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Projecting World Raw Sugar Prices

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Abstract

Three factors are critical to the long-term outlook for U.S. sugar supply and use: the U.S. sugar program, the availability of sugar imports from Mexico, and the level of sugar prices in the world market. This report presents a modeling framework that can be used to generate world sugar price projections. In addition to using the traditional world supply and demand analysis, the modeling framework emphasizes the role of Brazil, the world's largest producer of sugarcane, sugar, and sugarcane-based ethanol. The resulting model is intended to improve USDA's world sugar price forecasts and enhance scenario analyses to derive implications for future world prices and U.S. sugar policy. Analysis of alternative Brazil scenarios illustrates impacts on the U.S. budgetary cost of loan forfeitures for sugar under current U.S. policies. The report includes documentation, analysis, and model projections for world sugar markets through 2024/25.

Keywords: world raw sugar prices, Intercontinental Exchange No. 11 raw sugar futures contract, world sugar model, Brazil, Center/South Brazil, Brazil ethanol supply and demand, long-term USDA sugar price forecasting

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Approved by USDA's World Agricultural Outlook Board

Introduction

The most important factors affecting U.S. sugar supply and use are the U.S. sugar program, the availability of sugar imports from Mexico, and the level of sugar prices in the world market. This last factor has recently become of increased interest to market participants, analysts, and policy-makers. In the past, interest has been limited because world sugar prices have been far below levels at which the U.S. sugar program supports domestic prices. However, during the period August 2009 through July 2012, world prices for raw sugar averaged more than 5 cents/pound (lb) above the U.S. raw sugar loan rate. Although world prices have since fallen below loan-rate levels, changes in U.S. raw sugar prices have remained strongly correlated with changes in world prices. In fiscal year 2013 (2012/13), weakness in world raw sugar prices contributed notably to sugar loan forfeitures and USDA purchases of sugar for ethanol and livestock-feed resale and trade-license exchanges, costing the Commodity Credit Corporation (CCC) more than $250 million.[1]

Due to Brazil's large percentage share of world sugar production and trade, long-term upward trends in Brazilian sugar production costs are expected to keep world sugar prices from descending to the low levels of the early-to-mid 2000s (which ranged between 6.44 and 9.99 cents/lb).[2] Higher world prices, along with normal year-to-year volatility, will affect U.S. sugar policy analysis and projections of future USDA budget expenditures.[3]

ERS has developed a model that generates world sugar price forecasts for timelier forecasting and improved scenario analyses to derive implications for future world prices and U.S. sugar policy. The model emphasizes the large influence of Brazilian sugar production and exports on world sugar pricing. Unlike all other sugar-producing countries and regions, Brazil's sugarcane sector supplies large quantities of both sugar and sugarcane-based ethanol. It is important for the price-projection framework to capture the factors influencing the choice of how much sugar and ethanol to produce, and this report describes and documents the resulting model.

[1]See "The Road to Forfeitures" in *Sugar and Sweeteners Outlook*, SSS-M-303, Nov. 2013.

[2]Situation and Outlook Report No. SSSM-297-01, May 2013, "World Sugar Prices: The Influence of Brazilian Costs of Production and World Surplus/Deficit Measures."

[3]For a discussion of world sugar pricing volatility, see M. J. McConnell, E. Dohlman, and S. Haley, "World Sugar Price Volatility Intensified by Market and Policy Factors," in *Amber Waves,* (USDA, Economic Research Service, September 2010).

USDA Modeling of the World Sugar Market

In addition to monitoring and analyzing supply/demand balances in the United States and Mexico, the monthly ERS *Sugar and Sweetener Outlook* examines developments in world sugar markets based on data and analysis by the Foreign Agricultural Service (FAS), LMC International, the International Sugar Organization, and others. At least twice a year (in May and/or June and December), ERS evaluates world production, trade, and pricing prospects for the current and out-marketing year.

ERS has done previous research on the structure of world sugar pricing. McConnell, Dohlman, and Haley (2010) emphasized the role of Brazil in determining the long-term course of world prices. As the world's largest exporter of sugar, Brazil has the dominant role in meeting the growing world demand for sugar, but its world market competitiveness is vulnerable to exchange rate volatility and uncertain developments in the domestic ethanol market.

The growth of flex fuel vehicles (FFVs) in Brazil has made its transportation sector the sugar industry's main competitor. FFVs give Brazilian drivers the option of using either gasoline, which has a minimum anhydrous ethanol blend requirement set by the Government, or hydrous ethanol (no blending with gasoline). Because ethanol in Brazil is derived from sugarcane, the price relationship between sugar and ethanol is fundamental to the supply of both products. At the same time, ethanol producers must keep their prices competitive with gasoline in energy-equivalent terms. Government-determined gasoline prices heavily influence ethanol prices and the subsequent return to sugar/ethanol producers. State governments impose different tax rates on ethanol, changing the economics of ethanol regionally within Brazil. Therefore, changes in gasoline and oil prices and tax policy can have major implications for domestic use of ethanol and producer profitability. These effects are transmitted to the world sugar market and directly influence world sugar prices.

Haley (2013) investigated trends in world raw sugar prices and concluded that there are three basic determinants of medium-to-long-term world raw sugar pricing. The first is the long-term equilibrium between world raw sugar prices and costs of producing sugar in Brazil, the world's largest sugar producer and exporter. The relationship between the Brazilian currency exchange rate and the U.S. dollar has an important impact on costs. The second determinant is medium-term world sugar supply/demand conditions. Two important measures from the U.S. Department of Agriculture's world sugar Production, Supply, and Distribution (PSD) database were derived to show that stock-holding relative to levels of sugar consumption has an important effect on the sensitivity of the world sugar prices to changes in overall world sugar availability. Results also supported findings of the aforementioned 2010 sugar price volatility report that Government policies in India, Pakistan, and China, along with short sugarcane production cycles in those countries, lead to volatility in the world sugar supply as these countries can swing from net exporting to net importing and back over a relatively short period. The third determinant, a risk-related component, is errors in forecasting supply and demand balances of previous years due to unanticipated events.

Traditional analysis of the world sugar market has stressed comparisons of supply with demand. Demand is relatively inelastic in the short to medium term, implying that consumers reduce demand only when world sugar prices move to very high levels. Over the same time span, sugar production has also often been considered unresponsive to prices because of the 1-year planting-harvesting-processing cycle for sugarcane and sugarbeets. Supply/demand conditions are reflected in stock-holding, with prices the signal for market participants to allocate supplies between usage and stocks.

In recent decades, the structure of the world sugar market has changed fundamentally because of sugar/ethanol production tradeoffs in Brazil. The emergence and rapid growth of FFVs in Brazil has motivated large investments in sugarcane in the Center/South region. Already the world's largest sugarcane producer, Brazil has very large tracts of unimproved livestock pasture that can be developed for sugarcane cultivation. Because of good long-term prospects for continued population and income growth, large increases in the country's automotive fleet—and the subsequent demand for transportation fuel, both ethanol and gasoline—are expected.

These developments will be primary determinants of world sugar pricing. Any effort to make projections will have to carefully model Brazil's sugarcane and transportation energy sectors, emphasizing analyses of the sugarcane, sugar, ethanol, energy, and automotive industries.

There are reliable data with which to examine sweetener and transportation energy markets. Sources include FAS's Production, Supply, and Distribution (PSD) database (global supply and use data); FAS's Global Agricultural Information Network (GAIN) Reports (current policy and medium-term forecasts); Brazil's Ministério da Agricultura Pecuária e Abastecimento (MAPA); UNICA (Brazil's sugarcane industry association); Agencia Nacional do Petróleo, Gás Natural e Biocombustiveis (ANP) (Brazil energy statistics); Departmento Nacional de Trânsito (Deantran) and Associação Nacional dos Fabricantes dos Veiculos Automotores (ANFAVEA) (Brazil's automotive industry); Economic Research Service (world macroeconomic projections for USDA long-term projections); and LMC International (sugar production cost estimates and production data for sugarcane, sugarbeets, and sugar).

Modeling Brazil's Sugar Sector

There are three primary tasks for developing this modeling framework. In each, simplifying assumptions are made to keep the overall approach as basic as possible. The tasks are:

1. ***Specifying how ethanol prices are determined (that is, within the framework)***. This poses the question of how ethanol is actually used, which involves consideration of fuel, export, and nonfuel demand, with fuel demand—because of its relative size—the most important. Relevant factors include consumer gasoline pricing and the ratio at which anhydrous ethanol is required for blending with gasoline. In a dynamic setting, we would need to project how underlying fuel demand will evolve over time. In a more complex exercise (not pursued here), much attention would be paid to national, regional, and local taxing policies and the vast array of other policies that favor or tax ethanol production and consumption. Further, export demand may influence domestic producer pricing. However, development of a model of the world ethanol market—though potentially important— is beyond the scope of the present study.

2. ***Determining net returns for sugarcane products.*** Ethanol prices come from the first task, and world sugar prices are determined simultaneously in the world sugar market. Because Brazil is the world's largest sugar producer and exporter, trends in long-run world sugar prices follow trends in Brazil's dollar costs of producing sugar.[4] Exchange rate changes, as well as agronomic and macroeconomic conditions in Brazil and other sugar-trading countries, have a strong effect on returns. Brazilian costs of producing sugar are the lowest among major producers and are likely to continue lower because of the country's infrastructural ability to produce sugar and ethanol from a single sugarcane crop. Also important, but harder to model, are the sugarcane sector's contributions to domestic energy production from the burning of bagasse (sugarcane plant residue left after sucrose extraction) and the sale of power in excess of factory needs to the energy grid

3. ***Projecting area for sugarcane cultivation and the proportional split between sugar and ethanol by using net return estimates***. Annual fuel demand for an automotive fleet composed of ever-increasing FFVs is projected to expand, perhaps as much 5 percent per year. With a very large area of land suitable for sugarcane production that faces low opportunity costs (mainly cattle grazing), a core rate of projected expansion may not seem unreasonable. The important element is to account for deviations from the core rate proportional to modeled sugarcane sector returns. Projected returns not consistent with the expected long-term path of those returns could have a very strong effect on estimates of overall production of sugar and ethanol. Also, the expansion of milling, refining, and distilling facilities could affect the technological potential for tradeoffs between sugar and ethanol. According to Brazil's Agricultural Ministry (MAPA), over the last 10 years, ethanol's share of the sugarcane crop has varied between 50 and 60 percent. A shift in investment incentives could boost this share above the 60-percent level.

[4]See Haley (2013), referenced previously.

Brazil's Demand for Ethanol

Table 1 shows Brazil's marketing-year ethanol supply and use from 2003/04 through 2012/13. Total supply, including imports, reached its peak in 2010/11 at 27.812 million cubic meters (m3) and has leveled off in the last 2 years. The growth of FFVs helped propel fuel demand for hydrous ethanol to 15.437 million m3 in 2009/10, but demand has since decreased to only 9.885 million m3 as falling gasoline prices have proven more attractive to consumers. Demand for anhydrous ethanol has grown in line with increased use of gasoline for Brazil's automotive fleet. Export and nonfuel ethanol demand have been much smaller than fuel demand but have been variable. In the years before hydrous ethanol demand increased, combined export and nonfuel uses constituted over 30 percent of total demand. The combined ratio has varied inversely with hydrous fuel demand, topping 30 percent in 2012/13 when hydrous demand fell below the 10.0 million m3 level but falling below 20 percent in the years of greatest demand for hydrous ethanol.

The course of projecting export and nonfuel demand is beyond the scope of this modeling effort. Because overall fuel (that is, gasoline and hydrous ethanol) demand is expected to rise strongly through 2024/25, it is assumed that the combined demand for export and nonfuel ethanol will average about 20 percent of the total.

The steps taken to model ethanol fuel demand, including producer pricing projections, are detailed in Appendix 1, table 1. The first step employs the Brazilian macroeconomic data used in ERS's International Macroeconomic Database (table 2) for projecting growth in Brazil's automotive fleet. This report uses a simple method of projecting population per automotive vehicle as a function of changes in real per capita Gross Domestic Product (GDP).

Table 1
Brazil ethanol supply and use, May/April, 2003/04-2012/13

	Anhydrous ethanol production	Hydrous ethanol production	Imports	Total supply	Exports	Anhydrous fuel	Hydrous fuel	Nonfuel ethanol plus stocks	Exports/ Prod ratio	Nonfuel/ Prod ratio	Combined/ Prod ratio
2003/04	8,768	5,872	2	14,642	926	5,505	3,628	4,583	6.33	31.30	37.63
2004/05	8,172	7,035	0	15,208	2,539	5,817	4,464	2,388	16.69	15.70	32.40
2005/06	7,663	8,145	0	15,808	2,511	5,729	5,089	2,480	15.88	15.69	31.57
2006/07	8,078	9,861	4	17,943	3,846	5,143	6,960	1,995	21.43	11.12	32.55
2007/08	8,465	13,981	1	22,447	3,631	6,085	10,774	1,956	16.18	8.71	24.89
2008/09	9,630	18,051	2	27,684	4,689	6,307	14,450	2,238	16.94	8.09	25.02
2009/10	6,938	18,801	41	25,780	2,940	6,429	15,437	973	11.40	3.78	15.18
2010/11	8,027	19,577	207	27,812	1,896	7,811	14,594	3,511	6.82	12.62	19.44
2011/12	8,624	14,113	1,401	24,138	1,916	8,091	10,460	3,671	7.94	15.21	23.14
2012/13	9,695	15,749	216	25,661	3,480	7,988	9,885	4,308	13.56	16.79	30.35

Source: Production: MAPA; Trade: GTIS; Fuel demand: ANP; Nonfuel plus stocks: residual.

Table 2
Brazil macroeconomic projections through 2025

	Population (1,000)	Per capita GDP (US dollars)	Real/dollar exchange rate	Inflation rate
2000	176,320	4,360	1.83	7.0
2001	178,870	4,355	2.36	6.8
2002	181,418	4,408	2.92	8.5
2003	183,960	4,397	3.08	14.7
2004	186,489	4,585	2.93	6.6
2005	188,993	4,667	2.43	6.9
2006	191,469	4,789	2.18	4.2
2007	193,919	5,016	1.95	3.6
2008	196,343	5,210	1.83	5.7
2009	198,739	5,114	2.00	4.9
2010	201,103	5,433	1.76	5.0
2011	203,430	5,517	1.67	6.6
2012	205,717	5,538	1.95	5.4
2013	207,965	5,626	2.14	6.0
2014	210,174	5,761	2.25	5.5
2015	212,346	5,931	2.35	3.6
2016	214,479	6,106	2.45	3.9
2017	216,572	6,289	2.53	3.9
2018	218,622	6,480	2.61	3.8
2019	220,633	6,677	2.67	3.8
2020	222,608	6,883	2.74	3.7
2021	224,546	7,096	2.81	3.5
2022	226,443	7,318	2.88	3.5
2023	228,299	7,549	2.95	3.5
2024	230,113	7,789	3.02	3.5
2025	231,887	8,039	3.10	3.5

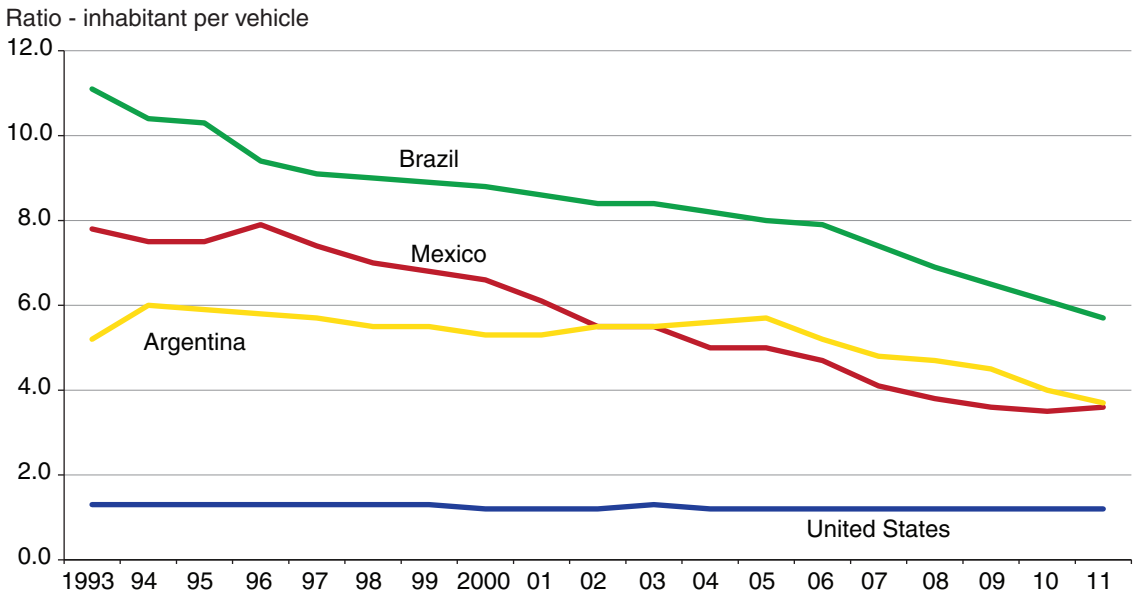
Source: USDA, Economic Research Service, Long-term International Macro Database.

