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Why is the Doha Development Agenda Failing? And What Can be Done?

A Computable General Equilibrium-Game Theoretical Approach

Antoine Bouët
David Laborde

Markets, Trade and Institutions Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Antoine Bouet, International Food Policy Research Institute
Senior Research Fellow, Markets, Trade and Institutions Division
a.bouet@cgiar.org

David Laborde, International Food Policy Research Institute
Research Fellow, Markets, Trade and Institutions Division

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ABSTRACT

We herein use a world Computable General Equilibrium (CGE) model to simulate 143 potential trade reforms and seek solutions to the issues hampering progress in the Doha Development Agenda (DDA). Inside the domain defined by all these possible outcomes, we apply the axiomatic theory of bargaining and select the Nash solution of cooperative games. The solutions vary according to the objective functions adopted by the trade negotiators. When real income is the objective and services are excluded, or when optimizing terms of trade is the objective, the Nash solution is the status quo. Trade liberalization is feasible only when the negotiators focus on national exports or Gross Domestic Product (GDP). Our assessment of some possible solutions reveals that excluding members having a GDP below a certain threshold improves the bargaining process, regardless of the governments' objective. Formation of coalition, such as the G20, constitutes an option for its members to block outcomes imposed by rich members. We also find that side payments may be a solution, but represent a very high share of the global income gain.

Keywords: trade negotiations, CGE modeling, Nash solution, side payments, cooperative games

1. INTRODUCTION

The trade negotiations led under the banner of the Doha Development Agenda (DDA) have been complex, as highlighted by the Cancún summit of September 2003 and the Geneva meeting of July 2008. These international meetings have been hindered by numerous quarrels among World Trade Organization (WTO) members over various issues: the United States (US) vs. China and India over the Special Safeguard Mechanism, Brazil vs. the European Union (EU) over agricultural tariffs, the EU and US vs. emerging countries over industrial liberalization, and so on. Until July 2004, there was a general feeling that negotiations had reached a stalemate. The Geneva meeting in July 2008 largely reaffirmed the perception that the DDA is a failure,[1] although WTO Director-General Pascal Lamy stated that: "looking at what is on the table now, members believe that the Doha round is still worth fighting for."[2]

During this meeting, Pascal Lamy tried to cut a deal among seven countries (the EU, US, China, India, Australia, Japan, and Brazil). This initiative was criticized (see Third World Network 2008[3]) because the WTO rules call for consensus.[4] Another distinctive feature of these negotiations was the emergence of country coalitions (e.g., the G20, G90, and G10[5]), which played an active role in the bargaining process. Another new player was the "Aid For Trade" package; according to the WTO, this package constitutes further assistance for developing countries "*to increase their capacity to take advantage of more open markets*."[6] Some observers, however, described this initiative as financial compensation for countries that are expected to suffer losses under the agreement: "*first and most straightforward is the political motivation often ascribed to the rich countries, namely, that aid for trade is an instrument to 'buy' progress in the Doha round*" (Stiglitz and Charlton 2006, p4; see also Evenett 2005b).

The objective of the present research is to provide a strategic analysis of these negotiations. In particular, we examine whether these trade negotiations can reach a pro-liberalization outcome, and if so, which packages may be approved. If no pro-liberalization outcome is possible, we ask the following questions: Which countries are preventing the achievement of an agreement, and why? Is there any way to change the negotiation rules in order to achieve a pro-liberalization outcome? How can we explain the creation of coalitions, and do they thwart the success of the negotiations?

Strategic analysis of international trade negotiations is common in the economic literature. Johnson (1953) studies tariff equilibrium between two large countries and shows that free trade may be negotiated through international cooperation unless there is a large asymmetry in import elasticities. In a later work (Johnson 1965), Johnson examines an international trade framework where the surplus of domestic producers is over-weighted compared to public revenues and consumer surplus, and where trading partners exchange reduced production in import-competing sectors for increased production in exporting sectors. Mayer (1981) considers the case of two domestic lobbies with divergent tariff interests and shows that this conflict of interests may prevent the negotiation of free trade between two large countries. The Prisoners' dilemma is used by Riezman (1982) to show that the outcome of a non-cooperative game between large countries is tariff equilibrium, whereas negotiation can lead to a return to

[1] The Economist, July 31, 2008.

[2] Report to the WTO General Council, July 31, 2008.

[3] http://www.twnside.org.sg/title2/wto.info/twninfo20080737.htm.

[4] The July 2008 Geneva group was supposed to identify a compromise representing interests well beyond those of group members.

[5] The G20 includes 20 emerging countries and Least Developed Countries (LDCs), and generally plays an active role in favor of agricultural liberalization. It is led by Brazil and India, and includes China and South Africa. The G90 is a set of 90 poor countries with more defensive pro-poor interests (most African countries are members of this group). The G10 includes 10 countries, mainly from the Organization for Economic Cooperation and Development (OECD); these include Japan, South Korea, Taiwan, Iceland, Norway, and Switzerland. The G10 primarily seeks to impede agricultural liberalization.

[6] http://www.wto.org/english/tratop_e/dda_e/background_e.htm.

free trade, which is Pareto-optimal. Baldwin and Clarke (1988) analyze the Tokyo round as a bargaining process between the EU and US, where both trading partners try to minimize an overall welfare loss function. The authors conclude that: "*while the final set of rates improved the welfare position of both the United States and the European Community as compared to their initial positions, the final outcome was inferior to that given by the various formulas or the different game-theoretic outcomes*" (Baldwin and Clarke 1988, p283). Tyers (1990) identifies policy preferences that are implicit in actual European and Japanese tariff patterns and uses the derived weights and their associated objective functions to assess which tariff reforms could be negotiated by both countries.

We think that the strategic context of the DDA is far different from that of previous rounds. A new feature is, obviously, the number of players. In 2008, Cape Verde became the 153rd WTO member. At the time of the first round, which took place in 1947 in Geneva, the General Agreement on Tariffs and Trade (GATT) consisted of only 23 members. Moreover, the economic sizes of WTO member countries vary widely. For example, the populations of members such as St Kitts and Nevis are under 50,000, while that of China (another member) is about 1.325 billion (bn) people. In 2006, Norway's GDP per capita was US$43,500 per year, in Purchasing Power Parity, while that of Malawi was only US$700 (these figures come from World Development Indicators 2008). The large number of players and the diversity of their economic situations are especially important because that the WTO rules call for consensus. Moreover, while the outcomes of previous rounds were largely negotiated between the EU and US, the number of active participants in the current bargaining process has increased. The trade representatives of Brazil, India, and Australia, for example, now actively participate in the bargaining process. Another strategic characteristic of this round, as stated earlier, is the emergence of coalitions whose roles have not been formally defined. The immediate question that comes to mind, therefore, is whether these new features (the increased number of WTO members and the creation of coalitions) can explain the apparent stalemate of these negotiations since the second half of 2008.

Recent methodological developments allow for a more systematic study of the bargaining process. Thanks to improvements in computation ability, the availability of databases on world macroeconomic variables (e.g., the GTAP database; Dimaranan and McDougall 2005) and market access (e.g. the MAcMAP_HS6 database; Bouët et al. 2008), and the development of multi-country multi-sector Computable General Equilibrium (CGE) models, it is possible to simulate numerous scenarios of trade reform and evaluate their impacts on each WTO member. This may be done against the economic theories of negotiation developed by Nash (1953), Shapley (1953), and Kalai and Smorodinsky (1975). Hence, the combination of theoretical developments and modeling capacities allows us to model negotiations among numerous countries/regions with microeconomic foundations.

To analyze the potential outcome of the DDA, we use the MIRAGE (Modelling International Relations in Applied General Equilibrium)[7] model of the world economy and recent databases covering market access and domestic support. Unlike traditional studies that begin with a particular scenario, we herein study a set of agreements representative of discussions at the time the Cancun ministerial meeting failed. These include 143 trade shocks that are expected to represent the whole set of negotiations, and are studied with the help of the MIRAGE model. Inside the domain defined by all these potential outcomes, the Nash solution, as defined by the theory of axiomatic bargaining, is selected. The Nash solution defines an efficient and rational solution to any bargaining problem.

We find that a pro-liberalization agreement is very difficult to achieve due to the heterogeneity of WTO members. There are, however, several possible solutions. For example, the exclusion of small countries improves the efficiency of the negotiation process, regardless of the governments' objectives. The creation of coalitions potentially allows developing countries to act against the solutions selected by rich countries. It may be possible and useful to expand the domain of trade negotiations. Finally, game theory indicates that side payments may be effective, in that large actors can maximize the "*size of the*

[7] The MIRAGE model was developed at the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) in Paris. A full description of the model is available in Decreux and Valin (2007).

cake" for their purposes by using side payments to compensate losers and buy the agreement of each player.

We arrive at two specific conclusions concerning agriculture and development: First, the liberalization of agriculture is a key element of the negotiations. It substantially increases the magnitude of expected gains and their dispersion, redistributing the gains in favor of small countries. Second, some poor countries may lose in the face of international trade reform, due to eroded preferences and/or increasing world agricultural prices. The '*Aid For Trade*' component of the current negotiations is especially important, as it may entail financial compensation for these countries.

The paper is organized as follows: Section 2 presents our methodology. Section 3 broadly characterizes the economic impacts of the 143 scenarios. Section 4 applies the theory of cooperative games and examines three potential mechanisms for improving the efficiency of the negotiations. Section 5 studies the emergence and effects of coalitions. Section 6 concludes.

2. METHODOLOGY

The MIRAGE Model

This study uses the MIRAGE model of the world economy in order to assess the economic consequences of various trade reforms. The MIRAGE model is a multinational, multisector CGE model (see Decreux and Valin 2007). In each country/region, a representative consumer maximizes a Constant Elasticity of Substitution (CES)-Linear Expenditure System (LES) utility function under a budget constraint to allocate his/her income across goods. The origin of goods is determined by a CES nested structure following the Armington assumption.[8] Northern countries/regions are assumed to produce higher-quality industrial goods compared to those supplied by Southern countries/regions. On the production side, value added and intermediate goods are complements under a Leontief hypothesis. The value added is a CES function of unskilled labor and a composite of skilled labor and capital; this allows us to include less substitutability between the last two production factors. In agriculture and mining, production also depends on land and natural resources. Investment is savings-driven and the current account is assumed to be constant in terms of world GDP. We use a static version of the MIRAGE model, with a perfect competition hypothesis and without modeling of foreign direct investment. The main purpose of this modeling scenario is to simulate many potential trade reforms and represent as exhaustively as possible the entire domain of the negotiation. We use perfect competition instead of imperfect competition, since the latter framework requires supplementary data (e.g., the number of firms, mark-up, and magnitude of scale economies) for calibration purposes, and these are difficult to gather for many countries/regions. We acknowledge that this theoretical option can deeply affect the impact of a trade reform (see Bouët 2008 and Tongeren et al. 2001). However, the use of the static version is justified by the fact that we are not interested in what happens between "now" and "then," but instead are only concerned with the final impact on the various countries/regions.

