Impacts of the Doha Round on Brazilian, Chinese and Indian agribusiness ☆

Matheus Wemerson GOMES PEREIRA [a,*], Erly Cardoso TEIXEIRA [b,1],
Sharon RASZAP-SKORBIANSKY [c]

[a] Federal University of Vicosa/Sponsored CNPq – Brazil, Department of Agricultural Economics (DER) – Campus da UFV – Viçosa-MG 36570-000, Brazil
[b] Federal University of Vicosa, Departament of Agricultural Economics (DER) – Campus da UFV – Viçosa-MG 36570-000, Brazil
[c] Purdue University, USA

ARTICLE INFO

ABSTRACT

The central themes to be addressed during the Doha Round of the world trade negotiations are the reduction of the agricultural production and export subsidies and improved market access for agricultural and non-agricultural goods. The G-20 group wields enough power to press negotiations at the Doha Round toward lower agricultural trade barriers and production and export subsidies. The objective of this study is to determine the impacts of the Doha Round on the economies of Brazil, China, and India. The Global Trade Analysis Project's (GTAP) general equilibrium model and database (version 7) are used. The Doha Round scenarios simulated in this paper consider the WTO agricultural production and export subsidy reduction requirement, and the application of the Harbinson approach, and Swiss formula to reduce import tariffs. Brazil and China present the highest GDP growth rate varying from 0.4 % to 1.4%. India shows a negative GDP growth rate in all scenarios, except in that which replicates the Uruguay Round. The welfare gains are positive, but small, for Brazil, China and India. The GDP loss observed in the economies of the EU25 and the US may make it difficult to reach a trade agreement at the Doha Round.

1. Introduction

The World Trade Organization (WTO) initiated in 1999 a revision of the Uruguay Round Agreement aimed at discouraging trade-distorting domestic support, non-tariff barriers, and reducing direct export subsidies, among other things. The revision meetings led to the Doha Round in Doha, Qatar, in 2001. One focus of the Doha Round was the easing of agricultural commodity access into the world market by reaching an agreement regarding the three controversial agricultural themes: the reduction of tariffs on imported agricultural goods, and the reduction of agricultural production and export subsidies.

Due to the nature of agribusiness, developing countries are burdened with high import tariffs. To make matters worse, the agricultural sector is the only sector still subsidized. These two facts are strong justifications for the improvement of the agricultural market and for the implementation of reduced subsidies within importing countries.

The G-20[2] currently plays an important role at the Doha Round. Created at the Cancun meeting in 2003 to serve as a trade bloc representing all developing countries, the G-20 now wields enough power to press negotiations at the Doha Round toward lower

agricultural trade barriers and a decrease in the agricultural production and export subsidies. There are currently 21 members in the G-20: 10 Latin American countries — Brazil, Mexico, Argentina, Uruguay, Paraguay, Venezuela, Chile, Bolivia, Guatemala and Cuba; 6 Asian countries — China, India, the Philippines, Indonesia, Pakistan and Thailand; and 5 African countries — South Africa, Egypt, Nigeria, Tanzania and Zimbabwe. The regions that make up the G-20 account for approximately 60% of the global population and have risen significantly in terms of exports over the past decades; especially the developing Asian countries, which accounted for almost 25% of all exports in 2000 (Fig. 1). In terms of agriculture, the G-20 accounts for 70% of the world's agricultural population and 26% of total agricultural exports (G20, 2007).

The G-20's vast and balanced representation put it in a strong position when negotiating agriculture related issues. This strength was proven when the G-20 was able to negotiate a deal with developed countries at the sixth WTO Ministerial Conference (Hong Kong, 2005) fixing a deadline for the elimination of agricultural export subsidies.

Brazil, China and India have a special interest in the results reached at the Doha Round. They have achieved substantial growth in the international trade market and their agribusiness trade activities are concentrated in the export of soy, coffee, maize, meats, sugar and cotton. These three countries' path to growth is associated with the capacity and strength of the G-20 to format a multilateral agreement that will allow for the unrestricted access of agribusiness products into the world market.

China, India, and Brazil have vast agricultural resources and their economies rely on agriculture and agribusiness to a great extent. China is the fourth largest economy in the world. Its economy grew at an average rate of 10% from 1990 to 2005, and is among the world's largest producers of rice, corn, wheat, soybeans and vegetables. Half of its labor force is employed in agriculture. China's main crops are paddy rice, maize, sweet potatoes, wheat, and sugar cane; however, its major exports are electrical and mechanical machinery and equipment, apparel and apparel accessories, and consumer durables. In 2004 its total export was US$ 593.3 billion.

India is the twelfth largest economy in the world and the third largest within Asia. It is also the world's fourth largest agricultural power, with 20% of its Gross Domestic Product (GDP) derived from agriculture, and is among the leaders in the export of milk, fruits, vegetables, wheat, rice, tea, cotton and sugar. Its main crops are sugar cane, paddy rice, wheat, potatoes and bananas. Still, India's main exports are jewels, mineral fuels, clothing, textiles, and organic chemicals. Furthermore, it has a strong potential in the exports of services. Its total exports were US$ 75.6 billion in 2004.

Brazil is the tenth largest economy in the world. It is the world's leading producer of coffee, sugar cane and oranges. Brazil's main agricultural products are soybeans, meats, sugar/ethanol, coffee, maize, manioc, tobacco and oranges. Just like China and India, Brazil's main exports are not related to agriculture; instead, they are vehicles, machinery, iron and steel, and ores (WTO, 2008). Agriculture constitutes 10% of Brazil's GDP and agribusiness accounts for 28.2% of its US$ 96.5 billion total in 2004.

All three countries have much room to grow in terms of agricultural product exports. The depreciation of the Brazilian *Real* since 1999 has stimulated exports. India has a high unemployment rate and 25% of its population lives below the poverty line. The reduction of international agricultural trade barriers could help India employ more citizens in agriculture and agribusiness. China already employs half of its inhabitants in agriculture related jobs; but this does not show up in its export list, demonstrating room for growth in the export of agricultural products. All three countries could benefit greatly from the potential trade reforms reached at the Doha Round.

Since July 2008, when the representatives of Brazil, India, the U.S. and the European Union met in Geneva, negotiations have been stalled. At this meeting, India decided to withdraw from the negotiations due to the impasse on the issues of subsidies to agricultural production and tariffs on imports, which led to the negotiation's failure. The new deadline set for the agreement is 2013.

There are many published papers that address the potential reduction of agribusiness product trade barriers at the Doha Round. Some influential papers include those by Harrison, Rutherford, Tarr, and Gurgel (2003), Cline (2003), Conforti and Salvatici (2004) and more recently by Gurgel (2001), Antimiani, Conforti, and Salvatici (2006), Anderson et al. (2006), Ferreira Filho and Horridge (2006) and Polaski (2006). Yet, there is still a need for current information on the different economic impacts that could arise from the implementation of the Doha Round multilateral trade agreements.

Such studies have demonstrated high potential gains to developing countries by the reduction or elimination of trade barriers in agricultural markets. Cline (2003) notes that the impacts of trade policies can help reduce poverty in developing countries. He
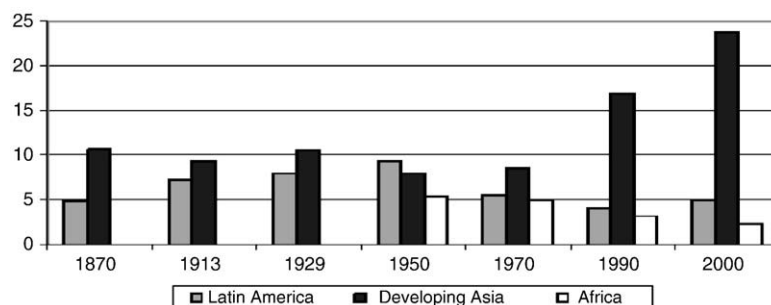

Fig. 1. Participation by Latin America, developing Asia, and Africa in global exports (%). Source: IOS (2005).

suggests that the progressive reduction or elimination of trade barriers in multilateral negotiation increases trade and growth opportunities in developing countries. Ferreira Filho and Horridge (2006) analyzed the Brazilian case and also found a reduction in poverty with the implementation of the Doha Round agreement.

Conforti and Salvatici (2004) used the GTAP model and database version 5 to see the impacts of alternative scenarios of trade liberalization in agricultural markets under the Doha Round. The results indicate that welfare gains could be reaped by both developed and developing countries. The possibility of inter-country compensations would allow for an agreement between countries.

