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Multilateral Trade and Agricultural Policy Reforms in Sugar Markets

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Abstract

We analyse the impact of trade liberalisation, removal of production subsidies and elimination of consumption distortions in world sugar markets using a partial-equilibrium international sugar model calibrated on 2002 market data and current policies. The removal of trade distortions alone induces a 27% price increase while the removal of all trade and production distortions induces a 48% increase in 2011/2012 relative to the baseline. Aggregate trade expands moderately, but location of production and trade patterns change substantially. Protectionist Organisation for Economic Co-operation and Development (OECD) countries (the EU, Japan, the US) experience an import expansion or export reduction and a significant contraction of production in unfettered markets. Competitive producers in both OECD countries (Australia) and non-OECD countries (Brazil, Cuba), and even some protected producers (Indonesia, Turkey), expand production when all distortions are removed. Consumption distortions have marginal impacts on world markets and the location of production. We discuss the significance of these results in the context of mounting pressures to increase market access in highly protected OECD countries and the impact on non-OECD countries.

Keywords: *Agricultural policy; Doha; domestic subsidies; sugar; trade liberalisation; WTO.*

JEL classifications: *Q18, F10.*

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1. Introduction

The current world sugar market situation has complex North–South, South–South and North–North components. A myriad of policy interventions make sugar one of the most distorted commodity markets in the world. The European Union (EU), Japan and the US are among the worst offenders in these markets. Producers in the EU and the US receive between two and three times the world market price because of production quotas, import controls and government-guaranteed prices. Organisation for Economic Co-operation and Development (OECD) countries' support to their sugar producers amounted to about $5.3 billion in 2002 (OECD, 2003), roughly the value of developing countries' sugar exports. In 2002, the EU, the US and Japan provided annual support of US$2.45 billion, US$1.18 billion and JPY40 billion, respectively (OECD, 2003). Such high protection has converted the EU, a natural importer of sugar, to a net exporter and has reduced sugar imports to the US and Japan to a fraction of expected free-trade levels. Furthermore, most countries, including the lowest-cost producers, offer some form of protection or subsidies to their producers, and/or distort price signals seen by consumers. These countries often impede or directly distort trade in some fashion with restrictive import policies (OECD, 2003; Mitchell, 2004). Import restrictions and regulated domestic markets are also prevalent in non-OECD (developing) countries like China and India, which protect their producers and maintain domestic sugar prices at a higher level than the current world price.

An obvious question is what unfettered markets would look like. What consumption and production levels would prevail and what world price could be sustained in the absence of distortions? The latter question has been a bone of contention with producers in protected markets. The current world price is often referred to as the 'world dump price' by sugar interests in protected OECD countries because a substantial share of world sugar trade occurs under preferential agreements (American Sugar Alliance, 2003). Beyond the politics of sugar protectionism, the determination of an undistorted world price is a legitimate concern.

Recent and interesting policy developments warrant a new analysis of the sugar market. Protectionist interests in the US won a battle with the virtual exclusion of sugar in the US–Australia Free Trade Agreement (FTA). Despite this setback, the US probably will soon be forced to reform its sugar programme because of internal market changes and international commitments already made under the North American Free Trade Agreement (NAFTA), minimum-market access commitments made under the Uruguay Round of the World Trade Organisation (WTO) and the Central American Free Trade Agreement (CAFTA). Further commitments are being negotiated under the Free Trade Agreement of the Americas (FTAA), and the latter will only exacerbate these pressures for reform. This is another case of border opening forcing domestic policy discipline, such as in the recent reform of the US peanut programme. With the recent WTO ruling that the EU has been illegally exporting too much subsidised sugar further complicated by the Everything But Arms (EBA) agreement, the European Commission's proposals to radically reform the EU's protectionist sugar regime in 2006 were adopted (WTO, 2004a; European Commission, 2005). Reforms may also coincide with the expiry of the US Farm Security and Rural Investment Act in 2007 and provide a target period to get reforms in place. Would these reforms be more palatable under free trade with a higher world price? What is the effect of domestic farm policies relative to border barriers on world prices and markets?

Multilateral trade liberalisation erodes benefits and market access from preferential bilateral trade agreements and pits low-cost producers from Brazil and Thailand against less-efficient producers in the South. For example, nine of the 42 countries that hold US quotas do not even produce the sugar they deliver under the quotas. Hence, sugar market liberalisation has an important South–South dimension. How these reforms occur will have important consequences for developing countries. If world price effects are large, what is the net effect of removing one's protection when it is combined with a substantial world price increase? Finally, the fact that Australia stands to gain as a net exporter of sugar and is at odds with many OECD partners who protect their sugar producers adds a North–North dimension to sugar trade liberalisation.

Most partial-equilibrium analyses of the sugar market examine trade liberalisation holding prices and policies constant in other markets. We depart from this approach and incorporate the impact of agricultural trade liberalisation on prices for crops competing with sugar in land use. These free-trade prices come from a similar policy analysis carried out with companion models and using the same baseline of the Food and Agricultural Policy Research Institute (FAPRI, 2004).[2] In addition to trade liberalisation, we also introduce the removal of production and consumption distortions into the analysis. Furthermore, as scenario results are contingent on market conditions and policy developments, this study incorporates more recent policy settings than previous liberalisation analyses.

In the following paragraphs, we summarise major policy interventions in world sugar markets. Then we briefly describe the international sugar model used for the simulations. After having introduced the policy-reform scenarios, we present the key results of our simulations and sensitivity analysis. Further detailed information on the country-by-country results for trade, production and consumption are available online (Elobeid and Beghin, 2005). We close with further reflection on what our results mean for global sugar policy reforms.

2. Distortions in Sugar Markets

Table 1 summarises key distortions as of 2002 by countries covered in our analysis. The table classifies countries by their development level (OECD, non-OECD/developing) and distortion levels (highly protected, minimally or moderately distorted). We use the nominal protection coefficient (npc) estimate from the sugar producer support estimate data of OECD countries to categorise them into the two protection categories (OECD, 2003) with a cut-off value of npc = 1.25. For non-OECD countries, we use cut-off criteria of greater than 25% *ad valorem* tariff or the combination of a 25% tariff or lower and the presence of domestic production

[2] The FAPRI baseline is a set of projections for the US agricultural and international commodity markets. The 10-year projections are published as FAPRI Outlooks, which are also used for policy analysis (FAPRI, 2003). FAPRI baseline projections are grounded in a series of assumptions about the general economy, agricultural policies, the weather, and technological change. The projections assume that during the projection period, current agricultural policies remain in place, and average weather conditions and historical rates of technological change prevail.

