land in the grains sector); most of the support to the dairy sector is treated as market price support in both the EU and the US; most of the support to coarse grains and oilseed is treated as decoupled in the US (with the exception of marketing loans, treated as output subsidies).

The introduction of recent policy changes. The representation of farm policies on the basis of the 2001 data and instruments, are then amended so as to take into account the changes brought about by the EU Agenda 2000 (including the June 2003 reform package) and the US FSRI. Note that in a counterfactual scenario presented in section II of this appendix, the simulation is run without the effect of the June 2003 package, for comparison purposes.

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[15] Even though in the scenario including of the June 2003 package, these payments are then considered as largely decoupled, reflecting the various options for partial decoupling chosen by the different member states.

The FSRI and the Agenda 2000 result in changes in the set-aside, compared to the 2001 data. In the baseline, the increase in the acreage under conservation programs caused by the FSRI is only partially taken into account (as an extra negative productivity shock on land for wheat) compared to the situation prevailing in 2001. Indeed, we consider that only a share of the increased acreage eligible will be used for conservation (Westcott et al., 2002), and that the overall effect on output will be limited, because of several arguments put forward by Gardner (2002) and Sumner (2003). In the EU, in order to account for exemption of small producers and other forms of slippage, the 10% set aside on arable crops was taken into account as a 7% land set-aside only (this amount of set-aside is assumed to be unchanged after the June 2003 reform package, and we assumed that the 5% rate in 2003/2004 was motivated by the unusual climatic and wheat price situation).

The Agenda 2000 and the FSRI also affect the various policy variables. Relatively to the 2001 figures, the effects of the implementation of the of the US 2002 FSRI are taken into account by an increase in the output subsidy for wheat (6%) and other coarse grains (3%), and a decrease in the case of soybean (4%). An output subsidy on dairy (3% of the value of production) is introduced.

In the European Union, the implementation of the Agenda 2000 was taken into account in the data on intervention prices and support for 2001, except in the case of oilseeds (where a further 13% decrease in subsidies based on acreage was introduced) and in the case of beef (a 32% decrease of the intervention prices was applied in order to account for the July 2002 decrease in intervention price). In order to account for the final (i.e. 2002) increase in beef premia, the overall support per head of cattle (introduced in the model as a capital subsidy in the live bovines sector), the 2001 support was increased by 13%.

Finally, the effects of the EU June 2003 reform package are introduced in the standard baseline. The June 2003 reform package shifts a most of the land subsidies to the decoupled category, as well as a percentage of the capital subsidies, reflecting the partial decoupling and the options chosen by the various member states.

In the rice sector, the June 2003 package results in a fall of intervention price of 50%, which is replaced by a 200 million euros of land payment and a 270 million euros of decoupled payment. In the beef sector, the Agenda 2000 led to a 12 billion capital subsidy, that the June 2003 package reduces to 3 billion, the difference also becoming a decoupled payment. In the dairy sector, the intervention price decrease by 15 percent, and a 4.2 billion decoupled payment is introduced.

In order to model the Doha agreement scenario as a change to the baseline, the AMS (i.e. after the recent policy changes) must be measured as a benchmark. The change in the actual AMS induced by the EU June 2003 package is estimated by using the 2002 output times the gap between future and 2002 intervention prices for each category, and the shift from amber/blue box to green box of some payments. Basically, the changes are dramatic in the crop sector AMS where more than 70% of the payments tied to the land allocated to each production in 2001 shift to the green box and are considered as returns to an aggregate of primary factors).

Note that the introduction of the June 2003 reform package in the baseline is debatable. Indeed, even if the main components of the reform (the single farm payment) will enter in force in 2005, some other components will only be fully implemented in 2012. In addition, the adoption of the June 2003 package, may be seen as an indirect consequence of the Doha Round, and one might argue that the assessment of the impact of the Doha agreement should be made against a benchmark that correspond to the assumption prevailing under the 1999 reform. Because this package has a considerable impact on the EU farm support (by shifting a large bulk of payments from the "blue box payments" that we treat mainly as subsidies to land or animal capital in the model, to more decoupled payments), we ran simulations of the impact of the Doha Agreement excluding the June 2003 package from the baseline. The results are presented in the section II on "sensitivity analysis" in this Appendix.

I.5. Tariff cuts in the Doha scenario

WTO negotiations deal with bound tariffs, which frequently differ widely from applied tariffs. In order to describe accurately the effect of a given, negotiated tariff cut formula, a separate database has been built for bound protection. Based on WTO's CTS database and on complementary sources (from national institutes and government and international organizations) when necessary, this database gives the *ad valorem* equivalent (AVE) of bound duties, at the HS-6 level, for all WTO members.
The methodology used in calculating AVEs is the same as for applied protection, and consistency between both databases is checked. The only methodological difference lies in the calculation of AVEs. As pointed out above, AVE of applied, specific tariff are computed so as to account for the different quality specialization of exporter. Based on the differences in unit values of worldwide exports of the reference group the exporter belongs to, this results in five different unit values being taken into account, for each product. This is intended to reflect the trade restrictiveness of specific tariff, but it is inconsistent with the WTO approach, and in particular with the most favored nation principle. This is why, for bound duties, the AVE of specific tariffs are computed using worldwide unit values. In applying the formula described below, applied specific duties are also converted using worldwide unit values. Once the percentage cut is computed, it is applied to the applied rates used in the model, namely to the AVEs computed for applied protection, using reference-group unit values. This method thus alternatively makes use of two distinct AVE calculation method: one (based on reference group unit values) is intended to reflect accurately trade restrictiveness, the other (based on multilateral unit values) aims at reflecting the "institutional" AVE, likely to be taken into account in the WTO negotiations.

Applied tariffs resulting from a given formula are computed separately for each HS-6 product, by combining these two databases. The formula is applied to the initial bound tariff, and the final applied duty is calculated as the minimum between the initial applied tariff and the final bound tariff (both computed using worldwide unit values). The rents of TRQs are re-calculated accordingly, assuming that the same formula is applied to out-of-quota tariff rates as to other applied tariffs.

Table A3: Scenario for tariff cuts

Developed countries		**Developing countries**	
Initial tariffs	*Reduction rate*	*Initial tariffs*	*Reduction rate*
t>90%	60%	*t>120%*	40%
T=<90% and t>15%	50%	*t=<120% and t>60%*	35%
T=<15%	40%	*t=<60% and t>20%*	30%
		T=<20%	25%

Table A3 provides the exact cuts in bound tariffs applied in the simulation scenario. They are drawn from WTO (2003), i.e. the March 2003 draft compromise on modalities (the so-called revised Harbinson proposal). These cuts in tariffs are applied to the existing tariffs at the HS6 level. Then the aggregation procedure described in Bouët et al. (2004) is used to construct new matrices (i.e. thirty 11x11 matrices) of bilateral tariffs for each of the 30 sectors and the 11 country groups that we consider here.

I.6. Cut in farm support in the Doha scenario

We assume that distorting farm support will be cut by 55% in the Doha scenario. This is an optimistic assumption, given that this figure failed to reach an agreement when proposed by the Chairman of the WTO agricultural committee Harbinson in March 2003. However, the 55% cut applies to the AMS ceiling. In the EU, Canada and Japan, the actual AMS is below this ceiling. (In the US, the amber box payments were above this ceiling for recent years, but the EU notified some of them under the *de minimis* clause).

The implementation of the Agenda 2000 and the June 2003 package will reduce even further the actual amber box support.

Table A4. Data on actual AMS, ceiling AMS, and counterfactual data as shock on actual support.