Polaski (2006), using the GTAP model and database version 6, says that with the implementation of the Doha Round, China would be the main winner of the round, with gains ranging from 0.8 to 1.2% of the GDP under different scenarios.

The objective of this paper is to determine the impacts of possible Doha Round outcomes, focusing on the economies of Brazil, China, and India. Four scenarios that emphasize agribusiness products key to the Brazilian, Chinese and Indian economies are examined using the Global Trade Analysis Project's (GTAP) computable general equilibrium model and database version 7. Each scenario implements a reduction of agricultural production and export subsidies taking into account the implementation of either the Swiss formula or the Harbinson approach to tariff reduction. Simulations of the changes specified in each of the four scenarios are run and the results from these simulations are analyzed.

This paper is divided into five sections and organized in the following way: an introduction, to provide the history of the Doha Round and the importance of the G-20; Section 2, to describe and clarify the model employed and its database; Section 3, an exploration of the simulations and the aggregations used in the analysis; Section 4, to provide an analysis of the results from the simulation of the four scenarios.

2. The model GTAP and its database

The Global Trade Analysis Project (GTAP) is a computable general equilibrium (CGE) package selected to conduct this research. GTAP was set up at Purdue University's Center for Global Trade Analysis by Hertel (1997) and is considered a reference in the analysis of regional integration. The GTAP model consists of a branch theory to analyze quantitative questions regarding the international economy, engaging several sectors and products with a global database and software for data manipulation (Hertel & Tsigas, 1997).

To facilitate the understanding of GTAP's structure, a model displaying the performance of an economy and its interaction with the Rest of the World while considering the presence of taxes and subsidies is provided (Fig. 2). A glossary of terms is included

Fig. 2. A multiregional open economy without government intervention. Where, VOA (endow): value of output at agent's prices of endowment commodities; VDFA: value of domestic purchases by firms at agent's prices; PRIVEXP: private expenditure; GOVEXP: government expenditure; VDPA: value of domestic purchases by private households at agent's prices; VDGA: value of domestic purchases by government at agent's prices; NETINV: the sale of investment goods to satisfy the regional household's demand for savings; VXMD: value of exports at market prices by destination; VIPA: value of import payments to rest of the world from private households; VIGA: value of import payments to Rest of the World from government; VIFA: value of import payments to Rest of the World from firms; XTAX: export tax, converts to fob values; MTAX: import tax.

with the figure. In this model, the regional income comes from payments by firms to purchase the primary factors of production, these being land, capital, labor and natural resources. This income corresponds to the flow of the Value of Output at Agents' Prices of Endowment Commodities (VOA), plus added taxes (TAX), and is allocated to four different categories: private consumption by regional households or families (PRIVEXP); consumption by the government (GOVEXP); the demand for savings (SAVINGS); and a bundle of income for the payment of taxes. Taxes in the model are defined by the difference between the value of output at market price and at agent's price. This computation of income variance allows the model to calculate change in regional income that is then used as an indicator of regional well-being. (Hertel & Tsigas, 1997).

The revenue the producers receive is spent on intermediate consumption (VDFA), since firms must combine commodities and intermediate goods to produce goods for the final demand, on imports payment (VIFA), and on tax payment (TAXES) to the government. In this way, all generated revenue is spent on the purchase of intermediate factors and services from primary factors; thus, satisfying the zero profit condition, an important assumption for the model's closure.

To better understand the multiregional model in an open economy, two economies are considered. One of them represents a regional economy and the other the Rest of the World. An open economy gives all agents the opportunity to pursue trade, allowing the domestic economy to spend part of its income on an outside financial system (VIPA and VIGA). Tax is the source of income for both the exporting country (XTAX) and the importing country (MTAX). The production sector also interacts with the remaining portion of world economy, represented by the variables VIFA and VXMD.

The GTAP database used is version 7.0 (GTAP 7), which has a 2004 reference year and includes 57 sectors and 113 regions (Narayanan & Walmsley, 2008).

2.1. Behavioral equations

The "technology tree" shown in Fig. 3 describes the assumed technologies that firms possess in the model. This production branch is a convenient way to represent separate firm technologies while permitting a constant return to scale.

The decisions taken by the firms are based on a constant elasticity of substitution (CES) function, where the firms optimize their profit. The CES function assumes that each sector of the economy produces only one manufactured good, and the firm maximizes its profit with the use of primary factors without taking into account the price of intermediate factors. The CES function can be represented by the equation:

$$Q = A[\delta K^{-p} + (1-\delta)L^{-p}]^{-1/p} \tag{1}$$

where, Q is the quantity produced; K is the capital factor; L is the labor factor; and A, p and δ are the given parameters, where, A represents the technological level, p the substitution parameter, and δ the distribution parameter. The restrictions for the
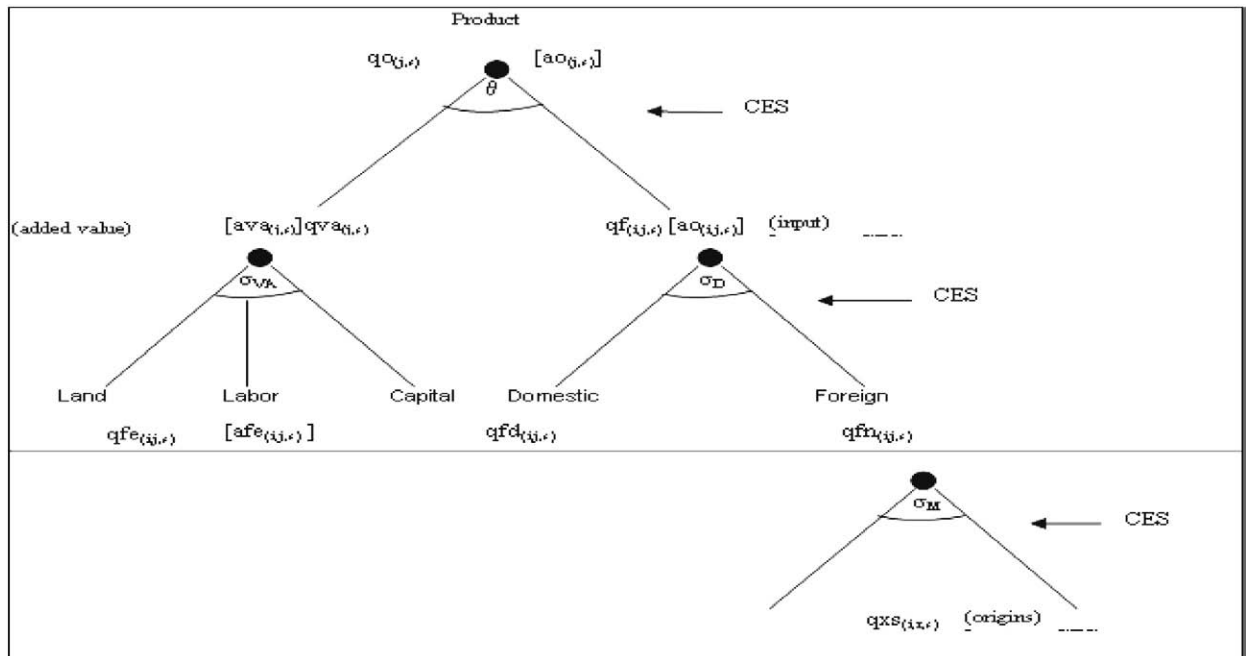

Fig. 3. Production structure. σ_{VA}: substitution elasticity enters the production factors that compose the added value. σ_D: elasticity of substitution between domestic and imported factors. σ_M: elasticity of substitution between imported factors. Source: Hertel & Tsigas (1997).

parameters are as follows: A must be greater than 0, δ must be between 0 and 1, and p must be greater than one (Chiang & Wainwright, 2005).

The distribution of income between the sectors is represented by a Cobb–Douglas per capita utility function, where an increase or a reduction of income in each country reflects an increase or a reduction proportional to the change in income for each sector. The government expenses are represented by a Cobb–Douglas utility function with sub-utilities in the form:

$$U = ACP^{\theta CP}CG^{\theta CG}S^{\theta S} \tag{2}$$

where U is the total utility in each region; CP is private consumption; CG is government consumption; S is savings in the economy; and A and θ are parameters representing the ratios of CP, CG and S, constant in the creation of total income.