Data

The first source of data is GTAP6.1 (Dimaranan and McDougall 2005), which provides world macroeconomic accounts and trade flows for the year 2001. Notably, we seek to describe the complexity of the negotiations at the beginning of the process. Of course it would be worthwhile to study whether the current trade features have made the negotiations even more difficult than they were at the beginning of the process. However, we contend that the main reasons for the present stalemate are:

i the large number of participants with heterogeneous economic and trade characteristics;

ii the dispersion of protection and other distortions across sectors; and

iii the existence of trade preferences and regional agreements that generate preferential access.

When considering these three points, no major change has occurred in the world trading system since 2001, even where new policies have been put in place (e.g., the US Farm Bills implemented in 2002 and 2008, the Economic Partnership Agreements, the recent developments in the European Common Agricultural Policies, etc.).[9]

Our market access data comes from the MacMap_HS6 database (Bouët et al. 2008), which measures protection in 2001 and includes all regional agreements and trade preferences existing at this time. A database of bound duties is also used (Bchir et al. 2006); this database applies tariff formulae to bound duties instead of applied duties. The latter is reduced only when the bound duty is cut under the applied tariff. As a result, the interaction between bound, Most Favored Nation (MFN) applied, and

[8] This is a traditional but key assumption in the modeling of international trade flows and trade preferences. We rely here on GTAP Armington trade elasticities; this is a rather conservative approach.

[9] Our baseline takes into consideration the US Farm Bill in place in 2001 and the Everything But Arms (EBA) Initiative.

preferential duties is accounted for in our simulations (all computations are performed at the six-digit level). It is important to account for the binding overhang effect, particularly in developing countries, which often have large binding overhangs.

We further use a database on domestic support constructed from the OECD's data on Production Subsidy Equivalent (PSE). This database takes into account trends in agricultural policies established by the US Farm bill in place in 2001 and the European Agenda of 2000. The existing databases on market access in services are incomplete and not reliable enough for our systematic analysis of trade negotiations conducted under the aegis of the WTO. In the GTAP database, protection in services is insufficiently assessed. Information on this parameter may be gained from frequency indexes (Hoekman 1996) and estimations based on price differences (Trewin 2000, Kalirajan et al. 2000) or residuals of the gravity equation (Francois and Hoekman 1999), but these do not fully account for the complexity of trade barriers in this sector. Whatever the methodological foundation, these assessments suffer from a lack of robustness or require too much information when seeking a global outlook of market access in services (see Chen and Schembri 2002). To cope with this lack of data, we impose a uniform *ad valorem* import tariff of 20% in all countries/regions and across all business service activities. This is a transaction cost that generates rents for economic agents in the importing country/region.

We acknowledge that applying a homogenous 20% import tariff on business services is a very crude modeling approach. Accordingly, we present our results with and without this modeling element, in order to check how it affects our findings. Moreover, one of the three solutions that we propose as a remedy for the stalemate in trade negotiations is an expansion of the domain on which WTO members bargain. In this way, we ask whether a broader domain of negotiation could bring more flexibility and efficiency to the process.

Geographical decomposition

Our initial expectation is that the heterogeneity of negotiating countries could lead to DDA failure. Therefore, when selecting the strategy of geographical decomposition to be used for this work, we give priority to analyzing the structural diversity of the various WTO members. Of course, the geographic decomposition is a key element of the methodological design of this study, as the characteristics of the countries/regions that we choose can deeply affect the outcome.
We think that the main elements that determine a country's stance in the negotiations are as follows:

i the average level of trade-related distortions that affect its imports and exports;
ii the sector and partner dispersion of its protection;
iii its economic size and dependence on trade; and
iv its concentration of imports and exports by product and geography.

On the basis of the GTAP6.1 database, we select countries/regions that are specific in the following terms: trade specialization [e.g., Brazil and Argentina (agriculture) vs. China and Bangladesh (industry) vs. India (services)]; preferential access received [e.g. Bangladesh (which is a beneficiary of the Everything But Arms initiative) vs. China, India, Indonesia and Thailand (which are not), or Mexico and Canada (which have preferential access to the US) vs. all other OECD countries (which do not)]; preferential access given (the EU vs. Japan and Australia); or the geographic structure of trade flows (all continents are represented). Another utilized element is the structure of protection, in terms of average level (OECD vs. Middle Income Countries vs. Low Income Countries) and sector-wide dispersion of protection (the EU, Japan, Korea and Taiwan vs. the US). We also account for the diversity in economic size and dependence on trade (Bangladesh vs. China and India, New Zealand and Chile vs. the US and EU). We seek to avoid blurring country differences through inadequate aggregation. For example, most Sub-Saharan Africa (SSA) countries are characterized by a high geographic concentration of exports (towards the EU and US) and have been granted large preferences (through the Everything But Arms – EBA- and African Growth Opportunity Act –AGOA- initiatives). Most Mediterranean countries

specialize in gas, oil, and apparel products, and have been granted free access to the EU in industry (for more details on this geographic decomposition, see Bouët and Laborde 2004). However, given that we herein simulate 143 trade reforms, we must use a reasonable number of countries/regions. In the present work, we select 25 countries/regions.

Table 1 presents our geographic decomposition.[10] In the context of inter-country/region trade and protection, this decomposition captures 95.5% of the world tariff revenue (which can be considered a measure of the global distortion in play) and 71.3% of world trade (which is the macroeconomic variable affected by the distortion).[11] This, therefore, appears to be a solid basis for our modeling exercise.

Table 1. Geographic decomposition

Region	GTAP code	Coalition
Argentina	arg - Argentina	G22/Cairns
Australia	aus - Australia	Cairns
Bang	bgd - Bangladesh	G90
Brazil	bra - Brazil	G22/Cairns
Canada	can - Canada	Cairns
Chile	chl - Chile	G22/Cairns
China	chn - China	G22
CIS	rus - Russia, xsu - Rest of Former Soviet Union	
EFTA	che - Switzerland, xef - Rest of EFTA	G10
EU25	aut, bel, dnk, fin, fra, deu, gbr, grc, irl, ita, lux, nld, prt, esp, swe, cyp, cze, hun, mlt, pol, svk, svn, est, lva, ltu - 25 countries of the European Union	
India	ind - India	G22
Indonesia	idn - Indonesia	Cairns
Japan	jpn - Japan	G10
Korea_Tw	kor - South Korea, twn - Taiwan	G10
MeditCount/	tur - Turkey, xme - Rest of Middle eEast, mar - Morocco , xnf - Rest of North Africa	G90
Mexico	mex - Mexico	G22
NewZealand	nzl - New-Zeland	Cairns
RoAsia	xea -Rest of East Asia , mys - Malaysia, phl - Philippines, vnm - Viet Nam, xse - Rest of Southeast Asia, lka - Sri Lanka, xsa - Rest of Asia	
RofCentAm	Rest of Central America and of the Caribbean	G22
RofSouthAm	Rest of South America	G22
ROW	xoc - Rest of Oceania, hkg - Hong Kong, sgp - Singapore, xna - Rest of North America, col - Colombia, per - Peru, ven - Venezuela, ury - Uruguay, xsm - Rest of South America, xer - Rest of Europe, alb - Albania, bgr - Bulgaria, hrv - Croatia, rom - Romania	
SouthAfrica	bwa - Botswana, zaf - South Africa, xsc -Rest of South Africa Custom Union	G90/G22/Cairns
SubSahAf	mwi - Malawi, moz - Mozambique, tza - Tanzania, zmb - Zambia, zwe - Zimbabwe, mdg - Madagascar, uga - Uganda, xss - Rest of Subsaharan Africa	G90
Thailand	tha - Thailand	G22/Cairns
USA	usa - United States	

Note: EFTA for European Free Trade Association; EU25 for European Union (25 countries); Korea_Tw for Korea and Taiwan; MediterraneanCo. For Mediterranean Countries; ROCentAm for Rest of Central America; ROAsia for Rest of Asia; RoSouAm for Rest of South America; SubSahAf for SubSaharan Africa.

[10] In 2001 the EU had 15 members, not 25, but the trade integration process was almost finished for the 10 newly enrolled members.

[11] These calculations are realized using the MAcMapHS6 database.

Sectoral Decomposition

Our sector decomposition focuses on agriculture; we identify 23 sectors, 10 of which are agricultural (see Table 2). In agriculture, large distortions are seen in the following sectors: Rice, Sugar, Cereals nec (not elsewhere classified), Livestock and Meat, Meat Products, and Milk and Dairy Products. In industry, large distortions are mainly seen in the Textile and Wearing.

Table 2. Sector decomposition

Sector Code	Description	GTAP Code
Agri_ind	Food products, not elsewhere classified	ofd, vol
Bev_Tob	Beverages and Tobacco	b_t
Bus_serv	Business Services	isr, obs, ofi
Cereals	Cereals, not elsewhere classified	gro, wht
Chim_ind	Chemical industry	crp, p_c
Dairy_prod	Milk and Dairy Products	mil, rmk
Electronic	Electronic	ome
Lvst_Meat	Livestock and Meat	ctl, oap
Mach_ind	Equipment goods	omf
Meat	Meat Products	cmt, omt
Metal_ind	Metal Industry	fmp, i_s, nfm
OthCrop	Other crops, not elsewhere classified	ocr, osd, pfb
OthInd	Other Industries	ely, nmm
OthPrim	Other Primary Products	coa, frs, fsh, gas, oil, omn, wol
OthServ	Other Services	cns, dwe, gdt, osg, ros, trd, wtr, ele
Rice	Rice	pcr, pdr
Sugar	Sugar	c_b, sgr
Textiles	Textile	tex
Tran_ind	Transportation Industry	mvh, otn
Trans_com	Transportation and Telecommunication	atp, cmn, otp, wtp
Veg_fruit	Vegetable and Fruit	v_f
Wearing	Wearing, Apparel	lea, wap
Wood_paper	Wood and paper	lum, ppp

The Objective of Trade Negotiators

Trade liberalization has various impacts on an economy. Changes in relative prices lead to variations in nominal and real remunerations, reallocation of productive factors, gains in efficiency, variations in public revenues, modifications of real exchange rates and of terms of trade, etc. Therefore, a strict definition of national objectives is necessary for analytical purposes. Such objectives must represent the elements taken into account by negotiators. This leads us to consider four indicators in this study:

i The Hicksian equivalent variation of the representative agent. This indicator, which means that governments seek to maximize national welfare, has often been adopted in the literature and has robust microeconomic foundations. However, within the government's objective, consumers' interests are weighted as equal to producers' interests and public receipts.

ii Real Gross Domestic Product (GDP). This is often cited as an objective by negotiators, although this statement lacks a microeconomic foundation.

iii Export growth. This is a mercantilist objective frequently quoted by negotiators.[12]

iv Optimizing terms of trade. This is another mercantilist objective, even though it implies that trade is a zero-sum game.