Estimates of inhabitants per vehicle through 2011 are shown in figure 1, along with comparisons with ratios for the United States, Mexico, and Argentina. The United States has the lowest ratio, which has not varied much over the observation period. Brazil's rate has been higher than either Mexico's or Argentina's, but has been consistently declining as per capita GDP has increased. As the first data column of table 3 indicates, Brazil's population per vehicle declines to Mexico's and Argentina's 2011 level (3.9) by 2022/23, and the projected level for 2024/25 is 3.6. The implication for Brazil's automotive fleet is strong growth, from 35.0 million vehicles in 2011/12 to over 64.0 million vehicles in 2024/25. As figure 2 shows, practically all new automotive vehicle registrations in Brazil since 2008 have been for FFVs, implying near-perfect substitutability between gasoline and hydrous ethanol through 2024/25.

The third data column of table 3 shows average fuel use per vehicle since 2000/01. Because there do not seem to be clear use trends through 2012/13 and because average fuel use stabilized between 2007/08 and 2012/13, the 2012/13 level of 1,286 liters per vehicle is assumed to hold throughout the projection period. (Fuel demand is somewhat responsive to energy prices, but no clear relationships could be discerned for use in the model.) The fourth data column shows calculated annual fuel requirements.

Figure 3 shows the modeling of automotive fuel supply and use. As explained, the number of vehicles and average unit fuel use determine demand. Fuel supply is constituted of gasoline C and hydrous ethanol. Gasoline C is a mixture of pure gasoline (referred to as "A") and anhydrous ethanol. The mix ratio is policy-determined. Because hydrous ethanol has only about 70 percent of the fuel mileage capacity of gasoline, the quantity for use must be adjusted downward by 30 percent to make it comparable with Gasoline A. The mix ratio determines the respective shares of hydrous and anhydrous ethanol in the total.

Figure 1
Inhabitants per vehicle: United States, Brazil, Mexico, Argentina, 1993-2011



Source: Associação Nacional dos Fabricantes dos Veiculos Automotores.

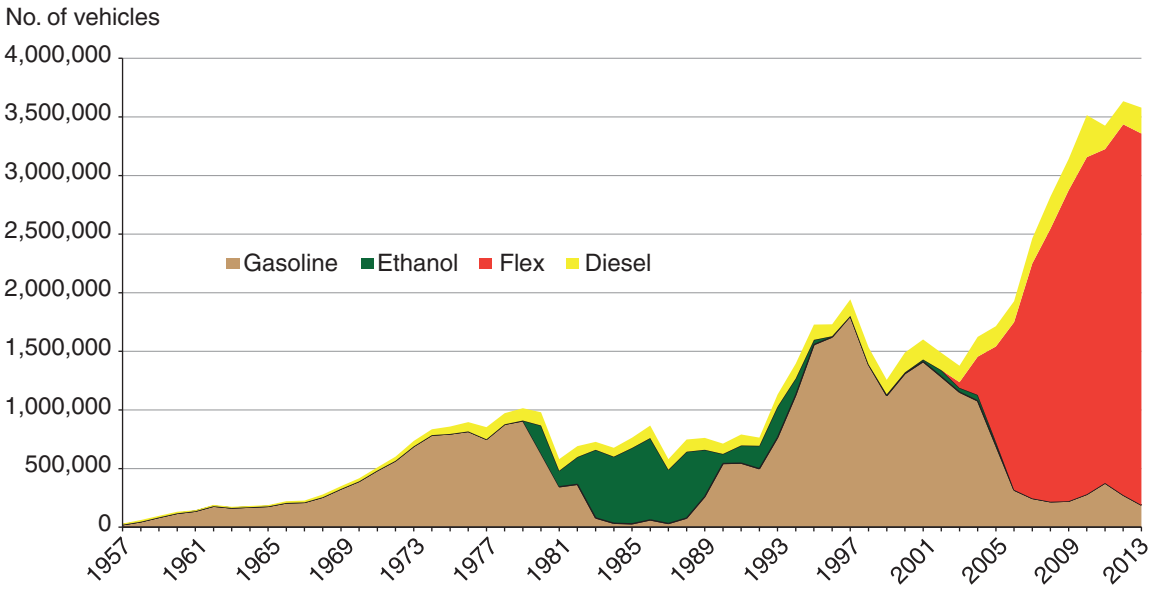
Table 3

Brazil automotive fuel requirements, estimated and projected through 2024/25

	Population per vehicle (calendar yr)[1]	Automotive vehicles (Adj. to Apr/Mar crop year)	Average fuel per vehicle (liters)	Fuel: gasoline C plus hydrous ethanol (gas basis) (1,000 liters)
2000/01	9.164	19,505,750	1,307	25,486,371
2001/02	8.934	20,262,000	1,221	24,730,154
2002/03	8.766	20,916,000	1,179	24,660,601
2003/04	8.643	21,560,750	1,150	24,798,802
2004/05	8.439	22,384,750	1,183	26,473,346
2005/06	8.236	23,284,500	1,169	27,210,191
2006/07	7.980	24,450,750	1,176	28,764,024
2007/08	7.600	26,067,250	1,215	31,666,853
2008/09	7.166	28,021,500	1,252	35,091,236
2009/10	6.724	30,248,500	1,250	37,801,624
2010/11	6.290	32,712,500	1,259	41,198,914
2011/12	5.887	35,013,454	1,255	43,950,016
2012/13	5.716	36,427,606	1,286	46,861,748
2013/14	5.569	37,856,063	1,286	48,699,366
2014/15	5.390	39,564,289	1,286	50,896,888
2015/16	5.195	41,496,915	1,286	53,383,085
2016/17	4.995	43,588,784	1,286	56,074,139
2017/18	4.801	45,780,947	1,286	58,894,214
2018/19	4.615	48,078,384	1,286	61,849,718
2019/20	4.435	50,486,528	1,286	64,947,638
2020/21	4.261	53,010,625	1,286	68,194,725
2021/22	4.093	55,655,439	1,286	71,597,106
2022/23	3.932	58,426,124	1,286	75,161,412
2023/24	3.776	61,328,735	1,286	78,895,433
2024/25	3.626	64,338,729	1,286	82,767,595

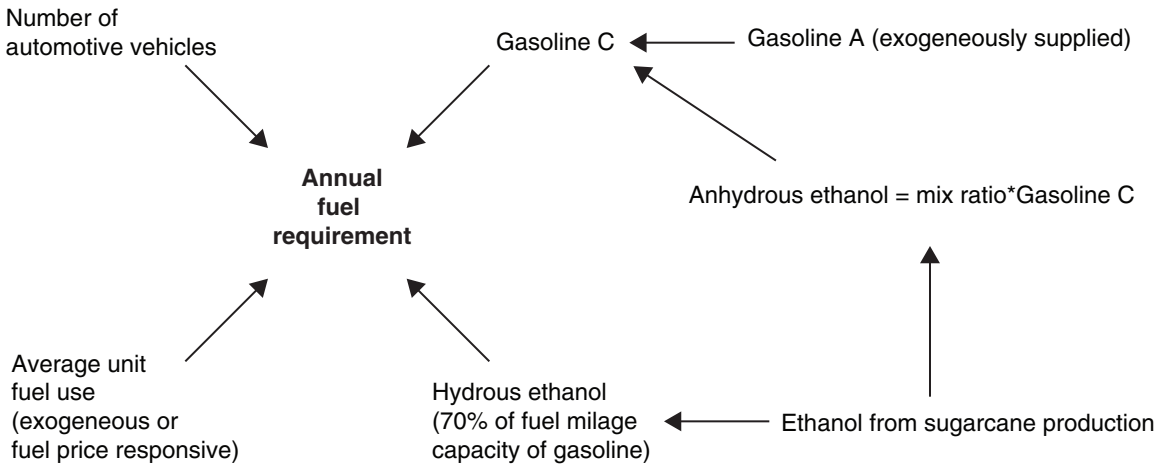
[1]Population per vehicle: percent change = -0.0219-0.564*(per capita GDP:percent change), adj R2=0.492, 1994-2010.
Source: Associação Nacional dos Fabricantes dos Veiculos Automotores; ANP, and USDA, Economic Research Service.

Figure 2
Total vehicle registrations, by fuel type, 1957-2013



Source: Associação Nacional dos Fabricantes dos Veiculos Automotores.

Figure 3
Modeling of Brazil automotive fuel supply and use



Source: USDA, Economic Research Service.

The total amount of ethanol available in a particular year is recursively determined by expected prices and realized investments from the prior year. This means that technological constraints of time period *t*, along with expected prices for *t*+1 formed in *t*, fix the proportion of sugar and ethanol that can be produced in *t*+1. Although the quality of the sugarcane crop can affect this ratio, this cannot be known in advance.

The price of gasoline is currently policy-determined. Its monthly price ranged narrowly between 2.70-2.90 reais ($1.40-1.50) per liter in 2011-13. It is assumed that the price will continue to be determined by policy, but will grow in line with the overall inflation rate. An alternative specification could make price changes proportional to changes in real-denominated oil prices.

The relationship of percentage changes of the hydrous ethanol-gasoline price ratio as a function of the proportion of hydrous ethanol use to gasoline use is estimated (see Appendix II, table 1). A statistically significant coefficient value of -0.2764 is used in the model to derive an annual pump price for hydrous ethanol.

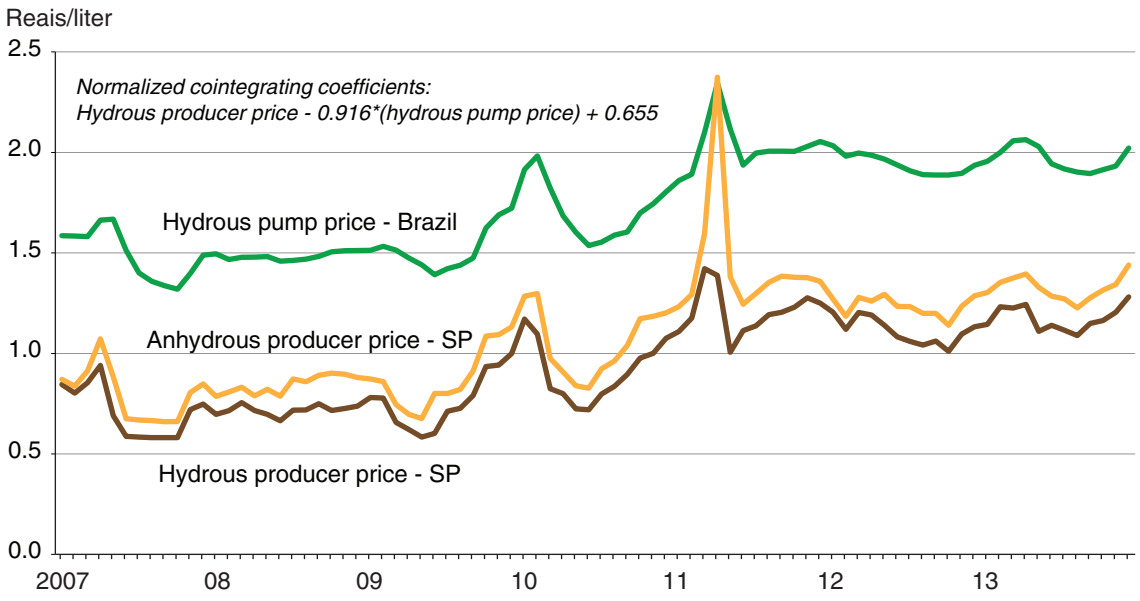
Figure 4 shows the close correspondence of producer and pump-level hydrous ethanol prices. An estimated long-term co-integrating relationship between these prices is used for mapping the pump price to the producer price. Figure 4 also illustrates the close relationship between anhydrous and hydrous producer prices. Because an additional step is required to produce anhydrous ethanol from hydrous ethanol, its price is higher by approximately the additional cost of that step.

Net Returns to Sugarcane Production in Brazil

Table 2 in Appendix I outlines the stages for determining the economic benefits and costs of sugarcane and its products. These returns are necessary for projecting production.

Brazil produces sugarcane in two distinct areas: the Center/South and the North/Northeast. The Center/South area is the larger of the two and is where all sugarcane area expansion is expected. Center/South sugar production costs are among the lowest of those in all sugar-producing countries. The North/Northeast is the traditional base for Brazilian sugar production. Its costs are much higher, and its facilities are not as new or efficient as in the Center/South. Returns must be projected for both regions.

Figure 4
Ethanol prices in Brazil



Source: MAPA (www.agriculture.gov.br).

The source of production cost estimates is LMC International; ERS estimates these costs forward through the projection period for both regions. Costs are affected by sugarcane sector yields and other factors, including exchange rate movements, inflation, crop sizes, energy costs, and wage rates (USDA/ERS, May 2014).

Dollar-denominated world sugar prices are determined in the world sugar market. Because most sugar-producing countries have an October/September marketing year, the larger world sugar model uses the price averaged over October of one year through September of the next year. More relevant for Brazil is the April/March world sugar price that more nearly coincides with the May/April crop year of the Center/South. ERS projects this price as a weighted function of the current and one-year-lagged October/September price and also converts it into real-denominated terms.

Two closely followed Brazilian price series are the Very High Polarity (VHP) export price and the crystal sugar price, both in São Paulo. Both these prices are strongly correlated with real-denominated world raw sugar prices. ERS projects both these prices and combines them in a sugar-blend price using proportional weighting. ERS does the same for ethanol and then follows with a blend price, with sugar and ethanol expressed in terms of total recoverable sugars (TRS)[5] TRS is commonly used to refer to the sugar-solids content of sugarcane. In countries where only sugar is processed from sugarcane, the usual reference is sucrose content. Because other sugar solids besides sucrose contribute to ethanol production, the TRS measure is used instead.

Differencing of the TRS blend price and costs produces the net return, which can also be expressed in percentage terms.

Sugarcane Production and Use in Brazil

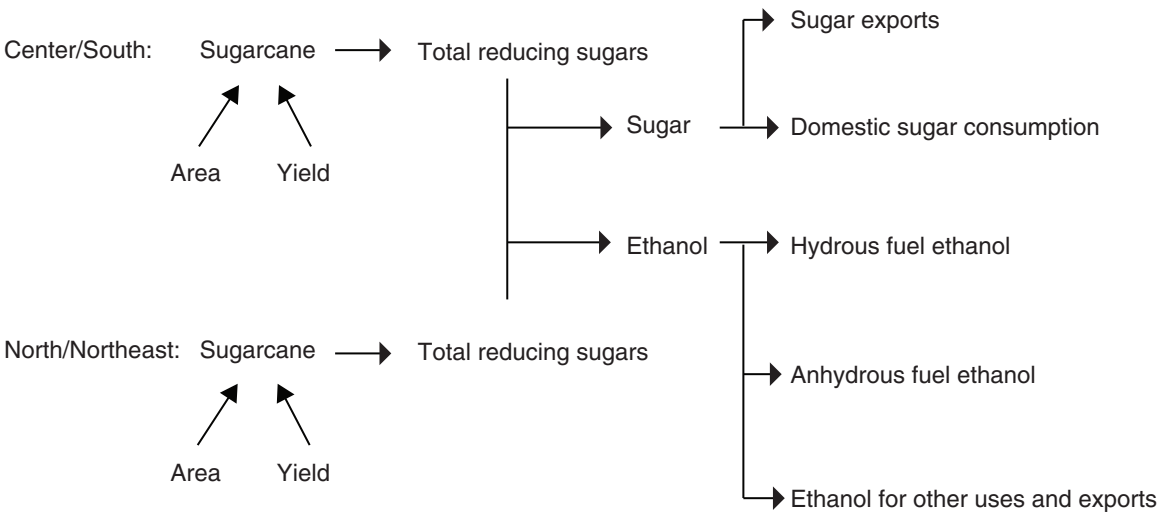
Figure 5 shows a diagram of Brazil sugarcane supply and use for any particular year. Sugarcane and TRS yields in both the Center/South and North/Northeast sugarcane production regions are variable from year to year, with no discernable trends. ERS uses averaged values for both types of yield in both regions and projects them as remaining flat through the entire projections period.