Table 1
Summary of sugar policies by country (2001/02)

	Trade policies			Domestic policies		
				Production		Consumption
Country classification	Import tariff[a] and TRQ schemes	Export subsidy	Export tax	Price support	Production quota	Consumer subsidy
OECD countries: highly distorted						
Eastern Europe[b]	40% in-quota rate with minimum of EUR0.17/kg; 96% out-of-quota rate with minimum of EUR0.43/kg					
European Union	EUR98/ton in-quota rate; EUR339/ton out-of-quota rate; ACP TRQ 1.3 million tons white sugar equivalent	X		X	X	
Japan	JPY21.5/kg refined sugar + additional surcharge of JPY53.88/kg			X		
Mexico	$0.3166/kg on US imports and $0.3958/kg on third-country imports			X		
South Korea	3% raw sugar and temporary 50% refined sugar			X		
Turkey	110.45% on EU imports; 138% on third-country imports			X	X	
US	0.625/lb MFN import duty; 15.36 ¢/lb out-of-quota rate raw sugar; 16.21 ¢/lb refined sugar; TRQ of 1.29 million tons in 2002; preferential treatment for Mexico under NAFTA			X		

Table 1
(*Continued*)

	Trade policies			Domestic policies		
				Production		Consumption
Country classification	Import tariff[a] and TRQ schemes	Export subsidy	Export tax	Price support	Production quota	Consumer subsidy
OECD countries: limited to moderate distortion						
Australia	No import tariffs					
Canada	CAD$30.86/ton refined sugar; CAD$22.07 – $24.69/ton raw sugar (MFN)					
Non-OECD countries: highly distorted						
Argentina	20% (+$60/ton on Brazilian imports)	4.05%	5%			
China	20% in-quota rate; 76% out-of-quota rate; TRQ 1.64 million tons increasing to 1.95 million tons by 2004			X		
Colombia	20% + variable surcharge (effective duty in 2002 $114/ton raw imports; $85/ton refined)	2.5%		X		
Egypt	5% raw sugar; 10% refined sugar			X		X

Table 1
(*Continued*)

Country classification	Trade policies			Domestic policies		
				Production		Consumption
	Import tariff[a] and TRQ schemes	Export subsidy	Export tax	Price support	Production quota	Consumer subsidy
Former Soviet Union (Russia)[c]	5% in-quota rate but no less than EUR0.015/kg; 40% out-of-quota rate but no less than EUR0.12/kg for raw sugar and EUR0.14/kg for white sugar; TRQ 3.65 million tons in 2002					
India	60% plus INR850/ton countervailing duty			X		
Indonesia	20% raw cane sugar; 25% beet sugar			X		
Malaysia	5% + specific tax of RM426.7/ton			X		
Morocco	35% + 0.25% parafiscal tax and 123% of the difference between a threshold price and CIF price			X		X
Pakistan	30%			X		
Philippines	65%					
South Africa	ZAR1312/ton in 2002 (based on difference between world price and set reference price)					
Thailand	65% in-quota rate; 99% out-of-quota rate 99%			X	X	

Table 1
(*Continued*)

	Trade policies			Domestic policies		
				Production		Consumption
Country classification	Import tariff[a] and TRQ schemes	Export subsidy	Export tax	Price support	Production quota	Consumer subsidy
Non-OECD countries: limited to moderate distortion						
Algeria	15% cane sugar; 5% beet sugar					
Brazil	17.5%					
Cuba	10%					X
Iran[d]	19%					
Peru	25% + additional duty based on price band system used in Colombia					
Venezuela	15% + additional duty based on price band system used in Colombia					

Notes: [a]Import tariffs are for raw sugar unless indicated otherwise.
[b]Poland is used to represent Eastern Europe as its production constitutes 60% of total sugar production in Eastern Europe.
[c]Russia is used to represent the Former Soviet Union as it is the region's largest importer. The Ukraine sets minimum purchase prices for sugar beets and refined sugar at the wholesale level. However, sugar prices are often below the mandated minimum.
[d]Regional average.

support for heavily distorted countries. Detailed coverage of sugar policies by country is available in Appendix A of Elobeid and Beghin (2005).

Policy categories in Table 1 are listed based on their distortionary impact. As is the case for many agricultural markets, trade distortions are predominant in sugar markets and affect both producers and consumers via border tariffs, tariff-rate quota (TRQ) schemes, and less importantly export taxes/subsidies (Aksoy and Beghin, 2004; Hoekman *et al*., 2004). Border restrictions reduce import demand flows and reduce world prices while increasing domestic prices received by producers and paid by sugar users. Export subsidies are less important except in the EU, where they have been instrumental in dumping non-competitive sugar on world markets and sustaining the domestic production of high-price sugar. EU sugar exports and associated subsidies will have to be dramatically reduced as mentioned in the Introduction. Border tariffs, TRQs and export subsidy policies are part of the current Doha negotiations (WTO, 2004b).

Next in importance are production distortions, which sometimes take the form of producer-price support, coupled with production controls such as quota limiting production under price support (e.g. EU and Turkey). It is well known that OECD countries provide domestic support in addition to border protection. It is less known that many developing countries engage in similar practice although these are now formally reported in WTO notifications because the generous *de-minimis* applies to their distorting domestic policies (WTO, 1994).[3] Domestic production support is often redundant as border protection binds first (e.g. Japan). This would change when border protection is reduced by commitments in trade agreements. Reductions in domestic price support are also under negotiation in the Doha round (WTO, 2004b). Finally, a few countries also intervene with targeted consumer policies to either subsidise consumption to offset some of the impact of the other distortions, or just by social objective (such as in Cuba and Egypt).

As shown in Table 1, many countries intervene in sugar markets; the degree and nature of interventions are what differentiate countries. OECD markets are by far the most distorted (OECD, 2003). Virtually all countries, including developing nations as well as countries considered low-cost producers, such as Brazil, provide some sort of support to their sugar producers (Mitchell, 2004).

To summarise the extent of distortions, 60% of trade in sugar and 80% of production takes place at prices above the world price (Mitchell, 2004). The table also shows the heterogeneity of support across countries. The policy debate on sugar protection has been oversimplified by pitching low-cost Brazil against industrialised countries (EU and US). Table 1 shows clearly that protection extends beyond the usual suspects among OECD countries to its poorer members (Mexico and Turkey), and also to many countries in the developing world.

[3] Distorting support is divided into product-specific and non-product-specific groups. The non-product-specific support (not specifically tied to a certain product), and the aggregate measure of support (AMS) is assigned to all agricultural production. For developing countries, AMS values below 10% of the product's value of production for product-specific support and AMS values below 10% of the country's overall value of agricultural production for non-product-specific support are exempted from the domestic support limits of the Uruguay Round Agreements Act and are not notified to the WTO (WTO, 1994).

Several developing countries (e.g. India, Egypt and Colombia) exhibiting high distortion levels provide domestic farm subsidies to their producers, either directly or through sugar processors. Several countries (e.g. Japan), support their domestic production policies by trade barriers, because closed borders reduce government outlays on farm programmes, and sugar users and consumers effectively bear the cost of the production subsidies. Finally, we note that protection is not always equivalent to lack of competitiveness as producers in several developing countries would be competitive in unfettered markets provided world prices increase sufficiently (e.g. Colombia, Indonesia, Malaysia and Pakistan).