These objectives appear to be gross approximations, but we will limit our analysis to them because it would be unviable to design a political model specifically adapted to every WTO member. It could be argued that real GDP and welfare are very closely linked objectives. In fact, if trade is initially balanced, we find that the change in Hicksian variation as a share of initial expenditure is the change in nominal GDP deflated by the change in the cost of expenditure. However, trade is not initially balanced in our modeling exercise. Moreover, we herein define real GDP by deflating nominal GDP by production prices rather than the cost of expenditure.

Optimizing terms of trade is an important objective, and are considered politically important by authors such as Bagwell and Staiger (1999). Terms of trade are usually improved when trading partners liberalize versus when they fail to liberalize. When only one country liberalizes and others do not, its terms of trade deteriorate, while a country that does not liberalize while others do may experience deterioration of its terms of trade due to its initial free access to foreign markets (this is the situation created by eroded preferences). In this sense, optimizing terms of trade can accurately characterize the mercantilist spirit of trade negotiators. It is possible to consider a trade reform wherein all WTO members receive improved terms of trade, in that the WTO does not comprise all countries in the world. Of course, this case is less conceivable given an international organization composed of 153 countries rather than the 23 present at the first negotiation.

Scenarios

A set of trade shocks is simulated in order to give a fairly accurate representation of the fundamental interests of WTO members and the scope of potential negotiations possible under the DDA at the inception of the negotiations. From this point of view, it would not be correct to design scenarios around the latest modalities, which were published in 2008 and do not reflect the problems associated with the negotiations at their outset. Therefore, we design scenarios around the main dimensions discussed during the first years of the round. The modeled shocks are designed around five key dimensions of the negotiations:

i The extent to which import duties are cut;

ii The degree of harmonization (progressivity) adopted in the tariff-reduction formulae;

iii The provision of Special and Differential Treatment (SDT);

iv Global or sector-level negotiations; and v. cuts in export subsidies.[13]

We consider services (A), industry (called NAMA for Non Agricultural Market Access; B), agriculture (called AMA for Agricultural Market Access; C) and reduction of export subsidies (D) (see Table 3). We suppose that liberalization in services takes the form of a 50% reduction in the previously defined transaction cost. Liberalization in industry has two aspects: first, two Swiss formulae are simulated with coefficients of a=5% and a=10%. Second, the agreement either includes or does not include SDT. In the former case, the coefficient of the Swiss formula is doubled for developing countries and tripled for Least Developed Countries (LDCs), thereby reflecting the reduced extent to which market access is improved in those countries. We test complete liberalization in the textile-apparel sector. This “0

[12] Herein the objective is of course the maximization of exports growth. Another option would be to consider defensive objectives, such as limiting import increases. This is apparently supported by some governments, although maximization of export growth is a more common national objective. As we had to limit the number of tested objectives, we did not examine minimization of import growth.

[13] Some of these aspects are still key elements of the trade negotiations today. However, this study focuses on the potential outcomes of the DDA when this negotiation was initiated.

for 0 option" is added to a scenario in which the Swiss formula for the other industrial sectors is set to 5%, and there is no SDT. In agriculture, two Swiss formulae are also considered, with less harmonizing coefficients (a=15% and a=30%), and SDT is the same as for industry. As the EU proposed a linear reduction of import duties by a 33% coefficient, we also test this non-harmonizing formula; in this case, the coefficient is set to 25% for developing countries and 15% for LDCs. Finally, we consider a 75% cut in export subsidies.

In all trade shocks, duties < 3% are annulled. From a global point of view, we simulate 143 trade shocks. To facilitate identification, we use the following code (see Table 3): a trade shock is designated in the format's ABCD,' where A, B, C, D is an integer belonging to {0, 1, 2, 3, 4, 5}. For instance, trade shock s0121 corresponds to (see Table 3):

i the status quo in services;
ii a Swiss formula for industry having a 10% coefficient and no SDT;
iii a Swiss formula for agriculture having a 25% coefficient and SDT; and
iv a 75% reduction in export subsidies

Table 3. Definition of scenarios

	Domain			
	A	B	C	D
Value	*Services*	*NAMA*	*AMA*	*Exp. Subsidies*
0	Statu-quo	Statu-quo	Statu-quo	Statu-quo
1	Reduc. by 50%	a=10%	a=25%	Reduc. by 75%
2	n.a.	a=10%+SDT	a=25%+SDT	n.a.
3	n.a.	a=5%	a=15%	n.a.
4	n.a.	a=5%+SDT	a=15%+SDT	n.a.
5	n.a.	0-0	Linear formula + SDT	n.a.

Note: NAMA for Non Agricultural Market Access; AMA for Agricultural Market Access.

3. ASSESSING THE ECONOMIC IMPACTS OF POTENTIAL REFORMS

The impact of the five modalities on the level of applied protection is shown in Table 4, split between the agricultural (AMA) and non-agricultural (NAMA) sectors. The tariff formulae are applied at the most disaggregated level, and then averages are calculated and compared to the initial averages; this procedure yields a much more detailed assessment of the potential impact of a tariff formula compared to procedures that apply tariff cuts to average applied import duties. Moreover, we account for the interaction between bound duties, MFN-applied duties and preferential duties.

Table 4. Impact of various tariff cuts on applied import duties

%	Initial level		Case 1		Case 2		Case 3		Case 4		Case 5
	Agri	Non-Ag	Agri	Non-Ag	Agri	Non-Ag	Agri	Non-Ag	Agri	Non-Ag	Agri
Argentina	11.8	12.7	10.6	6.9	11.7	10.0	8.8	4.3	11.0	6.9	11.8
Australia	3.1	5.4	2.2	3.0	2.2	3.0	1.9	2.1	1.9	2.1	2.2
Bangladesh	19.4	15.7	13.4	1.8	18.8	2.2	9.5	1.5	18.1	2.2	19.3
Brazil	11.1	12.5	9.6	6.5	10.9	9.4	7.8	4.0	10.1	6.5	11.1
Canada	23.2	2.9	6.0	1.7	6.0	1.7	4.3	1.3	4.3	1.3	15.7
Chile	7.0	6.8	7.0	6.8	7.0	6.8	7.0	4.3	7.0	6.8	7.0
China	23.5	7.4	9.9	3.7	12.9	4.8	7.7	2.7	10.7	3.7	18.5
CIS	16.9	8.8	16.8	8.8	16.9	8.8	16.8	8.8	16.9	8.8	16.9
EFTA	60.0	1.5	11.9	0.6	11.9	0.6	8.2	0.4	8.2	0.4	50.9
EU25	24.4	2.4	7.7	1.3	7.7	1.3	5.6	0.9	5.6	0.9	17.2
India	57.2	30.0	19.8	6.9	31.1	10.4	13.8	4.5	22.5	7.0	48.6
Indonesia	11.4	6.0	5.9	3.2	6.9	3.9	4.8	2.3	6.2	3.2	9.9
Japan	49.9	1.7	11.0	0.9	11.0	0.9	7.8	0.7	7.8	0.7	43.0
Medit. Count.	28.3	7.6	12.4	5.3	14.6	5.7	10.0	4.8	12.0	5.2	26.4
Mexico	41.1	10.4	14.2	5.3	19.5	7.6	10.7	3.5	15.6	5.3	34.3
New Zealand	2.3	2.8	1.9	2.5	1.9	2.5	1.9	1.9	1.9	1.9	2.1
Rest of Asia	16.0	9.6	8.2	3.4	9.3	4.1	7.5	2.9	8.6	3.5	15.4
Rof World	5.2	1.9	3.7	1.2	3.9	1.4	3.2	1.0	3.5	1.2	4.9
Rof Central Am.	16.8	4.7	9.2	3.0	11.6	3.7	7.2	2.1	9.9	3.0	14.8
Rof South Am.	15.7	11.0	11.7	8.6	13.5	9.7	9.7	7.4	12.0	8.5	15.2
South Africa	21.8	7.3	7.9	3.1	10.1	4.3	6.2	2.0	8.6	3.1	21.6
S. Korea-Taiwan	41.8	7.8	11.2	3.3	11.2	3.3	8.2	2.3	8.2	2.3	29.7
SubSaharan Af.	17.9	12.2	13.0	2.5	15.6	3.0	9.9	2.1	14.6	2.7	17.9
Thailand	27.1	11.5	14.0	3.8	19.1	5.2	10.4	2.6	15.4	3.8	23.4
United States	5.5	2.2	3.1	1.0	3.1	1.0	2.5	0.7	2.5	0.7	4.3

Sources: MAcMapHS6 and authors' calculations
Note: Reference group weights. See Bouet et al. 2008 for a detailed explanation.

The most protected commodities are found in the agricultural sector; their protection is especially high in the European Free Trade Area (EFTA) countries, India, Japan, and the South Korea/Taiwan region. Industry imports are relatively restricted in India, Bangladesh and most of the remaining MICs. In agriculture, the impact of the Swiss formula is large due to the presence of tariff peaks. In the EFTA region, new agricultural protection is a fifth of the initial one under a 25% Swiss formula (case 1), and

reduced by 86% with a 15% coefficient (case 3). For Japan, these reductions are similar. A linear formula has a much smaller impact (case 5), as it does not cut the tariff peaks as substantially; the average agricultural protection in the "Rest of Europe" region is reduced by only 15%, while that in Japan is cut by only 13.8%. In Australia, New Zealand and the US, the impact of various agricultural reforms is limited. In developing countries/regions, however, the effect of agricultural reform is very substantial; for example, in India the 25% Swiss formula cuts protection by 65%, while a 15% coefficient cuts protection by 76%. As expected, the inclusion of SDT yields a smaller reduction in protection for developing countries/regions.

In industry, the impact of the Swiss formula is softened because the tariff dispersion is smaller. Liberalization can be substantial under a 15% coefficient in emerging countries; under this modality, industrial protection is reduced by 85% in India and 68% in Brazil. Once again, the inclusion of SDT is associated with less liberalization in developing countries/regions.

Table 5. World optimum

	With liberalization in services	Without liberalization in services
Optimal scenario	s1531	s0531
Eq. Variation	US$105.05bn or +0.33%	US$93.8bn or 0,29%
Real GDP	US$127.21bn or 0.41%	US$114.99bn or 0.37%

Note: s1531 implies liberalization in services (1), the strongest liberalization (a=5%) in NAMA, including 0-0 in textiles and wearing (5), the strongest liberalization (a=15%) in AMA (3), and the reduction of export subsidies. s0531 is the same scenario without services liberalization.