Appendix I, table 3 shows the stepwise development of the production and use framework. Base area expansion is an exogenous assumption: 3 percent in the Center/South and 1 percent in the North/Northeast. These growth rates, especially in the Center/South, reflect the optimism of expanded ethanol fuel demand. Realization of these rates, however, is dependent on sector returns. In the absence of data to estimate a relationship, and in recognition of the need to allow for expansion, ERS incorporates into the framework a linear (straight-line) relationship between each region's average cash cost and average total cost of production (fig. 6). For revenues in excess of average total cost, the expansion rate is greater than the base rate, as shown in the figure. If the revenue equals the average total cost, the realized rate is equal to the base rate. Revenues between the average total and cash costs indicate an expansion greater than zero but less than the base, as per the linear schedule. For a revenue equal to the average cash cost, the expansion rate is zero, while a revenue below cash costs indicates area contraction.

Figure 7 shows the division of TRS for sugar production. The current-year ratio of the sugar-blend price to the ethanol price determines the next year's proportion of the TRS split between sugar and ethanol. Capital can be allocated between uses prior to the start of the producing season but cannot

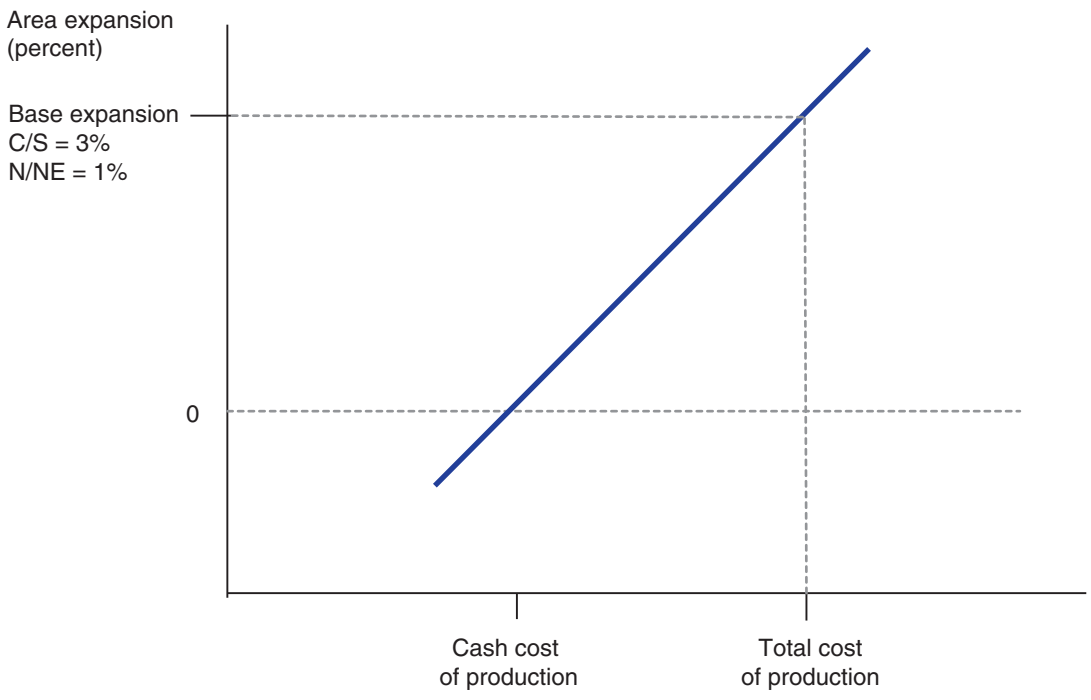
[5]In Portuguese, total recoverable sugar has the abbreviation ATR.

Figure 5
Brazil sugarcane sector - production and use



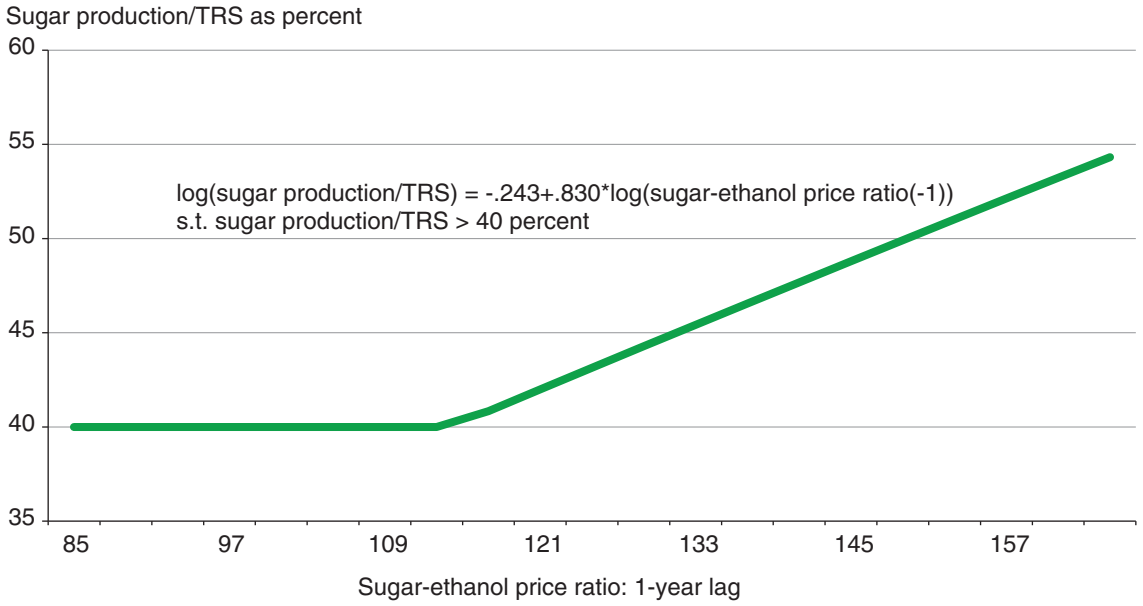
Source: USDA, Economic Research Service.

Figure 6
Brazil model: Area expansion as function of net production return



Note: C/S = Center/South; N/NE = North/Northeast.
Source: USDA, Economic Research Service.

Figure 7
Brazil Center-South sugar production share of total reducing sugars (TRS)



Source: USDA, Economic Research Service.

be adjusted after production has started. It is assumed, at least initially, that there is a low share (40 percent) of Center/South TRS that can only be used for producing sugar. This minimum reflects installed capital constraints on switching between sugar and ethanol production. As the sugar-ethanol price ratio increases, Center/South production capital is reconfigured to allow increased sugar production according to the schedule illustrated in the figure. With determination of their proportions, sugar and ethanol production can be projected in the next period.

ERS analysis could discern no income or own-price elasticity for Brazil sugar demand. Per capita sugar consumption is, therefore, fixed at the 2012/13 level for all projection years; that is, sugar consumption increases at the same rate as population. The framework assumes sugar imports equal to zero and a constant ending stocks level. Sugar exports are projected as the difference between production and consumption.

Appendix II, table 1 provides more detail regarding the structure and the equations discussed thus far.

Framework for Other Countries and Regions

Appendix II, table 2 lists all other countries and regions in the analytical framework and provides a general specification of the sugar supply and demand in each country/region. The equations shown in the table are a starting point for estimation and are modified where necessary to provide for the best fit. Appendix II, table 3 provides estimation results in detail.

The other-country specification is fairly simple: there is no detail regarding policies that influence production, consumption, or trade. The approach is very much one of reduced form, emphasizing quantitative responses to world sugar price changes with no regard for the intervening policy filters. Mostly, each region's equations provide a response mechanism to changes coming from Brazil. Although not ideal, the implemented specification is an approach that can be further refined in the future.[6]

[6]As discussed, an important goal of this report is to describe a framework that generates world price forecasts for use in analysis of U.S. and Mexico sugar and sweetener sectors. The model equations for the United States and Mexico are not currently specified in order to allow endogenous policy-specific reactions to world price changes. The next step in model development would be to incorporate equations similar to those in ERS's U.S.-Mexico sugar baseline model into the world model framework. See the *Sugar and Sweetener Outlook*, February 2014, pp. 3-17, for a discussion of the baseline modeling framework and results for 2014/15-2023/24.

Model Projections

The model is run to generate a base solution for world sugar supply and use and for world raw sugar prices. Values of exogenous variables (such as exchange rates, per capita income, and population) are the same as those used in USDA's *Agricultural Projections to 2023*. The Brazil ethanol-gasoline mix ratio is set at 25 percent. The lower limit of sugar's TRS share is 40 percent.

Table 4 shows the evolution of world sugar supply and use through 2024/25. (Results for individual countries and regions are detailed in Appendix III, table 1). Production, use, and stocks projections are shown in figure 8, along with earlier period results starting in 2000/01. Figure 9 shows world sugar production surpluses/deficits (that is, production minus use) and stocks-to-use ratios.[7]

Table 4
World sugar supply and use, base projection, 2013/14-2024/25

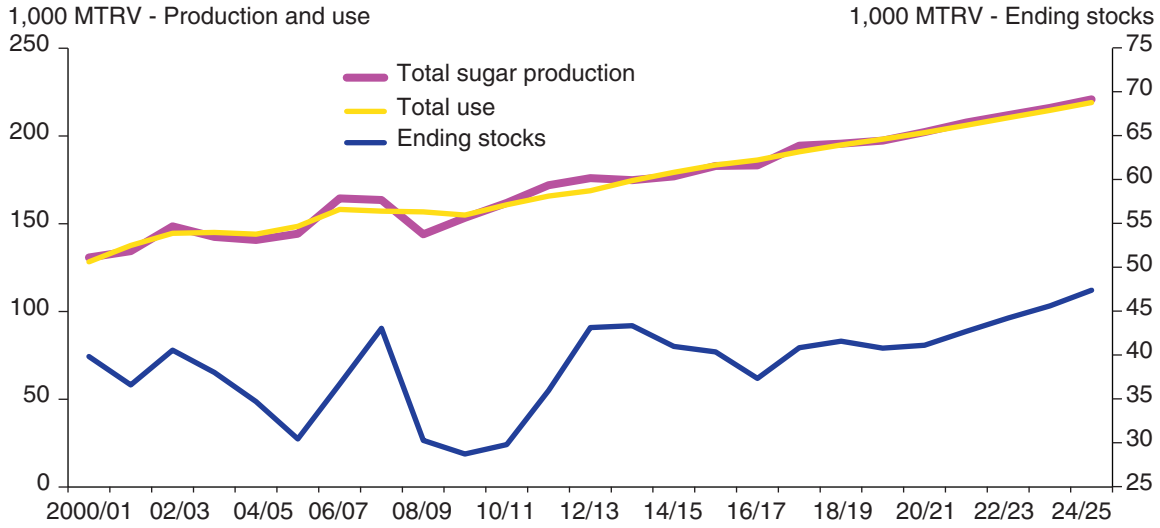
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)										
Beginning stocks	43,379	41,030	40,389	37,376	40,870	41,622	40,823	41,161	42,734	44,252	45,637
Beet sugar production	36,676	36,787	37,867	39,570	40,090	40,898	41,716	42,242	42,743	43,290	43,784
Cane sugar production	140,287	146,117	145,431	154,964	155,531	156,502	160,542	165,467	169,167	172,749	177,128
Total sugar production	176,963	182,904	183,298	194,535	195,621	197,400	202,258	207,709	211,910	216,039	220,912
Total imports	56,189	59,031	57,860	60,383	61,102	61,842	62,953	64,659	66,480	68,514	70,535
Total supply	276,532	282,965	281,547	292,294	297,593	300,864	306,034	313,530	321,124	328,805	337,083
Total exports	56,189	59,031	57,860	60,383	61,102	61,842	62,953	64,659	66,480	68,514	70,535
Human dom. consumption	178,490	182,723	185,489	190,219	194,046	197,377	201,097	205,314	209,569	213,832	218,298
Other disappearance	822	822	822	822	822	822	822	822	822	822	822
Total use	179,312	183,545	186,311	191,041	194,869	198,200	201,919	206,137	210,392	214,655	219,120
Ending stocks	41,030	40,389	37,376	40,870	41,622	40,823	41,161	42,734	44,252	45,637	47,428
Ending stocks-to-use ratio (percent)	22.88	22.01	20.06	21.39	21.36	20.60	20.39	20.73	21.03	21.26	21.64
Production surplus	-2,349	-641	-3,013	3,494	753	-799	338	1,572	1,519	1,385	1,791
World price (cents/lb)	17.22	15.42	19.81	16.57	16.96	19.19	20.37	19.99	19.82	19.93	19.65

Production surplus = Total sugar production - Total use.
Source: USDA, Economic Research Service.

[7]The drop in ending stocks and the associated increase in world prices in 2016/17 seen in the model projections in table 4, figures 8 and 9, and later tables and charts are the result of the approach used to model India's sugarcane production cycles. The specification chosen (see Appendix II, table 3) provides favorable statistical characteristics but incorporates a long lag structure that carries the effects of a sharp, largely policy-induced, cyclical downturn in production in 2009 to 2017. This result is likely to disappear as the projection period for the model is moved forward.

Figure 8

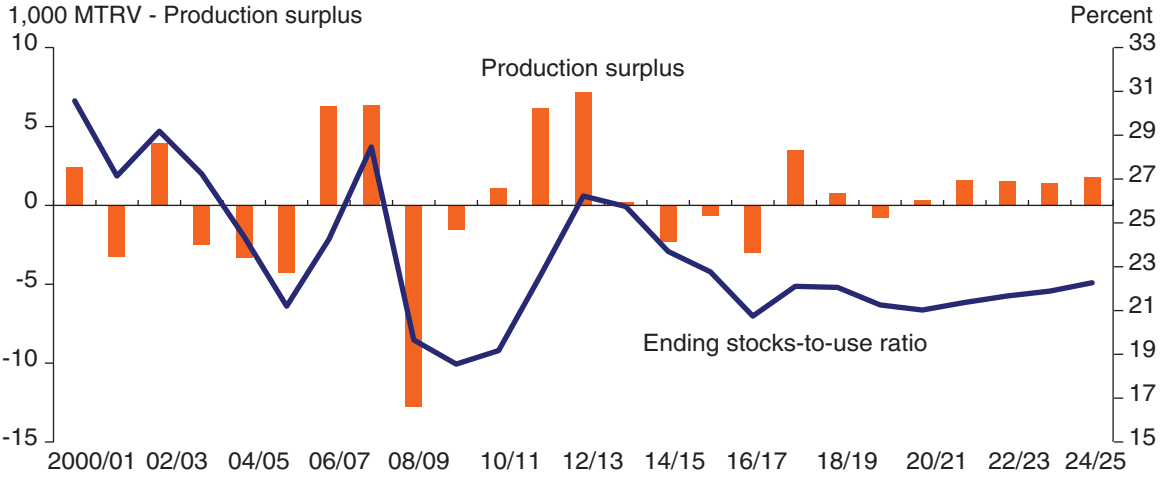
World sugar supply and use - estimated: 2000/01-2012/13 and projected: 2013/14-2024/25



Source: USDA, Foreign Agricultural Service, Sugar PSD; USDA, Economic Research Service.

Figure 9

World sugar production surplus and stocks-to-use: estimated 2000/01-2012/13 and projected 2013/14-2024/25



Source: USDA, Foreign Agricultural Service, Sugar PSD; USDA, Economic Research Service.

Total world sugar production grows from 174.8 million metric tons, raw value (MTRV) in 2013/14 to 220.9 million MTRV in 2024/25. Annual trend growth is 2.16 percent. Cane sugar and beet sugar increase at about the same rate, implying that the cane sugar share of total production is about 80 percent throughout.

Total use grows from 173.8 million MTRV in 2013/14 to 219.1 million MTRV in 2024/25. The annual trend growth is 1.98 percent. Per capita human consumption grows from 24.35 kilograms in 2012/13 to 27.49 kilograms in 2024/25, 12.9 percent higher. Production growth is more vari-

able than consumption growth, especially in the first half of the projections period. Ending stocks show some variability in the first half, decreasing from above 25 percent in 2013/14 to the 20.7-22.1 percent range. Starting in 2020/21, stocks grow from 21.0 percent of use to 22.3 percent in 2024/25.