3. Structure of the CARD International Sugar Model

The CARD[4] international sugar model is a non-spatial, partial-equilibrium econometric world model consisting of 29 countries/regions, including a rest-of-the-world aggregate to close the model. The model is used to establish the sugar component of the FAPRI baseline (FAPRI, 2003) and for policy analysis (Beghin *et al.*, 2003). Major sugar-producing, -exporting and -importing countries are included in the CARD international sugar model. The model specifies only raw sugar production, use and trade between countries/regions, and does not disaggregate refined trade from raw trade. Consequently, there is no category for importers as refiners or toll refiners because those countries that specialise in that role are well known and stable over time. Country coverage consists of the following countries/regions: Algeria, Argentina, Australia, Brazil, Canada, China, Colombia, Cuba, Eastern Europe,[5] Egypt, European Union-15, Former Soviet Union (FSU)[6] (mainly Russia and the Ukraine), India, Indonesia, Iran, Japan, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, South Africa, South Korea, Thailand, Turkey, the US, Venezuela and a Rest-of-World aggregate.[7]

The general structure of the country sub-model includes behavioural equations for area harvested, yield, production for sugarcane and sugar beet on the supply side, and per capita consumption and ending stocks on the demand side. Equilibrium prices, quantities and net trade are determined by equating excess supply and excess demand across countries and regions. Using price transmission equations, the domestic price of each country or region is linked with a representative world price (Caribbean f.o.b. price) through exchange rates and other price policy wedges such

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[4] CARD stands for Center for Agricultural and Rural Development, located at Iowa State University.

[5] Eastern Europe includes Albania, Bosnia, Bulgaria, Croatia, Czech Republic, Hungary, Macedonia, Poland, Romania, Slovak Republic, and Slovenia.

[6] The Former Soviet Union includes Armenia, Azerbaijan, the Baltic States (Estonia, Latvia, and Lithuania), Belarus, Georgia, Republic of Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, and Republic of Uzbekistan.

[7] Although exports from the African, Caribbean and Pacific (ACP) countries make up the majority of the EU's raw sugar imports, the ACP as a region is not modelled explicitly. Imports under TRQ are represented exogenously in the baseline and in scenario 1 and these imports go to zero in scenarios 2 and 3 with market liberalisation. The consensus view is that ACP countries would not be able to export sugar to the EU were it not for the EU's high guaranteed price. Most of these countries would cease to export in a free market environment.

as tariffs and transfer-service margins. Because of the overall scope of the model, it is not feasible to include the complete empirical model in the text. The general framework for each country sub-model consists of the following:

Harvested area at time t:

$$\mathrm{AH}_t = f(\mathrm{AH}_{t-1}, \mathrm{RSPP}_{t-1}, \mathrm{RGP}_{t-1}, \mathrm{Trend}), \tag{1}$$

yield at time t:

$$\mathrm{Yield}_t = f(\mathrm{Yield}_{t-1}, \mathrm{Trend}), \tag{2}$$

cane and beet crop production at time t:

$$\mathrm{Production}_t = \mathrm{AH}_t \times \mathrm{Yield}_t, \tag{3}$$

with AH denoting acreage, RSPP being the cane or beet price, and RGP denoting the price of alternative crops; subscripts indicate the time period.

Total sugar production is obtained by converting raw cane production and beet production into raw sugar equivalent. Sugar consumption per capita is determined by the real price of sugar and income per capita.

$$\text{Per capita sugar consumption at time } t = f(\mathrm{RSP}_t, \mathrm{PCRGDP}_t), \tag{4}$$

with RSP being the real consumer price of raw sugar, and PCRGDP representing real income per capita; total demand is the product (population $*$ per capita consumption). The GDP deflator is used to change nominal variables into real variables. Inventory demand at time t is

$$\mathrm{ES}_t = f(\mathrm{ES}_{t-1}, \mathrm{SC}_t, \mathrm{RSP}_t), \tag{5}$$

with ES representing ending stock, and SC denoting sugar consumption.

In many countries, the beet or cane prices are set by policy and can be treated as being predetermined. In countries where we lack information on agricultural price, the raw sugar price, RSP, is used instead of the agricultural prices in the specification of the acreage response. In some countries, yield improvements are captured by a time trend. The excess demand (supply) of each country goes to the world market for raw sugar, and the sum of all excess demands and supplies is equal to zero by market clearing to determine the world market price.

The CARD international sugar model uses price transmission elasticities to link the world and domestic markets for each country. The price transmission equations assume that agents in each country are price-takers in the world market. Countries are either a natural importer or exporter if their autarkic price falls above or below the world price, respectively. Net importers enjoy natural protection plus whatever barrier is set at the border. Abstracting from any spatial considerations and assuming an '*ad valorem* tariff' only regime, the domestic price can be expressed as

$$P^{\mathrm{d}} = \alpha + \beta * P^{\mathrm{w}} * r * (1 + d), \tag{6}$$

where P^{d} is the domestic sugar price, P^{w} the world price of sugar including international transportation cost if the country is an importer (f.o.b. price for exporters), r is the exchange rate, and d summarises policy interventions between the world and domestic markets and is expressed in *ad valorem* form. Parameter α captures the divergence of the domestic and border price that does not depend on the price level but rather reflects transaction costs arising between the farmgate and the

market place and/or marketing mark-ups. Parameter β allows imperfect transmission between world and domestic prices. Depending on data availability, domestic prices in the sugar model can be farm, wholesale, or retail prices. Because of the homogeneous nature of sugar, quality adjustments are not incorporated in the price transmission equations. In general, only one domestic price is used in the model.[8] Consumer and producer prices are differentially specified only in countries that have a deficiency type of producer support or an explicit tax on consumption.

This general structure is slightly modified to accommodate policy interventions other than price distortions, such as quantitative restrictions on area, supply, or trade flows. For example, imports constrained by binding TRQs are treated as exogenous, and domestic prices are solved endogenously. Policy interventions providing a price floor are treated as such and are effective whenever the domestic producer price falls to the price floor level (e.g. the US loan rate). This mechanism is important when we remove trade barriers in the first scenario but maintain domestic farm policies. The interaction with other model components used to establish the FAPRI baseline is limited to cross-price effects in supply (for wheat, rice and soya beans). There are no links in consumption.

Data for area, yield, sugarcane, and sugar beet production were gathered from the Food and Agricultural Organisation (FAO) of the United Nations, and data for sugar production, consumption and ending stocks were obtained from Production, Supply and Distribution (PS&D) View of the US Department of Agriculture. Cane and beet production is tied to sugar production through the extraction rate. Macroeconomic data such as real GDP, GDP deflator, population and exchange rate were gathered from various sources, including the International Monetary Fund and Global Insight (formerly WEFA-DRI).