The trade reforms that maximize world gains are presented in Table 5. Scenario s1531 is characterized by liberalization in services, a very harmonizing Swiss formula without SDT in industry or agriculture, a "0 for 0" option in textile and apparel, and a 75% reduction in exports subsidies; this yields the largest increase in world welfare. The optimum scenario is s0531 if we exclude negotiation in services. If the criterion of interest adopted by governments is the augmentation of exports, the best scenario is s1530, under which export subsidies are not cut. The gains seen under this scenario in the present work (USD105 bn under the most liberalizing scenario) are comparable with those obtained in similar studies (Bchir et al. 2005 for example).

For each of the 143 scenarios, Appendix 1 indicates the global gains (in USD bn, then in percentage), the un-weighted average gain in percent, and the standard deviation of gains (un-weighted). Global gain is important, as it measures the efficiency of the process. The un-weighted average gain in percent is also meaningful; when compared to global gain in percent, it indicates whether the trade reform favors large countries/regions (in which case the un-weighted average is less than the global gain in percent) or small countries/regions (in which case the un-weighted average is greater than the global gain in percent). A negative un-weighted average with a positive global gain indicates that there are many losers, and/or that small countries/regions are hurt by relatively large losses.

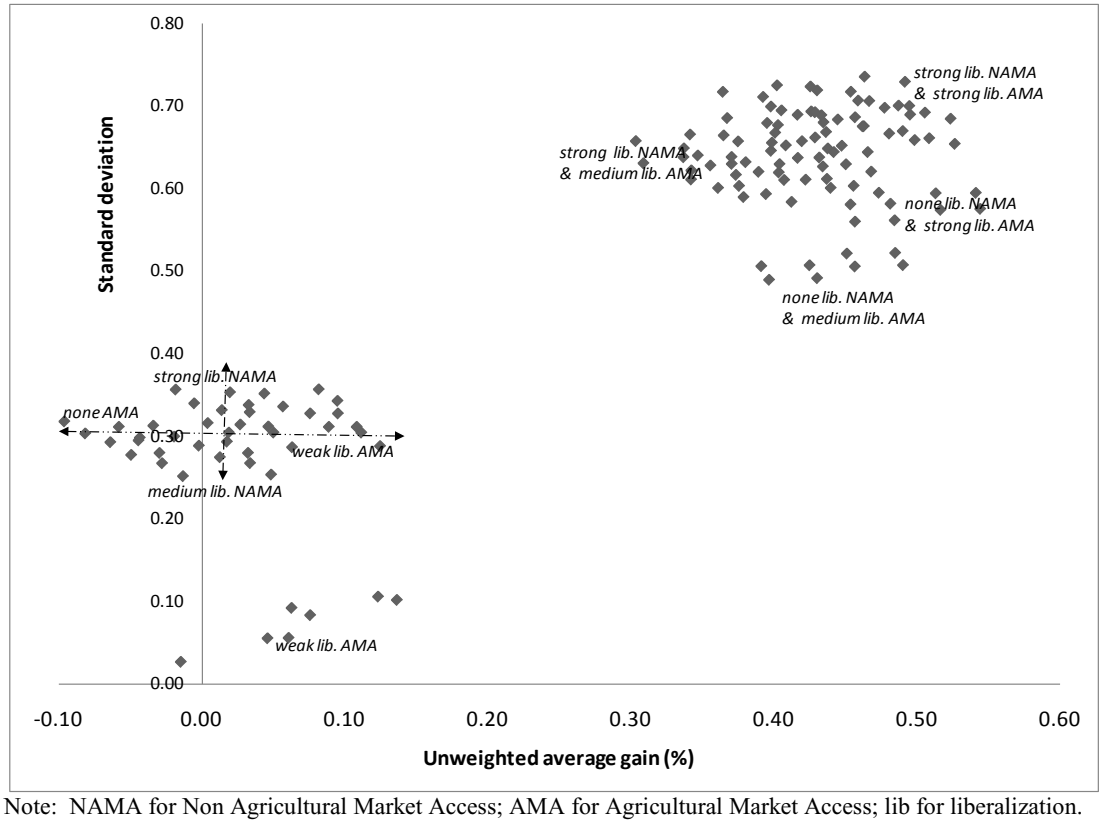
A major part of the world gains comes from agricultural liberalization, due to the high level of initial protection. This finding is consistent with the conclusions of other studies, such as those of Van der Mensbrugghe and Beghin (2004), Francois et al. (2005), and Hertel and Keeney (2006). The world welfare gains from reforms s1000, s0500, s0030 and s0001 add up to US$101.53bn, but the only agricultural reform yields a US$75.35bn gain. As tariff peaks are numerous in this sector, the design of the formula under which imports duties are reduced is fundamental. To understand this element, let us compare the welfare gain seen when we apply a linear formula (s0050) versus one obtained from a very harmonizing formula (s0030). Systematically, the latter confers about US$60bn of supplementary equivalent variation (in Appendix 1, note the differences among the global gains obtained from scenarios s0030 and s0050, s0530 and s0550, s1530 and s1550, s1531 and s1551, etc.).

Gains coming from liberalization of industry are smaller; in the best case scenario they add up to US$14bn. This corresponds to a very harmonizing Swiss formula, no SDT and with a "0 for 0" option in

textiles and apparel. A smaller initial protection explains these limited gains. Moreover, tariff peaks are less frequent. Two other elements are noteworthy. First, gains are over-additive; the sum of gains coming from elementary shocks is inferior to that derived from the scenario in which all these shocks are combined. Second, a cut in export subsidies is more fruitful if it is combined with a reduction in agricultural tariffs. Indeed, a reduction of these subsidies without any change in import duties brings a US$1bn welfare gain. When this reduction is added to a decrease in border protection, we see a much larger welfare gain: see the differences between s0531 and s0530, or between s1530 and s1531. One explanation for this is that reducing import duties increases trade flows. The same rate of export subsidization causes more distortion under larger trade flows.[14] Thus, the modeled trade shocks generate varied global welfare gains and we see large variations in their distribution among the 25 countries/regions.

Figure 1 shows each scenario according to two characteristics: the un-weighted average gain in the percentage of initial real income (horizontal axis), and the standard error of the gains in the countries/regions (vertical axis). In the lower left corner of Figure 1, we see a set of 47 trade reforms characterized by negative or low un-weighted average gains and low standard deviations. One common characteristic of these scenarios is that they yield a relatively small global gain for the world economy (the maximum is US$41.2bn). In contrast, the minimum global gain predicted for the set of trade reforms located in the upper right corner is US$68.5bn. Thus, we see that the larger the world gain, the more unequally its distribution.

Figure 1. Distribution of scenarios by simple average and standard deviation of country gains



Note: NAMA for Non Agricultural Market Access; AMA for Agricultural Market Access; lib for liberalization.

[14] We do not model the Uruguay Round Agricultural Agreement (URAA) constraints on export subsidies in terms of expenditures and volumes.

All of the trade reforms in the lower left corner of the graph are not only characterized by relatively low global gains for the world economy, but also relatively small standard deviations and small un-weighted average gains. Reforms leading to negative un-weighted average gains are projected to hurt many countries/regions through losses and/or hurt some countries with large relative losses. All of these reforms lack liberalization in agriculture or include a linear tariff reduction in this sector. The distribution of welfare gains varies according to the modalities of each liberalization scenario. For instance, while generating the same increase in world welfare (US$14bn, i.e. a growth rate of 0.04%), the scenarios of agricultural liberalization under a linear formula (s0050) or a large industrial liberalization (s0500) give us contrasting pictures in terms of distribution. In the first case, total real income gain is more evenly shared out among players (whatever their economic size), the percent un-weighted average gain is greater than the world gain, and the standard deviation is somewhat low. In the second case, industrial liberalization benefits the richest countries/regions, such that the percent of un-weighted average gain is negative, while the world gain is positive. The standard deviation is about four-fold higher.

Conversely, all reforms located in the upper right corner of the graph are characterized by a Swiss formula in agriculture, with or without SDT. For all scenarios in the upper right corner of the graph where a Swiss formula is applied on agricultural tariffs, the standard deviation of gains is high, but the un-weighted average gain (in percent) is greater than the global gain for the world economy, implying that these reforms are supported by numerous countries/regions and large countries/regions do not capture most of the gains. Based on Appendix 1, comparison of scenarios s1500 and s1530, s1501 and 1531, s1400 and s1430, and s1401 and s1431 shows that a "progressive" liberalization in agriculture not only generates a major increase in the global gain captured by the world economy, it also yields a much larger un-weighted average gain (in percent); this suggests that there are numerous winners, but at the price of a higher standard deviation.

The uneven distribution of the gains is understandable if we consider that the main effects are driven by agricultural liberalization. First, the cost of protection is quadratic for importing countries/regions. Therefore, we expect the gains to be concentrated in regions where the distortions were initially high. Second, for exporters, two complementary effects are in play, particularly for agricultural liberalization. First, the elimination of tariff peaks creates strong losses for exporters who initially enjoyed preferential access, but strong gains for non-preferred exporters; in this sense, developing countries/regions have contrasting interests. Furthermore, if agricultural liberalization drives the majority of the gains, such gains will be concentrated in countries/regions with stronger comparative advantages in this sector (e.g., the Cairns Group). In addition, the terms of trade will affect food prices, thereby creating opposite effects on net importers and net exporters of food products. Thus, liberalization of industry alone yields an unfair distribution of gains, while liberalization of agriculture alone confers large gains to numerous countries/regions, but these are more unequally distributed. Combining the two options increases the size of the cake, but with an even more unequal distribution (s1530). Therefore, agricultural liberalization is crucial in order to make the game politically acceptable.

4. MODELING THE BARGAINING PROCESS

We see above that the negotiating modalities have a huge impact on the distribution of gains and that it is not a trivial issue to study the feasibility of a positive outcome. Based on game theory, this section describes trade negotiations as a cooperative bargaining process among players. The Nash solution is exposed, according to several hypotheses about bargaining power.

The Nash Solution

Let us consider that the trade negotiation is a process of 25 countries/regions bargaining on 143 potential outcomes. Let W_0^m be the country/region *m*'s reference "payment" in the case that no agreement is reached, $W^m(s)$ is the payment when the outcome *s* is adopted, and *S* is the set of 143 feasible outcomes. We assume that in the case of bargaining game failure, the outcome (also called the threat point) will be the status quo, *i.e.*$W^m(s) = W_0^m, \forall m, \forall s$. However, we can also imagine other cases, as follows:

i Countries/regions start trade wars, increasing their applied duties to the maximum allowed by their bound duties (or even further). This alternative would require us to model and solve the Nash non-cooperative game across the 25 countries/regions.

ii Countries/regions decide to negotiate preferential agreements. In this case, we would have to define an optimal trade agreement for each of the 25 countries/regions with any combinations of the 24 other countries/regions, as well as potential agreements with third parties.