There are four instances of production deficits in the first 6 years of projections (2014/15 through 2019/20). The largest deficit—3.01 million MTRV in 2016/17—is completely offset by the next year's surplus of 3.49 million MTRV. The farther out one goes into the projections period, the more stable the production gains. As one might expect in a projections framework, there is much less production surplus/deficit and stocks-to-use variability compared with the historical period before the projections. This reflects the constancy of assumptions about policy and weather-related phenomena.

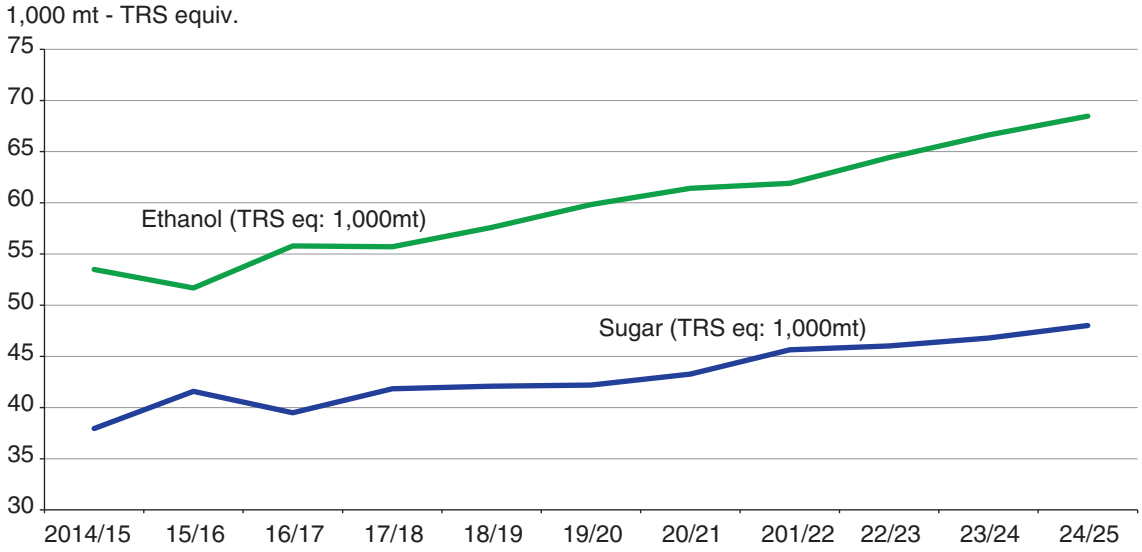
Table 5 shows projections for Brazil's sugarcane, total reducing sugars, sugar, and ethanol. Sugarcane area, production, and total reducing sugar production all increase 26.5–27.4 percent from 2014/15 to 2024/25. Ethanol production grows about 28.0 percent over the period, and sugar grows about 26.5 percent (fig. 10). Sugar's share of total reducing sugar production averages about 42.0 percent. Brazil's sugar exports in the first 6 years of the projections period average 27.850 million MTRV, compared with 32.179 million MTRV in the final 5 years. Brazil's share of total world exports varies between 45.0 and 49.5 percent.

Table 5
Base results for Brazil sugarcane sector

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Sugar blend price (reais/mt)	752.20	775.28	768.70	868.32	926.46	879.79	973.85	1,090.89	1,136.15	1,148.64	1,174.56	1,196.71
Anhydrous (sugar eq: reais/mt)	777.16	697.32	796.12	823.62	901.97	952.88	996.89	1,052.66	1,127.88	1,176.30	1,232.72	1,298.37
Hydrous (sugar eq: reais/mt)	695.90	624.41	712.88	737.51	807.67	853.26	892.66	942.60	1,009.96	1,053.31	1,103.84	1,162.62
Blend TRS price (reais/mt)	742.07	703.33	757.68	812.64	882.67	890.74	954.58	1,034.80	1,097.89	1,129.81	1,172.62	1,219.61
Cultivated area (1,000 hectares)	9,800	9,880	10,071	10,280	10,516	10,740	10,985	11,263	11,562	11,865	12,176	12,497
Sugarcane (1,000 mt)	640,000	667,208	680,568	695,158	711,614	727,196	744,280	763,612	784,457	805,498	827,134	849,489
TRS (1,000 mt)	87,322	91,436	93,273	95,279	97,540	99,682	102,030	104,687	107,551	110,443	113,416	116,489
Sugar (TRS eq: 1,000mt)	41,773	37,947	41,583	39,488	41,836	42,082	42,201	43,270	45,641	46,023	46,784	48,020
Anhyrous (TRS eq: 1,000 mt)	20,668	20,449	22,313	23,146	24,874	26,297	27,741	29,398	31,357	33,028	34,856	36,838
Hydrous (TRS eq: 1,000mt)	24,881	33,041	29,377	32,644	30,830	31,304	32,088	32,018	30,553	31,392	31,776	31,630
Ethanol (TRS eq: 1,000 mt)	45,548	53,490	51,690	55,790	55,704	57,600	59,829	61,417	61,910	64,420	66,632	68,468
Sugar (percent of TRS)	47.84	41.50	44.58	41.45	42.89	42.22	41.36	41.33	42.44	41.67	41.25	41.22
Total Exports (1,000 MTRV)	27,250	25,320	28,719	26,577	28,735	28,861	28,868	29,795	31,983	32,250	32,885	33,982
Brazil's share of world exports (percent)	46.44	45.06	48.65	45.93	47.59	47.23	46.68	47.33	49.46	48.51	48.00	48.18
World price (cents/lb)	16.92	17.22	15.42	19.81	16.57	16.96	19.19	20.37	19.99	19.82	19.93	19.65

Source: USDA, Economic Research Service.

Figure 10
Brazil sugar and ethanol production projections, 2014/15-2024/25



Source: USDA, Economic Research Service.

World prices are projected to range between 15.42 and 20.37 cents/lb. Prices are lower in the first half of the projections period: the average for the first 6 years (2014/15-2019/20) is 17.53 cents/lb, but the average for the remaining 5 years is much higher at 19.95 cents/lb. Prices in the latter half, like the supply and use measures, are less variable than in the first half.

Figure 11 pairs actual and projected world prices since 2000/01 with an index of Brazil Center/South dollar production costs. Prices in the early period averaged below 10 cents/lb. Starting in 2002/03, Center/South production costs began rising, and about a year later prices started rising as well. As noted earlier, Haley (2013) showed that world raw sugar prices and Center/South production costs are cointegrated, meaning that they are in a long-run equilibrium relationship with each other. The relationship holds because of Brazil's dominant share of the world sugar export market. During the projections period (2013-2025), production costs show only a weakly rising trend. This has a stabilizing effect on world prices, as seen in the figure, and is essentially true without the assumption of any destabilizing weather- or policy-related events taking place.

Alternative Scenarios

The framework is tested by varying assumptions made in the base run. Specifically, these include: (1) lowering Brazil's ethanol/gasoline ratio to 20 percent; (2) specifying that the price of gasoline increases 50 percent above the inflation rate; (3) reducing projected income per capita by 10 percent (which implies lower demand for fuel because of fewer automobile purchases); (4) a 10-percent currency depreciation as measured by the exchange rate; and (5) a 20-percent currency depreciation. Annual projection results are shown in table 10 for the main Brazil sugarcane sector products and the world sugar price, along with averaged values covering the whole projections period for each variable. In table 7, these averages are divided by the corresponding average for the base period to facilitate comparisons.

Table 6

Framework projections for Brazil and world sugar prices, 2014/15-2024/25 and 11-year averages

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Sugar blend price												
Base	775.3	768.7	868.3	926.5	879.8	973.8	1,090.9	1,136.2	1,148.6	1,174.6	1,196.7	994.5
20 percent mix ratio	777.8	727.4	818.6	920.6	863.5	989.8	1,094.5	1,092.0	1,164.5	1,192.6	1,206.4	986.2
Gas price 50 percent increase above inflation	774.3	786.5	885.2	943.2	895.2	946.0	1,031.9	1,106.9	1,134.0	1,123.8	1,126.5	977.6
10 percent per capita income reduction	777.1	736.2	829.6	922.1	869.4	986.9	1,099.1	1,106.5	1,160.3	1,196.1	1,213.9	990.7
10 percent exchange rate depreciation	824.5	793.3	929.6	973.9	912.9	1,078.4	1,157.8	1,169.2	1,247.8	1,260.3	1,291.9	1,058.1
20 percent exchange rate depreciation	858.7	817.8	1,013.5	1,010.5	929.9	1,192.0	1,183.9	1,187.8	1,342.5	1,282.7	1,373.2	1,108.4
Hydrous ethanol price (reais/mt, sugar equivalent)												
Base	624.4	712.9	737.5	807.7	853.3	892.7	942.6	1,010.0	1,053.3	1,103.8	1,162.6	900.1
20 percent mix ratio	573.6	674.8	671.5	743.2	800.3	810.8	883.6	941.7	966.1	1,032.5	1,069.9	833.4
Gas price 50 percent increase above inflation	647.2	748.5	808.6	884.2	955.9	1,023.2	1,092.3	1,163.3	1,237.1	1,314.6	1,395.2	1,024.6
10 percent per capita income reduction	584.7	688.2	686.5	761.1	816.8	833.5	902.3	969.2	993.4	1,058.0	1,100.6	854.0
10 percent exchange rate depreciation	635.0	730.8	733.2	827.7	853.9	878.1	964.6	1,009.6	1,044.2	1,115.3	1,142.2	903.1
20 percent exchange rate depreciation	651.8	742.2	733.5	858.7	838.8	857.9	995.9	958.0	1,025.5	1,115.9	1,084.3	896.6
Total reducing sugars (TRS) blend price												
Base	703.3	757.7	812.6	882.7	890.7	954.6	1,034.8	1,097.9	1,129.8	1,172.6	1,219.6	968.8
20 percent mix ratio	669.9	714.9	747.4	838.8	848.4	905.3	1,000.0	1,035.0	1,078.1	1,133.0	1,160.2	921.0
Gas price 50 percent increase	716.8	785.6	863.1	934.3	959.5	1,023.0	1,102.1	1,177.9	1,235.7	1,280.7	1,333.0	1,037.4
10 percent per capita income reduction	678.5	728.8	763.9	852.7	863.8	921.8	1,015.3	1,061.4	1,096.8	1,153.5	1,186.9	938.5
10 percent exchange rate depreciation	732.2	780.2	835.3	918.8	905.5	988.4	1,081.9	1,113.7	1,167.1	1,218.2	1,246.3	998.9
20 percent exchange rate depreciation	759.9	798.5	870.0	958.1	903.8	1,022.4	1,120.6	1,090.7	1,203.3	1,234.0	1,246.5	1,018.9
Cultivated area (1,000 hectares)	0.001											
Base	9,880	10,071	10,280	10,516	10,740	10,985	11,263	11,562	11,865	12,176	12,497	11,076
20 percent mix ratio	9,856	10,018	10,182	10,387	10,579	10,789	11,038	11,291	11,553	11,828	12,102	10,875
Gas price 50 percent increase	9,889	10,100	10,343	10,616	10,887	11,181	11,509	11,869	12,250	12,643	13,054	11,304
10 per percent capita income reduction	9,862	10,034	10,209	10,424	10,627	10,848	11,109	11,380	11,656	11,947	12,241	10,940

—continued

Table 6

Framework projections for Brazil and world sugar prices, 2014/15-2024/25 and 11-year averages—continued

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Average
10 percent exchange rate depreciation	9,900	10,107	10,333	10,595	10,830	11,100	11,412	11,727	12,059	12,406	12,752	11,202
20 percent exchange rate depreciation	9,919	10,140	10,390	10,680	10,918	11,213	11,554	11,861	12,221	12,584	12,939	11,311
Sugarcane production (1,000 mt)												
Base	667,208	680,568	695,158	711,614	727,196	744,280	763,612	784,457	805,498	827,134	849,489	750,565
20 percent mix ratio	665,604	676,918	688,429	702,699	716,147	730,752	748,109	765,755	783,968	803,172	822,245	736,709
Gas price 50 percent increase above inflation	667,857	682,547	699,517	718,466	737,340	757,794	780,588	805,592	832,050	859,402	887,928	766,280
10 percent per capita income reduction	666,018	677,994	690,282	705,230	719,423	734,833	752,979	771,886	791,081	811,372	831,798	741,172
10 percent exchange rate depreciation	668,598	683,065	698,783	717,003	733,433	752,217	773,892	795,836	818,916	843,010	867,124	759,261
20 percent exchange rate depreciation	669,936	685,314	702,718	722,880	739,452	759,973	783,671	805,045	830,080	855,341	879,998	766,764
Sugar production (TRS basis, 1,000 mt)												
Base	37,947	41,583	39,488	41,836	42,082	42,201	43,270	45,641	46,023	46,784	48,020	43,171
20 percent mix ratio	37,857	44,145	39,112	42,359	43,921	41,446	45,200	47,047	45,943	48,306	48,034	43,943
Gas price 50 percent increase above inflation	37,983	40,578	39,732	40,780	41,824	42,956	44,218	45,602	47,068	48,582	50,162	43,589
10 percent per capita income reduction	37,880	43,565	39,216	42,248	43,393	41,674	44,486	46,770	45,796	47,644	47,760	43,676
10 percent exchange rate depreciation	38,912	43,227	39,691	44,546	43,458	42,644	47,059	47,885	47,979	50,515	49,958	45,080
20 percent exchange rate depreciation	40,317	43,969	39,911	47,908	44,051	43,077	52,320	48,453	51,225	55,161	51,663	47,096
Ethanol production (TRS basis, 1,000 mt)												
Base	53,490	51,690	55,790	55,704	57,600	59,829	61,417	61,910	64,420	66,632	68,468	59,723
20 percent mix ratio	53,359	48,627	55,242	53,957	54,245	58,726	57,358	57,937	61,544	61,820	64,713	57,048
Gas price 50 percent increase above inflation	53,542	52,967	56,145	57,701	59,251	60,930	62,800	64,851	67,021	69,265	71,605	61,462
10 percent per capita income reduction	53,393	49,355	55,393	54,416	55,222	59,059	58,741	59,055	62,668	63,608	66,299	57,928
10 percent exchange rate depreciation	52,715	50,389	56,085	53,735	57,080	60,476	59,039	61,229	64,306	65,081	68,952	59,008
20 percent exchange rate depreciation	51,493	49,955	56,406	51,180	57,314	61,108	55,121	61,925	62,594	62,128	69,015	58,022
Sugar exports (1,000 mt)												
Base	25,320	28,719	26,577	28,735	28,861	28,868	29,795	31,983	32,250	32,885	33,982	29,816
20 percent mix ratio	25,233	31,197	26,214	29,241	30,640	28,138	31,661	33,342	32,172	34,357	33,996	30,563

—continued

Table 6

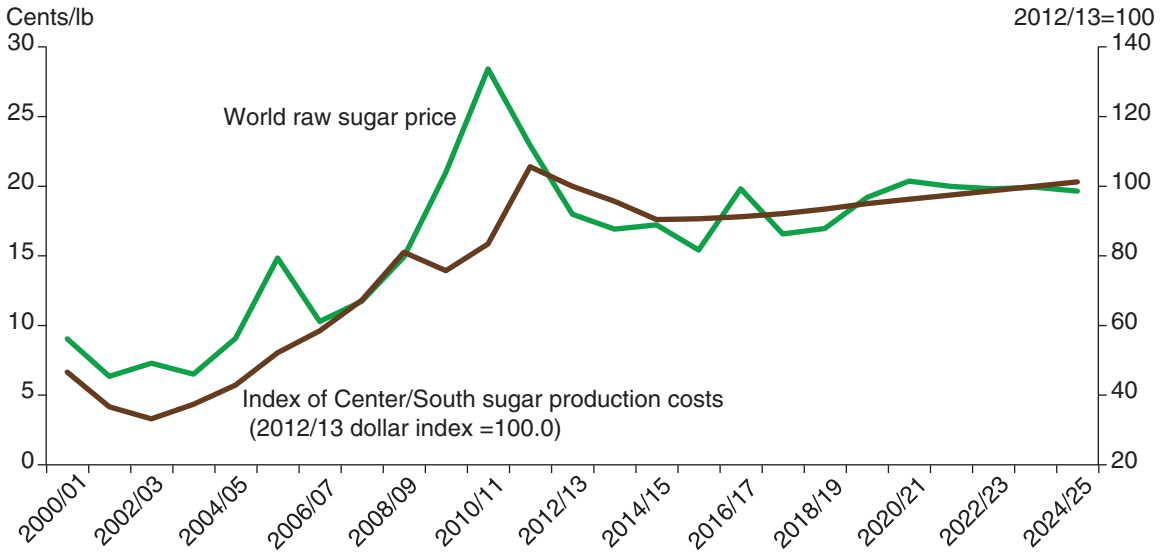
Framework projections for Brazil and world sugar prices, 2014/15-2024/25 and 11-year averages—continued

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Gas price 50 percent increase above inflation	25,355	27,746	26,813	27,714	28,612	29,598	30,711	31,945	33,260	34,624	36,054	30,221
10 percent per capita income reduction	25,255	30,635	26,314	29,133	30,129	28,358	30,971	33,075	32,030	33,716	33,731	30,304
10 percent exchange rate depreciation	26,253	30,309	26,773	31,355	30,192	29,296	33,460	34,153	34,142	36,494	35,857	31,662
20 percent exchange rate depreciation	27,613	31,027	26,986	34,607	30,766	29,715	38,547	34,702	37,280	40,987	37,506	33,612
World price (U.S. cents/lb)												
Base	17.22	15.42	19.81	16.57	16.96	19.19	20.37	19.99	19.82	19.93	19.65	18.63
20 percent mix ratio	17.32	13.74	19.45	16.76	16.29	20.41	19.42	19.49	20.88	19.59	20.33	18.52
Gas price 50 percent increase above inflation	17.18	16.13	19.80	17.14	16.95	18.22	19.28	20.06	19.33	18.84	18.58	18.32
10 percent per capita income reduction	17.30	14.11	19.54	16.71	16.52	20.08	19.87	19.53	20.68	19.86	20.27	18.59
10 percent exchange rate depreciation	16.18	14.57	19.75	15.24	16.52	19.93	18.52	19.44	20.05	19.00	20.02	18.11
20 percent exchange rate depreciation	14.80	14.32	20.00	13.48	16.23	20.76	15.59	19.86	19.32	17.40	20.79	17.50

Source: USDA, Economic Research Service.