Demand and supply price responses and income response for demand are econometric estimates or, when not available, consensus estimates. The elasticity values are available from FAPRI.[9] The period for the econometric estimation is 1980 to 2001. Simple linear specifications and ordinary least squares are used in the estimation of these equations to save degrees of freedom, given the short time series used. This estimation approach treats sugar prices as exogenous for estimation purposes.

Elasticities in the CARD international sugar model are comparable with most existing estimates (e.g. Hafi *et al*., 1993; Devadoss and Kropf, 1996; Wohlgenant, 1999) and do not depart from the consensus view of price-inelastic sugar markets. The own-price elasticities of sugarcane supply are highly inelastic in the short run. This feature is consistent with the fact that several annual crops can be harvested from one planting of sugarcane. Therefore, there is limited acreage adjustment to price fluctuations in the short run. The own-price supply elasticities for sugar beet production are generally not as inelastic as they are for sugarcane because beet is an annual crop. On the demand side, the own-price and income elasticities reflect the fact that in many developing countries sugar is considered a staple in the diet.

[8] Sugar is a true homogeneous commodity resulting in a single world price in a global sugar market. This implies that in trade its origin is undistinguishable, as opposed to cereals or oilseeds, which are highly differentiated products and for which trade is more specialised and spatial.

[9] Website: http://www.fapri.iastate.edu/tools/elasticity.aspx.

The Caribbean raw sugar price is generally considered to be the representative world market price. The nominal world price of sugar has been increasing over time, although in a volatile fashion, while the real price has decreased.

4. Reform Scenarios and Results

We consider the sequence of three scenarios as deviations from the FAPRI baseline. We use the 2002 baseline because it was used to carry the trade liberalisation analysis in all other agricultural markets (FAPRI, 2004). The sequence of scenarios starts with the removal of the largest distortions affecting sugar markets, i.e. trade and border distortions (tariffs, export taxes/subsidies, TRQs and state trading). To implement this scenario, we assume that governments have the fiscal resources to sustain sugar production subsidies. Producers not only receive the prevailing domestic market price under open borders but also get a production subsidy, which leaves the domestic policy support to production unchanged. This is, of course, an artificial device, which allows us to separate the specific effects of trade and domestic production policies. In reality, the mounting fiscal pressures of domestic subsidies would probably render them unsustainable in the medium run and policy reforms would follow. The second scenario considers the further removal of domestic production policies in addition to the trade liberalisation of the first scenario. The third considers the additional removal of consumption distortions, which are the least frequent, along with the previous reforms of trade and production policies.

In each scenario, the policy reforms are fully implemented in 2002/2003 and their impact is measured in the deviations for the years 2002/2003 to 2011/2012. We report the average of these annual changes as a summary indicator of the impacts as well as the impact in the final year (2011/2012), which represents a long-term impact as the model dynamics take time to settle. Table 2 presents summary impacts for the world market; Table 3 shows the detailed impacts for selected countries following the country taxonomy adopted earlier in the discussion of distortions (OECD, highly distorted; OECD, minimally or moderately distorted; non-OECD/developing, highly distorted; non-OECD/developing, minimally or moderately distorted). Figure 1 shows the impact of liberalisation under the three scenarios on average production shares (2002/2003 to 2011/2012) for major countries classified according to their development and distortion levels. Figure 2 shows the impact on average trade shares under scenarios 1, 2 and 3 for the major countries grouped by development and distortion levels.[10]

4.1. Scenario 1: Trade liberalisation impacts

The removal of trade distortions increases the world sugar price by 32% on average during the simulation period (Table 2). This average figure is inflated by a very strong initial price shock, which eventually tapers to 27% in 2011/2012. Aggregate trade increases by a moderate 4% in 2011/2012. The depth of the world market price formation mechanism increases dramatically, however, because preferential

[10] Not all countries mentioned in the text appear in the tables and figures. Individual country results are available in Appendix Tables B, C and D for the three scenarios, and in Appendix Table E for the sensitivity analysis, in Elobeid and Beghin (2005).

Table 2
Impact of reforms on world sugar

	Million metric tons						US Dollars per metric ton	
	Production		Consumption		Total exports[a]		FOB Caribbean price	
	11/12	Average	11/12	Average	11/12	Average	11/12	Average
Scenario 1								
Baseline	155.81	144.82	156.13	145.25	35.51	32.02	238.83	214.61
Reform	156.94	146.02	156.97	146.08	37.01	32.83	302.47	282.31
Change	1.13	1.20	0.85	0.82	1.50	0.81	63.64	67.69
% chg from baseline	0.72%	0.83%	0.54%	0.56%	4.22%	2.40%	26.65%	31.95%
Scenario 2								
Reform	153.06	140.76	153.12	141.21	38.42	35.76	353.32	353.93
Change	−2.75	−4.06	−3.01	−4.04	2.91	3.75	114.49	139.32
% chg from baseline	−1.76%	−2.86%	−1.93%	−2.82%	8.19%	11.73%	47.94%	66.18%
Scenario 3								
Reform	152.76	140.48	152.82	140.91	38.47	35.76	351.54	352.04
Change	−3.05	−4.34	−3.11	−4.33	2.96	3.75	112.71	137.42
% chg from baseline	−1.96%	−3.05%	−2.00%	−3.02%	8.33%	11.72%	47.19%	65.27%

Notes:
[a]Total exports are computed by summing up all positive net exports and negative net imports and not by summing trade flows of net exporters.
Average is the average for 2002/03 to 2011/12.
Scenario 1 = trade liberalisation; scenario 2 = trade liberalisation and domestic production subsidy reforms; scenario 3 = full market liberalisation.

trade and export subsidies are eliminated. This mostly concerns EU imports and exports, and US and Japanese imports. Aggregate effects on world production and consumption are small.

As shown in Table 3, changes in consumption and relocation of production are significant because of the magnitude of the price effects. In highly distorted OECD countries, sugar producers are also protected by domestic policies, and their production changes little or not at all. However, their consumption increases as sugar users face the world price of sugar. As a consequence, Figures 1 and 2 show countries like the EU experiencing a small decline in average production and trade shares, respectively, under trade liberalisation. Conversely, in Australia, a country with limited distortion and the only major competitive sugar producer among OECD countries, production increases by about 5% annually by 2011/2012, and consumption falls as consumers face higher world prices after reform. So Australia increases its average production and trade shares, albeit slightly, under scenario 1.