Country	European Union	United States	Canada	Japan
Currencies	mn euros	mn US$	mn C$	bn Yens
Actual data				
Green box support	19931	49749	1300	2686
Blue box support	19792	0	0	93
Amber box type support (including distortive support notified under the de minimis clause)	47941	24297	790	781
Official AMS (i.e. amber box adjusted for de minimis)	47886	16862	790	748
Present WTO ceilings				
AMS ceiling	69450	19899	4659	4139
Percent of ceiling filled	0.69	0.85	0.17	0.18
Support in the baseline				
Amber box	32486	24297	790	781
Blue box	792	0	0	0
Green box	46131	50814	331	228
Assumptions on ceilings under the Doha scenario				
Ceiling amber box	27780	7960	1864	1656
Ceiling blue box	9896	0	0	0
Ceiling de minimis	6408	5070	331	228
Actual shock on farm support under the counterfactual Doha scenario (relative to the baseline, i.e. shock zero if the baseline is smaller that the counterfactual ceiling under the Doha scenario)				
Green box support	0	0	0	0
Blue box support	-18%	0	0	0
Amber box support	-14%	-53%	0	0
Actual shock on farm support under the counterfactual Doha scenario under the alternative simulation where the June 2003 EU package is not implemented				
Green box support	0	0	0	0
Blue box support	-55%	0	0	0
Amber box support	-42%	-53%	0	0

Table A4 presents the actual effects of the 55% cut in AMS ceilings. It is noteworthy that in some countries such as Japan, the ceiling is so high that the actual cut will have little practical impact. In the EU, given that most of the blue box payments will have shifted to the green box by the end of the implementation period of the June 2003 reform package, the impact on the actual support is also very limited. In the alternative scenario, where we do not include the June 2003 reform package in the baseline, the impact of the Doha round is larger (a 42% reduction in the amber box support and a 55% reduction in the blue box support).

In order to assess the actual effects of the 55% cuts in AMS ceilings, we took into account the gap between the actual AMS and the ceiling, and we also accounted for the recent policy reforms. That is, in the EU baseline, we calculated the future AMS that will take place after implementation of the June 2003 package. In order to do so, we calculated sector specific market price support as the difference between the future intervention prices and the references prices used by the WTO for the calculation of the AMS.

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Appendix II. Results and sensitivity analysis

In this appendix, we provide some additional information on the results of the simulation of Doha agreement scenario described above. In the following tables, we provide the changes resulting from

- The three pillars of the Doha Agreement simulation:
  - a cut in domestic support (labeled "Domestic support"
  - the suppression of export subsidies (labeled "Export subsidies")
  - the cut in tariffs (labeled "Tariffs")
- The combined effects of the three pillars (labeled "Doha")

In addition, the tables provide the results of the Doha scenario (i.e. the three pillars combined) under alternative assumptions in order to test for sensitivity. These are :

- "Exogenous land": land supply is assumed to be exogenous in all countries
- "No dual labor market": the assumption of a dual labor market in DCs is removed, the labor is assumed to be perfectly competitive in all countries
- "Perfect competition": perfect competition is assumed to hold in all sectors
- "Double elasticities": all the elasticities of substitution in the demand functions are multiplied by two (Armington elasticities)
- "Without NCAP": the simulation is run assuming that, in the baseline, the package of EU reforms decided in June 2003 would not be implemented
- "Cut on applied tariffs": we assume that all the tariff cuts in our scenario (see Table A2) are made on applied tariffs rather than on the bound tariffs. That is, we ignore the existence of "binding overhang". The difference with the regular "Doha" scenario provides an assessment of the differences in results obtained if, like most modelers, we assumed that bound tariffs were actually applied

Table A5 Impact of scenario of Doha agreement on world prices (import prices) and sensitivity analysis (%)

Sector	Initial share in world agrofood exports	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
Paddy rice	0.6	8.2	0.1	1.3	9.4	9.5	9.2	9.3	10.8	10.2	11.7	9.5
Processed rice	1.2	0.6	0.0	0.3	1.0	1.0	0.9	0.9	1.3	1.2	1.4	1.2
Coarse grainss	3.6	2.6	0.1	0.5	3.1	2.7	3.0	3.1	3.0	4.5	2.1	3.4
Wheat	3.9	1.4	0.1	0.9	2.3	2.0	2.2	2.3	2.5	3.7	2.4	2.6
Sugar	2.7	0.2	5.6	-1.5	2.8	2.4	2.4	2.4	1.6	2.7	1.1	2.5
Oilseeds	5.7	9.1	0.0	0.5	9.7	9.5	9.6	9.7	9.6	10.0	11.0	10.0
Live animals	1.2	0.9	0.1	0.7	1.6	1.4	1.5	1.6	1.9	3.4	0.3	1.9
Animal products	3.4	0.6	0.0	0.1	0.8	0.6	0.6	0.8	0.7	1.0	0.1	0.9
Meat	4.0	0.6	0.1	0.5	1.2	1.0	1.1	1.2	1.4	3.4	0.5	1.4
Meat products	4.8	0.3	1.5	0.1	2.0	0.4	0.4	0.5	0.5	0.7	0.1	0.6
Dairy products	3.6	0.3	2.3	0.0	2.7	0.3	0.3	0.4	0.8	12.8	0.9	0.4
Fibers	3.6	25.6	0.0	0.2	26.0	25.8	26.0	26.3	35.9	26.2	30.4	26.2
Fruits & vegetables	8.3	0.1	0.2	0.5	0.8	0.5	0.4	0.6	0.6	0.9	1.0	0.9
Other crops	10.1	0.8	0.0	0.4	1.2	1.2	1.0	1.3	1.3	1.5	1.6	1.5
Fats	7.2	2.8	0.0	0.2	3.0	2.9	2.9	3.0	3.2	3.2	2.1	2.7
Beverage Tobacco	11.0	0.1	0.5	0.3	0.3	-0.2	-0.2	-0.2	-0.3	-0.1	-0.2	-0.2
Food	25.0	0.3	0.6	0.4	0.9	0.9	0.9	0.9	0.9	1.2	0.2	1.0
Total agrofood	100.0	2.1	0.5	0.3	2.8	2.4	2.5	2.6	2.9	3.4	2.5	2.7

Table A6 Impact of scenario of Doha agreement on world prices of developing countries trade and sensitivity analysis (%)

Sector	Initial share in world agrofood exports	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
Paddy rice	0.3	0.5	0.0	0.4	0.9	1.0	0.7	0.9	1.3	1.1	1.4	1.2
Processed rice	2.3	0.4	0.1	0.4	0.8	0.9	0.7	0.8	1.1	1.0	0.9	1.1
Coarse grainss	2.4	0.4	0.1	0.3	0.7	0.8	0.5	0.8	0.7	1.0	-3.1	1.2
Wheat	1.1	0.4	0.1	0.5	1.0	1.0	0.8	1.0	1.1	1.3	-1.6	1.3
Sugar	4.6	0.2	0.5	0.3	1.1	0.8	0.7	0.8	0.8	1.0	-1.0	0.9
Oilseeds	3.6	1.5	0.0	0.2	1.8	1.9	1.6	1.9	2.5	2.1	1.8	2.1
Live animals	0.6	0.4	0.1	0.4	0.8	0.8	0.6	0.9	1.0	1.2	-4.5	1.1
Animal products	3.2	0.4	0.1	0.2	0.6	0.6	0.4	0.6	0.7	0.9	-1.0	1.0
Meat	1.6	0.3	0.1	0.5	0.8	0.9	0.7	0.9	1.1	1.1	-2.3	1.2
Meat products	3.3	0.3	0.1	0.2	0.5	0.6	0.4	0.6	0.6	0.8	-1.0	0.8
Dairy products	0.6	0.3	1.3	0.3	1.9	0.6	0.5	0.6	0.6	1.0	-1.7	0.8
Fibers	1.5	3.0	0.0	0.3	3.3	3.3	3.1	3.3	7.0	3.5	3.8	3.6
Fruits & vegetables	12.8	0.3	0.0	0.5	0.9	1.0	0.6	1.0	1.1	1.1	1.5	1.3
Other crops	19.3	0.5	0.0	0.4	0.9	1.0	0.6	1.0	1.0	1.2	1.2	1.3
Fats	10.8	0.7	0.1	0.2	1.0	1.0	0.9	1.1	1.2	1.2	-0.1	1.3
Beverage Tobacco	3.4	0.2	0.1	0.2	0.4	0.4	0.4	0.4	0.4	0.6	0.3	0.6
Food	28.3	0.3	0.1	0.2	0.5	0.5	0.5	0.6	0.6	0.8	-0.8	0.8
Total agrofood	100.0	0.5	0.1	0.3	0.8	0.9	0.7	0.9	1.0	1.1	0.1	1.1

Table A.7 Changes in total welfare, Doha agreement on agriculture scenario and sensitivity analyis