Finally, consumer expenses are given by a constant difference of elasticity (CDE) function, which assumes that variations in consumption do not appear as proportional variations in a consumer's utility. The private demand function is represented by the maximization of the expenditure function of CDE, while government demand is given by the representative fixed coefficients of the consumed amounts. The CDE function is given by:

$$\sum_i B_i * UP^{\gamma_i \beta_i} * Z_i^{\beta_i} \equiv 1 \tag{3}$$

where B_i is a multiplicative variable; UP is the private total utility; γ_i is the substitution parameter; β_i is the parameter of expansion in the CDE function; and Z_i, is the normalization of the vector price (PP_i), represented in Eq. (4):

$$Z_i = f\left[\frac{PP_i}{E(PP_i)} * UP\right] \tag{4}$$

2.2. Macroeconomic closure and linearization of the equations

Papers from Hertel and Ivanic (2006), and Horridge and Wittwer (2008) applying the GTAP model do not consider the macroeconomic policies and monetary phenomena that usually explain investment. Since the GTAP model used in this paper is not dynamic, the investment is not able to affect the industries productive capacity. The allocation of investments across regions affects production and trade only through its effects on the final demand. In addition to the investment closure, it is necessary to deal with potential changes in the current account. Generally, the procedures to force convergence between domestic savings and investment, establishing the current account equilibrium, can be expressed by:

$$S - I = X + R - M \tag{5}$$

where S is the savings rate; I is the investment rate; X is the rate of exportation; M is the rate of importation; and R is the rate of international transfers.

Regionally fixing the right side of the identity given in Eq. (5), each region in the global market will have a fixed share of net savings. This approach represents a neoclassical closure, since the investment is forced to align to changes in regional savings. Thus, a mechanism is necessary to ensure equality between the demands for global savings and investment, which, in the case of GTAP, is the "global bank". Thus, the closure will also be neoclassical. Finally, as the CGE models are based on Walrasian assumptions of general equilibrium, where prices are relative, we must choose a numeraire. In the GTAP model, the numeraire is the world price index of the primary factor services.

The mathematical solution method used by GTAP works through linearization of a system of equations. The Gragg method, which allows the specification of a high number of steps, provides an accurate solution.[3]

3. Scenarios and model aggregation

Section 3 contains a discussion of the main WTO proposals, formalized since the Ministerial Conference of the Doha Round, in respect to production and export subsidies and import tariffs (Harbinson and Girard or Swiss approaches) and a restatement of the objectives declared at the Uruguay Round. The end of this section proposes a synthesis of these proposals grouped into four scenarios and a table delineating the products, product aggregations, and geographic areas addressed in this study.

3.1. WTO proposal for agricultural production subsidies and export subsidies

Developed countries were not satisfied with the results from the Uruguay Round regarding the reduction of agricultural production subsidies. For this reason, the WTO proposed the Doha Round to specifically address this issue through a more detailed

---

[3] More details on linearization in CGE models may be seen in Hertel, Mark Horridge, and Pearson (1992).

Table 1
Proposal by the WTO for the reduction of global agricultural subsidy expenditure.

Group	Expenditure in US$ billions	Reduction
1	0–10	31%
2	10–60	53%
3	>60	70%

Source: WTO (2005).

examination of production subsidies. To facilitate this examination, production subsidies were subdivided into the following five categories, conforming to recognized characteristics: green box, S&D box, red box, amber box, and blue box.

Provided that they comply with all relevant criteria, green box production subsidies are not prohibited and therefore unlimited. This green box encompasses resources destined for government programs directed toward research and extension, infrastructure, control of plagues and diseases, and emergency support for agricultural producers. According to the WTO (2006), this type of subsidy is justified due to the intrinsic characteristics of agricultural activities, such as the exposure to environmental risks that generally provoke large harvest losses. These subsidies are considered non-distortionary in regards to international trade.

The S&D box encompasses production subsidies provided directed toward agricultural development and are also not prohibited. These subsidies are intended to give special assistance to agricultural activities in developing countries. This policy takes into account the countries development needs, including food security and rural development. The S&D box may be a special safeguard mechanism for developing countries.

The production subsidies included in the red box are prohibited due to their strong capacity to distort commercial flow between countries. According to the WTO (2004), up until 2004 there were no records of countries using the red box category.

The production subsidies included in the blue and amber boxes distort international trade and must be reduced. Blue box subsidies are those that are not in accord with multilateral agreements. According to the WTO (2005), this type of subsidy is present in Japan and countries belonging to the European Union (EU), such as Slovenia, Iceland, Slovakia, and Norway, which have until 2010 to eliminate them. Some countries insist that blue box subsidies are an important tool for supporting and reforming local agriculture and argue that they must be kept. Amber box subsidies are those designed to maintain a particular market price, i.e., policies to achieve a particular price level and include direct payments to producers. Subsidies in the amber box that total less than 5% of the production value are exempt from WTO mandated cuts.

The WTO presented a proposal for the reduction of global agricultural subsidies that divided world economies into three groups, determined by the total amount of subsidies provided. Group 1 consists of countries that provide a total agriculture subsidy of up to US$ 10 billion, and the WTO proposed subsidy cuts ranging from 31% to 70%. Group 2 is made up of countries with subsidy expenditures ranging from US$ 10 billion to US$ 60 billion, with proposed cuts varying from 53% to 75%. Group 3 contains countries with subsidy expenditures superior to US$ 60 billion, and proposed subsidy cuts ranging from 70% to 80%. The groups and proposed production subsidy reductions are shown in Table 1. The subsidy reductions listed are the minimum proposed by the WTO for each group.

The United States of America (USA) falls into Group 2, the EU falls into Group 3, and other countries providing agricultural subsidies fall into in Group 1 (WTO, 2006).

Currently, the Doha Round negotiations have put forward a ban on export subsidies. This proposal is more stringent than those made at the Uruguay Round, which advocated only a reduction in export subsidies.

3.2. Proposals for the reduction of border tariffs

There are two main proposals to improve global market access through the reduction of tariff barriers. The first proposal repeats the formula used at the Uruguay Round, also known as the Harbinson approach, which employs an average reduction over all products, allowing some variations for individual products provided that a minimum total reduction is met. As shown by Antimiani et al. (2006), the fundamental problem with this approach is that it provides no reward for cutting a high tariff rather

Table 2
Scenarios for tariff reduction relative to the current tariff to imports (Harbinson approach).

Developed countries		Developing countries	
Current tariff interval	Reduction	Current tariff interval	Reduction
0%–15%	40%	0%–20%	25%
15%–90%	50%	20%–60%	30%
>90%	60%	60%–20%	35%
		>120%	40%

Source: adapted from Antimiani et al. (2006).

Table 3
WTO proposal for tariff reduction per product (Girard or Swiss approach).

Group	Current tariffs	Reduction
1	0%–20/30%	20%–65%
2	20/30%–40/60%	30%–75%
3	40/60%–60/90%	35 %–85%
4	>60/90%	42%–90%

Source: WTO (2005).

than a low one, allowing policymakers to avoid dealing with extra tariffs (tariff peaks) and with the gap between tariffs on finished products and raw materials (tariff escalation).

The other approach uses a Swiss formula to calculate "non-linear" reductions on higher tariffs. This method, known as the Girard approach, results in steeper cuts on higher tariffs and effectively establishes a maximum tariff level. In accordance with Antimiani et al. (2006), critics deem this model too complicated since it requires converting specific tariffs into *ad valorem* tariffs. Supporters of the model assert that the Swiss formula, or a model similar to it, is needed to deal with tariff peaks and to narrow tariff escalation.

According to the Harbinson approach, and from experience gained from the previous round of world trade negotiations, governments may reduce tariffs by a small percent on some high tariff commodities while reducing tariffs a large percent on products with small tariffs, diminishing the trade liberalizing intent of tariff reduction. As this is an arbitrary assumption, the scenarios created in our study impose a uniform tariff reduction on every country that falls within a particular tariff group. That is, the scenario employing the Harbinson approach implements a simple proportional cut, frequently described in policy discussions as a linear cut:

$$T_1 = cT_0 \tag{6}$$

where T_0 is the initial bounded tariff; T_1 the rate after application of the formula, and c is the constant proportion tariffs are to be reduced from their original rate. Table 2 shows the tariff cuts for both developed and developing countries used in this study's Harbinson scenario.