Among the most heavily distorted developing countries, such as FSU and the Philippines, production decreases substantially whenever domestic subsidies are not present. In developing countries in which domestic production support is present (e.g. India) production changes little as producers are shielded from world competition;

Table 3
Impact of reforms on select OECD and non-OECD countries

	Thousand metric tons					
	Production		Consumption		Net exports	
	11/12	Average	11/12	Average	11/12	Average
OECD: heavily distorted						
European Union sugar production, consumption and net exports						
Scenario 1						
Baseline	19,752.11	18,702.35	15,087.83	14,932.70	4634.06	3734.87
Reform	19,752.11	18,702.35	15,659.04	15,597.65	4078.36	3032.31
Change	0.00	0.00	571.21	664.94	−555.70	−702.57
% chg from baseline	0.00%	0.00%	3.79%	4.46%	−11.99%	−19.56%
Scenario 2						
Reform	7987.60	7230.69	15,520.31	15,382.79	−7555.19	−8214.96
Change	−11,764.50	−11,471.66	432.47	450.09	−12,189.24	−11,949.83
% chg from baseline	−59.56%	−61.28%	2.87%	3.01%	−263.04%	−323.47%
Scenario 3						
Reform	7966.22	7209.62	15,525.17	15,388.48	−7581.52	−8242.02
Change	−11,785.89	−11,492.73	437.34	455.78	−12,215.58	−11,976.89
% chg from baseline	−59.67%	−61.40%	2.90%	3.05%	−263.60%	−324.21%

Table 3
(*Continued*)

	Thousand metric tons					
	Production		Consumption		Net imports	
	11/12	Average	11/12	Average	11/12	Average
Japanese sugar production, consumption and net imports						
Scenario 1						
Baseline	897.94	854.26	2432.89	2383.36	1535.03	1531.41
Reform	688.78	736.93	2478.30	2453.02	1788.59	1719.17
Change	−209.16	−117.33	45.41	69.66	253.57	187.77
% chg from baseline	−23.29%	−13.46%	1.87%	2.93%	16.52%	12.27%
Scenario 2						
Reform	146.32	385.92	2466.63	2433.09	2319.58	2050.05
Change	−751.62	−468.34	33.74	49.72	784.55	518.65
% chg from baseline	−83.71%	−53.85%	1.39%	2.09%	51.11%	33.92%
Scenario 3						
Reform	144.04	384.26	2467.04	2433.61	2322.27	2052.24
Change	−753.90	−469.99	34.15	50.25	787.24	520.83
% chg from baseline	−83.96%	−54.04%	1.40%	2.11%	51.29%	34.06%
US sugar production, consumption and net imports						
Scenario 1						
Baseline	7983.34	7965.40	10,975.62	10,258.58	3132.43	2423.20
Reform	7921.85	7688.57	11,049.92	10,394.51	3339.86	3043.80
Change	−61.49	−276.83	74.30	135.93	207.43	620.61
% chg from baseline	−0.77%	−3.46%	0.68%	1.35%	6.62%	29.62%
Scenario 2						
Reform	7614.48	7482.78	10,992.55	10,306.18	3430.32	2941.35
Change	−368.86	−482.62	16.93	47.60	297.89	518.16
% chg from baseline	−4.62%	−6.06%	0.15%	0.47%	9.51%	22.58%
Scenario 3						
Reform	7594.61	7461.36	10,994.56	10,308.51	3453.22	2966.04
Change	−388.73	−504.03	18.94	49.93	320.79	542.84
% chg from baseline	−4.87%	−6.33%	0.17%	0.50%	10.24%	23.67%

Table 3
(*Continued*)

	Thousand metric tons					
	Production		Consumption		Net exports	
	11/12	Average	11/12	Average	11/12	Average
OECD: moderately distorted						
Australian sugar production, consumption and net exports						
Scenario 1						
Baseline	6684.35	6063.38	1116.69	1074.69	5568.31	4989.95
Reform	7026.17	6364.24	1095.17	1052.37	5930.74	5318.02
Change	341.82	300.86	−21.51	−22.32	362.43	328.07
% chg from baseline	5.11%	4.86%	−1.93%	−2.08%	6.51%	6.46%
Scenario 2						
Reform	7340.35	6700.27	1063.43	1019.19	6273.27	5691.56
Change	656.00	636.89	−53.25	−55.50	704.96	701.60
% chg from baseline	9.81%	10.33%	−4.77%	−5.17%	12.66%	13.88%
Scenario 3						
Reform	7331.61	6691.67	1064.74	1020.44	6263.21	5681.59
Change	647.25	628.29	−51.95	−54.26	694.90	691.64
% chg from baseline	9.68%	10.19%	−4.65%	−5.06%	12.48%	13.68%

Table 3
(*Continued*)

	Thousand metric tons					
	Production		Consumption		Net imports	
	11/12	Average	11/12	Average	11/12	Average
Non-OECD: heavily distorted						
Chinese sugar production, consumption and net imports						
Scenario 1						
Baseline	8980.43	8375.08	11,149.15	9834.95	2154.64	1450.67
Reform	9244.23	8733.96	10,964.54	9493.71	1711.10	746.37
Change	263.79	358.88	−184.61	−341.24	−443.53	−704.30
% chg from baseline	2.94%	4.31%	−1.66%	−3.59%	−20.58%	−53.24%
Scenario 2						
Reform	9769.23	9469.22	10,389.91	8529.91	624.47	−965.58
Change	788.79	1094.14	−759.24	−1305.04	−1530.16	−2416.26
% chg from baseline	8.78%	13.10%	−6.81%	−13.66%	−71.02%	−182.19%
Scenario 3						
Reform	9747.82	9445.55	10,410.05	8555.14	666.11	−916.27
Change	767.39	1070.47	−739.10	−1279.81	−1488.53	−2366.94
% chg from baseline	8.55%	12.82%	−6.63%	−13.40%	−69.08%	−178.53%
Former Soviet Union sugar production, consumption and net imports						
Scenario 1						
Baseline	4719.42	4523.13	12,653.62	12,206.35	7840.12	7613.89
Reform	3782.04	3904.78	12,772.54	12,325.21	8893.43	8371.37
Change	−937.38	−618.35	118.92	118.86	1053.31	757.47
% chg from baseline	−19.86%	−13.45%	0.94%	0.97%	13.43%	9.91%
Scenario 2						
Reform	4821.15	4854.56	12,668.91	12,162.57	7766.81	7239.65
Change	101.73	331.43	15.29	−43.78	−73.30	−374.24
% chg from baseline	2.16%	7.37%	0.12%	−0.37%	−0.93%	−4.95%
Scenario 3						
Reform	4793.29	4830.33	12,672.54	12,166.86	7798.42	7268.77
Change	73.87	307.20	18.92	−39.49	−41.70	−345.12
% chg from baseline	1.57%	6.84%	0.15%	−0.33%	−0.53%	−4.57%

Table 3
(*Continued*)