	Initial GDP (Bn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	8 235	0.04	0.01	0.09	0.14	0.14	0.14	0.12	0.29	0.39	0.18	0.18
USA	7 952	0.05	0.00	0.00	0.05	0.07	0.05	0.04	0.06	0.04	0.06	0.05
Asia Developed	5 233	-0.05	0.00	0.11	0.05	0.06	0.05	0.04	0.09	0.04	0.24	0.13
EFTA	408	-0.04	0.08	0.03	0.11	-0.03	-0.03	-0.01	-0.04	-0.14	0.91	0.07
Cairns Developed	1 092	-0.01	0.00	0.04	0.04	0.04	0.03	0.08	0.05	0.04	0.04	0.07
Mediterranean	454	-0.27	-0.07	0.16	-0.16	-0.16	-0.10	-0.11	-0.20	-0.34	0.23	-0.11
Cairns Developing	2 012	-0.02	0.00	0.02	0.00	-0.07	0.03	0.04	-0.05	0.00	0.00	0.02
China	876	-0.21	0.00	0.38	0.15	0.15	0.13	0.13	0.22	0.17	-0.32	0.15
RoW	2 026	-0.07	-0.06	0.01	-0.10	-0.08	-0.04	-0.05	-0.08	-0.17	0.04	-0.02
South Asia	527	-0.01	0.00	0.19	0.17	0.15	0.14	0.12	0.16	0.17	0.31	0.18
SubSaharan Africa	207	0.01	-0.08	0.03	-0.03	-0.05	-0.01	0.01	-0.04	-0.11	0.02	0.06
World	29 023	0.02	0.00	0.06	0.08	0.09	0.08	0.07	0.15	0.18	0.13	0.11
Rich	22 920	0.02	0.00	0.06	0.08	0.09	0.08	0.07	0.15	0.17	0.16	0.11
DCs	5 368	-0.09	-0.03	0.08	-0.03	-0.05	0.01	0.01	-0.03	-0.07	-0.02	0.01
Poorest	734	-0.01	-0.03	0.15	0.11	0.10	0.09	0.09	0.11	0.09	0.23	0.15

Table A.8 Changes in the terms of trade, Doha agreement on agriculture scenario and sensitivity analyis

	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	-0.02	0.07	-0.07	-0.05	-0.07	-0.06	-0.08	0.06	0.08	0.11	-0.16
USA	0.28	-0.01	0.08	0.35	0.35	0.35	0.34	0.39	0.33	0.44	0.35
Asia Developed	-0.19	-0.02	-0.11	-0.31	-0.29	-0.30	-0.32	-0.31	-0.34	-0.36	-0.36
EFTA	-0.06	0.06	0.00	0.00	-0.09	-0.09	-0.07	-0.09	-0.14	-0.38	-0.09
Cairns Developed	0.06	0.00	0.19	0.26	0.23	0.25	0.33	0.28	0.28	0.29	0.33
Mediterranean	-0.41	-0.06	-0.04	-0.48	-0.46	-0.47	-0.46	-0.75	-0.57	-0.63	-0.38
Cairns Developing	0.03	0.00	0.17	0.21	0.21	0.19	0.25	0.09	0.20	0.16	0.33
China	-0.04	0.01	-0.13	-0.18	-0.19	-0.16	-0.18	-0.33	-0.16	-0.22	-0.08
RoW	-0.07	-0.09	0.04	-0.09	-0.05	-0.05	-0.04	-0.10	-0.18	-0.21	0.01
South Asia	0.20	-0.01	-0.19	0.01	0.00	0.00	-0.05	-0.12	0.01	-0.65	0.03
SubSaharan Africa	0.17	-0.13	0.10	0.18	0.20	0.15	0.22	0.14	0.04	-0.08	0.40

Table A.9 Changes in agrifood production, Doha agreement on agriculture scenario and sensitivity analyis

	Initial output (Bn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	117	-0.83	-0.20	-0.63	-1.57	-1.34	-1.41	-1.42	-3.05	-1.94	-1.33	-2.11
USA	84	-1.85	0.12	0.75	-1.05	-0.87	-1.17	-1.10	-1.39	-0.90	-1.30	-1.08
Asia Developed	52	-0.28	0.14	-1.93	-2.08	-2.15	-2.19	-2.08	-3.96	-1.95	-3.50	-2.23
EFTA	5	0.71	-1.87	-0.47	-2.73	0.18	0.35	0.27	-0.11	1.39	-18.98	-0.68
Cairns Developed	17	0.54	0.30	2.88	3.66	3.28	3.35	3.06	5.89	4.47	4.75	4.80
Mediterranean	21	0.73	0.29	-0.27	0.73	0.62	0.67	0.57	0.88	1.09	1.85	0.83
Cairns Developing	65	0.48	0.02	0.78	1.25	1.09	1.31	1.23	2.28	1.36	2.80	1.60
China	37	0.41	0.01	-0.41	0.01	-0.03	0.12	0.00	-0.03	0.00	2.54	0.08
RoW	55	0.33	0.34	0.13	0.64	0.42	0.58	0.47	0.65	1.03	-0.29	0.50
South Asia	25	0.21	0.01	-0.23	0.00	-0.05	0.01	0.01	0.18	0.02	0.16	-0.02
SubSaharan Africa	11	0.34	0.10	0.40	0.76	0.65	0.82	0.72	1.21	0.92	0.96	0.89
World	489	-0.34	0.03	-0.06	-0.39	-0.35	-0.36	-0.38	-0.74	-0.29	-0.29	-0.44
Rich	276	-0.93	-0.04	-0.23	-1.20	-1.03	-1.16	-1.14	-2.10	-1.17	-1.66	-1.36
DCs	178	0.45	0.15	0.21	0.74	0.60	0.77	0.66	1.13	0.94	1.68	0.85
Poorest	36	0.25	0.04	-0.04	0.23	0.16	0.26	0.23	0.49	0.29	0.40	0.26

Table A.10 Changes in agrifood exports, Doha agreement on agriculture scenario and sensitivity analyis

	Initial level (Mn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	61 642	-1.9	-4.2	7.4	2.7	4.6	4.5	4.3	7.4	-1.6	17.0	6.6
USA	69 969	-6.7	0.6	7.2	0.8	1.1	0.1	0.5	-0.9	1.0	4.1	2.2
Asia Developed	5 716	0.6	1.2	10.7	11.8	11.1	11.2	11.6	22.2	11.9	27.2	21.1
EFTA	6 428	2.4	-6.6	2.7	-3.8	4.3	4.7	4.3	6.4	2.8	2.8	4.5
Cairns Developed	38 875	2.2	0.6	10.2	12.8	12.0	12.1	11.5	20.2	15.0	17.7	17.3
Mediterranean	8 304	2.0	-0.2	6.2	8.8	8.6	8.4	7.5	18.4	8.6	17.6	13.4
Cairns Developing	54 934	2.7	-0.1	7.9	10.4	10.0	10.4	10.1	18.7	10.7	21.5	13.6
China	11 947	2.0	0.0	11.0	13.2	12.9	13.5	13.0	27.2	13.0	32.6	18.0
RoW	35 074	2.1	-0.5	5.5	6.8	6.6	6.9	6.8	10.2	6.5	13.5	7.9
South Asia	7 513	3.1	-0.4	3.3	6.4	6.2	6.4	6.5	10.3	6.3	19.6	5.7
SubSaharan Africa	12 420	3.3	-1.2	2.7	4.7	4.6	4.8	4.7	6.2	4.5	12.4	7.0
World	312 822	-0.5	-0.9	7.4	6.1	6.5	6.4	6.3	10.8	5.7	15.0	6.6
Rich	182 630	-2.6	-1.3	7.9	4.2	5.0	4.6	4.6	7.4	3.5	12.0	7.6
DCs	110 260	2.4	-0.2	7.3	9.4	9.1	9.5	9.2	16.9	9.5	19.9	12.3
Poorest	19 933	3.3	-0.9	2.9	5.4	5.2	5.4	5.4	7.8	5.2	15.1	6.5

Table A.11 Changes in agrifood imports, Doha agreement on agriculture scenario and sensitivity analyis