These two alternatives would require strenuous calculations that are beyond the scope of the current analysis. Here, we seek to understand, within a simple framework, the stalemate in which the trade negotiations have been stalled since 2001. Bouët and Laborde (2008) investigated the potential outcome of DDA failure, but the alternative scenarios they used are ad hoc and inconsistent with the game-theory approach discussed herein.

In the following, we present Nash solutions without the inclusion of bargaining power, and then add bargaining power into the analysis.

The Nash solution without bargaining power

First, we consider that all countries/regions m participate in negotiations and have identical bargaining power, regardless of their geography, population, and economic size. The Nash solution is:

$$s^* \in Arg_{s\in S} MaxG(s) = \prod_m [W^m(s) - W_0^m] \quad (1)$$

With:

$$W^m(s) - W_0^m \geq 0, \forall m \quad (2)$$

Condition 2 ensures that the solution will be individually rational.

Table 6. Nash solutions of the cooperative game

	Equivalent variation	Real GDP	Exports	Terms of trade
1 region, 1 voice	s1000	s1520	s1530	No solution
1 country, 1 voice	s1000	s1510	s1530	No solution
Economic weight	s1000	s1551	s1530	No solution

Note: s1000 is a status quo with liberalization only in services (a net gain for everyone in our modeling).
s1510 implies liberalization in services (1), the strongest liberalization (a=5%) in NAMA (including 0-0 in textiles), a moderate liberalization (a=25% +SDT) in AMA, and no export subsidies reduction. s1520 differs from s1510 by the introduction of SDT in agriculture. On the contrary, s1530 is the same scenario, but with the strongest AMA liberalization (a=15%, no SDT). s1551 implies liberalization in services (1), the strongest liberalization (a=5%) in NAMA, including 0-0 in textiles and wearing (5), the weakest liberalization (linear reduction) in AMA (3) and the reduction of export subsidies. s0531 is the same scenario without services liberalization.

Therefore the Nash solution is characterized by the following features:

i The outcome is individually rational (no player loses relative to the pre-negotiation situation).

ii The outcome is Pareto-optimal (no negotiable outcome is unanimously preferred).

iii The outcome depends on the initial point ("threat point").

iv The outcome may be democratic or it may reflect a given distribution of power among players ("bargaining powers"). The latter option is presented in subsection 4.1.2.

These characteristics exemplify the uniqueness of the Nash solution. Moreover, unlike other axiomatic approaches (e.g., egalitarian solutions, utilitarian solutions, the Kalai Smorodinsky solution), the Nash solution fulfils a set of other properties: independence of irrelevant alternatives, independence of a change of unity, weak Pareto constraint, and symmetry (Mas-Colell et al. 1995).

The Nash solution is an equilibrium concept that should not be confused with the concept of the Nash equilibrium. The distinguishing features are as follows:

i The Nash equilibrium applies to non-cooperative games and states that the outcome of a game where players do not cooperate is a situation in which no player will change his/her strategy as long as all other players do not change their strategies;

ii The Nash solution applies to cooperative games and states that the issue of a negotiation should be individually rational and Pareto-optimal.

Table 6 shows the different Nash solutions according to the objective adopted by governments and the negotiation rule defined by equations 1 and 2. The first row gives the Nash solutions when the 25 countries/regions have no bargaining power, the second row reflects the situation in which each country has the same power (democratic weights; see the next subsection), and the third row reflects the situation when countries/regions have bargaining powers proportional to their economic sizes (Gross Domestic Product –GDP- source: CHELEM database,[15]; see the next subsection).

When maximizing exports, the Nash solution represents a very ambitious degree of liberalization (s1530) that benefits all players. Optimizing terms of trade is not a sustainable objective, as this criterion features a purely mercantilist world where international liberalization is a constant-sum game and where no Paretian improvement is feasible. In our study, the only possible solution under this objective would be a situation in which all WTO members agree on a reform that improves their terms of trade while deteriorating those of non-WTO members. When maximizing equivalent variation, the outcome is the status quo, except for liberalization of services, which gives every player a welfare gain. Considering that our modeling of services is relatively limited, we can focus on the result without services. In this case,

[15] http://www.cepii.fr/anglaisgraph/bdd/chelem.htm

negotiation reaches a stalemate. If governments maximize GDP, it is likely that industry will be hugely liberalized but market access in agriculture will be only slightly improved.

As far as the objective of equivalent variation is concerned, Bangladesh clearly plays a key role in trade negotiations, as this country does not see improvement of its equivalent variation under numerous scenarios, due to deterioration of terms of trade and erosion of preferential margins. This illustrates the position of numerous developing countries/regions that have been granted significant preferences in rich and large markets and are highly specialized in a few products. Thus, our results suggest that the position of such countries forms the underlying basis for the stalemate of trade negotiations.

In the absence of bargaining power, each player has the same influence. However, our definition of a player follows the countries/regions modeled herein, meaning that our disaggregation scheme introduces a bias into the structure of the game. By introducing bargaining power based on measurable country/region features, we can correct for the arbitrary choices inherent in our disaggregation.

The Nash solution with bargaining power

Several elements justify the allotment of more bargaining power to larger countries/regions, as follows:

i Multilateral trade negotiation is a process of bargaining for market access, and all players make it a priority to gain access to large and rich countries/regions;

ii Large countries/regions have strong bargaining powers based on the threat of potentially detrimental retaliation; and

iii Large countries/regions (e.g., the US, EU, Japan, Brazil, China and India) have a higher capacity to understand the impact of reforms and can more easily influence other WTO members on non-trade issues.

Cooperative game theory allows us to account for this element. It is possible to introduce differentiated bargaining powers into the Nash axiomatic approach; to do this, we modifying equation 1 by weighting each player's surplus by α_m. The Nash solution is then given by:

$$s^* \in Arg_{s\in S} MaxG(s) = \prod_m [W^m(s) - W_0^m]^{\alpha_m} \quad (3)$$

Under the same individual rationality constraint expressed by equation (2).

Two alternative weights are considered:

i The term α_m equals the number of voices representing each country/region within the WTO (1 voice for the US, 1 for the EU, 2 for the Korea/Taiwan zone, 11 for the Mediterranean countries, etc.). This weighting structure is qualified as a "democratic"[16] system.

ii The term α_m equals the share of the country/region in the world GDP. This is the economic power, and may be interpreted as an indirect way to consider a better threat point for this country/region in the case of trade wars or bilateral negotiations.

The last two rows of Table 6 present the results when we use these weights. As demonstrated above for the "no bargaining" case, the objectives of terms of trade optimization and equivalent variation maximization lead to the status quo. The individual rationality constraint considerably reduces the bargaining space. When exports are maximized, the Nash solution does not change. Only the Nash solution under the real GDP criterion is modified when weights are included. In a democratic context, the same solution is adopted at the end of the bargaining process, except that it does not includes SDT. This option has a restrictive impact on South-South trade, and is abandoned when developing countries have

[16] "Democratic" must be interpreted as a relative concept, and should not be interpreted strictly. The term is herein applied to an international institution comprising members of very different sizes, populations and political systems.

greater decision power. In contrast, when an economic weighting system is adopted, the trade reform s1551 is adopted. This is clearly a compromise among the EU, Japan and other industrialized countries/regions. The US maximizes GDP when s1500 (i.e., large openness of industry and services) is adopted.

Thus, the main conclusion of this section is as follows: if exports and GDP are not consistent objectives for trade negotiators, then the status quo is highly probable. In the next subsections, we consider three ways to avoid the status quo: the exclusion of some players, the implementation of side payments, and the extension of the negotiation domain.

Excluding Some Players

A key reason for the Doha stalemate is obviously the large number of negotiating members, which constrains the bargaining program. Thus, one possible solution would be to exclude some members from the negotiation process. As suggested by Sally (2004):

> *"Stated baldly: only a minority of the WTO members have the bargaining power and capacity to advance negotiations. These are the OECD countries and about a score or so of advanced developing countries (most of them in the G20). Hence the key liberalizing and rule-making deals in the WTO must be done by the 30-plus countries (counting the EU as one) that account for over 80% of international trade and an even bigger share of foreign direct investment" (Sally 2004).*

Table 7. Cardinal of the set of feasible and rational (IR) scenarios when player exclusion is allowed

Exclusion threshold	Equivalent variation	Real GDP	Exports	Terms of trade
None	1	31	39	0
< 2% of world GDP	59	47	142	0
< 3% of world GDP	60	47	142	0
< 4% of world GDP	87	47	142	112

Note: The exclusion threshold is applied to the GDP of the player (region in the model) and not to each country belonging to the region. IR is the set of scenarios where all players have non-negative payoffs (individual rationality constraints).

Sally's proposal is to confine WTO trade negotiations to OECD and a few middle-income countries. Several points support this view:

i Reaching a trade accord among more than 150 countries is an extremely difficult task, as countries' preferences are often quite different;

ii Trade negotiations require human and technical resources that are often available only to rich countries;

iii It is seen as useless and inefficient to include countries with negligible shares in world trade and investment;

iv LDCs and Small and Vulnerable Economies (SVEs) would not have to liberalize under the current negotiations, so although they are not officially excluded, their lack of obligation to the issues at hand mean that they are functionally excluded from the negotiations and

v Observers often describe the past negotiations conducted under the aegis of the General Agreement on Tariffs and Trade as a bargaining process among a few rich countries (see for example the Blair House agreement between the EU and US; Messerlin 1995).

Notably, while these justifications are particularly relevant for LDCs and SVEs, they are less so for emerging countries (e.g., Brazil, China and India) that have recently acquired a major role in the international trading system.

It is possible to examine how the exclusion of poor countries (i.e., eliminating some of the *m* countries/regions from the optimization program) affects the negotiation. For this, we define the *IR*-set as the set of scenarios that fulfill the individual rationality constraint in each program (see equation 2). Table 7 indicates the number of solutions in the *IR*-set, according to various degrees of exclusion of poor countries /regions (the criterion being a share in world GDP above/below a given threshold).