The Girard method or the Swiss approach, used in two of this study's scenarios, has been suggested as a reasonable approach to tariff reduction; although, according to its creator, it should be seen as a set of basic elements for possible modalities. This method applies the Swiss formula and would result in steeper reductions in higher tariffs than in lower tariffs, thereby obtaining final rates that fall within a smaller tariff range. The formula was put forward by the Chairman of the WTO Non-Agricultural Market Negotiating Group, Pierre-Louis Girard in an attempt to set targets for negotiation. According to the formula, all non-agricultural tariffs are to be reduced on a line-by-line basis using the following formula:

$$T_1 = \frac{t_a T_0}{t_a + T_0} \tag{7}$$

where T_1 is the final rate to be bound in ad *valorem* terms; t_a is the national average of the bounded rates within each band; and T_0 is the initial rate. Table 3 contains stipulated WTO tariff reduction limits (WTO, 2005), clearly stating permitted divergence. The advantage this methodology has is that it harmonizes proposed reductions within each tariff grouping.

To reflect non-agricultural market access (NAMA) negotiations, this study also employs an average of the Girard approach to tariff reduction to analyze the effect of reduced manufactured product tariffs, shown in Table 4 and simulated in Scenario 4. It is hoped that by reducing both agricultural and non-agricultural tariffs, potential negotiating friction between developing and developed countries will be diminished.

3.3. Repetition of the objectives of the Uruguay Round

Table 5 shows the agricultural tariff, export subsidy, and direct domestic production subsidy reductions agreed to at the Uruguay Round. The effects of these reductions are simulated in Scenario 3.

Table 4
Proposal for the tariff reduction of manufactured products.

Group	Current tariff	Reduction
1	0%–20%	42.5%
2	20%–40%	52.%
3	40%–60%	60%
4	>60%	66%

Source: WTO (2005).

Table 5
General measures for the reduction of agricultural protection established in the Uruguay Round.

TARIFFS AND INCIDENCE OF SUBSIDIES	Description of the cuts	Countries and chronology of the reduction for the protection of agricultural trade	
		Developed	Developing
		6 years	10 years
IMPORTS	General mean	36%	24%
	Minimum cut per product	15%	10%
PRODUCTION	Total subsidies	20%	13%
EXPORTS	Value of subsidies	36%	24%
	Quantity subsidized	21%	14%

Source: WTO (2005).

3.4. Scenarios and model aggregation

This study contains four scenarios. The scenarios are used to analyze the effects of possible Doha Round tariff and subsidy reductions. Box 1 gives an abbreviated breakdown of conditions implemented in the four scenarios.

This study addresses eight regions and ten commodities, shown in Table 6.

4. Impacts on production, trade, growth and welfare

4.1. Scenario 1

Scenario 1 simulates the implementation of a Doha Round agreement by eliminating agriculture export subsidies; reducing agriculture production subsidies, using the WTO recommendation (Table 1); and reducing import tariffs to all commodities, using the Harbinson approach (Table 2). It should be considered that Scenario 1, the Harbinson approach, is simulated cutting tariffs on a product by product base, implying higher tariff cuts than that from the WTO recommended average cut. The results for Scenario 1 are presented in Table 7 and Fig. 4.

Changes in this scenario resulted in a generalized decrease in the agribusiness output in developed countries and a mixed effect on less developed countries. China presents production growth in some sectors such as rice, soybean and sugar and small reduction in other sectors. On the positive side, China increased the exports of rice, soybean and sugar and increased the imports of all commodities, except wheat. Results for India show small variation in output quantities, with small decrease in some agribusiness products and a rise in manufactured production. Indian international trade increases, prominently in manufactured exports. Brazil presents general growth in agribusiness production (corn, dairy, sugar and meats) and a decrease in manufactured production, the Brazilian economy's most sensitive sector. There are strong increases in the Brazilian exports of meats, dairy and raw milk, sugar, and other foods and a significant rise in the imports of manufactured products.

For the rest of the G-20 countries (RG-20), there is an increase in agribusiness production and a small decrease in the manufactured output. This group of countries showed strong growth in the exports of agribusiness products and smaller increases in the imports of all analyzed products. For the rest of the world (ROW), Scenario 1 resulted in small variations in produced quantities and generalized increases in exports and imports.

Box 1

Review of the scenarios proposed at the Doha Round.

Issue		Scenarios			
		1	2	3	4
Production subsidies	Proposal by the WTO	X	X		X*
	Repetition of the Uruguay Round	–	–	X	
Export subsidies	Elimination	X	X	–	X
	Repetition of the Uruguay Round	–	–	X	
Tariff reduction	Harbinson approach	X	–	–	
	Girard approach	–	X	–	X**
	Repetition of the Uruguay Round	–	–	X	

*For Scenario 4, the proposal by the WTO is performed for all products except manufacturing. Manufacturing subsidies are eliminated.
**For scenario 4, tariffs for all goods except manufacturing are reduced using the WTO Girard approach. For manufactured goods, an average of the WTO Girard approach is used.

Table 6
Regions, and commodity sectors considered by GTAP.

Regions	Commodities
1- China (CHI)	1- Paddy rice and processed rice (RICE)
2- India (IND)	2- WHEAT
3- Brazil (BRA)	3-Cereal grains (MAIZE)
4- Rest of G-20 (RG-20)	4- Oil Seed and vegetable oils (SOYBEAN)
5- United States of America (USA)	5- Sugar cane , sugar beet and sugar (SUGAR)
6- European Union (EU_25)	6- Raw milk, milk derivatives (DAIRY)
7- Rest of developed countries (RDEVELOPED)	7- Meats, sheep, goats, horses, animal products and meat products (MEAT)
8- Rest of the World (ROW)	8- Other foods (tobacco, fibers, coffee, orange juice, fruits, vegetables and others) (REAGRIBIS)
	9- Manufactured (metals in general, vehicles, chemical products, machines and equipments, petroleum, gas and others) (MNFCS)
	10- Services and public administration (SVCES)

Source: GTAP version 7.0.

The U.S. showed a strong increase only in the agribusiness production of rice and wheat. A strong increase occurred in the export of rice, dairy and meat and in the import of dairy, and sugar, a sector strongly protected by the United States. The scenario proved to be very negative for the EU (EU25) production and trade flows, with a great decrease in the production of agricultural goods, reflecting the EU's high subsidies. The EU manufacturing sector is not affected negatively. This confirms the expectations that the EU manufacturing sector would be able to take advantage from trade liberalization scenarios. Agribusiness exports by the EU25 decrease strongly under this scenario, however its effects on imports are less accentuated.

Fig. 4 summarizes the changes elicited by Scenario 1 in the quantities produced (qo), exported (qxw), and imported (qiw) for the aggregated agribusiness and manufacturing sectors of Brazil, China and India. In general, we observed only small changes in quantities produced, except for Brazilian agribusiness, a high rise in the export of agribusiness goods from China, India, and Brazil,

Table 7
Percentage change in production and trade — Scenario 1.

	CHI	IND	BRA	RG-20	USA	EU25	RDEVELOPED	ROW
Percentage change in quantity produced (qo)								
RICE	3.1	0.2	1.0	2.9	26.3	−40.9	−24.0	−1.0
WHEAT	−0.7	−0.6	16.3	3.4	5.7	0.0	−21.1	0.6
MAIZE	−0.1	0.2	8.2	1.0	−1.0	−2.2	4.2	0.1
SOYBEAN	1.9	−5.2	−1.7	2.4	−0.8	−8.8	−3.6	9.4
SUGAR	1.1	−1.4	7.0	6.4	−3.3	−27.0	−2.9	10.3
DAIRY	−0.5	0.4	1.8	1.0	−1.0	−0.9	1.4	0.7
MEAT	−1.1	0.8	25.7	1.9	1.0	−3.8	−4.1	−1.1
REAGRIBIS	0.2	−0.6	2.9	−0.1	0.2	−0.2	0.0	0.0
MNFCS	−0.2	0.5	−3.8	−0.5	0.0	0.2	0.3	−0.3
SVCES	0.1	0.3	0.0	0.0	0.0	0.1	0.1	0.0
Percentage change in export quantity (qxw)								
RICE	282.2	7.0	−22.5	30.8	76.1	−55.4	110.9	11.8
WHEAT	−23.2	−14.3	32.0	15.0	6.8	9.8	−13.0	27.8
MAIZE	−1.0	3.0	−2.3	6.2	−3.1	−3.4	20.9	10.6
SOYBEAN	42.1	16.0	−3.4	7.9	−1.9	−15.2	3.5	28.5
SUGAR	95.1	−1.4	18.0	60.9	−20.4	−68.1	68.2	83.6
DAIRY	13.6	31.1	74.1	39.9	−0.1	−3.6	34.3	19.3
MEAT	−19.6	38.2	76.1	24.8	23.1	−7.3	21.6	−5.4
REAGRIBIS	6.3	0.9	16.4	1.5	5.2	1.1	8.3	4.7
MNFCS	3.9	10.2	−6.0	1.4	1.8	1.0	2.4	1.8
SVCES	−2.0	0.2	−4.8	−0.2	1.5	0.9	0.3	−0.1
Percentage change in import quantity (qiw)								
RICE	2.3	38.2	7.3	30.6	9.2	21.0	276.3	6.6
WHEAT	−3.8	10.9	10.4	1.2	−5.0	4.7	12.5	4.7
MAIZE	0.9	4.2	12.2	−0.6	5.2	0.8	0.3	2.1
SOYBEAN	1.5	44.9	5.3	5.0	0.7	3.6	4.9	4.3
SUGAR	3.4	44.0	8.1	7.5	33.8	40.9	38.7	2.0
DAIRY	5.9	13.7	6.6	2.5	23.7	1.3	46.2	1.1
MEAT	15.5	10.9	20.8	4.5	6.3	1.9	39.3	5.4
REAGRIBIS	6.1	19.2	7.9	4.9	1.9	1.5	7.4	5.1
MNFCS	5.4	6.6	6.9	2.6	0.8	0.5	2.6	2.6
SVCES	1.6	0.5	2.7	0.3	−0.7	−0.2	0.5	0.4