	Initial level (Mn 1997 USD)	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	71 390	0.5	-1.3	13.9	12.8	13.2	13.4	13.0	22.5	13.4	19.6	20.7
USA	48 160	1.6	-0.4	1.4	2.8	2.4	3.1	2.8	4.3	1.8	7.5	5.0
Asia Developed	77 500	1.0	-0.3	8.9	9.6	9.8	9.9	9.3	15.9	9.2	17.9	12.4
EFTA	7 461	-0.4	-2.3	5.5	3.7	4.8	4.7	4.6	8.1	2.3	50.6	6.3
Cairns Developed	14 003	-1.7	-0.5	4.8	2.8	3.3	3.0	3.7	7.0	2.5	9.5	6.3
Mediterranean	15 821	-5.4	-1.4	5.0	-1.5	-1.0	-1.1	-0.5	1.8	-3.9	15.9	-0.5
Cairns Developing	22 349	-4.0	-0.3	3.5	-0.7	-0.2	-0.8	-0.3	0.7	-1.6	5.4	0.1
China	18 403	-6.7	-0.1	16.9	10.1	10.1	9.8	10.6	11.2	10.0	-2.1	10.7
RoW	51 952	-1.4	-1.8	1.9	-0.7	0.2	-0.2	0.0	0.3	-2.0	14.7	0.4
South Asia	6 698	-3.3	-0.4	11.5	7.8	7.9	7.5	7.5	2.4	7.4	26.7	7.5
SubSaharan Africa	5 524	-0.1	-2.8	1.6	-0.8	-0.4	-0.8	-0.5	-3.1	-2.4	18.5	0.6
World	339 261	-0.7	-0.9	7.4	6.0	6.3	6.3	6.2	10.2	5.4	14.8	6.4
Rich	218 514	0.8	-0.8	8.5	8.5	8.7	8.9	8.5	14.7	8.3	16.7	12.9
DCs	108 525	-3.4	-1.1	5.2	1.0	1.6	1.2	1.7	2.4	-0.2	10.1	2.0
Poorest	12 223	-1.8	-1.5	7.0	3.9	4.2	3.8	3.9	-0.1	3.0	23.0	4.4

Table A.12 Changes in net trade position, as a percentage of original trade (Delta X- Delta M)/(X+M)

	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	-1.1	-1.3	-4.1	-5.6	-4.9	-5.1	-5.0	-8.6	-7.9	-2.6	-8.0
USA	-4.6	0.5	3.7	-0.7	-0.4	-1.2	-0.8	-2.3	-0.2	-0.7	-0.7
Asia Developed	-0.9	0.4	-7.5	-8.1	-8.4	-8.5	-7.8	-13.3	-7.8	-14.8	-10.1
EFTA	1.3	-1.8	-1.7	-3.7	-0.6	-0.3	-0.5	-1.4	0.1	-25.9	-1.3
Cairns Developed	2.0	0.5	6.2	8.7	7.9	8.1	7.5	13.0	10.4	10.5	11.1
Mediterranean	4.2	0.9	-1.1	4.0	3.6	3.6	2.9	5.2	5.6	-4.4	5.0
Cairns Developing	3.1	0.0	4.6	7.6	7.2	7.6	7.3	13.1	8.1	13.7	9.6
China	4.8	0.0	-5.9	-0.9	-1.1	-0.6	-1.3	3.9	-0.9	14.1	0.6
RoW	1.7	0.8	1.1	3.1	2.5	2.9	2.7	3.9	3.8	-3.3	2.9
South Asia	3.2	0.0	-3.7	-0.3	-0.4	-0.2	-0.1	4.3	-0.2	-2.2	-0.6
SubSaharan Africa	2.3	0.0	1.4	3.5	3.3	3.6	3.4	5.3	3.8	2.9	4.7
Rich	-1.6	-0.2	-1.1	-2.7	-2.5	-2.8	-2.5	-4.6	-2.9	-3.6	-3.6
DCs	2.9	0.5	1.1	4.2	3.8	4.2	3.8	7.3	4.9	5.0	5.2
Poorest	2.7	0.0	-0.9	1.8	1.7	1.9	1.9	4.9	2.1	0.6	2.4

Table A.13 Changes in (real) returns to agricultural labor, Doha agreement on agriculture scenario and sensitivity analyis

	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	-0.52	-0.04	-0.54	-1.12	-1.15	-1.06	-1.06	-2.65	0.24	-1.14	-1.71
USA	-2.24	0.03	0.57	-1.69	-1.95	-1.74	-1.68	-2.51	-1.56	-1.54	-1.53
Asia Developed	0.34	0.02	-1.19	-0.81	-0.92	-0.85	-0.80	-1.82	-0.73	-2.99	-1.37
EFTA	0.29	-1.59	0.20	-1.50	0.40	0.44	0.43	0.69	1.46	-5.69	0.01
Cairns Developed	1.03	0.09	1.71	2.81	2.58	2.67	2.65	4.05	3.19	3.04	3.41
Mediterranean	-0.01	-0.11	0.29	0.21	0.18	0.22	0.36	0.07	0.03	2.81	0.59
Cairns Developing	0.50	0.04	0.84	1.37	1.06	0.75	1.65	1.74	1.55	2.82	1.91
China	-0.12	0.05	0.86	0.72	0.67	0.22	0.69	0.96	0.92	2.24	1.07
RoW	0.57	-0.20	0.72	1.14	1.14	0.60	1.38	1.71	1.36	1.77	1.69
South Asia	0.47	0.01	0.17	0.64	0.60	0.18	0.47	1.13	0.74	0.72	0.71
SubSaharan Africa	1.08	-0.21	0.29	1.17	1.14	0.52	1.26	1.66	1.21	2.15	2.08

Table A.14 Changes in (real) returns to agricultural land, Doha agreement on agriculture scenario and sensitivity analyis

	Domestic support	Export subsidies	Tariffs	Doha	Exogenous land	No dual labor market	Perfect competition	Double elasticities	Without NCAP	Cut on applied tariffs	Excluding preferences
EU 25	-14.59	0.01	-0.35	-15.06	-14.4	-15.1	-15.1	-18.4	-12.7	-22.6	-15.3
USA	-0.37	0.00	0.24	-0.21	-1.6	-0.2	-0.2	-0.9	-0.3	-1.2	-0.4
Asia Developed	0.48	0.03	-2.28	-1.79	-2.2	-1.8	-1.8	-2.6	-1.8	-5.2	-3.7
EFTA	1.14	0.52	-0.50	1.10	1.0	0.9	0.9	1.5	1.2	-6.0	0.7
Cairns Developed	-0.32	0.00	1.33	1.08	0.8	1.0	0.7	2.8	1.1	3.5	1.0
Mediterranean	0.74	-0.04	0.03	0.77	0.9	0.8	0.8	1.5	0.5	0.9	0.7
Cairns Developing	0.63	-0.03	-0.01	0.60	1.1	0.6	0.6	1.7	0.5	2.1	0.6
China	0.52	-0.01	-0.26	0.30	0.3	0.3	0.3	1.0	0.2	1.6	0.3
RoW	1.10	0.00	0.03	1.15	1.3	1.1	1.2	1.9	1.1	1.6	1.1
South Asia	-0.07	-0.03	-0.02	-0.10	-0.1	-0.1	-0.1	0.0	-0.2	2.6	-0.2
SubSaharan Africa	0.23	-0.08	0.05	0.22	0.6	0.2	0.2	0.6	0.2	0.6	0.1

Appendix III. Welfare decomposition

Table A15 shows the effect of the various factors. This decomposition shows the impact of the various mechanisms at stake in the welfare gains or losses. More specifically, the contribution of the following changes to the overall variation of welfare:

i/ changes in the number of productive units of labor (in the case of a dual labor market);

ii/ changes in the quantity of arable land;

iii/ changes in the quota rents; iv/ changes in the terms of trade;

v/ changes in allocative efficiency of resources;

vi/ other sources;

Table A16 shows the same decomposition under the alternative model specifications that were used to assess the sensitivity of the results in section II.