Figure 11

World raw sugar price and Brazil Center/South production costs



Source: Intercontinental Exchange No.11; LMC International; USDA, Economic Research Service.

Table 7

Framework projections for Brazil and world raw sugar price: average percentage changes relative to the base scenario

Scenarios	Sugar blend price	Hydrous ethanol price	TRS blend price	Sugarcane production	Sugar production	Ethanol production	Sugar exports	Sugar world price
20 percent mix ratio	-0.84	-7.40	-4.93	-1.85	1.79	-4.48	2.50	-0.60
Gas price 50 percent increase above inflation	-1.70	13.83	7.09	2.09	0.97	2.91	1.36	-1.67
10 percent per capita income reduction	-0.38	-5.12	-3.12	-1.25	1.17	-3.01	1.64	-0.22
10 percent exchange rate depreciation	6.40	0.34	3.11	1.16	4.42	-1.20	6.19	-2.78
20 percent exchange rate depreciation	11.46	-0.39	5.18	2.16	9.09	-2.85	12.73	-6.04

Source: USDA, Economic Research Service.

These simulated changes cause aggregate TRS production to change. This type of expansion/contraction change affects sugar and ethanol in the same direction. The exogenous changes also affect the relative amounts of ethanol and sugar produced—a substitution effect favoring one product over the other. Both the 20-percent mix-ratio scenario and the 10-percent per capita income reduction imply small reductions in sugarcane area and production, but the stronger reduction effect on ethanol production implies more sugar production. Sugar exports expand, and the world sugar price decreases slightly (less than 1 percent).

An increase in the gasoline price of 50 percent above inflation (a price equal to inflation is the base assumption) has the strongest effect on the TRS blend price in spite of a lower sugar-blend price. Under that same scenario, sugarcane production expands by 2.1 percent. This expansion effect is strong enough to imply an increase in sugar production of 0.9 percent, although the effect on ethanol production is much greater (2.9 percent). Although U.S. gasoline prices fell more than 30 percent between June and December 2014, mainly due to reductions in the price of petroleum in world markets, it is not clear that this phenomenon will affect Brazil. Gasoline prices have not fallen in Brazil because the national government controls the price of gasoline. If authorities were to lower gasoline prices to reflect lower petroleum prices, the producer return on ethanol sales would be lower and, all else constant, lead to more production of sugar. Over the longer term, the return to sugarcane would likely be reduced, with, consequently, less sugarcane grown.

The strongest effect on sugar production and exports comes from the depreciations of the currency as measured by the exchange rate. The value of world sugar increases in terms of reais proportionate to the exchange rate change, thereby favoring sugar over ethanol (little of which is traded or linked to world oil prices, at least as specified in the framework). Although sugarcane production increases (which could result in more ethanol), the relative price effect dominates so that sugar expands proportionately more than sugarcane production, and ethanol production contracts. The 10-percent currency depreciation results in a world sugar price reduction of 2.8 percent. The 20-percent depreciation, in turn, results in a 6.0 percent world raw sugar price decline.

The next section presents an analysis of forecast world prices from the base and alternative solutions on U.S. Federal expenditure using ERS's U.S.-Mexico baseline model.

Modeling Impacts on U.S. Sugar Policy

In addition to examining the impacts of alternative scenarios for Brazil or other countries on world sugar prices, the model can also be used to estimate the implications for U.S. sugar policy. With a sufficiently high level of U.S. sugar imports from Mexico, low world sugar prices can increase the likelihood of sugar loan rate forfeitures in the United States. As seen in 2012/13, sugar from Mexico competes with sugar imported by the United States from countries that have raw sugar tariff-rate quota (TRQ) allocations. If the TRQ sugar is not needed because of plentiful supplies from Mexico (and/or from domestic sources), the margin between U.S. and world prices contracts to discourage those TRQ imports from being supplied. If the margin (whose minimum value is probably about 3 cents/lb.) plus the world price add up to less than what a U.S. sugar processor needs to sell sugar to repay loans to the USDA, then the processor has an incentive to settle the loan by forfeiting ownership of the sugar collateral to the USDA, as set out in both the 2008 and 2014 Farm Acts. These Acts also contain provisions that require the USDA to purchase a sufficient amount of sugar in the market for resale to ethanol producers to forestall the risk of loan forfeitures. The difference between the sugar purchase price and the subsequent price at which the sugar is sold constitutes a subsidy expense for USDA. Table 8 details how domestic raw sugar prices and the unit subsidy can be determined in the model.

For illustrative purposes, table 9 shows the estimated impacts of the alternative Brazil scenarios (see table 7) on loan forfeitures and U.S. budget outlays. All of the illustrative scenarios indicate

Table 8
U.S. raw sugar pricing and CCC-budget outlay estimation

Method 1 - U.S. raw sugar price when supported by world price
Margin between third-quarter U.S. and world raw sugar prices is a function of projected ending stocks-to-use ratio: U.S. raw sugar price = world raw sugar price + margin Margin = max(28.284 - 1.2673*[stocks-to-use ratio], 3 cents per pound) If the initial margin is less than 3 cents per pound, then: Minimum margin of 3 cents per pound achieved by increasing the tariff-rate quota shortfall up to 50 percent of initial allocation; and, if necessary, divert a required percentage of total Mexico exports to third-country destinations: these actions reduce U.S. sugar supply and thereby stocks so that the ending stocks-to-use ratio rises to a level that implies a 3-cent price margin
Method 2 - U.S. raw sugar price when supported by U.S. sugar loan rate program
U.S.raw sugar price in 3rd quarter is a function of projected ending stocks-to-use ratio: U.S. raw sugar price = max(43.301*[stocks-to-use ratio]^(-0.2532), minimum price-to-avoid-forfeiture) Minimum price-to-avoid forfeiture = loan rate + interest payable on loan + transportation cost less discount If U.S. raw sugar price = minimum, then private stocks-to-use ratio = (Minimum price^(-1/0.2532))/43.301 USDA purchase of sugar for ethanol = (total stocks-to-use ratio - private stocks-to-use ratio)*(total supply - use) Note: USDA purchase equal to zero if raw sugar price is above the minimum price-to-avoid forfeiture USDA sells sugar to ethanol producers at a price consistent with the value of corn used for ethanol production: $(\text{Sugar price})_{\text{cents/lb}}$-[$(\text{corn price - byproduct credit})_{\text{dollar/bushel}}$*(100*1.378618)/56 + $\text{Premium-to-motivate purchase}_{\text{cents/lb}}$ where 1.378618 = ratio of corn-to-sugar in pounds to produce the same amount of ethanol
U.S. raw sugar price = Max(Method 1, Method 2)

Source: USDA, Economic Research Service.

Table 9

Illustrative impacts of alternative Brazil-related scenarios on U.S. Federal Budget expense for Feedstock Flexibility Program (FFP)

Scenario	Present value in 2013/14[1]	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
						1,000 dollars						
Base	214,372	60,691	62,615	0	53,354	52,589	0	0	0	0	0	0
20 percent mix ratio	214,467	60,691	62,615	0	53,376	52,672	0	0	0	0	0	0
Gas price 50 percent increase	214,375	60,691	62,615	0	53,355	52,591	0	0	0	0	0	0
10 percent per capita income reduction	214,443	60,691	62,615	0	53,370	52,651	0	0	0	0	0	0
10 percent exchange rate depreciation	214,389	60,691	62,615	0	53,358	52,604	0	0	0	0	0	0
20 percent exchange rate depreciation	256,226	60,654	64,174	0	53,435	52,624	0	0	0	0	48,779	0

[1]interest rate = 0.018.

Source: USDA, Economic Research Service.

sufficiently low raw sugar prices to imply forfeitures in 2014/15, 2015/16, 2017/18, and 2018/19. The present value of the USDA budget expense in those years to purchase sugar and then resell it for ethanol is $214.4-$214.5 million, except for the final scenario. In the final scenario, a 20-percent exchange rate depreciation implies a sufficiently low world price in 2023/24 to add an additional $41.8 million (present value) to the total.

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Appendix I—table 1

Brazil sugar-ethanol model component: Brazil hydrous fuel ethanol price determination

Stage 1 - project automotive vehicle growth
Stage 2 - project automotive vehicle fuel demand
Stage 3 - ethanol supply: size of current sugarcane crop plus production capacity proportions determined from price expectations formed in the previous year
Stage 4 - ethanol split into hydrous and anhydrous ethanol proportions based on policy-determined ethanol/gasoline mix ratio
Stage 5 - gasoline price is exogenous: policy-determined and assumed to grow at the inflation rate
Stage 6 - estimate: %Δ (hydous ethanol-gasoline price ratio) = ϕ*%Δ (hydrous ethanol use/gasoline use)
Stage 7 - project hydrous ethanol price based previous year's prices plus %Δ from stage 6
Stage 8 - project hydrous ethanol producer price based on consumption price
Stage 9 - anhydrous ethanol producer price set as proportion of hydrous price

Source: USDA, Economic Research Service

Appendix I—table 2

Brazil sugar-ethanol model component: Net returns for sugarcane based products

Regions for each stage: Center/South and North/Northeast
Stage 1 - project costs of production from LMC International over projection period; Types of costs: average field, factory, admininstrative costs, plus cash/non-cash proportions as functions of sugarcane and total reducing sugar (TRS) yields and production plus inflation
Stage 2 - calculate April/March world raw sugar price denominated in reais per metric ton (mt) weighted function of October/September world price, current and 1-year lagged, multiplied by corresponding period real/dollar exchange rate:
World raw: April/Mar, real/mt = 0.478*world raw:Oct/Sept,dollar/mt * real:dollar exch.rate + (1-0.478)*world raw (-1):Oct/Sept,dollar/mt * real:dollar exch.rate (-1)
Stage 3 - calculate a blend sugar price of VHP (very high polarity) export (Sao Paulo:SP) and of crystal sugar in domestic market, both of which are functionally related to real-denominated world raw sugar price
VHP export (reais/mt) = 0.873*world raw (reais/mt)
Crystal sugar (reais/mt) = 3.114*world raw (reais/mt) - 2.142*VHP export (reais/mt)
Sugar blend (reais/mt:TRS basis) = (sugar proportion for export)*VHP export + (sugar proportion for consumption)*crystal sugar
Stage 4 - calculate blend ethanol producer price as weighted average of hydrous and anhydrous producer prices
Ethanol blend (reais/mt: TRS eq.) = (hydrous proportion)*hydrous producer (TRS eq.) + (anhydrous proportion)*anhydrous producer (TRS eq.)
Stage 5 - calculate blend TRS price as weighted average of TRS-equivalent sugar and ethanol prices
Blend TRS (reais/mt)= (sugar proportion of TRS)*sugar blend + (ethanol proportion of TRS)*ethanol blend
Stage 6 - calculate sugarcane products net return as difference between blend TRS price total average cost of production
Sugarcane products net return (reais/mt:sugar basis) = Blend TRS/1.0495 - total cost, average

Source: USDA, Economic Research Service.

Appendix I—table 3

Brazil sugarcane and products model component: production of sugarcane and products, and use

Regions for each stage: Center/South and North/Northeast

Stage 1 - set regional base area expansion

Center/South = 3 percent
North/Northeast = 1 percent

Stage 2 - set projected area expansion on the linear evaluation of TRS net return:

Case 1: net return > total average cost --> projected > base
Case 2: net return = total average cost --> projected = base
Case 3: cash average cost < net return < total average cost --> 0 < projected < base
Case 4: net return = 0 --> projected = 0
Case 5: net return < 0 --> projected < 0

Stage 3 - sugarcane and total reducing sugars (TRS) yields set at predetermined values, allowing calculation of sugarcane and TRS

Stage 4 - determine split between sugar and ethanol for next year:
Max(estimated sugar/TRS ratio as function of world sugar price/producer price of hydrous ethanol, 100 - maximum ethanol share (60 percent initially))

Stage 5 - use stage 4 coefficient to calculate sugar and ethanol production

Stage 6 - sugar consumption set as fixed per capita (amount times population) and ending year stocks set at -295,000 mt, raw value (MTRV) and imports set at zero

Stage 6 - calculate sugarcane products net return as difference between blend TRS price total average cost of production

Stage 7 - Sugar exports = Sugar production - sugar consumption

Source: USDA, Economic Research Service.

Appendix II—table 1

Brazil model: data sources and equation structure

Symbols:

LOG - natural log

D - difference operator

DX or DXtoY: X,Y - year or year month indicator - DX=1 or DXtoY=1 for period X or X to Y, 0 otherwise

Mix ratio - Policy-determined ratio of anhydrous ethanol blended with gasoline A to produce Gasoline C

(-1) - 1-year lag indicator

C/S - Center/South Brazil

N/NE - North/Northeast Brazil

SP - Sao Paulo

3-year average - average over 2011/12 - 2013/14

Automotive sector - hydrous ethanol price determination

Data	Source
Population	USDA-ERS long term projections database: to 2024/25
Exchange rate: real/dollar	USDA-ERS long term projections database: to 2024/25
Per capita income 2000$	USDA-ERS long term projections database: to 2024/25
Crude oil price: $/barrel EIA refiner acquisition cost	USDA-ERS long term projections database: to 2024/25
Automotive fleet (no. of vehicles)	ANFAVEA
Fuel consumption per vehicle	ANP

Equations

DLOG(Population/vehicle) = -0.021914-0.502289*D2009-0.564284*DLOG(percap income) adj. R2 = 0.492
Automotive fleet projection = Population/(Population/vehicle)
Total fuel (1,000 liters): gasoline C + hydrous ethanol (gas basis) = Number of vehicles*fuel consumption per vehicle (2012/13 level)
Fuel ethanol = 0.800*total ethanol from domestic production* (determined in production sector - see below)
Hydrous fuel ethanol = (Fuel ethanol - (mix ratio)*(total fuel))/(1-(mix ratio)*0.7)
Hydrous fuel ethanol: gasoline basis = hydrous fuel ethanol*0.7
Gasoline C = Total fuel - hydrous fuel ethanol: gasoline basis
Anhydrous fuel ethanol = (mix ratio)*Gasoline C
Hydrous ethanol sales ratio = 100*(Hydrous fuel ethanol: gasoline basis)/total fuel
Projected change in consumer prices = change in exchange rate
Gasoline C price = Gasoline C price (-1)*change in consumer prices - Note: gasoline price is policy determined
Fuel price ratio = 100*hydrous pump price/gasoline price
DLOG(fuel price ratio) = -0.0601*D200706to200707+0.0480*D200711to200712-0.0419*D201103to201104+0.4405*D201105 -0.2764*DLOG(hydrous ethanol sales ratio)+[ar(1)=0.4228] adj. R2 = 0.790
Hydrous ethanol pump price =.01*Gasoline C price*(projected fuel price ratio)
Hydrous ethanol producer price per liter = 0.916007*hydrous ethanol pump price-0.6553 from normalized cointegration coefficients
Hydrous ethanol producer price, sugar equivalent, per metric ton = 1000*(1.0495/1.676)*hydrous ethanol producer price per liter
Hydrous ethanol producer price, TRS basis, per metric ton = (1/1.0495)*Hydrous ethanol producer price, sugar basis, per metric ton
Anhydrous ethanol producer price, TRS basis, per metric ton = 1.11676*hydrous ethanol producer price, TRS basis, per metric ton
Pricing and Cost of Production sector - net returns determination

Data	Source
Field, Factory, Administrative Costs: total, cash, and non-cash, dollars per metric tons	LMC International.