The sectors are: China (CHI); India (IND); Brazil (BRA); Rest of G-20 (RG-20); United States of America (USA); European Union (EU25); rest of developed countries (RDEVELOPED); and Rest of World (ROW).
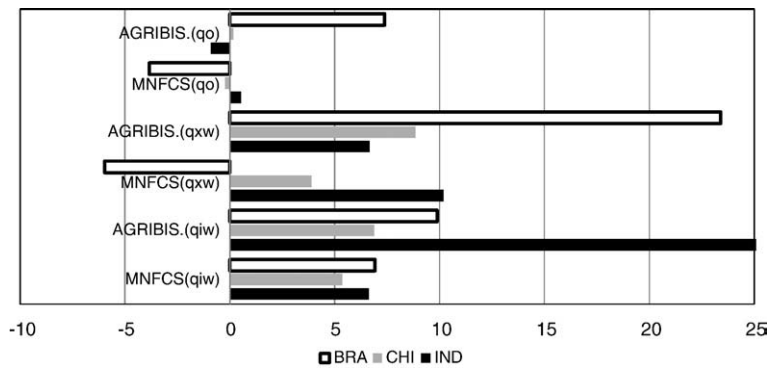Source: Research results.

Fig. 4. Percentage change in production (qo), export (qxw), and import (qiw) quantities for the aggregated agribusiness and manufacture sectors of Brazil, China, and India — Scenario 1. Source: Results from this study.

a rise in the exports of Chinese and Indian manufactured goods, and large increases in quantities imported, especially agribusiness and manufactured goods by India and China.

4.2. Scenario 2

This scenario simulates the same conditions found in Scenario 1, except that the Girard approach is used to determine import tariff reductions. Since the tariff cuts in Scenarios 1 and 2 are done in a product by product base, the tariff cuts in this scenario are smaller than in Scenario 1 (Table 3). The Girard formula is a non-linear tariff reduction formula, in which cuts vary in accordance with the current tariff. The formula defines higher cuts to higher tariffs and lower cuts on lower tariffs in accordance with Table 3.

Table 8
Percentage change in production and trade — Scenario 2.

	CHI	IND	BRA	RG-20	USA	EU25	RDEVELOPED	ROW
Percentage change in quantity produced (qo)								
RICE	1.3	0.4	0.2	1.1	15.7	−28.7	−13.1	−0.9
WHEAT	−0.2	−0.5	18.3	3.2	6.6	0.7	−21.3	0.6
MAIZE	−0.1	0.2	6.0	0.8	−1.6	−1.2	5.9	0.1
SOYBEAN	1.7	−6.4	0.0	3.1	−0.4	−8.2	−2.4	7.1
SUGAR	0.7	−1.8	5.4	5.3	−2.3	−18.4	−2.3	6.2
DAIRY	0.0	0.4	1.5	0.9	−0.7	−0.6	0.6	0.6
MEAT	−1.0	0.7	19.6	0.8	0.6	−2.3	−3.9	−0.9
REAGRIBIS	0.0	−0.6	1.2	−0.1	0.1	0.0	−0.1	−0.2
MNFCS	−0.1	0.6	−2.8	−0.4	0.0	0.1	0.2	−0.2
SVCES	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.0
Percentage change in export quantity (qxw)								
RICE	122.4	11.3	−16.6	20.7	45.8	−42.1	78.2	11.7
WHEAT	−17.6	−11.1	36.0	10.9	8.2	6.7	−16.0	19.3
MAIZE	−0.6	3.2	−1.8	4.9	−4.6	−1.9	21.2	7.8
SOYBEAN	32.8	17.9	−0.4	8.9	−1.1	−14.8	1.5	21.4
SUGAR	53.8	5.9	14.0	50.7	−16.2	−56.4	36.1	49.9
DAIRY	10.2	25.5	65.2	29.8	−8.9	−3.5	15.7	12.2
MEAT	−16.5	33.3	58.0	11.0	14.1	−3.9	9.8	−5.2
REAGRIBIS	2.8	2.2	6.0	1.0	2.7	1.1	3.0	2.9
MNFCS	2.9	8.0	−4.2	1.1	0.9	0.6	1.4	1.4
SVCES	−0.9	0.9	−3.4	−0.1	1.0	0.5	0.3	0.0
Percentage change in import quantity (qiw)								
RICE	1.8	44.2	5.6	30.5	7.2	11.7	139.4	5.7
WHEAT	−5.5	9.5	7.9	−0.2	−5.5	1.5	11.9	2.6
MAIZE	−0.6	4.3	8.6	−1.2	4.9	0.3	−0.4	1.4
SOYBEAN	0.8	56.0	3.5	4.5	−0.6	3.3	2.2	3.1
SUGAR	1.5	57.3	3.6	6.7	21.2	17.8	18.5	0.6
DAIRY	1.8	11.4	4.3	−0.1	6.1	0.3	20.1	−1.0
MEAT	12.3	7.0	15.2	2.9	3.4	0.6	24.5	4.0
REAGRIBIS	4.1	19.9	5.4	3.9	0.8	0.6	3.5	3.8
MNFCS	3.8	4.8	5.2	2.1	0.4	0.3	1.4	2.0
SVCES	0.8	0.1	1.9	0.1	−0.5	−0.1	0.3	0.2

The sectors are: China (CHI); India (IND); Brazil (BRA); Rest of G-20 (RG-20); United States of America (USA); European Union (EU25); rest of developed countries (RDEVELOPED); and Rest of World (ROW).
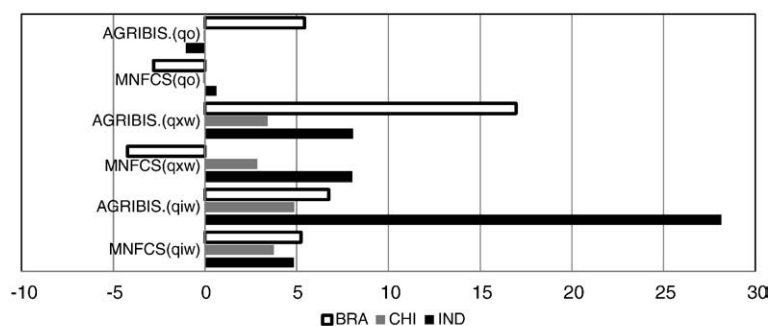Source: Results from this study.

Fig. 5. Percentage change in production (qo), export (qxw), and import (qiw) quantities for the aggregated agribusiness and manufacture sectors of Brazil, China, and India — Scenario 2. Source: Results from this study.

In the Doha Round, this formula, known as the Swiss formula, is preferred by the G-20. The proposed WTO subsidy reduction calls for the elimination of export subsidies. Table 8 shows the percentage changes in production, exports, and imports from the simulation of Scenario 2.

The results present in Scenario 2 are very similar to those from Scenario 1 for RG-20, USA, EU25, RDEVELOPED and ROW, although the changes were smaller. Brazil also presented similar behavior but the exception was in the production of soy where Scenario 1 presented a decrease but not in Scenario 2. China presented similar behavior, with exceptions in dairy production, where Scenario 1 presented a decrease. The quantity of Chinese imports dropped in Scenario 2 relative to Scenario 1. The same behavior is observed in India, except for dairy and sugar that presented larger decreases, but in general Indian imports increased more across most sectors in Scenario 2 than in Scenario 1. For the EU25, trade decreased less in Scenario 2.