Table A15 Welfare decomposition, three pillars and Doha agreement (in%)

Scenario	Contributions to welfare gains	EU 25	USA	Asia Dd	EFTA	Cairns Dd	Mediter'n	Cairns Dg	China	RoW	Sth Asia	SS Africa	World
Dom. Support	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.06	-0.02	-0.06	-0.02	-0.02	-0.02	-0.20
	Land supply gains	0.00	-0.02	0.00	0.00	-0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.05
	Allocation efficiency gains	0.04	0.03	0.00	-0.01	-0.01	-0.02	0.00	-0.05	-0.01	-0.02	0.01	-0.05
	Tariff-quota gains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Terms of trade gains	0.00	0.03	-0.03	-0.02	0.02	-0.11	0.01	-0.01	-0.02	0.03	0.06	-0.06
	Other gains	0.01	0.01	-0.02	-0.01	-0.01	-0.09	-0.02	-0.10	-0.02	-0.02	-0.04	-0.33
	Total welfare gains	0.04	0.05	-0.05	-0.04	-0.01	-0.27	-0.02	-0.21	-0.07	-0.01	0.01	-0.60
Exp. Subsidies	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	-0.01	-0.02
	Land supply gains	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Allocation efficiency gains	0.00	0.00	0.00	0.06	0.00	-0.03	0.00	0.00	-0.02	0.00	-0.02	-0.02
	Tariff-quota gains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Terms of trade gains	0.01	0.00	0.00	0.03	0.00	-0.01	0.00	0.00	-0.02	0.00	-0.04	-0.04
	Other gains	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	-0.02	0.00	-0.01	-0.05
	Total welfare gains	0.01	0.00	0.00	0.08	0.00	-0.07	0.00	0.00	-0.06	0.00	-0.08	-0.13
Tariffs	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	0.03	-0.01	0.08	0.00	0.04	0.02	0.18
	Land supply gains	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	-0.01	0.01	0.03
	Allocation efficiency gains	0.07	0.00	0.08	0.00	0.00	0.10	0.01	0.22	0.02	0.15	0.02	0.66
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	-0.01	0.01	-0.01	0.00	0.05	-0.02	0.03	-0.03	0.01	-0.03	0.03	0.04
	Other gains	0.02	-0.01	0.04	0.03	-0.02	0.05	-0.03	0.11	-0.01	0.04	-0.01	0.21
	Total welfare gains	0.09	0.00	0.11	0.03	0.04	0.16	0.02	0.38	0.01	0.19	0.03	1.06
Doha scenario													
	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.04	-0.02	0.02	-0.02	0.03	-0.01	-0.04
	Land supply gains	0.00	-0.01	0.00	-0.01	0.00	0.01	0.03	0.01	0.01	0.01	0.02	0.07
	Allocation efficiency gains	0.11	0.03	0.07	0.10	-0.01	0.06	0.01	0.17	-0.01	0.12	0.01	0.66
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	-0.01	0.04	-0.04	0.01	0.07	-0.13	0.04	-0.04	-0.02	0.00	0.06	-0.03
	Other gains	0.03	0.00	0.02	0.01	-0.03	-0.06	-0.05	0.00	-0.04	0.01	-0.07	-0.18
	Total welfare gains	0.14	0.05	0.05	0.11	0.04	-0.16	0.00	0.15	-0.10	0.17	-0.03	0.40

Table A.16 Welfare decomposition, sensitivity analysis scenarios (in %)

Scenarios	Contributions to welfare gains	EU 25	USA	Asia Dd	EFTA	Cairns Dd	Mediter'n	Cairns Dg	China	RoW	Sth Asia	SS Africa	
Exogenous land	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.03	-0.03	0.02	-0.02	0.02	-0.02	-0.06
	Land supply gains	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Allocation efficiency gains	0.11	0.03	0.08	-0.01	-0.01	0.07	0.00	0.17	0.00	0.12	0.01	0.57
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	-0.01	0.04	-0.04	-0.03	0.07	-0.13	0.04	-0.04	-0.01	0.00	0.06	-0.06
	Other gains	0.03	0.00	0.02	0.01	-0.02	-0.06	-0.07	0.00	-0.03	0.01	-0.07	-0.18
	Total welfare gains	0.14	0.07	0.06	-0.03	0.04	-0.16	-0.07	0.15	-0.08	0.15	-0.05	0.22
No dual labor market	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land supply gains	0.00	-0.01	0.00	0.00	0.00	0.01	0.03	0.00	0.01	0.01	0.02	0.06
	Allocation efficiency gains	0.11	0.03	0.08	-0.01	-0.01	0.07	0.01	0.16	0.00	0.12	0.01	0.56
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	-0.01	0.04	-0.04	-0.03	0.07	-0.14	0.04	-0.03	-0.01	0.00	0.05	-0.07
	Other gains	0.03	0.00	0.02	0.01	-0.03	-0.05	-0.04	0.00	-0.03	0.01	-0.05	-0.12
	Total welfare gains	0.14	0.05	0.05	-0.03	0.03	-0.10	0.03	0.13	-0.04	0.14	-0.01	0.37
Perfect competition	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.03	-0.02	0.02	-0.01	0.02	-0.01	-0.03
	Land supply gains	0.00	-0.01	0.00	0.00	0.00	0.01	0.04	0.01	0.01	0.01	0.02	0.08
	Allocation efficiency gains	0.11	0.03	0.07	0.01	-0.01	0.06	0.01	0.16	0.00	0.11	0.01	0.56
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	-0.01	0.03	-0.05	-0.02	0.09	-0.13	0.05	-0.04	-0.01	-0.01	0.07	-0.02
	Other gains	0.02	-0.01	0.02	0.00	0.00	-0.03	-0.03	0.00	-0.02	-0.01	-0.05	-0.12
	Total welfare gains	0.12	0.04	0.04	-0.01	0.08	-0.11	0.04	0.13	-0.05	0.12	0.01	0.41
Elasticities x 2	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.04	-0.05	0.03	-0.02	0.01	-0.04	-0.12
	Land supply gains	0.00	-0.02	-0.01	0.00	0.01	0.01	0.05	0.01	0.01	0.03	0.03	0.13
	Allocation efficiency gains	0.23	0.04	0.12	0.00	-0.01	0.13	0.02	0.30	0.01	0.16	0.02	1.02
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	0.01	0.04	-0.04	-0.03	0.08	-0.21	0.02	-0.08	-0.02	-0.02	0.05	-0.21
	Other gains	0.04	0.00	0.02	-0.01	-0.03	-0.09	-0.08	-0.03	-0.03	-0.02	-0.07	-0.29
	Total welfare gains	0.29	0.06	0.09	-0.04	0.05	-0.20	-0.05	0.22	-0.08	0.16	-0.04	0.46
Without EU June 2003 CAP	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.07	-0.02	0.03	-0.03	0.03	-0.03	-0.10
	Land supply gains	0.00	-0.01	0.00	0.01	0.00	0.02	0.04	0.01	0.01	0.02	0.03	0.12
	Allocation efficiency gains	0.03	0.03	0.07	-0.06	-0.02	0.00	0.00	0.17	-0.03	0.12	0.00	0.31
	Tariff-quota gains	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.04	-0.06
	Terms of trade gains	0.01	0.03	-0.05	-0.05	0.08	-0.16	0.04	-0.04	-0.04	0.00	0.02	-0.15
	Other gains	0.34	0.00	0.02	-0.04	-0.02	-0.13	-0.06	0.00	-0.06	0.01	-0.09	-0.03
	Total welfare gains	0.39	0.04	0.04	-0.14	0.04	-0.34	0.00	0.17	-0.17	0.17	-0.11	0.09
Cut in applied duties	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	0.02	-0.06	-0.19	-0.01	0.01	-0.03	-0.25
	Land supply gains	0.00	-0.01	-0.01	-0.08	0.00	0.05	0.07	0.06	0.01	0.01	0.04	0.13
	Allocation efficiency gains	0.11	0.03	0.22	0.69	0.00	0.11	0.01	-0.03	0.10	0.32	0.14	1.72
	Tariff-quota gains	0.00	-0.01	0.01	0.07	-0.02	0.02	-0.01	-0.02	-0.01	0.00	-0.05	-0.01
	Terms of trade gains	0.01	0.05	-0.05	-0.12	0.08	-0.17	0.03	-0.06	-0.05	-0.10	-0.04	-0.42
	Other gains	0.05	0.00	0.07	0.36	-0.03	0.20	-0.04	-0.08	0.01	0.07	-0.05	0.55
	Total welfare gains	0.18	0.06	0.24	0.91	0.04	0.23	0.00	-0.32	0.04	0.31	0.02	1.71
Excluding preferences	Dual labor market gains	0.00	0.00	0.00	0.00	0.00	-0.03	-0.03	0.01	-0.01	0.03	-0.02	-0.06
	Land supply gains	0.00	-0.01	0.00	0.00	0.00	0.01	0.04	0.01	0.01	0.02	0.04	0.12
	Allocation efficiency gains	0.16	0.03	0.14	0.05	0.01	0.08	0.01	0.16	0.00	0.12	0.02	0.77
	Tariff-quota gains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Terms of trade gains	-0.02	0.04	-0.05	-0.03	0.09	-0.11	0.07	-0.02	0.00	0.00	0.13	0.11
	Other gains	0.04	0.00	0.04	0.05	-0.04	-0.07	-0.07	-0.02	-0.03	0.01	-0.09	-0.17
	Total welfare gains	0.18	0.05	0.13	0.07	0.07	-0.11	0.02	0.15	-0.02	0.18	0.06	0.77