	Thousand metric tons					
	Production		Consumption		Net exports	
	11/12	Average	11/12	Average	11/12	Average
Non-OECD: moderately distorted						
Brazilian sugar production, consumption and net exports						
Scenario 1						
Baseline	22,728.95	21,871.81	11,211.34	10,565.25	11,521.02	11,311.48
Reform	24,811.63	23,617.86	10,831.02	10,201.03	13,982.53	13,434.52
Change	2082.67	1746.05	−380.32	−364.23	2461.51	2123.04
% chg from baseline	9.16%	7.92%	−3.39%	−3.46%	21.37%	18.70%
Scenario 2						
Reform	26,796.25	25,651.73	10,238.31	9633.87	16,551.51	16,045.25
Change	4067.30	3779.92	−973.03	−931.38	5030.49	4733.77
% chg from baseline	17.89%	17.16%	−8.68%	−8.83%	43.66%	41.72%
Scenario 3						
Reform	26,740.52	25,599.59	10263.56	9655.55	16,470.37	15,971.14
Change	4011.56	3727.78	−947.78	−909.70	4949.34	4659.66
% chg from baseline	17.65%	16.93%	−8.45%	−8.63%	42.96%	41.07%

Table 3
(*Continued*)

	Thousand metric tons					
	Production		Consumption		Net exports	
	11/12	Average	11/12	Average	11/12	Average
Cuban sugar production, consumption and net exports						
Scenario 1						
Baseline	4797.62	4024.91	839.07	777.13	3952.72	3245.84
Reform	5258.59	4269.67	810.55	744.48	4442.04	3523.86
Change	460.97	244.76	−28.52	−32.64	489.32	278.02
% chg from baseline	9.61%	5.73%	−3.40%	−4.24%	12.38%	8.14%
Scenario 2						
Reform	6014.83	4722.58	774.08	693.96	5234.16	4028.13
Change	1217.22	697.67	−64.99	−83.17	1281.44	782.29
% chg from baseline	25.37%	16.43%	−7.75%	−10.84%	32.42%	23.01%
Scenario 3						
Reform	5994.78	4710.47	524.82	448.03	5461.68	4245.18
Change	1197.17	685.56	−314.25	−329.10	1508.96	999.33
% chg from baseline	24.95%	16.14%	−37.45%	−42.58%	38.18%	29.76%

Notes:
Average is the average for 2002/03 to 2011/12.
Scenario 1 = trade liberalisation; scenario 2 = trade liberalisation and domestic production subsidy reforms; scenario 3 = full market liberalisation.

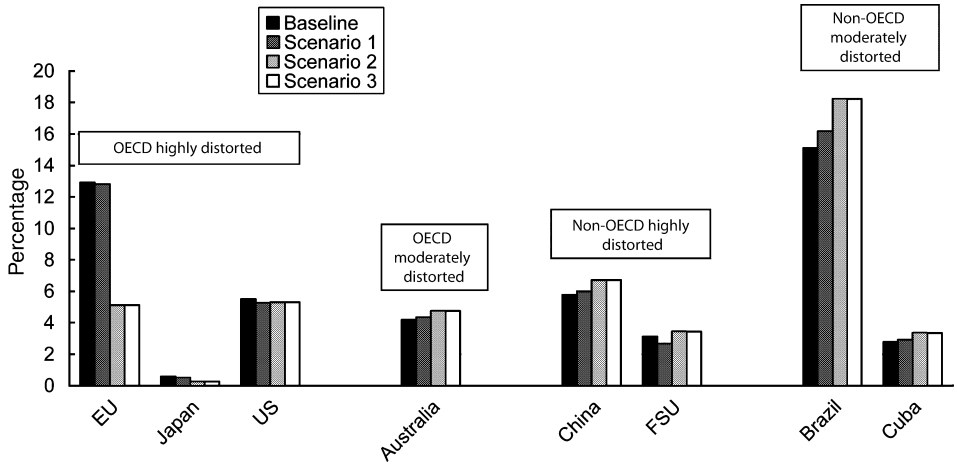

Figure 1. Average production shares under the three reform scenarios.
Note 1: Scenario 1 = trade liberalisation; scenario 2 = trade liberalisation and domestic production subsidy reforms; scenario 3 = full market liberalisation. ***Note 2***: Average is the average for 2002/03 to 2011/12

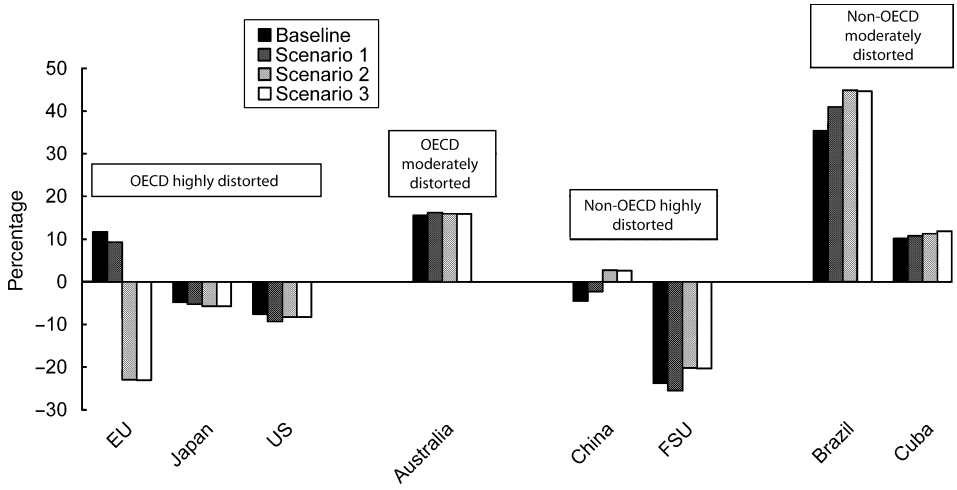

Figure 2. Average trade shares under the three reform scenarios.
Note 1: Positive trade shares (expressed in percentage of total net exports) represent net export shares while negative trade shares represent net import shares. ***Note 2***: Scenario 1 = trade liberalisation; scenario 2 = trade liberalisation and domestic production subsidy reforms; scenario 3 = full market liberalisation. ***Note 3***: Average is the average for 2002/03 to 2011/12

consumption increases, however, as consumers face a lower domestic price. In terms of global shares, with the removal of trade barriers, importing countries like the FSU, Japan and the US experience a small reduction in average production shares (Figure 1) and an increase in trade shares compared with the baseline (Figure 2). In a few countries such as China, the net impact of the tariff removal and the increase in world prices turns out to increase production and decrease consumption as domestic prices increase. Moderately distorted developing countries increase their production significantly; for

example, Brazilian production increases by an annual average of 8%. As a response to the higher world price, Brazil's average production and trade shares increase from 15% and 35%, respectively, in the baseline to 16% and 41%, respectively, under the trade liberalisation scenario (Figures 1 and 2). Consumption falls in all countries of the latter group as sugar users face higher world and consumer prices after reform.