Table 9
Percentage change in production and trade — Scenario 3.

	CHI	IND	BRA	RG-20	USA	EU25	RDEVELOPED	ROW
Percent changes in quantity produced (qo)								
RICE	0.3	0.0	0.3	0.5	4.1	−9.0	−3.4	−0.4
WHEAT	0.3	−0.2	6.5	1.9	4.0	0.5	−12.4	0.6
MAIZE	0.1	0.0	1.7	0.4	−0.4	−0.5	0.4	0.0
SOYBEAN	0.3	−1.4	−0.1	0.7	−0.3	−2.2	−1.9	2.3
SUGAR	0.1	−0.3	2.1	1.4	−0.8	−6.0	−0.6	1.8
DAIRY	−0.2	0.1	0.4	0.3	−0.3	−0.1	0.1	0.2
MEAT	−0.3	0.1	4.7	0.5	0.3	−0.7	−1.2	−0.4
REAGRIBIS	0.1	−0.2	0.8	0.0	0.1	0.0	−0.1	0.0
MNFCS	−0.1	0.1	−1.0	−0.2	−0.1	0.3	−0.1	−0.2
SVCES	0.1	0.1	0.0	0.0	0.0	−0.1	0.1	0.1
Percent changes in quantity exported (qxw)								
RICE	25.5	2.0	−2.9	6.8	12.2	−14.4	20.9	5.5
WHEAT	−2.8	−4.7	12.2	5.0	5.0	3.2	−10.8	10.1
MAIZE	0.5	0.7	0.2	2.3	−1.1	−0.8	4.5	3.2
SOYBEAN	9.8	3.5	−0.2	2.4	−0.6	−3.7	−1.0	7.5
SUGAR	12.7	4.4	5.4	14.1	−3.0	−21.4	12.7	15.1
DAIRY	4.3	9.3	18.5	9.7	−3.1	−0.6	7.0	5.5
MEAT	−5.9	6.0	13.9	6.8	6.5	−1.2	5.8	−0.7
REAGRIBIS	2.2	0.1	4.6	0.8	2.0	0.5	2.0	1.9
MNFCS	1.4	3.4	−1.1	0.4	0.1	0.8	0.5	0.6
SVCES	−0.6	0.1	−0.9	0.1	0.5	0.2	0.1	0.1
Percent changes in quantity imported (qiw)								
RICE	0.7	11.4	1.9	8.6	2.9	2.3	33.3	2.5
WHEAT	−3.6	4.9	2.3	−0.6	−5.1	0.5	5.7	0.7
MAIZE	−0.3	1.3	2.2	−0.3	1.6	0.2	0.1	0.7
SOYBEAN	0.5	11.2	1.7	1.7	0.3	0.8	1.3	1.4
SUGAR	0.8	10.4	1.0	2.4	8.3	2.4	5.0	0.4
DAIRY	1.9	4.3	1.2	0.7	4.9	0.2	10.9	0.6
MEAT	4.8	3.8	4.2	1.5	1.9	0.1	9.8	2.2
REAGRIBIS	2.2	5.4	2.2	1.8	0.7	0.5	2.5	2.0
MNFCS	2.1	2.6	2.4	1.1	0.5	0.1	1.0	1.1
SVCES	0.5	0.2	0.5	0.0	−0.2	−0.1	0.2	0.1

The sectors are: China (CHI); India (IND); Brazil (BRA); Rest of G-20 (RG-20); United States of America (USA); European Union (EU25); rest of the developed countries (RDEVELOPED); and Rest of the World (ROW).
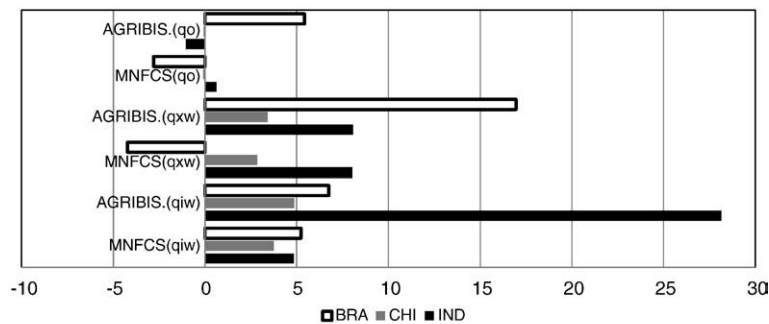Source: Research results.

Fig. 6. Percentage change in production (qo), export (qxw), and import (qiw) quantities for the aggregated agribusiness and manufacture sectors of Brazil, China, and India — Scenario 3. Source: Results from this study.

Fig. 5 summarizes the results from the simulation of Scenario 2 in quantities produced (qo), exported (qxw), and imported (qiw) for aggregated agribusiness and manufacturing sectors of China, India, and Brazil. In Scenario 2, we observed only small changes in quantities produced by China, India, and Brazil and greater changes in their trade, similar to Scenario 1, with highlights for increases in imports of the agribusiness sector.

4.3. Scenario 3

Scenario 3 applied the requirements contained in the tariff agreements negotiated during the Uruguay Round of GATT. Developed and less developed countries should cut tariffs by 15% and 10% per product line respectively (Table 5). This scenario considers that the agreements reached through the Doha Round will contain tariff and subsidy reductions at least as great as those obtained through the Uruguay Round. Table 9 provides the results obtained from the Scenario 3 simulation in percentage variations of output quantity produced, exported, and imported.

The results from Scenario 3 are similar but smaller than those from Scenarios 1 and 2 due to the smaller cuts on subsidies and tariffs agreed upon at the Uruguay Round. Chinese economic sectors show fewer variations in production when compared to Scenarios 1 and 2. India, Brazil, RG-20 and ROW show smaller variations in Scenario 3 than in Scenarios 1 and 2. The production variations in the US are similar to those of Scenarios 1 and 2. All EU25 agricultural products, except wheat, decrease. This production decrease is smaller and less pronounced than in Scenarios 1 and 2.

Variations in exported quantities generated by the Scenario 3 simulation are significantly less than those generated in Scenarios 1 and 2. The corn and sugar sectors in the United States are less affected in this scenario since there are smaller subsidies cuts.

Variations in imported quantities show the same tendencies as the variations generated by Scenarios 1 and 2, although less accentuated. This reduced variation is particularly evident in the sugar sector in the US and EU25, where these sectors are highly protected. The same thing may be said about the rice sector in the rest of the developed countries.

Fig. 6 summarizes results from the Scenario 3 simulation in the quantities produced (qo), exported (qxw), and imported (qiw) for the aggregated agribusiness and manufacturing sectors of China, India, and Brazil. In general, only smaller variations are present in produced quantities and in trade quantities relative to Scenarios 1 and 2 for China, India, and Brazil.

4.4. Scenario 4

Scenario 4 simulates a possible Doha Round compromise that goes beyond the reduction of agricultural tariffs and subsidies. The Swiss formula through the Girard model is applied to produce a differentiated reduction in tariffs on industrial goods, that is, non-agriculture market access (NAMA) (Table 4). Table 10 shows the results for Scenario 4 in the percentage change of production, export, and import quantities.

Scenario 4 shows a small general increase in the production of agribusiness goods in Brazil and the Rest of G-20; a drop in the production of these goods in developed countries, and an increase in trade.

This scenario shows a small negative variation in production for main Chinese activities. There are great variations in Chinese exports, with large increases in the exports of rice, sugar and soy and great reductions in the exports of wheat and meat. Chinese imports increase over all sectors, except for wheat and maize, providing evidence of the strong impact from the removal of trade barriers on the Chinese economy.

In this scenario, the Indian economy experienced small variations in production with small reductions in agribusiness production, except for soy, and an increase in output from the manufacturing and services sectors. Indian agricultural product exports increased in this scenario, particularly the exports of meat (31.3%) and dairy products (23.6%). Also, manufactured goods increased production by 16%. There is an increase in Indian imports, with extreme growth in sugar, soy and rice imports.

The production results are very promising for the Brazilian agribusiness sectors if compared to Scenarios 1, 2 and 3. There is an increase in Brazilian exports of milk and meat and an increase in the imports of manufactured goods. The sectors meat, sugar and

Table 10
Percentage changes in production and trade — Scenario 4.