Appendix IV. Elements on the structure of the model

Supply

Leontieff relation between value added and intermediate consumption:

Imperfect competition:

$$NB_{i,r}\ (Y_{i,r} + cf_{i,r}) = a_{VAi,r}\ VA_{i,r} = a_{CNTERi,r}\ CNTER_{i,r}$$

$$NB_{i,r}\ PY_{i,r}\ (Yi,r + cf_{i,r}) = PVA_{i,r}\ VA_{i,r} + PCNTER_{i,r}\ CNTER_{i,r}$$

Perfect competition:

$$Y_{i,r} = a_{VAi,r}\ VA_{i,r} = a_{CNTERi,r}\ CNTER_{i,r}$$

$$PY_{i,r}\ Yi,r = PVA_{i,r}\ VA_{i,r} + PCNTER_{i,r}\ CNTER_{i,r} + Pquota_{i,r}\ Quota_{i,r}$$

For sectors where production quotas hold (perfect competition only):

$$Y_{i,r} = Quota_{i,r}$$

Determination of factors demand by producers results from the following optimization programs:

$$Min\ \ PVA_{i,r}VA_{i,r} = PL_{i,r}L_{i,r} + PTE_{i,r}TE_{i,r} + PRN_{i,r}RN_{i,r} + PQ_{i,r}Q_{i,r}$$

$$\text{s.t.:}\qquad VA_{i,r}^{\,1-\frac{1}{\sigma_{VA_i}}} = a_{Li}L_{i,r}^{\,1-\frac{1}{\sigma_{VA_i}}} + a_{Q_{i,r}}Q_{i,r}^{\,1-\frac{1}{\sigma_{VA_i}}} + a_{RNi,r}RN_{i,r}^{\,1-\frac{1}{\sigma_{VA_i}}} + a_{TEi,r}TE_{i,r}^{\,1-\frac{1}{\sigma_{VA_i}}}$$

and

$$Min\ \ PQ_{i,r}\ Q_{i,r} = PK_{i,r}\ K_{i,r} + PH_{i,r}\ H_{i,r}$$

$$\text{s.t.:}\qquad Q_{i,r}^{\,1-\frac{1}{\sigma_{CAP_i}}} = a_{Ki,r}K_{i,r}^{\,1-\frac{1}{\sigma_{CAP_i}}} + a_{Hi,r}H_{i,r}^{\,1-\frac{1}{\sigma_{CAP_i}}}$$

Comment: in the agricultural version of the model, production quotas have been introduced. For the associated sectors production is equal to the quota and an additional income, equal to $Pquota_{i,r}\ Quota_{i,r}$, is drawn from of the quota.

Demand

LES-CES (first stage)

$$C_{i,r} - cmin_{i,r} = a_{Ci,r}\ UT_r \left[\frac{P_r}{PC_{i,r}}\right]^{\sigma_C}$$

$$P_r\ UT_r = \sum_i PC_{i,r}\left(C_{i,r} - cmin_{i,r}\right)$$

$$BUDC_r = \sum_i PC_{i,r}C_{i,r}$$

$$PC_{i,r} = PDEMTOT_{i,r}\ (1+taxcc_{i,r})$$

Intermediate consumption (first stage)

$$IC_{i,j,r} = a_{ICi,j,r}\ CNTER_{j,r}\left[\frac{PCNTER_{j,r}}{PIC_{i,j,r}}\right]^{\sigma_{IC}}$$

$$PCNTER_{j,r}\ CNTER_{j,r} = \sum_i PIC_{i,j,r}IC_{i,j,r}$$

$$PIC_{i,j,r} = PDEMTOT_{i,r}\ (1+taxicc_{i,j,r})$$

Capital good (first stage)

$$epa_r\ REV_r = PINVTOT_r\ INVTOT_r$$

$$KG_{i,r} = a_{KGi,r}\ INVTOT_r \left[\frac{PINVTOT_r}{PKG_{i,r}} \right]^{\sigma_{KG}}$$

$$PINVTOT_r\ INVTOT_r = \sum_i PKG_{i,r} KG_{i,r}$$

$$PKG_{i,r} = PDEMTOT_{i,r}\ (1+taxkgc_{i,r})$$

Total demand

$$DEMTOT_{i,r} = C_{i,r} + \sum_j IC_{i,j,r} + KG_{i,r}$$

Groups of regions (second stage)

$$Min\ \ PDEMTOT_{i,r}\ DEMTOT_{i,r} = PDEMU_{i,r}\ DEMU_{i,r} + PDEMV_{i,r}\ DEMV_{i,r}$$

$$\text{s.t.:} \qquad DEMTOT_{i,r}^{\,1-\frac{1}{\sigma_{GEOi}}} = a_{Ui,r} DEMU_{i,r}^{\,1-\frac{1}{\sigma_{GEOi}}} + a_{Vi,r} DEMV_{i,r}^{\,1-\frac{1}{\sigma_{GEOi}}}$$

Armington (third stage)

$$Min\ \ PDEMU_{i,r}\ DEMU_{i,r} = PDEM_{i,r,r}\ DEM_{i,r,r} + PDEMETR_{i,r}\ DEMETR_{i,r}$$

$$\text{s.t.:} \qquad DEMU_{i,r}^{\,1-\frac{1}{\sigma_{ARMi}}} = a_{LOCi,r} DEM_{i,r,r}^{\,1-\frac{1}{\sigma_{ARMi}}} + a_{ETRi,r} DEMETR_{i,r}^{\,1-\frac{1}{\sigma_{ARMi}}}$$

Regions (forth stage)

For foreign regions of the same level of development:

$$DEM_{i,r,s} = a_{IMPi,r,s}\ DEMETR_{i,s} \left[\frac{PDEMETR_{i,s}}{PDEM_{i,r,s}} \right]^{\sigma_{IMPi}}$$

$$PDEMETR_{i,s}\ DEMETR_{i,s} = \sum_{r \in Etra(s)} PDEM_{i,r,s} DEM_{i,r,s}$$

For foreign regions of a different level of development:

$$DEM_{i,r,s} = a_{IMPi,r,s}\ DEMV_{i,s} \left[\frac{PDEMV_{i,s}}{PDEM_{i,r,s}} \right]^{\sigma_{IMPi}}$$

$$PDEMV_{i,s}^{\,(1-\sigma_{IMPi})} = \sum_{r \in V(s)} a_{IMPi,r,s} PDEM_{i,r,s}^{\,(1-\sigma_{IMPi})}$$