4.2. Scenario 2: Trade liberalisation and domestic production policy reform

Tables 2 and 3 show the combined removal of trade distortions and domestic policies that affect production. Major changes occur in scenario 2 with the additional removal of domestic production subsidies. The removal of all trade and production distortions induces a 48% price increase in 2011/2012 as shown in Table 2. Aggregate world sugar production and use decrease by about 3% on average. Aggregate trade expands but the location of production and trade patterns are even more substantially affected than in the previous scenario. The most protected OECD and non-OECD countries (e.g. the EU, India, Japan, and, to a lesser extent, Mexico and the US) experience an import expansion or export reduction because of substantial contraction in production and slightly increased consumption.

Two factors are important to note when considering these results. First, the overall price response in each country depends on the magnitude of the domestic price change given the higher world price after liberalisation. Second, the short-run own-price elasticities of sugarcane supply are highly inelastic while those of sugar beet are relatively less inelastic as explained in Section 3. The larger supply response in the EU and Japan is attributed both to the fact that the two countries produce more sugar beet than sugarcane and that the domestic price drop is large even with the higher world price (on average by 40% and 62% in the EU and Japan, respectively, in scenario 2) (Figure 3). On the other hand, in the US the magnitude of the reduction in the domestic price is much lower (by 9% on average) after the significant increase in the world price and therefore the supply response is relatively smaller.

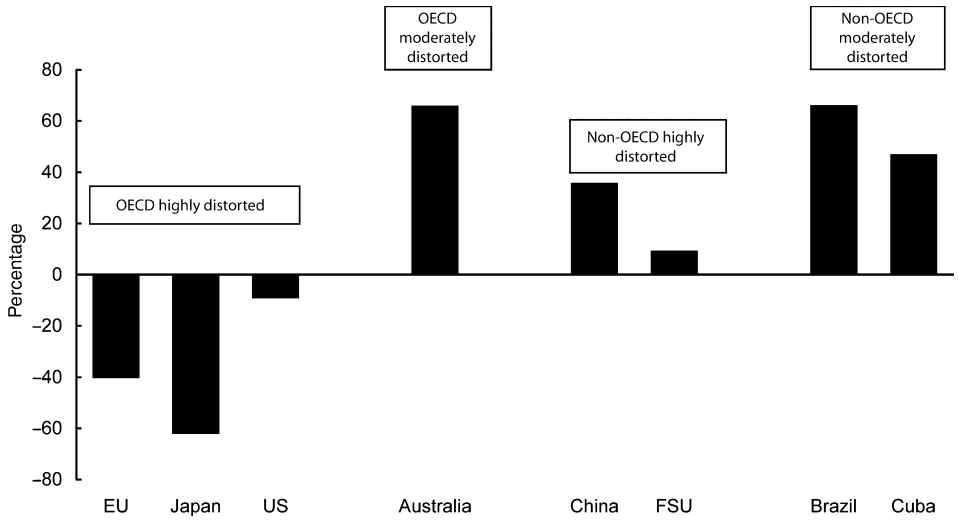

Figure 3. Average producer price change under scenario 2.
Note: Average is the average for 2002/03 to 2011/12

In Figure 1, the average production share for the EU declines to 5% in scenario 2 from about 13% in the baseline and Figure 2 shows that the region experiences a trade reversal from a net exporter of sugar to a net importer when domestic support is removed. Japan reduces its average production share and increases its trade share compared with the baseline (Figures 1 and 2). The US production share remains where it was in the trade reform as the world price increase in scenario 2 offsets the loss of domestic subsidies. US imports increase relative to the baseline but not as much as in the previous scenario because the price faced by sugar users does not fall as much as it does in scenario 1. World beet production decreases by 23% by the end of the decade, whereas world cane production increases by 7%. Hence, in aggregate terms, the conventional wisdom that cane sugar production tends to be more competitive than beet sugar production is reflected here.

In contrast to the first scenario, the drop in production among the most protected countries is such that the world price increase induces higher production in many countries. Higher production is obviously seen not only among non-OECD competitive producers such as Brazil and Cuba but also in some countries with significant distortions such as Indonesia, Malaysia and China. For these countries, the world price increase is large enough to provide improved incentives to produce, and lesser incentives to use sugar. Figure 1 shows the average production share of Brazil increasing from 15% in the baseline to 18% with the removal of domestic support while, in Figure 2, its trade share increases from 35% to 45%. Indonesia, although highly distorted, also increases its average production and decreases its imports by about 50% relative to the baseline. Among highly distorted OECD countries, Turkey also expands production because higher world prices and the removal of producer policies lead to improved incentives to produce. Negative changes in consumption observed in the first scenario are accentuated in this second scenario because consumers face even higher prices in the latter scenario. This occurs not only in OECD and non-OECD countries with moderate border protection (e.g. Australia, Brazil and Canada), but also in a few non-OECD countries with significant protection but for which the net effect of the removal of distortions and higher world price worsens consumer prices. For example, in China, consumption decreases by 7% in 2011/2012 relative to the baseline level.

4.3. Full market liberalisation (trade, consumption and production reforms)

In this scenario, consumption distortions are removed in Cuba, Egypt and Morocco, in addition to the policy reforms of the previous scenario.[11] As Table 2 shows, the removal of pure consumption distortions has small effect on world market price relative to scenario 2.[12] In 2011/2012, the world price increase is 47%, or 1% lower than in scenario 2, as consumption subsidies are removed. Hence, the

[11] Although in the past sugar was sold at subsidised prices to consumers in Turkey, consumer sugar subsidies have been gradually reduced over the last several years and prices have increased according to production costs, resulting in consumption increases closer to the population growth rate. For this reason, consumer subsidies in Turkey were not considered.

[12] A border tariff constitutes a tax on consumption and a subsidy on production. Hence sugar consumption has been extremely distorted by high tariffs rather than by pure consumer taxes/subsidies occurring only in a few countries.

bulk of the effects of this reform occurs in the countries removing their own consumer price distortions with limited feedback on the world market. Table 3 shows that the removal of the consumer subsidies in these select developing countries has little impact on the rest of the countries when compared with scenario 2. Among non-OECD countries, Cuba has the largest subsidy removal and consumption decreases significantly, by an average of 42.6% between 2002/2003 and 2011/2012. This translates to an expansion of Cuban exports on world markets which are responsible for the 1% decrease in world price relative to the prevailing world price after removing trade and production distortions (47% vs. 48% increase in 2011/2012). In Egypt, consumption decreases by 21%, whereas it would decrease by 15% under scenario 2. Finally, in Morocco, the removal of the consumption subsidy results in the reduction of sugar consumption by 11.4% relative to the baseline. Under scenario 2, Moroccan sugar consumption would decrease by nearly 4%.