	CHI	IND	BRA	RG-20	USA	EU25	RDEVELOPED	ROW
Percent changes in quantity produced (qo)								
RICE	1.2	0.3	0.3	1.1	16.6	−28.5	−13.1	−0.9
WHEAT	−0.6	−0.6	19.0	3.3	7.4	0.7	−21.7	0.5
MAIZE	−0.2	0.2	6.2	0.9	−1.4	−1.2	5.7	0.0
SOYBEAN	0.9	−6.6	0.4	3.2	0.0	−8.2	−2.6	6.9
SUGAR	0.5	−1.9	5.7	5.3	−2.2	−18.4	−2.4	6.1
DAIRY	−0.4	0.3	1.5	1.0	−0.6	−0.6	0.5	0.6
MEAT	−1.1	0.6	20.0	0.8	0.8	−2.3	−4.1	−1.0
REAGRIBIS	−0.2	−0.7	1.3	0.0	0.2	0.0	−0.1	−0.2
MNFCS	−0.2	0.6	−3.1	−0.5	0.0	0.1	0.2	−0.3
SVCES	0.2	0.4	0.0	0.0	0.0	0.0	0.1	0.1
Percent changes in quantity exported (qxw)								
RICE	117.6	11.0	−15.9	20.8	47.9	−41.8	77.7	11.7
WHEAT	−20.4	−11.8	37.0	11.1	9.1	6.8	−16.6	18.9
MAIZE	−2.0	2.7	−1.7	4.7	−4.4	−1.8	20.9	7.6
SOYBEAN	30.0	16.8	0.2	9.1	−0.3	−14.9	0.9	21.1
SUGAR	49.8	5.0	14.9	50.8	−15.3	−56.3	35.4	49.5
DAIRY	5.7	23.6	66.6	30.0	−7.2	−3.4	14.9	12.0
MEAT	−19.9	31.3	59.1	10.9	16.2	−3.7	9.0	−5.7
REAGRIBIS	1.0	1.4	6.4	1.1	3.7	1.1	2.5	2.7
MNFCS	6.3	16.0	−1.5	3.0	2.0	1.0	2.8	3.2
SVCES	−2.0	0.8	−2.7	0.2	2.1	0.8	0.3	0.1
Percent changes in quantity imported (qiw)								
RICE	3.4	44.1	5.1	30.5	6.3	11.7	140.2	5.7
WHEAT	−4.6	9.8	8.0	−0.2	−6.0	1.5	11.9	2.7
MAIZE	−0.1	4.5	8.6	−1.1	4.6	0.3	−0.4	1.5
SOYBEAN	1.2	56.5	3.3	4.5	−1.0	3.3	2.3	3.1
SUGAR	2.6	58.4	3.2	6.7	20.6	17.7	18.6	0.7
DAIRY	3.5	12.2	3.9	−0.3	5.1	0.3	20.5	−1.0
MEAT	14.0	7.3	15.0	3.1	2.4	0.5	24.8	4.1
REAGRIBIS	5.1	20.3	5.2	3.8	0.3	0.6	3.7	3.9
MNFCS	8.2	10.9	9.6	4.6	0.8	0.7	3.1	4.3
SVCES	1.7	0.4	1.6	0.1	−1.0	−0.1	0.7	0.4

The sectors are: China (CHI); India (IND); Brazil (BRA); Rest of G-20 (RG-20); United States of America (USA); European Union (EU25); rest of developed countries (RDEVELOPED); and Rest of World (ROW). Source: Research results.

maize, that are important for the Brazilian economy should be highlighted. The rest of the G-20 countries (RG-20) presented small increases and decreases in agribusiness production. The increase in all agribusiness exports should be highlighted. There was a considerable increase in the RG-20 countries exports of rice, sugar and dairy.

The Scenario 4 simulation is quite positive for the economy of the United States, with increases in the production of rice and wheat. Exports also increase greatly, especially that of rice, dairy, and meats. The US imports also increase. For the European Union, Scenario 4 is negative. It was brought about by a strong reduction in the production of agricultural goods, with the exception of wheat. Production from the EU25's manufacturing sector is negatively affected. In this scenario, EU25 exports decrease considerably, and imports increase somewhat. For the rest of the developed countries (RDEVELOPED), results from Scenario 4
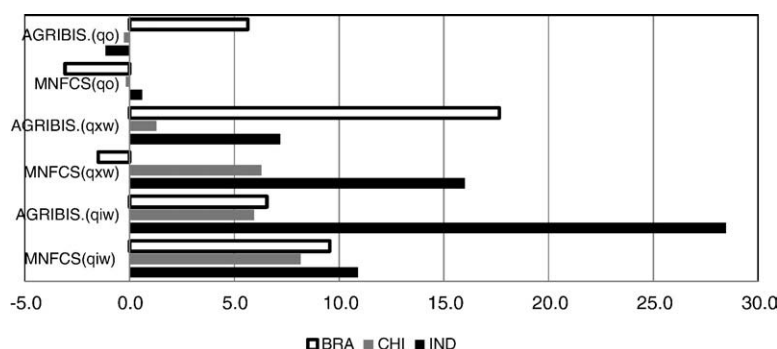

Fig. 7. Percentage change in production (qo), export (qxw), and import (qiw) quantities for the aggregated agribusiness and manufacture sectors of Brazil, China, and India — Scenario 4. Source: Results from this study.
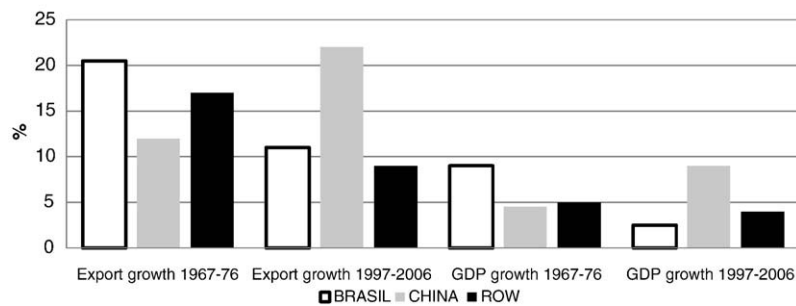
Fig. 8. Average exports and GDP growth: Brazil, China, and ROW. Source: Netto (2007).

show a small drop in the production of main agricultural products; however, trade increased. Exports by RDEVELOPED countries generally increased and imports increased by an even larger amount; rice imports increased 140.2%.

Fig. 7 summarizes the results for the quantities produced (qo), exported (qxw), and imported (qiw) for the aggregated agribusiness and manufacturing sectors of Brazil, China, and India. In general there were only small variations in production, except for Brazilian agriculture. There was a large increase in the exports of manufactured products by India and China; a drop in the exports of agribusiness products by India, and an increase in the exports of agribusiness products from Brazil. There are also large variations in imported quantities, with an increase in agribusiness product imports by China and India, and of manufactured goods by Brazil, China and India.

The expansion of Chinese global trade over the last decade (Fig. 8), similar to the case of Brazil from 1968 to 1973, indicates there is a probable relationship between increase in trade and GDP growth. The results from Scenarios 1 and 4 suggest that the growth of Chinese trade will continue to generate significant increases in that country's GDP. The Brazilian economy can take advantage of the Doha Round to become a more important global exporter of agricultural products by increasing its participation in the global trade flow.

4.5. Impacts on growth and welfare

The GDP growth rate for the four scenarios is presented in Fig. 9. Results from Scenario 1, the Harbinson approach, show a GDP increase for Brazil and China, and a small GDP reduction for India, RG-20, ROW, United States and the EU25. Brazil and China present the highest GDP increase in scenario one. It should be considered that Scenario 1, the Harbinson approach, is simulated by cutting tariffs on a product by the product base, implementing higher tariff cuts than that from the WTO recommended average cut. Applying the Girard formula in Scenario 2 offers similar results to those from Scenario 1, but the changes are smaller. Scenario 3 replicates the Uruguay Round agreement requiring smaller cuts in subsidies and tariffs. The results show smaller GDP changes than those from Scenarios 1 and 2. The exception is India that presents a GDP increase only in this scenario. Scenario 4 presents the largest GDP reduction for the RG-20, USA and ROW regions. These results are interesting, since this is the only scenario that simulates a reduction of NAMA tariffs.

It is worth noting that the GDP of the US decreases in all scenarios, most substantially, −0.6 %, in Scenario 4. Due to the importance of the US to the global economy, representing 30% of the world's economy and 14% of its exports (IMF, 2007), this result deserves attention by Doha Round negotiators.