Excluding countries/regions always expands the *IR*-set of the game. For example, when the equivalent variation is the objective of all negotiators, the exclusion of countries/regions with GDP < 2% of world GDP yields an *IR*-set of 59 instead of 1. When optimizing terms of trade is the objective, the exclusion must be large in order for the *IR*-set being not empty; the 4% threshold excludes India from the bargaining process, allowing some agreements to be reached (e.g., s1311 with economic weights, s1351 in other cases). When negotiators maximize equivalent variation, even the 2% threshold (which excludes only small countries/regions) is efficient. The s1510 outcome is adopted under bargaining weights based on economic powers, except when the interests of all countries/regions with < 4% of world GDP are precluded; in these cases the US, EU, and Japan (i.e., the Triad countries) are the only negotiators and s1551 should be chosen (see above). With democratic weights, the outcome of trade negotiations is s1530 for a 2% threshold, s1230 for a 3% threshold, and s1511 for a 4% threshold. Democracy undermines the influence of the US and EU, while improving the position of the Mediterranean countries. From a global point of view, restricting negotiation to richer countries/regions leads to the adoption of a less harmonizing tariff reduction formula in agriculture. Moreover, when only Bangladesh is excluded from the bargaining process, an outcome may be reached under the equivalent variation criterion. In our configuration, Bangladesh exemplifies the situation of LDCs and other small countries/regions that will experience mainly adverse effects from multilateral liberalization, due to erosion of preference and deterioration of terms of trade.[17]

Thus, we find that the exclusion of WTO members is efficient. However, this is quite opposite to the essence of multilateralism. Excluding poorer countries/regions is particularly inconsistent with the developmental objective of this round. Therefore, the following subsection addresses a more cooperative solution: the inception of side payments among countries/regions.

Setting up Side Payments

It is impossible to find a Pareto-superior outcome, such that the negotiation is blocked. In a cooperative framework, a worldwide Pareto-optimum should be agreed on when countries/regions are allowed to redistribute the benefits obtained from trade liberalization. Setting side payments entails a supplementary degree of freedom, and all outcomes are then feasible as long as total welfare increases. The "Aid For Trade" package cements this idea into a workable strategy (see Evenett 2005a). From an institutional point of view, these international transfers may take several shapes: aid for development, financing of facilities, adjustment packages (see IMF Anne Krueger's proposal18 in Cancún). For example, various proposals have been put forth regarding the compensation of ACP (African-Caribbean-Pacific) countries for preference erosion as part of the tentative banana deal reached between Latin-American producers, the EU and the US. Equivalent variation is the criterion that best fits these international financial transfers; for this reason, we herein study implementation of side payments under this objective function.
From a mathematical point of view, the program of the cooperative game with side payments is defined by the equations:

[17] This point can be extended to other small countries (e.g., Benin, Burkina Faso, Chad, Mali and Ecuador) that expressed their concerns over concluding the Doha Round without reaching a meaningful outcome on either the cotton or the banana issues.

[18] http://www.imf.org/external/np/speeches/2003/091003.htm

$$s^* \in Arg_{s\in S} MaxG(s) = \prod_m [W^m(s) + T^m - W_0^m]^{\alpha_m} \quad (4)$$

With:

$$W^m(s) + T^m - W_0^m \geq 0, \forall m \quad (5)$$

And:

$$\sum_m T^m = 0 \quad (6)$$

Here, T^m represents the payments received/paid by m. The objective function to be maximized (equation 4) indicates that each country/region's real income variation due to the trade reform is increased (decreased) by the side payment when it is positive (negative). Equation 5 expresses individual rationality and differs from equation 2 in that the side payment is included. Equation 6 means that the sum of the international transfers is balanced.

It can be shown that the optimal solution s* is defined by:

$$W^m(s^*) + T^m - W_0^m = \alpha^m \times \sum_m (W^m(s^*) - W_0^m) \quad (7)$$

At the optimum, a player should get share α^m of the total gain (i.e., his/her bargaining power). If all players have the same power (the un-weighted situation), the final distribution of gains must be even. Otherwise, a player will use his/her veto power to block the outcome. Therefore, the more uneven the initial distribution, the larger the redistribution.

Keeping in mind that the Nash bargaining game describes a redistribution process on an absolute level of gains, we see that attributing the same bargaining power to different players means they will try to obtain the same share of the overall gain. However, identical shares can represent very different relative gains (the final payment compared to each player's initial real income). Adopting a weighting scheme that provides the same bargaining power to both large and small countries/regions may be quixotic, since an even distribution of absolute gains will lead to a very extreme distribution of relative gains. Using GDP weights allows us to correct for such a problem. However, a development-friendly outcome of the DDA may target the reduction of world inequalities, meaning that the gains of developing countries/regions should be more than proportional to their initial GDP. The "un-weighted" and "democratic" weighting schemes have such properties.

When setting side payments, a first-best solution may be agreed on (i.e. s1531); this is the most ambitious scenario in terms of liberalization. When services are excluded from negotiation, the solution is s0531. Implementation of transfers allows the negotiations to reach its worldwide first-best equilibrium.

Table 8. Nash solutions with side payments

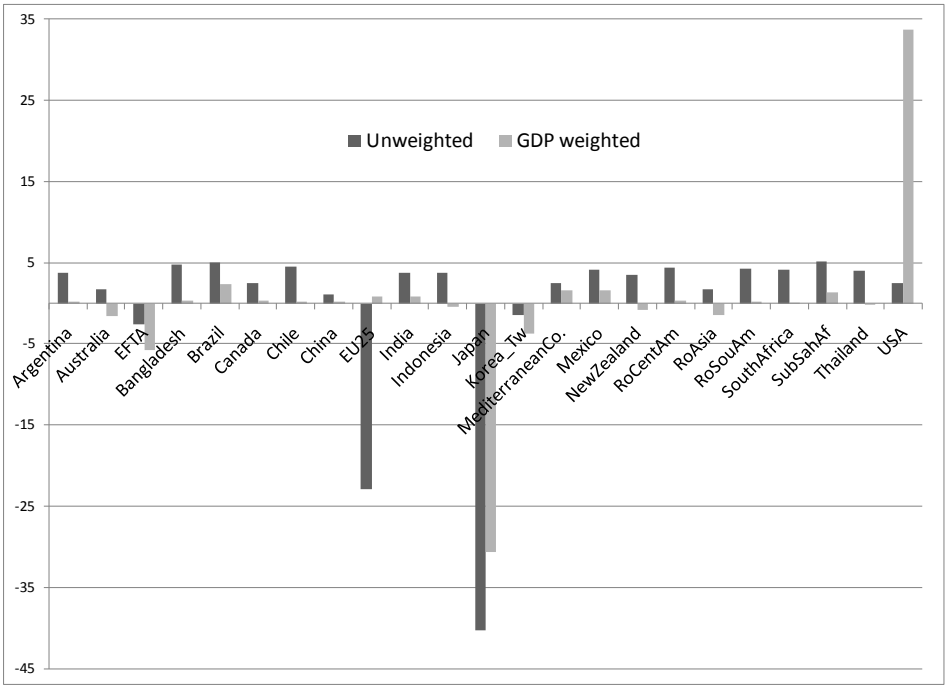
Global transfers (US$ bn)	Un-weighted	Democratic	Economic weights (GDP)
With liberalization in services	66.4	80.7	44.0
Without liberalization in services	63.2	78.8	44.1

The total amount of international transfers is shown in Table 8. Notably, the international transfers are very large. As discussed in Section 3, the more efficient the reform, the larger the global gain and the higher its dispersion. So, in a sense the large sizes of these transfers are due to the consensus rule and the right of veto given to each WTO member. They are much larger (between 20 and 30 times larger, in fact) than the amounts the countries/regions need to make up for the losses induced by the negotiated outcome. This is because countries/regions do not only need to be compensated for losses (the difference between the initial equivalent variation and the equivalent variation generated by reform), but also for not

receiving the average gain. These transfers add up to between 40% and 80% of the total welfare gain and represent a considerable financial compensation. Moreover, the more power the rich countries/regions have, the smaller the transfers. For a similar reason, the "democratic" weighting scheme induces large redistribution, since most WTO members are small economies that will see little or no gain. The liberalization of services, by increasing the size of the cake, leads to more redistribution except in the case of bargaining power based on economic size (this is specifically due to the situation in the US; see below).

Figure 2 shows the distribution of transfers under side payments; services are included in the liberalization process and the Nash solution is defined with and without bargaining powers. This solution defines three net payers who are among the main beneficiaries from the liberalization process, namely the EU, EFTA, and Japan. This finding is obviously related to the presence of a tariff structure with numerous peaks. Japan pays US$40bn to other countries/regions upon a total gain of US$45bn. For LDCs, the obtained side payments are the only source of gain (e.g., Bangladesh and SSA) and are quite significant (about 2.5% of SSA's income.) The weighted case is obviously more advantageous for rich countries/regions. For example the EU does not pay anything, Japan's payment is reduced by about 25%, and the US receives large payments (US$34bn). When services are excluded, the profile of the distribution is similar. The larger side payments received by the US are noteworthy because this country also gains from trade liberalization in services.

Figure 2. Distribution of transfers among players (in US$ bn)



Note: EFTA for European Free Trade Association; EU25 for European Union (25 countries); Korea_Tw for Korea and Taiwan; MediterraneanCo. for Mediterranean Countries; ROCentAm for Rest of Central America; ROAsia for Rest of Asia; RoSouAm for Rest of South America; SubSahAf for SubSaharan Africa. The most ambitious scenario is the optimal outcome with transfers (s1531) when transfers are allowed. A negative transfer is a payment made, a positive one is a payment received.

Extending the Domain of Negotiation

Another possible solution is to extend the objective of the negotiation. For example, the introduction of Singapore issues such as trade facilitation, or (more generally) the inclusion of services in the negotiation might be viewed as extending the domain of negotiation, since countries/regions that lose due to the liberalization of agriculture and industry might have their losses offset by gains from the liberalization of

services. As it is not possible to extend the negotiation domain from the situation depicted in the previous section, we consider a restriction of this domain and evaluate the *IR*-set of the game when the negotiation takes place *only* in agriculture, industry, services, or export subsidies. Table 9 illustrates the results of this investigation; for each criterion (equivalent variation, real GDP, or terms of trade), we can compare the number of scenarios in the set of feasible issues (column Domain) with the number of scenarios in the *IR*-set (column *IR*-set).

A negotiation among all players gives rise to a quasi-stalemate (even when all dimensions are included) when players maximize the equivalent variation; in this case, the only solution is a liberalization of services. Furthermore, under these conditions a complete stalemate is reached when the objective is the optimization of terms of trade. Therefore, we also consider situations in which we exclude countries/regions representing < 2% and < 4% of the world GDP.