—continued

Appendix II—table 1

Brazil model: data sources and equation structure—continued

Equations

Field costs, average, C/S (reais/mt) = 3.1805*change in consumer prices -0.7574*TRS_yield, adj. R2 = 0.949
Factory costs, average, C/S (reais/mt) = -11.396+2.557*change in consumer prices+27.545*D2009-0.002269*TRS adj. R2 = 0.980
Administrative costs, average, C/S (reais/mt) = -8.895 + 0.683*change in consumer prices, adj. R2 = 0.951
Total costs, average, C/S (reais/mt) = Field + Factory + Administrative
Total costs, average, N/NE (reais/mt) = 267.49 + 6.163*change in consumer prices - 0.0053*sugarcane production, N/NE
Cash field cost, average, C/S (reais/mt) = ((Field labor: 3-yr average + Field inputs: 3-year average)/Total field (3-year average))*projected field costs
Cash factory cost, average, C/S (reais/mt) = ((Factory labor: 3-yr average + Factory inputs: 3-year average)/Total factory (3-year average))*projected factory costs
Cash costs, average, C/S (reais/mt) = Cash field + cash factory + administrative costs
Cash costs, average, N/NE (reais/mt) = Cash average: 3-yr average/Total costs: 3=yr average
World raw sugar price, April/March (reais/mt) = 0.478*(world sugar price, Oct/Sept (dollar/mt)*exchange rate(reais/dollar)) + (1-0.478)*(world sugar price (-1), Oct/Sept (dollar/mt)*exchange rate (-1) (reais/dollar))
VHP export price (reais/mt) = 0.873*world raw sugar price (reais/mt)
Crystal sugar price (reais/mt) = 3.114*world raw sugar price (reais/mt) - 2.142*VHP export price (reais/mt)
Sugar blend price, TRS basis (reais/mt) = (sugar proportion for export)*VHP export price/1.0495+(sugar proportion for domestic use)*crystal sugar price/1.0495
Ethanol blend price, TRS basis (reais/mt) = (hydrous proportion of total ethanol)*Hydrous ethanol producer price, TRS basis + (anhydrous proportion of total ethanol)*anhydrous ethanol producer price, TRS basis
Blend TRS price (reais/mt) = (sugar proportion of total TRS)*sugar blend price + (ethanol proportion of total TRS)*ethanol blend price
Sugarcane products net return, sugar basis, C/S, N/NE (reais/mt) = Blend TRS price/1.0495 - total cost, average, C/S, N/NE
Sugarcane production and use sector

Data	Source
Sugarcane, sugar, hydrous and anhydrous production, and share production data	UNICA.
Sugar consumption, trade, and stocks data	USDA, FAS, Production, Supply, and Distribution (PSD)

Equations

Base area expansion rate (percent): C/S = 3 percent; N/NE = 1 percent.
Projected area expansion rate, C/S, N/NE (percent) = Base area expansion rate*(100+100*(sugarcane products net return/(Total cost, average, C/S,N/NE-cash costs, average, C/S, N/NE)*.01
Sugarcane area (1,000 hectares): C/S, N/NE = sugarcane area(-1)*(1+projected area expansion: C/S, N/NE)
Sugarcane production (1,000 mt): C/S, N/NE = sugarcane area: (C/S, N/NE) * yield(C/S = 70mt/hectare, N/NE = 50mt/hectare)
TRS production (1,000 mt) = sugarcane production*average TRS/sugarcane ratio(C/S = .0001*137.50, N/NE = .0001*132.50)
Calculated sugar/TRS percent, C/S = exp(-0.243+.083*log(world raw sugar price, April/March (reais/mt)/Hydrous ethanol producer price, sugar equiv (reais/mt)))
Sugar/TRS ratio, C/S = max(calculated sugar/TRS, C/S,100-maximum ethanol percent share (initially assumed constant at 60 percent))
Sugar/TRS ratio, N/NE = 70 percent
Sugar production: C/S, N/NE (1,000 mt) = Sugar/TRS ratio: C/S, N/NE * TRS production: C/S, N/NE/1.0495
Ethanol production, TRS basis, C/S, N/NE (1,000 mt) = TRS production: C/S, N/NE - sugar production - 1.0495*sugar production: C/S, N/NE
Total ethanol production, hydrous basis (1,000 liters) = 1,000*(ethanol production, TRS basis, C/S + ethanol production, TRS basis, N/NE)/1.676
Sugar consumption (1,000 mt, raw basis) = Average per capita sugar consumption (54.14 kilogram)*population (millions)
Sugar imports (1,000 mt, raw basis) = 0
Sugar ending stocks (1,000 mt, raw basis) = -295
Sugar exports (1,000 mt, raw basis) = Sugar production(1,000 mt, raw basis) - Sugar consumption (1,000 mt, raw basis)

Source: USDA, Economic Research Service.

Appendix II—table 2

World sugar model and region listing for countries/regions other than Brazil, with general equation specifications

Regions	Sub-regions or countries
North America	Canada, Mexico, United States
Caribbean	Cuba, Dominican Republic, Other Caribbean
Central America	Guatemala, Other Central America
South America	Argentina, Colombia, Other South America
Europe	European Union - 28, Other Europe
Former Soviet Union	Russia, Ukraine, Other Former Soviet Union
Middle East	Turkey, Other Middle East
North Africa	Egypt, Other North Africa
Sub-Sahara Africa	South Africa, Other Sub-Sahara Africa
South Asia	India, Pakistan, Other South Asia
East Asia	China, Japan, Other East Asia
Southeast Asia	Thailand, Philippines, Other Southeast Asia
Oceania	Australia, Other Oceania

Measure units/symbol definition:
Area = 1,000 hectares, for sugarcane (CANE) or sugarbeets (BEET)
Cost of Production (COP) = U.S. Dollars per metric ton of sugar
Yield = Metric ton per hectare, for crop (YIELD) or sugar (SUYIELD)
WPRICE = world raw sugar price
T = trend
EXRATE = exchange rate
Sugar consumption per capita (SUGAR_PERCAP) = kilograms
Stocks-to-use (STKSUSE) or Stocks-to-consumption (STKSCONS) = percent
Sugar quantities (production, TRADE:export, import, consumption, stocks, etc) = 1,000 metric tons

Supply and use components	Estimated equation structure
Area	LOG(AREA) = β0 + β1*LOG(AREA(-1)) + β2*(WPRICE(-1)/COP(-1))
Cost of production	COP = β0 + β1*EXRATE + β2*SUYIELD + β3*T + β4*WPRICE
Crop yield	YIELD = β0 + β1*T + β2*WPRICE(-1)
Sugar yield	SUYIELD = β0 + β1*YIELD + β2*T
Sugar production	SUGAR = AREA*SUYIELD
Sugar consumption per capita	SUGAR_PERCAP = β0 + β1*INCOME_PERCAP + β2*WPRICE + β3*T
Sugar consumption (CONS)	SUGAR_CONS = POPULATION*SUGAR_PERCAP
Stocks-to-use	STKSTOUSE = β0 + β1*(WPRICE or WPRICE/COP)
Stocks	STOCKS = STKSTOUSE*USE
Trade	TRADE = STOCKS(-1) + SUGAR - SUGAR_CONS - STOCKS

Source: USDA, Economic Research Service.

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil

Measure units:
Area = 1,000 hectares
Cost of Production (COP) = U.S. Dollars per metric ton of sugar
Yield = Metric ton per hectare
WPRICE = world raw sugar price
T = trend
DXXXX or DXXXXtoYYYY=1 for year XXXX or 1 for years XXXX to YYYY, zero otherwise
Sugar consumption per capita (Sugar_percap) = kilograms
Stocks-to-use (Stkstouse) or Stocks-to-consumption (Stkstocons) = percent
Sugar quantities (production, export, import, consumption, stocks, etc) = 1,000 metric tons

Regions/supply and use components	Estimated equation structure	Sample period	Adj. R2
Argentina			
Cane_Area	LOG(CANE_AREA) = 2.384+0.5893*LOG(CANE_AREA(-1))+0.1281*LOG((WPRICE_11(-1)/CANE_COP(-1)))	1981-2013	0.713
Cane_COP	CANE_COP = 915.015-183.420*D2003-80.313*CANE_SUYIELD+19.138*EXRATE	1995-2013	0.772
Cane_Suyield	CANE_SUYIELD = -0.670*D1987TO1990+0.020*T+0.103*CANE_YIELD	1995-2013	0.772
Sugar_Percap	LOG(SUGAR_PERCAP) = -0.235*D1997+0.513*LOG(INCOME_PERCAP)-0.117*LOG(WPRICE_11)	1980-2013	0.939
Stkstouse	DLOG(STKSTOUSE) = 0.279-1.033*D2006TO2007-1.503*DLOG(WPRICE_11/CANE_COP)	1995-2009, 2012-2012	0.269
Australia			
Cane_Area	LOG(AUST_AREA) = 0.598-0.196*D2011+0.900*LOG(AUST_AREA(-1))+0.051*LOG(WPRICE_11(-1)/AUST_COP(-1))+0.104*D2000+0.134*D2012	1981-2013	0.966
Cane_COP	AUST_COP = 1274.615-278.877*EXRATE-50.072*AUST_SUYIELD	1995-2014	0.770
Cane_Yield	AUST_YIELD = 112.400-0.917*T-21.275*D2001TO2002	1995-2014	0.780
Cane_Suyield	AUST_SUYIELD = -1.496*D1999+0.140*AUST_YIELD	1980-2014	0.839
Sugar_Percap	SUGAR_PERCAP = 55.0		
Stkstouse	STKSTOUSE = 2.5 percent		
Other Oceania			
Sugar_Export	SUGAR_EXPORT = 175		
Sugar_Import	SUGAR_IMPORT = 295		
Canada			
Beet_Area	BEET_AREA = 0.835*BEET_AREA(-1)+4.801*(1.07*WPRICE_11(-1)+65)/BEET_COP(-1)	1981-2013	0.714
Beet_COP	BEET_COP = 791.60	2010-2013	
Beet_Yield	BEET_YIELD = 53.7	2009-2013	
Beet_Suyield	BEET_SUYIELD = 0.067*T+0.106*BEET_YIELD	1980-2013	0.829
Sugar_Percap	SUGAR_PERCAP = 34.367	2010-2014	
Stkstouse	STKSTOCONS = 20.494 percent	2010-2014	
China			
Cane_Area	LOG(CANE_AREA) = 0.224*D2003+0.187*D2008+1.013*LOG(CANE_AREA(-1))+0.231*LOG(WPRICE_11(-1)/CANE_COP(-1))	1995-2013	0.913
Cane_COP	CANE_COP = 375.580+27.282*T-84.267*CANE_SUYIELD	1995-2012	0.828

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Cane_Yield	CANE_YIELD = 64.076	2000-2013	
Cane_Suyield	CANE_SUYIELD = 0.598*D2004+0.049*T+0.104*CANE_YIELD+[AR(1)=0.349]	1991-2013	0.944
Beet_Area	BEET_AREA = 250		
Beet_Yield	BEET_YIELD = 1.237*T+8.331*D2007TO2008	2005-2013	0.781
Beet_Suyield	BEET_SUYIELD = 0.114*BEET_YIELD	1980-2013	0.958
Sugar_Percap	LOG(SWT_PERCAP) = -0.935-0.119*D2000TO2002+0.448*LOG(INCOME_PERCAP)-0.048*LOG(WPRICE_11)	1995-2012	0.966
Stkstouse	DLOG(STKSTOCONS) = 1.129*D2008-1.092*DLOG(WPRICE_11)	1996-2012	0.477
Colombia			
Cane_Area	CANE_AREA = 1.005*CANE_AREA(-1)		
Cane_COP	DLOG(CANE_COP) = -0.241*D1991+0.299*D1994-0.550*DLOG(CANE_SUYIELD)	1981-2014	0.292
Cane_Yield	CANE_YIELD = 113.145	1995-2014	
Cane_Suyield	CANE_SUYIELD = -0.959*D1985TO1988+0.094*T+0.106*CANE_YIELD	1980-2014	0.919
Sugar_Percap	SUGAR_PERCAP = 29.873+0.00170*INCOME_PERCAP-5.042*D1999	1980-2014	0.439
Stkstouse	STKSTOCONS = 20.611 percent	2010-2014	
Cuba			
Cane_Area	LOG(CANE_AREA) = 1.045+0.857*LOG(CANE_AREA(-1))+0.271*LOG(WPRICE_11(-1)/CANE_COP(-1))	1995-2013	0.901
Cane_COP	CANE_COP = 387.563-142.855*CANE_SUYIELD+25.215*T-122.937*D2002TO2005	1995-2013	0.940
Cane_Yield	CANE_YIELD = 32.311	1995-2013	
Cane_Suyield	CANE_SUYIELD = 1.181-0.028*T+0.087*CANE_YIELD	1980-2013	0.951
Sugar_Percap	SUGAR_PERCAP = 61.766-13.460*D2012	1995-2014	0.235
Stkstouse	LOG(STKSTOUSE) = 2.127-0.307*LOG(WPRICE_11/CANE_COP)	1980-2012	0.117
Dominican Republic			
Cane_Area	LOG(CANE_AREA) = -0.244*D1998TO1999+1.00472225*LOG(CANE_AREA(-1))+0.050*LOG((WPRICE_11(-1)/CANE_COP(-1)))	1981-2013	0.911
Cane_COP	CANE_COP = 550.185+82.002*D2001-93.061*D2003TO2004-54.294*CANE_SUYIELD+5.539*EXRATE	1995-2013	0.475
Cane_Yield	CANE_YIELD = 13.526+1.223*T	1995-2013	0.584
Cane_Suyield	CANE_SUYIELD = 0.062*T+0.068*CANE_YIELD	1995-2013	0.912
Sugar_Percap	LOG(SUGAR_PERCAP) = 4.183+0.245*D1985TO1987-0.072*LOG(INCOME_PERCAP)	1980-2014	0.548
Stkstouse	LOG(STKSTOUSE) = 1.520+1.208*D1995TO1998-0.343*LOG(WPRICE_11/CANE_COP)	1995-2012	0.533
Egypt			
Cane_Area	CANE_AREA = 101.166+0.161*T	1980-2013	0.016
Cane_Yield	CANE_YIELD = 82.500+0.606*T+17.474*D2003TO2004-7.878*D2008TO2014	1980-2013	0.787
Cane_Suyield	CANE_SUYIELD = 12.229+0.045*T-0.039*CANE_YIELD	1996-2013	0.466
Beet_Area	BEET_AREA = 10.520+1.036*BEET_AREA(-1)-7.358*(WPRICE_11(-1)*1.07+65)/BEET_COP(-1)	1989-2013	0.943