Varieties (fifth stage, imperfect competition)

$$DEMVAR_{i,r,s} = DEM_{i,r,s}\ NB_{i,r,t}^{\,1-\frac{1}{\sigma_{VARi}}}$$

$$PDEM_{i,r,s} = PDEMVAR_{i,r,s}\ NB_{i,r,t}^{\,\frac{1}{1-\sigma_{VARi}}}$$

Commodity market equilibrium

Imperfect competition:

$$Y_{i,r} = \sum_s DEMVAR_{i,r,s}$$

$$TRADE_{i,r,s} = NB_{i,r}\ DEMVAR_{i,r,s}$$

Perfect competition:

$$Y_{i,r} = \sum_{s} DEM_{i,r,s} \quad (i \neq TrT)$$

$$Y_{TrT,r} = \sum_{s} DEM_{TrT,r,s} + TRM_{r}$$

$$TRADE_{i,r,s} = DEM_{i,r,s}$$

Transport sector

Transport demand:

$$TR_{i,r,s} = \mu_{i,r,s}\, TRADE_{i,r,s}$$

$$MONDTR = \sum_{i,r,s} TR_{i,r,s}$$

Transport supply:

$$MONDTR = a_T \prod_{r} TRM_r^{\theta_r}$$

$$PY_{TrT,r}\,(1+taxp_{TrT,r})\,TRM_r = \theta_r\, PT\, MONDTR$$

Factor market

Labor allocation between agricultural and non agricultural sectors (developed countries):

$$La_r = b_{La\,r}\, Lbar_r \left(\frac{PLa_r}{PLbar_r} \right)^{\sigma_L}$$

$$Lna_r = b_{Lna\,r}\, Lbar_r \left(\frac{PLna_r}{PLbar_r} \right)^{\sigma_L}$$

Dual labor market (developing countries):

$$PLna_r \frac{REV_r}{REV_r - RECTAX_r} = PlnaO_r \frac{REVO_r}{REVO_r - RECTAXO_r} \prod_{i} \left(\frac{PC_{i,r}}{PCO_{i,r}} \right)^{\frac{PCO_{i,r} CO_{i,r}}{\sum_i PCO_{i,r} CO_{i,r}}}$$

$$Lna_r + La_r = Lbar_r$$

Labor market (both cases):

$$PLbar_r\, Lbar_r = PLa_r\, La_r + PLna_r\, Lna_r$$

Full use of endowments:

$$La_r = \sum_{i \in Agr(i)} L_{i,r}$$

$$Lna_r = \sum_{i \notin Agr(i)} L_{i,r}$$

$$Hbar_r = \sum_{i} H_{i,r}$$

$$Kbar_r = \sum_{i} K_{i,r}$$

Mobility:

$$PL_{i,r} = PLa_r \quad (i \in Agr(i))$$

$$PL_{i,r} = PLna_r \quad (i \notin Agr(i))$$

$$PH_{i,r} = PHbar_r$$

$$PK_{i,r} = PKbar_r$$

K and Land returns, subsidies included:

$$WK_{i,r} = PK_{i,r} + TsubK_{i,r}$$
$$WTE_{i,r} = PTE_{i,r} + TsubTE_{i,r}$$

Land supply:

$$WTEbar_r\ TEbar_r = \sum_i WTE_{i,r} TE_{i,r}$$

$$TEbar_r = TEbarO_r\ WTEbar_r^{\sigma_{TEbar}} \quad (NB: WTEbarO_r = 1)$$

Land allocation:

$$TE_{i,r} = b_{Ti,r}\ TEbar_r \left(\frac{WTE_{i,r}}{WTEbar_r} \right)^{\sigma_{TE}}$$

Comments:

a) In comparison to the standard model, the agricultural version distinguishes between two types of unskilled labor: agricultural labor and non agricultural labor. A partial mobility between these two types of labors is allowed through a Constant Elasticity of Transformation supply function. Within each category, labor is perfectly mobile.
b) A duality of labor market has been assumed in developing countries: an efficiency wage scheme determines the level of wages in non agricultural sectors and the corresponding labor demand, and labor supply in agricultural sectors is computed as a residual. The efficiency wage is set such that the purchasing power of non agricultural wages, including tax receipts so that fiscal policy do not affect the results, remain unchanged after the shock.
c) Since the model is static, capital is assumed to be mobile among sectors.

Price definition

CIF Price:

$$PCIF_{i,r,s} = \frac{PY_{i,r}}{(1 + EP_{i,r,s})} (1+taxP_{i,r}) (1+TAXEXP_{i,r,s}+taxAMF_{i,r,s}) + \mu_{i,r,s}\ PT \quad \text{(imp. competition)}$$

$$PCIF_{i,r,s} = PY_{i,r} (1+taxP_{i,r}) (1+TAXEXP_{i,r,s}+taxAMF_{i,r,s}) + \mu_{i,r,s}\ PT \quad \text{(perfect competition)}$$

Sale price:

$$PDEMVAR_{i,r,s} = PCIF_{i,r,s} (1+DD_{i,r,s}) \quad \text{(imperfect competition)}$$
$$PDEM_{i,r,s} = PCIF_{i,r,s} (1+DD_{i,r,s}) \quad \text{(perfect competition)}$$

Revenue

Profits (imperfectly competitive sectors):

$$0 = PY_{i,r} \sum_s \frac{TRADE_{i,r,s}}{(1 + EP_{i,r,s})} - (PVA_{i,r}\ VA_{i,r} + PCNTER_{i,r}\ CNTER_{i,r})$$

Comment: in the static version of the model the computation of profits in imperfectly competitive sectors is replaced by a zero profit condition that determines the number of varieties in each sector through a free entry hypothesis.

Tax revenues:

$$RECPROD_{i,r} = taxP_{i,r}\ PY_{i,r} \sum_s \frac{TRADE_{i,r,s}}{(1 + EP_{i,r,s})} \quad \text{(imperfect competition)}$$

$$RECPROD_{i,r} = taxP_{i,r}\ PY_{i,r}\ Y_{i,r} \quad \text{(perfect competition)}$$

$$RECEXP_{i,r} = PY_{i,r} (1+taxP_{i,r}) \sum_s (TAXEXP_{i,r,s} + taxAMF_{i,r,s}) \frac{TRADE_{i,r,s}}{(1 + EP_{i,r,s})} \quad \text{(imp. competition)}$$

$$RECEXP_{i,r} = PY_{i,r} (1+taxP_{i,r}) \sum_s (TAXEXP_{i,r,s} + taxAMF_{i,r,s})\ TRADE_{i,r,s} \quad \text{(perf. competition)}$$

$$RECDD_{i,s} = \sum_r DD_{i,r,s} PCIF_{i,r,s} TRADE_{i,r,s}$$

$$RECCONS_{i,r,} = PDEMTOT_{i,r} (taxcc_{i,r} C_{i,r} + taxkgc_{i,r} KG_{i,r} + \sum_j taxicc_{i,j,r} IC_{i,j,r})$$

$$RECTAX_r = \sum_i RECPROD_{i,r} + RECEXP_{i,r} + RECDD_{i,r} + RECCONS_{i,r}$$

Regional equilibrium:

$$REV_r + SOLD_r = \sum_i PRN_{i,r} RN_{i,r} + PTE_{i,r} TE_{i,r} + PK_{i,r} K_{i,r} + Pquota_{i,r} Y_{i,r}$$

$$+ PLbar_r Lbar_r + PHbar_r Hbar_r + RECTAX_r + \sum_s rente_{r,s} - rente_{s,r}$$

Savings:

$$BUDC_r = (1\text{-}epa_r)\ REV_r$$

Imperfect competition

Definition of market shares:

$$SE_{i,r,s} = \frac{PDEM_{i,r,s} DEM_{i,r,s}}{\sum_{rr \in Etra(s)} PDEM_{i,rr,s} DEM_{i,rr,s}}, SU_{i,r,s} = \frac{PDEM_{i,r,s} DEM_{i,r,s}}{\sum_{rr \notin V(s)} PDEM_{i,rr,s} DEM_{i,rr,s}},$$

$$SV_{i,r,s} = \frac{PDEM_{i,r,s} DEM_{i,r,s}}{\sum_{rr \in V(s)} PDEM_{i,rr,s} DEM_{i,rr,s}}, \qquad ST_{i,r,s} = \frac{PDEM_{i,r,s} DEM_{i,r,s}}{\sum_{rr} PDEM_{i,rr,s} DEM_{i,rr,s}}$$

Mark-up in domestic markets:

$$NB_{i,r}\left[EP_{i,r,r} + \frac{1}{\sigma_{VAR_i}}\right] = \left[\frac{1}{\sigma_{VAR_i}} - \frac{1}{\sigma_{ARM_i}}\right] + \left[\frac{1}{\sigma_{ARM_i}} - \frac{1}{\sigma_{GEO_i}}\right] SU_{i,r,r} + \left[\frac{1}{\sigma_{GEO_i}} - \frac{1}{\sigma_{C_i}}\right] ST_{i,r,r}$$

Mark-up in foreign markets in countries with the same level of development:

$$NB_{i,r}\left[EP_{i,r,s} + \frac{1}{\sigma_{VAR_i}}\right] = \left[\frac{1}{\sigma_{VAR_i}} - \frac{1}{\sigma_{ARM_i}}\right] + \left[\frac{1}{\sigma_{IMP_i}} - \frac{1}{\sigma_{ARM_i}}\right] SE_{i,r,s} + \left[\frac{1}{\sigma_{ARM_i}} - \frac{1}{\sigma_{GEO_i}}\right] SU_{i,r,s} + \left[\frac{1}{\sigma_{GEO_i}} - \frac{1}{\sigma_{C_i}}\right] STi, r, s$$