Table 9. Impact of an extension of the negotiation domain (IR)

Criteria	Dimension	Card of the scenarios set	Card of the IR set		
			All players	Exclusion at 2% of world GDP	Exclusion at 4% of world GDP
Equivalent variation	Services	1	1	1	1
	Industry	5	0	0	5
	Agriculture	5	0	0	0
	Export subsidies	1	0	0	1
	All dimensions	143	1	59	87
Real GDP	Services	1	1	1	1
	Industry	5	5	5	5
	Agriculture	5	0	0	0
	Export subsidies	1	1	1	1
	All dimensions	143	47	47	47
Terms of trade	Services	1	0	0	0
	Industry	5	0	0	2
	Agriculture	5	0	0	0
	Exports subsidies	1	0	0	1
	All dimensions	143	0	0	112

Note: The results for the "all dimensions" rows mimic the information in Table 8. IR is the set of scenarios where all players have non-negative payoffs (individual rationality constraints).

It appears from Table 9 that an extension of the domain of negotiation systematically increases the number of trade reforms that countries/regions can potentially agree on. The agricultural sector appears once again at the cornerstone of the trade negotiations. Regardless of the negotiators' objective or the tested scheme of country/region participation (all players, exclusion at 2% of world GDP, or exclusion at 4% of world GDP), we do not see any solution other than the status quo if the negotiation takes place only in agriculture; the *IR*-set of the game is systematically empty. When the objective is equivalent variation and we exclude countries/regions with < 2% of world GDP, a negotiation in all dimensions is especially beneficial, as shown by an *IR*-set of 59 potential agreements instead of the 0 agreements reached if the negotiation takes place only in agriculture or industry.

5. ANALYZING COALITIONS

Since 1995, the function of the WTO has clearly been affected by coalitions whose the *raison d'être* has not been precisely explained in the economic literature. The case of the G20 clearly illustrates this point; this coalition gathers countries as diverse (in terms of trade characteristics) as Argentina, Bolivia, Brazil, Chile, China, India, Mexico, Nigeria, Pakistan, Zimbabwe, etc. Thus, it is useful to examine the role and impact of such coalitions. We suppose that a coalition is justified when small players have been excluded from a negotiation, and see the formation of a coalition as a means to continue participating. The presence of small countries/regions in a negotiation that is supposedly taking place only among large countries deeply affects the cooperative game. To exemplify this, we examine the situation in which a 4% threshold has been applied; in this case, if no coalition is introduced, the Nash solution is determined by taking into account only gains for the Triad countries (i.e., the US, EU, and Japan).

Table 10. Effects of the G-10 coalition on its members (in US$ bn)

Country	Un-weighted	GDP weights	Democratic weights
EFTA	0	4.6	0.3
Japan	0	44.4	1.2
Korea-Taiwan	0	4.2	0.2

Note: This table represents the change in real income for the different members of the G-10 upon the coalition's appearance. The exclusion threshold is set to 4% of world GDP, meaning that the reference situation is the case in which only the US, EU and Japan participate in the negotiations. The presence of the G-90 and/or G-20 does not allow the G-10 to modify the outcome of the game; these cases are not represented here.

Table 11. Effects of the G-20 coalition on its members (in US$ bn USD)

	G-20 facing the Triad (US, EU, Japan)			G-20 facing the Triad and the G10		
Country	Un-weighted	GDP weights	Democratic weights	Un-weighted	GDP weights	Democratic weights
Argentina	0.6	**1.0**	0.6	0.6	0.4	0.4
Brazil	**0.9**	**0.8**	**0.9**	**0.9**	**0.9**	**0.9**
Chile	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
China	1.1	3.9	1.1	1.1	0.8	0.8
India	1.6	**3.6**	1.6	1.6	1.0	1.1
Mexico	1.4	**2.5**	1.4	1.4	1.0	1.0
RoCentAm	0.1	**0.3**	0.1	0.1	0.1	0.1
RoSouthAm	0.2	**0.5**	0.2	0.2	0.1	0.2
South Africa	0.1	0.3	0.1	0.1	0.1	0.1
Thailand	0.1	0.3	0.1	0.1	0.1	0.1

Note: RoCentAm for Rest of Central America; RoSouthAm for Rest of South America. This table represents the change in real income for the different members of the G-20 upon the coalition's appearance. The exclusion threshold is set to 4% of world GDP. The presence of the G-90 does not allow the G-20 to modify the outcome of the game; this case is not represented here.
Figures in bold indicate countries that move from losses to positive gains upon implementation of the coalition.

Table 12. Effects of the G-90 coalition on its members (US$ bn)

G-90 facing…		Bangladesh	Mediterranean Countries	SubSaharan Africa
Triad	Un-weighted	**0.3**	-1.3	**1.1**
	GDP Weighted	**0.3**	0.8	**1.5**
	Democratic weights	**0.3**	-1.3	**1.1**
Triad + G-10	Un-weighted	**0.3**	-1.3	**1.1**
	GDP Weighted	**0.3**	-1.7	**0.9**
	Democratic weights	**0.3**	-1.6	**1.0**
Triad + G-20	Un-weighted	**0.2**	-2.5	**0.6**
	GDP Weighted	**0.3**	-2.3	**0.7**
	Democratic weights	**0.2**	-2.5	**0.6**
Triad + G-10 + G-20	Un-weighted	**0.2**	-2.5	**0.6**
	GDP Weighted	**0.3**	-2.3	**0.7**
	Democratic weights	**0.2**	-2.5	**0.6**

Note: This table represents the change in real income for the different members of the G90 upon the coalition's appearance. The exclusion threshold is set to 4% of world GDP. South Africa is not represented here, but the existence of the G-90 always reduces its gains. Figures in bold indicate countries that move from losses to positive gains upon implementation of the coalition.

Table 13. Effects of the coalitions on gains by the EU and US (US$ bn)

	Un-weighted		GDP weights		Democratic weights	
Game configuration	EU25	USA	EU25	USA	EU25	USA
Triad + G-10	0.0	0.0	1.9	-2.8	1.4	-0.4
Triad + G-20	-11.4	-2.0	-3.0	-5.1	-11.4	-2.0
Triad + G-90	-27.5	0.1	-18.3	-3.3	-27.5	0.1
Triad + G-10 + G-20	-11.4	-2.0	-3.0	-5.1	-11.4	-2.0
Triad + G-10 + G-90	-27.5	0.1	-18.3	-3.3	-27.5	0.1
Triad + G-20 + G-90	-27.5	0.1	-18.3	-3.3	-27.5	0.1
Triad + G-10 + G-20 + G-90	-27.5	0.1	-18.3	-3.3	-27.5	0.1

Note: The Triad is composed of the EU, US and Japan; these three countries have GDPs above 4% of world GDP, which is the threshold we have chosen for participating in the negotiations.
The reference situation is the scenario chosen when only the Triad participates in the negotiations.

Numerous coalitions of countries appeared during the eight years of the Doha negotiations. Among them, the G90, G20, and G10 have been especially effective, and are studied herein. Assuming that each WTO country has veto power under the principle of unanimity, it is difficult to justify the appearance of coalitions. Indeed, Harsanyi's paradox (Harsanyi 1977) notes that by pooling their veto capacity, players lose bargaining power. However, we feel that coalitions allow small countries to gather in order to participate in negotiations from which they would otherwise be excluded.

As far as the consequences of a coalition, we compare the gain obtained by each country/region in the presence and absence of a coalition. For a country/region, participation in the coalition implies that its interests are taken into account, while such interests are not accounted for in the absence of the coalition, and/or because the formation of this coalition entails a change in the set of agreeable reforms

and in the solution of the cooperative game. Moreover, we assume that the bargaining power of a coalition equals the sum of its members' bargaining powers.[19] Tables 10 to 13 show these comparisons for different countries/regions in different game configurations (with or without other coalitions, with or without bargaining power).

Table 10 provides the results for the G-10, which is a very stable coalition that provides gains to all its members. The situation of Japan is strongly improved (+44bn) when we introduce the participation constraints of the other G-10 members; this is especially noteworthy for GDP weights. The G-10 is worthwhile for its members only if they have to face the US and EU. However, in the presence of other coalitions (G-20 and G-90), the G-10 does not influence the final outcome of the game.

The situation for G-20 members is displayed in Table 11. This coalition improves the welfare of all of its members, especially when bargaining powers are based on GDP size. In this case, seven of the 10 G-20 countries/regions modeled herein move from net losses to net gains when we switch from the s1551[20] (weighted case) outcome selected by the Triad to the s1210 situation, in which NAMA liberalization is limited, SDT is introduced, and the AMA tariff reduction is deepened with a moderate Swiss formula coefficient instead of the linear formula chosen by the Triad. In the presence of the G-10, the G-20 still has incentives to appear. However, the presence of the G-90 eliminates the incentives for the G-20 to appear. Indeed, the G-90 allows small economies to step back in the arena and enforce their participation constraints; they empty the core of the game, meaning that there is only one possible outcome (i.e., s1000, which is the status quo or the unique liberalization of services, depending on the possibility of negotiating in this sector). The presence or absence of other players cannot modify the outcome. In all configurations, India benefits the most from the G-20 implementation.

The G-90 (Table 12) is the most interesting coalition. By allowing Bangladesh to reenter the negotiations, the presence of this coalition empties the core of the game. The G90 allows both Sub-Saharan countries and Bangladesh to avoid the losses from the outcomes that would be negotiated by the other players if these small and vulnerable countries were excluded. Therefore, the G-90 always improves the situation of both Sub-Saharan countries and Bangladesh. For the Mediterranean countries, in contrast, status quo in AMA and NAMA is not the best outcome. These countries would prefer a liberalization scheme that is agreed upon by the largest players. For this reason, the G-90 brings them net losses. Finally, the G-90 is never useful for South Africa; this country is always better off when playing with the G-20. These two last remarks illustrate the heterogeneity of the interests inside this coalition.

We conclude by looking at the effects of these coalitions on EU and US gains (Table 13). As expected, in most situations the gains of the two major players are negatively impacted by the appearance of counter-powers. This is particularly true for the EU in the presence of the G-90, which blocks negotiations and eliminates nearly all of the EU's gains. The G-20 also cuts the EU's payoff by more than half. On the other hand, the presence of the G-10 improves the situation of the EU in its negotiations with the US. For the US, the effects are much more limited in absolute terms, but the presence of the G-20 still cuts gains by about 80% in the different weighting scheme configurations. Notably, the GDP-based weighting scheme is highly interesting for the US. Under this weighting scheme, the US can get a very positive outcome when facing Japan and the EU. However, the limitations introduced by other coalitions considerably reduce the US's gains. When the bargaining power of the US is diluted (un-weighted or democratic weights), there are only limited gains in the reference situation and the effects of the coalitions are reduced (G-20 or G-10) or even positive (G-90). In the latter case and contrary to our findings for the EU, the emptying of the core by the presence of the G-90 is positive for the US, since it leads to liberalization only in services, where the US has a strong comparative advantage.

[19] An existing coalition larger than the fixed threshold keeps its right of veto when individual rationality is not satisfied.

[20] We consider that s1551 is the scenario closest to the US-EU agreement that preceded the Cancùn meeting.