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Beet_Yield	BEET_YIELD = 45.662	1993-2013	
Beet_Suyield	BEET_SUYIELD = 0.058*T+0.100*BEET_YIELD	1993-2013	0.823
Sugar_Percap	LOG(SUGAR_PERCAP) = 0.534*LOG(INCOME_PERCAP)-0.068*LOG(WPRICE_11)	1995-2012	0.754
Stkstouse	LOG(STKSTOCONS) = 2.607-2.223*D2000-0.688*LOG(WPRICE_11/CANE_COP)	1995-2012	0.575
Other North Africa			
Cane_Production	CANE_PRODUCTION = 350		
Beet_Production	BEET_PRODUCTION = 60		
Sugar_consumption	SUGARNA_CONS = 1078.145802 + 71.82620865*T - 637.7582697*D2011	1995-2014	
Stkstouse	STKSTOCONS = 11.41 percent	2010-2014	
European Union			
Beet_Area	BEET_AREA = 1,580		
Beet_Yield	BEET_YIELD = 20.821+1.522*T	2005-2013	0.743
Beet_Suyield	BEET_SUYIELD = 0.152*BEET_YIELD	1995-2013	0.945
Sugar_Percap	SUGAR_PERCAP = .35402		
Stkstouse	STKSTOUSE = WPRICE_11^(-0.25)		
Other Europe			
Beet_Production	BEET_PRODUCTION = MOVING AVERAGE(5 year)		
Sugar_exports	SUGAR_EXPORTS = 325		
Sugar_consumption	SUGAR_CONS = 0.995*(SUGAR_CONS(-1))		
Stkstouse	STKSTOCONS = 33.0 percent		
Guatemala			
Cane_Area	LOG(CANE_AREA) = 0.342+0.942*LOG(CANE_AREA(-1))+0.060*LOG(WPRICE_11(-1)/CANE_COP(-1))	1990-2013	0.985
Cane_COP	CANE_COP = -137.470*D1999TO2003-52.684*CANE_SUYIELD+115.300*EXRATE	1995-2013	0.784
Cane_Yield	CANE_YIELD = 88.258	1995-2013	
Cane_Suyield	CANE_SUYIELD = 0.054*T+0.098*CANE_YIELD+0.829*D2000TO2005	1995-2013	0.889
Sugar_Percap	DLOG(SUGAR_PERCAP) = -0.044 - 0.095*D2005+0.068*D2007TO2009+3.652*DLOG(INCOME_PERCAP)	1995-2014	0.536
Stkstouse	LOG(STKSTOUSE) = 2.158-1.095*D1998TO2004-0.986*LOG(WPRICE_11/CANE_COP)+[AR(1)=0.5200015723]	1983-2012	0.747
India			
Cane_Area	LOG(INDIA_AREA) = 0.175*LOG(WPRICE_11(-1)/INDIA_COP(-1))-0.272*LOG(INDIA_AREA(-2))-0.132*LOG(INDIA_AREA(-3)) 0.009*LOG(INDIA_AREA(-4)) + 0.149*LOG(INDIA_AREA(-5)) + 0.29*LOG(INDIA_AREA(-6))+0.43*LOG(INDIA_AREA(-7)) +0.571*LOG(INDIA_AREA(-8))	1989-2013	0.780
Cane_COP	CANE_COP = -58.562*INDIA_SUYIELD+18.0824*EXRATE	1995-2013	0.496
Cane_Yield	INDIA_YIELD = 68.102-8.716*D2004	1995-2013	0.352
Cane_Suyield	INDIA_SUYIELD = -0.531*D1996+0.110*INDIA_YIELD	1995-2013	0.807

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Sugar_Percap	LOG(INDIA_CONSPERCAP) = 1.011+0.366*LOG(INDIA_ PERCAPINCOME)-0.096*LOG(WPRICE_11)	1990-2012	0.897
Stkstouse	DLOG(INDIA_STKSTOUSE)=0.194-4.048833623*DLOG(INDIA_ CONS)-0.696*DLOG(WPRICE_11)	1981-2012	0.228
Japan			
Cane_Area	CANE_AREA = 22		
Cane_Suyield	CANE_SUYIELD = 0.118*CANE_YIELD	1980-2013	0.836
Beet_Area	BEET_AREA = 60		
Beet_Yield	BEET_YIELD = 51.011+0.292*T	1980-2013	0.264
Beet_Suyield	BEET_SUYIELD = 0.166*BEET_YIELD	1995-2013	0.806
Sugar_Percap	SWT_PERCAP(20.75) - HFCS_PERCAP(6.00)		
Stkstouse	STKSTOCONS = 26.607 percent	2009-2014	
Other East Asia			
Cane_Production	CANE_PRODUCTION = 65		
Sugar_Percap	ROASIACONS = 1645.720+29.268*T-0.595*WPRICE_11+209.739*D1997	1995-2012	0.802
Stkstouse	STKSTOCONS = 31.0 percent		
Mexico			
Cane_Area	LOG(CANE_AREA) = 1.007*LOG(CANE_AREA(-1))+0.060*LOG(WPRICE_11(-1)/CANE_COP(-1))	1993-2013	0.863
Cane_COP	CANE_COP = -29.135*CANE_SUYIELD+53.012*EXRATE	1998-2013	0.771
Cane_Yield	CANE_YIELD = 70.853	2000-2014	
Cane_Suyield	CANE_SUYIELD = 0.0179*T+0.106*CANE_YIELD	1998-2014	0.868
Swt_Percap	SWT_PERCAP = 23.266+0.003*INCOME_PERCAP	1987-2014	0.825
HFCS	HFCS: as specified in USDA sugar baseline model		
Sugar_Percap	SUGAR_PERCAP = (SWT_PERCAP*POP-HFCS)/POP		
Stkstocons	STKSTOCONS = 22.0 percent		
Other Central America			
Cane_Area	LOG(CANE_AREA) = 0.966+0.836*LOG(CANE_AREA(-1))+0.069*LOG(WPRICE_11(-1)/CANE_COP(-1))	1995-2013	0.815
Cane_COP	CANE_COP = 136.166+18.951*CANE_SUYIELD+0.360*WPRICE_11+99.651*D2008TO2009+[AR(1)=-0.5187034158]	1995-2012	0.923
Cane_Yield	CANE_YIELD = 60.471+0.522*T	1980-2013	0.776
Cane_Suyield	CANE_SUYIELD = 0.102*CANE_YIELD+[AR(1)=0.6802225293]	1995-2013	0.813
Sugar_Percap	SUGAR_PERCAP = 34.358+0.305*T+1.382*D1998-2.131*D2005TO2011	1995-2014	0.926
Stkstouse	LOG(STKSTOUSE) = 2.945-0.280*LOG(WPRICE_11/CANE_COP)+[AR(1)=0.8923098015]	1995-2012	0.453
Other South America			
Cane_Area	CANE_AREA = CANE_AREA(-1)*(1+PERCENTCHANGE(WORLD PRICE(-1))		
Cane_Yield	CANE_YIELD = 61.935+0.169*T	1995-2013	0.103
Cane_Suyield	CANE_SUYIELD = 0.043*T+0.084*CANE_YIELD	1980-2013	0.795

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Beet_Area	BEET_AREA = BEET_AREA(-1)*(1+PERCENTCHANGE(WORLD PRICE(-1))		
Beet_Yield	BEET_YIELD = 40.122+1.945*T-17.560*D2009-11.144*D1996TO2002	1983-2012	0.940
Beet_Suyield	BEET_SUYIELD = 0.145*BEET_YIELD	1983-2013	0.968
Sugar_Percap	SUGAR_PERCAP=1.005*SUGAR_PERCAP(-1)		
Stkstouse	LOG(STKSTOCONS) = 3.553-0.1864388644*LOG(WPRICE_11/CANE_COP)+[AR(1)=0.8156111093]	1995-2012	0.811
Pakistan			
Cane_Area	LOG(CANE_AREA) = 0.297*D1989TO1995-0.100*LOG(CANE_AREA(-2))+0.135*LOG(CANE_AREA(-3)) +0.369*LOG(CANE_AREA(-4))+0.604*LOG(CANE_AREA(-5))	1987-2013	0.882
Cane_COP	CANE_COP = 320.415-120.091*D2002+180.630*D2009TO2010+4.221*EXRATE- 27.782*CANE_SUYIELD	1980-2013	0.878
Cane_Yield	CANE_YIELD = 35.736+0.548*T	1980-2013	0.845
Cane_Suyield	CANE_SUYIELD = 0.022*T+0.086*CANE_YIELD	1980-2013	0.920
Sugar_Percap	SUGAR_PERCAP = 20.735+2.806*D1996+1.220*D1998+1.934*D2001+0.00175*INCOME_PERCAP	1995-2014	0.839
Stkstouse	LOG(STKSTOCONS) = 0.593*D2004TO2008+0.711*D2011TO2012 +0.891*LOG(SUGAR_PERCAP)	1995-2014	0.667
Philippines			
Cane_Area	LOG(CANE_AREA) = 1.008*LOG(CANE_AREA(-1))+0.110*LOG(WPRICE_11(-1)/CANE_COP(-1))	1995-2013	0.723
Cane_COP	CANE_COP = 361.669+192.326*D2009TO2013	1995-2013	0.727
Cane_Yield	CANE_YIELD = 59.268-9.491*D2010	1995-2013	0.149
Cane_Suyield	CANE_SUYIELD = 3.081-0.949*D1986TO2000-0.724*D2001-0.024*T+0.053*CANE_YIELD	1980-2013	0.867
Sugar_Percap	SUGAR_PERCAP = 20.9	2014	
Stkstouse	STKSTOUSE = 35.0 percent		
Other Southeast Asia			
Cane_Production	SEASIA_PROD = 744.618+10.847*T+0.681*SEASIA_PROD(-1)	1981-2014	0.841
Sugar_Consumption	SEASIA_CONS = 552.233+256.9*T	2000-2014	0.972
Russia			
Beet_Area	PERCENTCHANGE_AREA = PERCENTCHANGE(WORLDPRICE(-1)*EXRATE(-1)/COP(-1))^.578	2013	
Beet_COP	BEET_COP = 42.410*EXRATE-136.487*BEET_SUYIELD	2009-2013	0.633
Beet_Suyield	BEET_SUYIELD = 0.681*D2010+0.00235*T+0.1074*BEET_YIELD	2000-2013	0.952
Sugar_Percap	SUGAR_PERCAP = 40.0		
Stkstouse	LOG(STKSTOCONS) = 1.579+1.253*D2001TO2003-1.666*LOG((1.07*WPRICE_11+65)/BEET_COP)	2000-2012	0.831
South Africa			
Cane_Area	CANE_AREA = 275		
Cane_COP	CANE_COP = 424.009-111.475*D2000TO2003-28.173*CANE_SUYIELD+17.008*EXRATE	1980-2013	0.750
Cane_Yield	CANE_YIELD = 65.678	1996-2013	
Cane_Suyield	CANE_SUYIELD = 0.021*T+0.115*CANE_YIELD	1980-2013	

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Sugar_Percap	SUGAR_PERCAP = 1.01*SUGAR_PERCAP(-1)		
Stkstouse	DLOG(STKSTOCONS) = -0.757*D2007TO2009-0.578*DLOG(WPRICE_11)	1981-2012	0.447
Sub-Saharan Africa			
Cane_Production	LOG(SS_CANEPRODN) = 2.286+0.737*LOG(SS_CANEPRODN(-1))+0.0515*LOG(WPRICE_11(-1)/SS_COP(-1))	2001-2013	0.927
Cane_COP	DLOG(SS_COP) = -0.810*DLOG(SS_SUYIELD) + 0.00153*T	1996-2013	0.096
Sugar_Percap	SS_PERCAPCONS = 5.401+0.007*SS_PERCAPINCOME	1998-2014	0.873
Stkstouse	LOG(SS_STKSTOCONS) = 2.425-0.312*D1997TO1999+0.863*LOG(SS_PERCAPCONS)-0.198*LOG(WPRICE_11)	1995-2012	0.759
Thailand			
Cane_Production	LOG(THAI_AREA) = 2.130+0.232*LOG(WPRICE_11(-1)/THAI_COP(-1))+0.696*LOG(THAI_AREA(-1))	1982-2013	0.814
Cane_COP	THAI_COP = -36.399*THAI_SUYIELD+20.552*T+[AR(1)=0.834]	1995-2013	0.842
Cane_Yield	THAI_YIELD = 32.496+1.223*T	1995-2013	0.473
Cane_Suyield	THAI_SUYIELD = 0.015*T+0.104*THAI_YIELD	1985-2013	0.965
Sugar_Percap	LOG(THAI_CONSPERCAP) = 2.176-0.035*D1990TO1997-0.016*D2004TO2008 +0.266*LOG(THAI_PERCAPINCOME)-0.0198*LOG(WPRICE_11)	1980-2012	0.995
Ending stocks	THAI_STOCKS = 1,500.		
Turkey			
Beet_Area	LOG(BEET_AREA) = 2.657-0.328*D1996+0.528*LOG(BEET_AREA(-1))+0.0678*WPRICE_BTEQ(-1)/BEET_COP(-1) +0.0977*WPRICE_BTEQ(-2)/BEET_COP(-2)	1982-2013	0.424
Beet_COP	BEET_COP = 339.567-153.960*D2001TO2003-16.975*BEET_SUYIELD+240.843*EXRATE+[AR(1)=0.706]	1981-2013	0.892
Beet_Yield	BEET_YIELD = 18.812+0.892*T	1995-2013	0.754
Beet_Suyield	BEET_SUYIELD = 0.022*T+0.125*BEET_YIELD	1980-2013	0.937
Sugar_Percap	SUGAR_PERCAP = 1.603+0.002022*INCOME_PERCAP+3.572*D2010+[AR(1)=0.9678]	1995-2014	0.756
Stkstouse	LOG(STKSTOCONS) = 5.899-0.470*LOG(WPRICE_11)	1995-2012	0.256
Other Middle East			
Beet_Production	BEET_PRODUCTION = 800	2014	
Cane_Production	CANE_PRODUCTION = 350	2014	
Sugar_Percap	LOG(ME_CONSPERCAP) = -4.153-0.145*D2011+0.891*LOG(ME_INCOMEPERCAP)+[AR(1)=0.562]	1995-2014	0.919
Stkstouse	LOG(ME_STKSTOCONS) = 4.145+0.444*D2005TO2008-0.186*LOG(WPRICE_11)	1995-2012	0.753
Ukraine			
Beet_Area	BEET_AREA = -389.184*D2009+0.9062521522*BEET_AREA(-1)+109.137*WPRICE_BTEQ(-1)/BEET_COP(-1)	1993-2013	0.966
Beet_COP	BEET_COP = 526.718+380.666*D2008+48.194*EXRATE	1992-2013	0.744
Beet_Yield	BEET_YIELD = 45.0	2014 forecast	
Beet_Suyield	BEET_SUYIELD = 0.120*BEET_YIELD	1992-2013	
Sugar_Percap	SUGAR_PERCAP = 41.0		

—continued

Appendix II—table 3

Detailed equation structure for countries and regions other than Brazil—continued

Stkstouse	STKSTOCONS = 20.25 percent	2010-2013	
United States			
Cane_Area	CANE_AREA = 338.533		
Cane_Yield	CANE_YIELD = 75.726	1995-2014	
Cane_Suyield	CANE_SUYIELD = 0.038*T+0.109*CANE_YIELD	1995-2014	0.871
Beet_Area	LOG(BEET_AREA) = -0.210*D2009+0.9311167084*LOG(BEET_AREA(-1))+0.072*DNAFTA*LOG(1.07*WPRICE_11(-1)+65)	2008-2013	0.099
Beet_Yield	BEET_YIELD = 31.422+0.875*T	1995-2014	0.675
Beet_Suyield	BEET_SUYIELD = 2.298+0.596*D2009+0.112*T+0.054*BEET_YIELD	1995-2014	0.967
TRQ_Shortfall	TRQ_SHORTFALL = 100 + .25*MAX(0, IMPORTS from MEXICO - 1,000)		
Sugar_Percap	SUGAR_PERCAP = 32.12	2010-2013	

Source: USDA, Economic Research Service.