Mark-up in foreign markets in countries with a different level of development:

$$NB_{i,r}\left[EP_{i,r,s} + \frac{1}{\sigma_{VAR_i}}\right] = \left[\frac{1}{\sigma_{VAR_i}} - \frac{1}{\sigma_{ARM_i}}\right] + \left[\frac{1}{\sigma_{IMP_i}} - \frac{1}{\sigma_{GEO_i}}\right] SV_{i,r,s} + \left[\frac{1}{\sigma_{GEO_i}} - \frac{1}{\sigma_{C_i}}\right] ST_{i,r,s}$$

Intervention price scheme (European Union)

Mode 0, no subsidy change:

$$TAXEXP_{i,r,s} = TAXEXPO_{i,r,s}$$

Mode 1:

$$TAXEXP_{i,r,s} = 0$$

Mode 2, perfect competition:

$$PY_{i,r} = PInt_i$$

Mode 2, imperfect competition:

$$\sum_s \frac{PY_{i,r}}{1 + EP_{i,r,s}} TRADE_{i,r,s} = PInt_i \sum_s TRADE_{i,r,s}$$

Mode 3:

$$\sum_{s \neq r} TRADE_{i,r,s} = MaxExpSub_{i,r}$$

Mode 2 or 3, or subsidy change and subsidy for at least one destination before the change:

$$TAXEXP_{i,r,s} = TAXREF_{i,r}\ TAXEXPO_{i,r,s}$$

Mode 2 or 3, or subsidy change and no subsidy for all destinations before the change:

$$TAXEXP_{i,r,s} = TAXMOY_{i,r}$$

Mode 2 or 3, or subsidy change:

$$TAXMOY_{i,r} \sum_{s \neq r} TRADE_{i,r,s} = \sum_{s \neq r} TAXEXP_{i,r,s} TRADE_{i,r,s}$$

Comments:

a) The intervention price scheme in the EU is modeled as follows: as soon as the internal price becomes lower than the intervention price, the EU subsidies exports so as to raise the internal price to the level of the intervention price. In actual facts the EU also increases inventories, but inventories are not accounted for in Mirage.

b) In practice, the price schemes is divided into 4 possible modes:
   Mode 0: For countries other than the EU or sectors not concerned by intervention prices, the subsidy rate is exogenous.
   Mode 1: When the intervention price is lower than the internal price there is no export subsidy.
   Mode 2: When the intervention price would be higher than the internal price the export subsidy rate is endogenous. The distribution across importers is the same as in the baseline. If there was no subsidy in the baseline this distribution is homogenous.
   Mode 3: The subsidization of exports is limited by a maximum of subsidized exports by the WTO. If this limit is reached, then this constraint replaces the price constraint.

c) Our baseline integrates new data on export subsidy rates, which may be different from the one provided by the GTAP database for the year 1997. In case of such a change, the average subsidy rate is exogenous, and the distribution across importers remains the same as in the GTAP distribution.

d) When a simulation is complete, the model checks if the constraints defined a mode still hold. If they don't then the mode is changed automatically until there is no more necessary change.

List of Notations

The i and j indices refer to sectors, r and s refer to regions.

Parameters definition

σ_{VAj}, σ_{CAPj}, σ_C, σ_{IC}, σ_{KG}, σ_{GEOi}, σ_{ARMi}, σ_{IMPi}, σ_{VARi}	Substitution elasticities of factors and goods demand
$cmin_{i,r}$	Minimal consumption of good i in the final demand of region r
epa_r	Saving rate in region r
$\mu_{i,r,s}$	Transport demand per volume of good
θ_r	Value share of region r transport sector in the world production of transport
$taxp_{i,r}$, $taxcc_{i,s}$, $taxicc_{i,s}$, $taxkgc_{i,s}$	Tax rate applied on production, final consumption, intermediate consumption and capital good
$taxp_{i,r}$, $taxcc_{i,s}$, $taxicc_{i,s}$, $taxkgc_{i,s}$	Tax rate applied on production, final consumption, intermediate consumption and capital good
$taxAMF_{i,r,s}$	Export tax rate equivalent to the Multifiber Arrangement
$cf_{j,r}$	Fixed cost per unit of output in imperfectly competitive sectors
$mmoy_{i,r}$	Mark-up average
α	Elasticity of investment to capital return rate
δ	Depreciation rate of capital
a_{XXX}	Various share and scale coefficients in CES or Cobb-Douglas functions

Variables definition

Production

$Y_{j,r}$	Output of sector j firms
$VA_{j,r}$	Added value
$CNTER_{j,r}$	Aggregate intermediate consumption
$Quota_{j,r}$	Production quota when applicable
$Q_{j,r}$	Aggregate of human capital and physical capital

Factors

$L_{j,r}$	Unskilled labor
La_r	Total unskilled labor in agriculture
Lna_r	Total unskilled labor in sectors other than agriculture
$H_{j,r}$	Skilled labor
$TE_{j,r}$	Land
$RN_{j,r}$	Natural resources
$K_{j,r}$	Capital stock
$Lbar_r$, $Hbar_r$, $Kbar_r$, $TEbar_r$	Total supply of unskilled labor, skilled labor, capital and land

Demand

$BUDC_r$	Budget allocated to consumption
$SOLD_r$	Current account balance
UT_r	Utility
P_r	Price of utility
$C_{i,r}$	Aggregated consumption
$IC_{i,j,r}$	Intermediate consumption of good i used in the production of sector j
$INVTOT_r$	Total investment in region r
$KG_{i,r}$	Capital good demand of good i in region r
$DEMTot_{i,r}$	Total demand
$DEMU_{i,r}$	Total demand, in region r, of good i originating from regions with the same development level than region r (including region r)
$DEMV_{i,r}$	Total demand, in region r, of good i originating from regions with a different development level than region r
$DEMETR_{i,r}$	Total demand, in region r, of good i originating from regions with the same development level than region r other than region r
$DEM_{i,r,s}$	Demand, in region s, of good i originating from region r
$DEMVAR_{i,r,s}$	Demand, in region s, of good i produced by each firm of region r

Transport

$TRADE_{i,r,s}$	Exports to region s, of industry i in region r
$TR_{i,r,s}$	Transport demand
MONDTR	Transport aggregate
PT	Transport of commodities price
TRM_r	Supply of international transportation by region r

Monopolistic competition

$EP_{i,r,s}$	Perceived price-elasticity of total demand
$NB_{i,r}$	Number of varieties in imperfectly competitive sectors
$SE_{i,r,s}$, $SU_{i,r,s}$, $SV_{i,r,s}$, $ST_{i,r,s}$	Auxiliary variables corresponding to market share

Tax Revenue

$RECPROD_{i,r}$, $RECDD_{i,r}$, $RECCONS_{i,r}$, $RECEXP_{i,r}$	Revenue[16] of production tax, tariff, consumption tax, exports tax
$RECTAX_r$	Total tax revenue
REV_r	Regional revenue

Prices and taxes

P*XXX*	The generic notation « P*var* » is used to indicate the price of the variable « *var* »
$PCIF_{i,r,s}$	CIF price

[16] Tax revenues can be negative (expenditure), because tax rates can be negative (subsidies).

$PInt_i$	Intervention price (European Union only)
$WK_{i,r}$	Capital return rate paid to the investor
$WTE_{i,r}$	Land return rate paid to the owner
$TAXEXP_{i,r,s}$	Export tax rate
$TAXMOY_{i,r}$	Average Export tax rate across the various destinations
$TAXREF_{i,r,s}$	Auxiliary variable to adjust TAXMOY to its proper level while keeping unchanged the distribution across destinations
$MaxExpSub_{i,r}$	Maximum level of subsidized exports according to WTO rules
$DD_{i,r,s}$	Ad-valorem tariff rate applied by region s on its imports from region r
$TsubK_{i,r}$	Subsidy rate on capital
$TsubTE_{i,r}$	Subsidy rate on land

Institute for International Integration Studies
The Sutherland Centre, Trinity College Dublin, Dublin 2, Ireland