6. CONCLUDING REMARKS

In this paper, the simultaneous use of CGE analysis and game theory allows us to explain some strategic features of the DDA trade negotiations. In particular, we see that agricultural market access talks play a crucial role: they increase the overall gain but also reduce the inequalities driven by NAMA liberalization. Simultaneously, trade negotiation cannot take place if only liberalization in agriculture is negotiated, as the core of the game would be empty. Moreover, the adoption of tariff-harmonizing formulae (more cuts in higher import tariffs) leads to greatly increased global gains. Finally, the dramatic complexity in the current structure of protection and market access convincingly explains why trade negotiations are so difficult today. Thus, it does not seem surprising that our game theoretic CGE approach concludes with a rather pessimistic statement: status quo is often the Nash solution.

Obviously, the number of negotiating members adds constraints to the bargaining program. We show that the exclusion of countries/regions with GDPs below a certain threshold drastically improves the efficiency of the negotiation process, regardless of the governments' objective. We also demonstrate that the formation of coalitions is a potential means through which developing countries/regions may block solutions imposed by rich countries/regions. The G-20 coalition is successful with the inclusion of the SDT clause and with less liberalization of the industrial sector. Moreover the G-10 is always beneficial for its members. We also consider the expansion of the domain of trade negotiation. Negotiating in services, industry and agriculture is more efficient than negotiating in only industry and agriculture, which is itself more efficient than negotiating in agriculture alone. Side payments may also be a workable solution, as they allow large agents to maximize the size of the cake, while compensating losers. When we implement a cooperative solution of the game with side payments, we find that the exchange of financial flows for signed agreements represent a significant share of global income gain. Notably, however, in one solution, side payments are used to remunerate very rich countries/regions (e.g., the US). Both characteristics of this cooperative solution make it implausible.

An illustration of the realistic aspect of our conclusions is that WTO Director-General Pascal Lamy is currently combining the three solutions that we propose herein, in the hopes of breaking the stalemate. i. He has sought to expand the coverage of the negotiations. We feel that more could be done in this regard, especially with the inclusion of the Singapore issues. ii. He has excluded WTO members from the negotiation process (most of the WTO Geneva meetings in July of 2008 took place among seven countries). iii. He has sought to implement side payments ("Aid For Trade" can be interpreted along these lines). Let us note that there may be other means to compensate for losses related to erosion of preferences, such as granting new preferences (e.g., see the Duty Free Quota Free regime given by rich countries to LDCs at the Hong-Kong Ministerial). Given the complexity of the current trade and protection structures, negotiators must be highly creative when designing a final trade agreement that could be accepted by all WTO members.

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APPENDIX 1

Table A1: Characteristics of the 143 scenarios in terms of welfare gains and their distribution

Scenario	Global gains (US$ bn2001)	Global gains (%)	Un-weighted average gains (%)	Standard deviation of average gains (un-weighted)
s0001	1.00	0.00	-0.01	0.03
s0010	71.40	0.22	0.43	0.49
s0011	75.23	0.24	0.42	0.51
s0020	68.51	0.22	0.40	0.49
s0021	72.19	0.23	0.39	0.51
s0030	75.35	0.24	0.48	0.56
s0031	79.82	0.25	0.48	0.58
s0040	72.98	0.23	0.46	0.56
s0041	77.24	0.24	0.45	0.58
s0050	14.41	0.05	0.08	0.08
s0051	15.79	0.05	0.06	0.09
s0100	9.56	0.03	-0.05	0.28
s0101	10.52	0.03	-0.06	0.29
s0110	81.06	0.25	0.38	0.60
s0111	84.85	0.27	0.37	0.63
s0120	78.14	0.25	0.34	0.61
s0121	81.80	0.26	0.34	0.64
s0130	85.00	0.27	0.43	0.66
s0131	89.44	0.28	0.43	0.69
s0140	82.60	0.26	0.40	0.67
s0141	86.83	0.27	0.40	0.70
s0150	24.20	0.08	0.03	0.31
s0151	25.55	0.08	0.01	0.33
s0200	8.61	0.03	-0.01	0.25
s0201	9.58	0.03	-0.03	0.27
s0210	80.10	0.25	0.41	0.58
s0211	83.92	0.26	0.41	0.61
s0220	77.19	0.24	0.38	0.59
s0221	80.87	0.25	0.37	0.62
s0230	84.05	0.26	0.47	0.64
s0231	88.51	0.28	0.46	0.68
s0240	81.65	0.26	0.44	0.65
s0241	85.91	0.27	0.43	0.68
s0250	23.21	0.07	0.06	0.29
s0251	24.58	0.08	0.05	0.30
s0300	10.32	0.03	-0.08	0.30
s0301	11.27	0.04	-0.10	0.32

Table A1: Characteristics of the 143 scenarios in terms of welfare gains and their distribution (continued)

Scenario	Global gains (US$ bn2001)	Global gains (%)	Un-weighted average gains (%)	Standard deviation of average gains (un-weighted)
s0310	81.78	0.26	0.34	0.62
s0311	85.56	0.27	0.34	0.65
s0320	78.87	0.25	0.31	0.63
s0321	82.51	0.26	0.30	0.66
s0330	85.71	0.27	0.39	0.68
s0331	90.14	0.28	0.39	0.71
s0340	83.31	0.26	0.37	0.69
s0341	87.53	0.28	0.36	0.72
s0350	24.98	0.08	-0.01	0.34
s0351	26.32	0.08	-0.02	0.36
s0400	9.96	0.03	-0.03	0.28
s0401	10.92	0.03	-0.04	0.30
s0410	81.43	0.26	0.39	0.59
s0411	85.23	0.27	0.39	0.62
s0420	78.52	0.25	0.36	0.60
s0421	82.18	0.26	0.36	0.63
s0430	85.36	0.27	0.45	0.65
s0431	89.81	0.28	0.44	0.68
s0440	82.97	0.26	0.42	0.66
s0441	87.21	0.27	0.42	0.69
s0450	24.60	0.08	0.05	0.31
s0451	25.95	0.08	0.03	0.33
s0500	14.05	0.04	-0.04	0.30
s0501	15.00	0.05	-0.06	0.31
s0510	85.46	0.27	0.38	0.63
s0511	89.25	0.28	0.37	0.66
s0520	82.57	0.26	0.35	0.64
s0521	86.22	0.27	0.34	0.67
s0530	89.38	0.28	0.43	0.69
s0531	93.81	0.30	0.43	0.72
s0540	87.00	0.27	0.40	0.69
s0541	91.23	0.29	0.40	0.72
s0550	28.70	0.09	0.03	0.34
s0551	30.05	0.09	0.02	0.35
s1000	11.13	0.03	0.06	0.06
s1001	12.13	0.04	0.05	0.06
s1010	82.62	0.26	0.49	0.51
s1011	86.44	0.27	0.48	0.52
s1020	79.72	0.25	0.46	0.51

Table A1: Characteristics of the 143 scenarios in terms of welfare gains and their distribution (continued)

cenario	Global gains (US$ bn2001)	Global gains (%)	Un-weighted average gains (%)	Standard deviation of average gains (un-weighted)
s1021	83.40	0.26	0.45	0.52
s1030	86.57	0.27	0.54	0.58
s1031	91.04	0.29	0.54	0.59
s1040	84.20	0.26	0.52	0.57
s1041	88.46	0.28	0.51	0.59
s1050	25.55	0.08	0.14	0.10
s1051	26.93	0.08	0.12	0.11
s1100	20.71	0.07	0.01	0.27
s1101	21.67	0.07	0.00	0.29
s1110	92.29	0.29	0.44	0.61
s1111	96.08	0.30	0.43	0.64
s1120	89.37	0.28	0.40	0.62
s1121	93.02	0.29	0.40	0.65
s1130	96.24	0.30	0.49	0.67
s1131	100.68	0.32	0.49	0.70
s1140	93.84	0.30	0.46	0.68
s1141	98.07	0.31	0.46	0.71
s1150	35.35	0.11	0.09	0.31
s1151	36.70	0.12	0.08	0.33
s1200	19.75	0.06	0.05	0.25
s1201	20.73	0.07	0.03	0.27
s1210	91.33	0.29	0.47	0.59
s1211	95.15	0.30	0.47	0.62
s1220	88.42	0.28	0.44	0.60
s1221	92.09	0.29	0.43	0.63
s1230	95.29	0.30	0.53	0.65
s1231	99.75	0.31	0.52	0.68
s1240	92.89	0.29	0.50	0.66
s1241	97.14	0.31	0.49	0.69
s1250	34.37	0.11	0.12	0.29
s1251	35.73	0.11	0.11	0.30
s1300	21.46	0.07	-0.02	0.30
s1301	22.41	0.07	-0.03	0.31
s1310	93.01	0.29	0.40	0.63
s1311	96.79	0.30	0.40	0.66
s1320	90.10	0.28	0.37	0.64
s1321	93.74	0.29	0.36	0.66
s1330	96.95	0.30	0.46	0.69
s1331	101.37	0.32	0.45	0.72

Table A1: Characteristics of the 143 scenarios in terms of welfare gains and their distribution (continued)

Scenario	Global gains (US$ bn2001)	Global gains (%)	Un-weighted average gains (%)	Standard deviation of average gains (un-weighted)
s1340	94.55	0.30	0.43	0.69
s1341	98.77	0.31	0.43	0.72
s1350	36.13	0.11	0.06	0.34
s1351	37.47	0.12	0.04	0.35
s1400	21.10	0.07	0.03	0.28
s1401	22.06	0.07	0.02	0.29
s1410	92.66	0.29	0.46	0.60
s1411	96.46	0.30	0.45	0.63
s1420	89.75	0.28	0.42	0.61
s1421	93.41	0.29	0.42	0.64
s1430	96.60	0.30	0.51	0.66
s1431	101.05	0.32	0.51	0.69
s1440	94.21	0.30	0.48	0.67
s1441	98.44	0.31	0.48	0.70
s1450	35.75	0.11	0.11	0.31
s1451	37.11	0.12	0.10	0.33
s1500	25.20	0.08	0.02	0.30
s1501	26.15	0.08	0.00	0.32
s1510	96.69	0.30	0.44	0.64
s1511	100.48	0.32	0.44	0.67
s1520	93.80	0.29	0.41	0.65
s1521	97.45	0.31	0.40	0.68
s1530	100.62	0.32	0.49	0.70
s1531	105.05	0.33	0.49	0.73
s1540	98.24	0.31	0.47	0.71
s1541	102.47	0.32	0.46	0.74
s1550	39.87	0.13	0.09	0.34
s1551	41.21	0.13	0.08	0.36

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2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ADDIS ABABA

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

IFPRI NEW DELHI

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org