Equivalent variation (EV), expressed in US$ million, are shown in Fig. 10. EV is obtained by multiplying the percentage change in per capita utility by the benchmark expenditure, thus representing changes in regional welfare. This indicator takes into consideration the size of the geographic area economy.

The economies of China, India, Brazil, RG-20, RDEVELOPED and ROW show increases in welfare in all four scenarios. This behavior may be the effect of eliminating trade barriers, which resulted in lower domestic prices, an increase in consumption, and
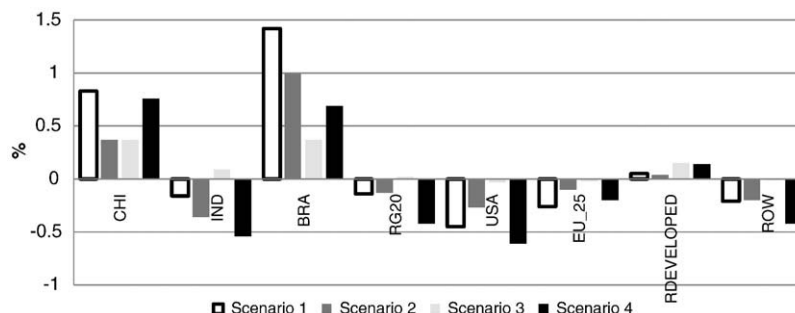

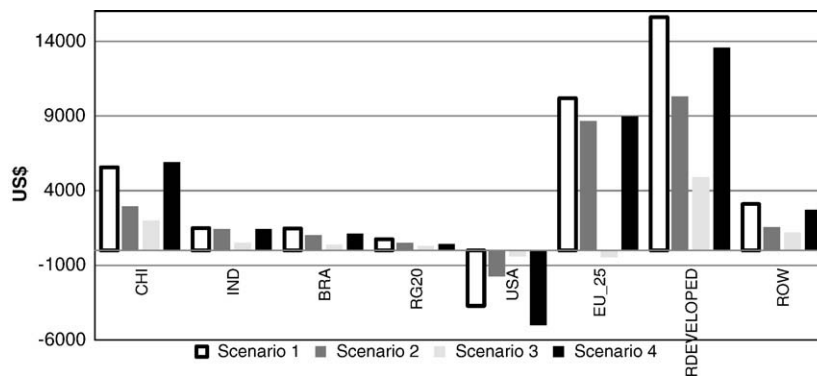**Fig. 9.** Percent change in GDP.

Fig. 10. Equivalent variation in US$ million.

a consequent increase in welfare. The United States shows a welfare loss in all scenarios, with the greatest loss in Scenario 4, explained by the decrease in GDP and per capita utility. The EU25 presents welfare gains in all scenarios, with the greatest gain in Scenario 1.

5. Conclusions

Brazil and China present the highest GDP growth rate varying from 0.4 % to 1.4%. India shows a negative GDP growth rate in all scenarios, except in that which replicates the Uruguay Round. The welfare gains are positive, but small, for Brazil, China and India.

Brazil agricultural production increases in all scenarios from 1.5% in Scenario 3 to 8% in Scenario 1. On the other hand, manufactured production in Brazil is not competitive in all scenarios showing a negative growth rate varying from −1.0% to −4.0%. Chinese and Indian agricultural and manufactured production show negligible changes in all scenarios.

Regarding agribusiness exports, Brazil presents the highest growth rate, increasing 23% in Scenario 1. Manufactured exports from Brazil present negative growth rates in all scenarios, contrary to the positive results from China and India. Brazil, China and India agribusiness and manufactured imports increase in all scenarios due to tariff cuts. India shows the greatest increase in imports.

The GDP loss observed in the economies of the EU25 and the US may make it difficult to reach a trade agreement. It may be that the developed countries could help avoid an impasse at the continuation of the Doha Round if they were to advocate a reduction in the number of sensitive products and negotiate a longer term for developing countries to reduce tariff and subsidies.

Acknowledgements

References

Anderson, K. (1997). Global impacts of the Doha scenarios on poverty. In T. Hertel, & L. Winters (Eds.), *Poverty and the WTO* Palgrave Macmillan: World Bank's Trade and Development Series.

Antimiani, A., Conforti, P., & Salvatici, L. (2006). Alternatives scenarios and strategic interactions between developed and developing countries in the agricultural trade negotiations of the Doha Round: A reappraisal. *Agricultural trade agreements (TRADEAG* Roma: Italian Ministry of University and Technological Research 34 pp.

Chiang, A. C., & Wainwright, K. (2005). *Fundamental methods of mathematical economics*, 4. ed. New York: McGraw-Hill 784 p.

Cline, W. (2003). *Trade Policy and Global Poverty*. Washington, D.C.: Institute for International Economics.

Conforti, P., & Salvatici, L. (2004). Agricultural trade liberalization in the Doha Round. Alternative scenarios and strategic interactions between developed and developing countries. *7th Annual conference on global economic analysis* (pp. 17—19).

Ferreira Filho, J. B. S., & Horridge, M. (2006). The Doha development agenda and Brazil: Distributional impacts. *Review of Agricultural Economics, American Agricultural Economics Association, 28*(3), 362—369.

G-20 History, 2007. Official home page. Available at: http://www.g-20.mre.gov.br/history.asp

Gurgel, A. C. (2001). Impactos da Liberalização Comercial de Produtos do Agronegócio na Rodada de Doha.*Brazilian Economia Review - RBE., 60*(2), 133—151 jan./ mar.

Harrison, G. W., Rutherford, T. F., Tarr, D. G., & Gurgel, A. (2003). Políticas de Comércio Regionais, Multilaterais e Unilaterais do Mercosul para o Crescimento Econômico e a Redução da Pobreza no Brasil. *Pesquisa e Planejamento Econômico, 33*(1), 1—60.

Hertel, T. W. (Ed.). (1997). *Global trade analysis: modeling and applications*. Cambridge University Press: New York 403p.

Hertel, T. W., & Tsigas, M. E. (1997). Structure of GTAP. In T. W. HERTEL (Ed.), *Global trade analysis: Modeling and applications* New York: Cambridge University Press 403 pp.

Hertel, T. W., Mark Horridge, J., & Pearson, K. R. (1992). Mending the family tree: A reconciliation of the linearization and levels schools of AGE modelling. *Economic Modelling, Elsevier, vol. 9(4)* (pp. 385—407). October.

Hertel, T. W., & Ivanic, M. (2006). World Market Impacts of Multilateral Trade Reforms. In T. Hertel, & L. Winters (Eds.), *Poverty and the WTO,* Palgrave Macmillan: World Bank's Trade and Development Series.

Horridge, Mark., & Wittwer, Glyn (2008). SinoTERM, a multi-regional CGE model of China. *China Economic Review, vol. 19(4)*. (pp. 628—634): Elsevier December.

IMF, 2007. Finance & development. Washington DC, USA, March, .44(1):14 – 15.

Instituto Observatòrio Social — IOS, 2005. OMC, desigualdades Norte/Sul e a geopolítica do desenvolvimento : as negociações do NAMA e os impactos sobre a América Latina e o Brasil. São Paulo, Dec., 122p. (http://www.os.org.br/download/nama.pdf)

Narayanan, B., & Walmsley, T. L. (Eds.). (2008). Global trade, assistance, and production: The GTAP 7 data base, center for global trade analysis : Purdue University Available at https://www.gtap.agecon.purdue.edu/databases/v7/default.asp

Netto, A. D. (2007). Pensem no Brasil, sem esquecer a China. Conjuntura Econômica, 61(7), 25—27.

Polaski, Sandra. (2006) Winners and Losers: The Impact of the Doha Round on Developing Countries. Washington: Carnegie Endowment for International Peace Available at: http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=18083

WTO. (2004). WTO agriculture negotiations: The issues, and where we are now. Available at: http://www.wto.org/english/tratop_e/agric_e/agnegs_e.pdf

WTO. (2005). Doha work program: Preparations for the sixth session of the ministerial conference draft ministerial text Available at: (http://www.wto.org/english/thewto_e/minist_e/in05_e/draft_min05_text_e.pdf

WTO. (2006). Exploring links between subsidies, trade and WTO. World Trade Report 2006 Available at: http://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report06_e.pdf

WTO. (2008). Trade policy review page Available at: http://www.wto.org/english/tratop_e/tpr_e/s212-04_e.doc