4.4. Sensitivity analysis

In conducting the sensitivity analysis, baseline price–response elasticities in the supply, demand and inventory equations for all countries were first doubled and then halved. The analysis involved the recalibration of the intercepts in these equations in order to maintain the original baseline. Then the scenarios were run with the alternative elasticities. Detailed results are presented in Appendix Table E of Elobeid and Beghin (2005).

The doubling of elasticities makes the model more price responsive. Policy reforms induce larger marginal changes in supply, demand and trade, and as a result, more moderate world price increases. Brazil and Australia expand their production beyond levels indicated in the original scenarios 2 and 3, whereas Japan and FSU decrease their production and increase their consumption by a larger extent. The loss of protection is exacerbated in highly distorted markets such as the EU and Japan and the response to the larger loss is also greater as the elasticity of supply is doubled.

With the halving of elasticities these tendencies are reversed: world price increases are larger because marginal responses of supply and demand, and trade flows are diminished. Note that the qualitative results of the original analysis are maintained throughout as the direction of changes is unaffected by changes in elasticities, with the unique exception of the US in scenario 2 when elasticities are halved. In the latter case, 'nothing' happens compared with the baseline as the US sub-model becomes so inelastic and the US policy removal is offset fully by the world price increase. In average terms, when elasticities are halved in scenarios 2 and 3, the world price is about 11% higher than that when elasticities are unchanged.

The sensitivity analysis produces a few extreme results. In the case of scenarios 2 and 3, when elasticities are doubled, the model goes to a corner solution in terms of inventories for Brazil as inventories become more responsive to the higher world price. This also occurs for production in Japan with the removal of protection. Sugar beet area harvested in Japan falls to zero faster than sugarcane area harvested resulting in positive, albeit drastically diminished, sugar production during the projection period. In scenario 3, where consumer subsidies are removed, Cuba's sugar consumption falls to zero in the first year because of the dramatic increase in world price, the removal of subsidies and the higher demand response to price. Cuban sugar consumption remains positive although very low after the first year.

Sensitivity analysis was also conducted on the price transmission equations (in conjunction with the supply, demand and inventories equations). We first doubled and then reduced by half the elasticities in these equations. Where elasticities were originally high, an upper bound of one was implemented (full transmission). The latter analysis tended to exacerbate tendencies observed in the two previous cases, accentuating price responses when elasticities were halved and decreasing them when elasticities were doubled. Results of the latter analysis are available from the authors.

5. Conclusions

We analyse a sequence of incremental policy reforms in international sugar markets: the removal of trade distortions, followed by the removal of trade distortions and domestic production support, and finally the removal of pure consumption distortions in addition to the previous removals. The sequence of reforms is structured by order of decreasing importance of these types of distortions. Trade distortions are the largest contributor to distortions in sugar markets and are responsible for large price and consumption effects. But domestic production policies in highly protected OECD countries are also important to maintain production in these countries. With the removal of both trade and production distortions, it is clear that a major sugar production relocation would take place away from highly protected OECD markets (the EU, Japan, and, to a lesser extent, Mexico and the US) towards competitive producers in moderately protected developing economies, chiefly Brazil and Cuba, and to moderately protected OECD countries, mostly Australia, and less obviously to producers in protected countries such as Turkey and Indonesia because of the large world price effects. EU and Japanese producers have much to lose in unfettered sugar markets. The large increase in price under free trade is little solace for these sugar producers, many of whom would exit the industry. The latest negotiated buy-out programme in the EU focuses on compensation for high-cost producers to exit the domestic market as part of the new sugar Common Market Organisation. This, in addition to the elimination of export subsidies, will prepare the EU to eventually become a net sugar importer as EBA sugar imports will be unrestricted starting in 2009. Japanese sugar producers may well be the last bastion of protectionism in global sugar markets.

The analysis also makes clear that trade liberalisation without domestic reforms would induce import surges in the US. These surges are likely to increase the fiscal cost of domestic programmes under current policy commitments. A similar tension between trade and domestic policies has already emerged in the EU, which soon will no longer be able to export expensive domestic sugar displaced by cheaper imports. Trade liberalisation would just exacerbate this situation. Further domestic reforms will have to be put in place as suggested by the forthcoming reforms of the Common Market Organisation for sugar.

We obtained large world price effects reflecting the price-inelastic nature of sugar markets. We found that at the end of the outlook period, world prices would increase by about 27% with the imposition of free trade and by a staggering 48% when all trade and production distortions are removed. These figures are slightly inflated by strong initial price shocks, which take time to taper because of the slow dynamic adjustment of sugar production. Supply adjustment in sugar production takes time, and the price changes in the later years provide a sense of how markets

would adjust in the long run to such radical policy shocks. These estimates of the price effects are large but within the ballpark of previous estimates obtained with partial-equilibrium models (Borrell and Pearce, 1999; Sheales *et al*., 1999; Wolhgenant, 1999). Sugar markets are price-inelastic both on the supply and demand sides. This fundamental characteristic explains why reforms have large price effects but more moderate effects on production, consumption and trade. Partial-equilibrium models reflect the belief in limited factor substitution within agriculture. By contrast, computable general equilibrium (CGE) models predict smaller price effects and larger production and consumption effects because they encompass factor price changes and associated adjustments in factor use leading to larger market responses to prices in supply.

There is no consensus about the undistorted world price. Partial-equilibrium estimates tend to be higher than those of CGE studies (Borrell and Duncan, 1992; Frandsen *et al*., 2003; van der Mensbrugghe *et al*., 2003). Given that policies and market conditions change over time, a useful contribution to this debate is to provide a new estimate of the undistorted world price of sugar. CGE analyses provide a consistent framework to assess economy-wide effects of sugar reform, which are typically very small. However, these models assume constant returns to scale in production – marginal cost is horizontal as long as factor and input prices do not change. CGE models compare and contrast equilibrium states after supply adjustments, which may include 'rigidities', e.g. a short-run case in which land use is fixed. CGE models encompass factor/input price changes and associated adjustments in factor use, which typically help explain the differences between partial equilibrium and general equilibrium results. Supply eventually exhibits some positive slope when land is constrained, and supply expansion implies higher land rental rates and input prices as resources are moved. For sugar reforms, these effects are small in most CGE models. Furthermore, the biology of the slow growth and perennial nature of sugarcane is typically not considered by CGE models. All these reasons explain why commodity price effects tend to be smaller in CGE models than those estimated using the CARD/FAPRI model.

Sugar producers' groups in protected markets tend to insist on using the multilateral negotiation route to liberalise sugar markets often as a convenient veil of legitimacy for their protectionist interests. Our results provide some credence to this strategy as it appears that the competitive segment of the sugar industries would survive in unfettered markets in the US, Turkey and other protected markets. A major qualifier to our analysis is that our model may understate exit/entry and investment decisions. The drastic world price increases predicted by our analysis may induce massive investment in sugar production and reduce these price changes considerably.

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