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Brazil												
Beginning stocks	-535	-295	-295	-295	-295	-295	-295	-295	-295	-295	-295	-295
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	38,750	36,699	40,216	38,190	40,461	40,698	40,814	41,848	44,141	44,510	45,246	46,442
Total sugar production	38,750	36,699	40,216	38,190	40,461	40,698	40,814	41,848	44,141	44,510	45,246	46,442
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	38,215	36,404	39,921	37,895	40,166	40,403	40,519	41,553	43,846	44,215	44,951	46,147
Total exports	27,250	25,320	28,719	26,577	28,735	28,861	28,868	29,795	31,983	32,250	32,885	33,982
Human dom. consumption	11,260	11,380	11,497	11,613	11,726	11,837	11,946	12,053	12,158	12,261	12,361	12,459
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	11,260	11,380	11,497	11,613	11,726	11,837	11,946	12,053	12,158	12,261	12,361	12,459
Ending stocks	-295	-295	-295	-295	-295	-295	-295	-295	-295	-295	-295	-295
Argentina												
Beginning stocks	446	186	217	252	166	199	194	163	151	157	160	160
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	1,800	2,505	2,557	2,554	2,636	2,626	2,629	2,673	2,721	2,744	2,755	2,763
Total sugar production	1,800	2,505	2,557	2,554	2,636	2,626	2,629	2,673	2,721	2,744	2,755	2,763
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	2,246	2,691	2,775	2,805	2,802	2,824	2,823	2,836	2,873	2,901	2,915	2,923
Total exports	220	589	563	684	554	533	539	524	494	461	419	362
Human dom. consumption	1,830	1,874	1,950	1,945	2,039	2,087	2,111	2,151	2,211	2,270	2,326	2,388
Other disappearance	10	10	10	10	10	10	10	10	10	10	10	10
Total use	1,840	1,884	1,960	1,955	2,049	2,097	2,121	2,161	2,221	2,280	2,336	2,398
Ending stocks	186	217	252	166	199	194	163	151	157	160	160	163
Colombia												
Beginning stocks	300	390	368	375	381	387	394	401	407	414	421	428
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	2,400	2,343	2,369	2,395	2,422	2,449	2,476	2,503	2,530	2,558	2,586	2,614
Total sugar production	2,400	2,343	2,369	2,395	2,422	2,449	2,476	2,503	2,530	2,558	2,586	2,614
Total imports	290	253	257	262	266	271	275	280	285	290	294	299
Total supply	2,990	2,986	2,994	3,032	3,069	3,107	3,145	3,184	3,222	3,262	3,302	3,342
Total exports	600	826	797	797	797	796	795	794	793	791	789	787
Human dom. consumption	1,995	1,787	1,818	1,849	1,880	1,912	1,944	1,977	2,010	2,044	2,079	2,114
Other disappearance	5	5	5	5	5	5	5	5	5	5	5	5
Total use	2,000	1,792	1,823	1,854	1,885	1,917	1,949	1,982	2,015	2,049	2,084	2,119
Ending stocks	390	368	375	381	387	394	401	407	414	421	428	436
Other South America												
Beginning stocks	1,590	1,569	1,554	1,579	1,605	1,631	1,657	1,683	1,709	1,735	1,761	1,787
Beet sugar production	330	355	351	361	355	356	361	363	362	362	362	362
Cane sugar production	3,073	3,084	3,114	3,106	3,219	3,191	3,223	3,291	3,336	3,355	3,377	3,404
Total sugar production	3,403	3,439	3,465	3,467	3,574	3,547	3,584	3,654	3,698	3,717	3,739	3,766
Total imports	1,724	1,741	1,838	1,912	1,902	2,003	2,050	2,070	2,111	2,174	2,233	2,288

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Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Total supply	6,717	6,749	6,857	6,959	7,082	7,181	7,291	7,407	7,519	7,626	7,733	7,841
Total exports	555	526	531	529	549	544	549	561	569	572	576	580
Human dom. consumption	4,593	4,670	4,747	4,824	4,902	4,980	5,058	5,137	5,215	5,293	5,371	5,448
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	4,593	4,670	4,747	4,824	4,902	4,980	5,058	5,137	5,215	5,293	5,371	5,448
Ending stocks	1,569	1,554	1,579	1,605	1,631	1,657	1,683	1,709	1,735	1,761	1,787	1,813
Cuba												
Beginning stocks	149	150	149	152	136	144	139	129	125	125	124	122
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	1,600	1,578	1,547	1,461	1,474	1,400	1,335	1,313	1,302	1,275	1,239	1,199
Total sugar production	1,600	1,578	1,547	1,461	1,474	1,400	1,335	1,313	1,302	1,275	1,239	1,199
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	1,749	1,728	1,696	1,614	1,610	1,544	1,474	1,442	1,427	1,401	1,363	1,321
Total exports	850	897	864	798	788	729	670	643	630	606	573	535
Human dom. consumption	749	681	680	679	678	677	675	674	672	670	668	666
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	749	681	680	679	678	677	675	674	672	670	668	666
Ending stocks	150	149	152	136	144	139	129	125	125	124	122	119
Dominican Republic												
Beginning stocks	50	39	38	40	37	40	40	39	38	39	40	41
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	541	575	581	584	593	597	602	609	618	627	634	642
Total sugar production	541	575	581	584	593	597	602	609	618	627	634	642
Total imports	40	0	0	0	0	0	0	0	0	0	0	0
Total supply	631	614	619	623	630	637	641	648	657	666	675	683
Total exports	212	193	192	195	196	199	201	204	209	214	219	223
Human dom. consumption	380	384	388	391	395	398	402	405	409	412	415	418
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	380	384	388	391	395	398	402	405	409	412	415	418
Ending stocks	39	38	40	37	40	40	39	38	39	40	41	42
Other Caribbean												
Beginning stocks	128	128	138	140	141	143	144	145	147	148	150	151
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	210	189	191	193	195	197	199	201	203	205	207	209
Total sugar production	210	189	191	193	195	197	199	201	203	205	207	209
Total imports	405	435	431	435	439	444	448	453	457	462	466	471
Total supply	743	753	760	768	775	783	791	799	807	815	823	831
Total exports	150	145	146	148	149	151	152	154	155	157	158	160

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Human dom. consumption	465	470	474	479	484	489	494	499	504	509	514	519
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	465	470	474	479	484	489	494	499	504	509	514	519
Ending stocks	128	138	140	141	143	144	145	147	148	150	151	153
Guatemala												
Beginning stocks	120	73	82	96	75	92	96	90	90	98	106	113
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	2,600	2,940	3,026	3,151	3,233	3,310	3,403	3,499	3,579	3,645	3,700	3,739
Total sugar production	2,600	2,940	3,026	3,151	3,233	3,310	3,403	3,499	3,579	3,645	3,700	3,739
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	2,720	3,013	3,107	3,247	3,307	3,402	3,499	3,589	3,669	3,743	3,806	3,852
Total exports	1,850	2,117	2,178	2,311	2,324	2,383	2,453	2,505	2,540	2,567	2,583	2,577
Human dom. consumption	797	814	833	861	891	923	957	993	1,030	1,070	1,110	1,153
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	797	814	833	861	891	923	957	993	1,030	1,070	1,110	1,153
Ending stocks	73	82	96	75	92	96	90	90	98	106	113	122
Other Central America												
Beginning stocks	618	602	639	659	670	689	700	710	724	740	755	768
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	2,697	2,702	2,768	2,806	2,890	2,930	2,971	3,034	3,104	3,163	3,214	3,262
Total sugar production	2,697	2,702	2,768	2,806	2,890	2,930	2,971	3,034	3,104	3,163	3,214	3,262
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	3,315	3,304	3,407	3,465	3,560	3,618	3,670	3,744	3,828	3,903	3,969	4,029
Total exports	1,275	1,311	1,370	1,393	1,445	1,467	1,485	1,520	1,563	1,599	1,628	1,652
Human dom. consumption	1,418	1,334	1,358	1,382	1,407	1,431	1,455	1,480	1,504	1,529	1,553	1,578
Other disappearance	20	20	20	20	20	20	20	20	20	20	20	20
Total use	1,438	1,354	1,378	1,402	1,427	1,451	1,475	1,500	1,524	1,549	1,573	1,598
Ending stocks	602	639	659	670	689	700	710	724	740	755	768	779
Canada												
Beginning stocks	260	260	247	249	251	253	255	256	258	260	261	263
Beet sugar production	125	144	148	149	156	158	160	165	171	175	179	183
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	125	144	148	149	156	158	160	165	171	175	179	183
Total imports	1,195	1,109	1,129	1,137	1,139	1,146	1,153	1,156	1,158	1,162	1,166	1,169
Total supply	1,580	1,514	1,524	1,535	1,546	1,556	1,567	1,577	1,587	1,597	1,606	1,615
Total exports	45	60	60	60	60	60	60	60	60	60	60	60
Human dom. consumption	1,275	1,206	1,215	1,224	1,233	1,242	1,251	1,259	1,267	1,275	1,283	1,291
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	1,275	1,206	1,215	1,224	1,233	1,242	1,251	1,259	1,267	1,275	1,283	1,291
Ending stocks	260	247	249	251	253	255	256	258	260	261	263	265

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Mexico												
Beginning stocks	1,548	1,044	1,066	1,046	1,067	1,090	1,107	1,117	1,132	1,150	1,168	1,187
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	6,890	6,398	6,530	6,616	6,800	6,909	7,025	7,191	7,383	7,566	7,744	7,924
Total sugar production	6,890	6,398	6,530	6,616	6,800	6,909	7,025	7,191	7,383	7,566	7,744	7,924
Total imports	231	231	231	231	231	231	231	231	231	231	231	231
Total supply	8,669	7,673	7,827	7,893	8,098	8,230	8,363	8,540	8,746	8,947	9,143	9,341
Total exports	2,485	1,400	1,665	1,614	1,694	1,731	1,808	1,900	2,008	2,108	2,203	2,294
Human dom. consumption	4,743	4,846	4,756	4,852	4,954	5,032	5,078	5,148	5,228	5,311	5,394	5,481
Other disappearance	397	360	360	360	360	360	360	360	360	360	360	360
Total use	5,140	5,206	5,116	5,212	5,314	5,392	5,438	5,508	5,588	5,671	5,754	5,841
Ending stocks	1,044	1,066	1,046	1,067	1,090	1,107	1,117	1,132	1,150	1,168	1,187	1,206
United States												
Beginning stocks	1,980	2,175	2,117	2,257	2,366	2,532	2,729	2,974	3,305	3,695	4,154	4,677
Beet sugar production	4,559	4,521	4,577	4,638	4,691	4,749	4,796	4,870	4,906	4,960	5,015	5,070
Cane sugar production	3,495	3,254	3,267	3,280	3,293	3,306	3,319	3,332	3,345	3,358	3,371	3,384
Total sugar production	8,054	7,775	7,844	7,918	7,984	8,056	8,115	8,202	8,252	8,318	8,386	8,454
Total imports	3,059	2,972	3,173	3,140	3,203	3,235	3,295	3,365	3,447	3,524	3,596	3,666
Total supply	13,093	12,922	13,134	13,315	13,553	13,822	14,139	14,541	15,003	15,537	16,136	16,797
Total exports	227	181	181	181	181	181	181	181	181	181	181	181
Human dom. consumption	10,523	10,431	10,503	10,575	10,647	10,719	10,791	10,863	10,935	11,010	11,085	11,161
Other disappearance	168	192	192	192	192	192	192	192	192	192	192	192
Total use	10,691	10,624	10,696	10,768	10,840	10,912	10,984	11,055	11,127	11,202	11,277	11,353
Ending stocks	2,175	2,117	2,257	2,366	2,532	2,729	2,974	3,305	3,695	4,154	4,677	5,263
European Union - 28												
Beginning stocks	4,044	3,894	3,764	3,878	3,648	3,821	3,804	3,693	3,642	3,663	3,673	3,670
Beet sugar production	15,700	16,444	16,526	16,609	18,361	18,453	18,564	18,757	18,900	18,979	19,066	19,167
Cane sugar production	300	275	275	275	275	275	275	275	275	275	275	275
Total sugar production	16,000	16,719	16,801	16,884	18,636	18,728	18,839	19,032	19,175	19,254	19,341	19,442
Total imports	3,650	2,989	3,185	2,793	1,472	1,216	1,034	920	864	788	696	620
Total supply	23,694	23,602	23,751	23,554	23,757	23,765	23,677	23,645	23,681	23,704	23,710	23,731
Total exports	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Human dom. consumption	18,300	18,337	18,373	18,406	18,435	18,461	18,484	18,503	18,519	18,531	18,541	18,547
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	18,300	18,337	18,373	18,406	18,435	18,461	18,484	18,503	18,519	18,531	18,541	18,547
Ending stocks	3,894	3,764	3,878	3,648	3,821	3,804	3,693	3,642	3,663	3,673	3,670	3,684
Other European												
Beginning stocks	374	374	387	385	383	381	379	377	375	373	372	370
Beet sugar production	684	712	711	706	700	703	706	705	704	704	704	705
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	684	712	711	706	700	703	706	705	704	704	704	705
Total imports	690	838	818	818	817	809	800	795	791	785	779	773
Total supply	1,748	1,924	1,916	1,908	1,901	1,893	1,885	1,878	1,870	1,863	1,855	1,848

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Total exports	156	325	325	325	325	325	325	325	325	325	325	325
Human dom. consumption	1,178	1,172	1,166	1,160	1,155	1,149	1,143	1,137	1,132	1,126	1,120	1,115
Other disappearance	40	40	40	40	40	40	40	40	40	40	40	40
Total use	1,218	1,212	1,206	1,200	1,195	1,189	1,183	1,177	1,172	1,166	1,160	1,155
Ending stocks	374	387	385	383	381	379	377	375	373	372	370	368
Russia												
Beginning stocks	275	260	427	427	427	426	426	425	424	423	423	421
Beet sugar production	4,400	4,737	4,596	5,436	5,155	5,379	5,918	6,302	6,448	6,636	6,886	7,077
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	4,400	4,737	4,596	5,436	5,155	5,379	5,918	6,302	6,448	6,636	6,886	7,077
Total imports	1,100	1,392	1,363	519	795	563	0	0	0	0	0	0
Total supply	5,775	6,389	6,386	6,382	6,376	6,369	6,343	6,727	6,872	7,060	7,308	7,498
Total exports	100	250	250	250	250	250	234	630	787	989	1,252	1,457
Human dom. consumption	5,400	5,697	5,694	5,690	5,685	5,678	5,669	5,658	5,647	5,634	5,620	5,606
Other disappearance	15	15	15	15	15	15	15	15	15	15	15	15
Total use	5,415	5,712	5,709	5,705	5,700	5,693	5,684	5,673	5,662	5,649	5,635	5,621
Ending stocks	260	427	427	427	426	426	425	424	423	423	421	420
Ukraine												
Beginning stocks	629	209	365	363	361	358	356	353	351	348	346	343
Beet sugar production	1,700	2,561	2,663	2,730	2,867	2,942	3,021	3,134	3,261	3,375	3,479	3,580
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	1,700	2,561	2,663	2,730	2,867	2,942	3,021	3,134	3,261	3,375	3,479	3,580
Total imports	5	0	0	0	0	0	0	0	0	0	0	0
Total supply	2,334	2,770	3,028	3,093	3,228	3,300	3,377	3,487	3,612	3,723	3,825	3,923
Total exports	325	600	872	952	1,101	1,188	1,278	1,404	1,543	1,669	1,786	1,900
Human dom. consumption	1,800	1,804	1,793	1,781	1,769	1,757	1,745	1,733	1,720	1,708	1,695	1,683
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	1,800	1,804	1,793	1,781	1,769	1,757	1,745	1,733	1,720	1,708	1,695	1,683
Ending stocks	209	365	363	361	358	356	353	351	348	346	343	341
Other Former Soviet Union												
Beginning stocks	931	1,156	751	764	778	791	805	819	832	846	860	873
Beet sugar production	1,010	960	960	960	960	960	960	960	960	960	960	960
Cane sugar production	3	3	3	3	3	3	3	3	3	3	3	3
Total sugar production	1,013	963	963	963	963	963	963	963	963	963	963	963
Total imports	1,684	1,333	1,788	1,824	1,861	1,897	1,934	1,970	2,007	2,043	2,079	2,115
Total supply	3,628	3,452	3,502	3,551	3,601	3,652	3,702	3,752	3,802	3,852	3,901	3,951
Total exports	506	700	700	700	700	700	700	700	700	700	700	700
Human dom. consumption	1,966	2,002	2,038	2,074	2,110	2,147	2,183	2,220	2,256	2,292	2,328	2,364
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	1,966	2,002	2,038	2,074	2,110	2,147	2,183	2,220	2,256	2,292	2,328	2,364
Ending stocks	1,156	751	764	778	791	805	819	832	846	860	873	887

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Turkey												
Beginning stocks	157	82	234	254	233	260	265	257	257	267	275	282
Beet sugar production	2,200	2,047	2,029	2,022	2,035	2,068	2,058	2,071	2,106	2,133	2,143	2,149
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	2,200	2,047	2,029	2,022	2,035	2,068	2,058	2,071	2,106	2,133	2,143	2,149
Total imports	5	461	425	462	570	587	659	731	784	836	906	985
Total supply	2,362	2,590	2,687	2,737	2,838	2,916	2,983	3,059	3,147	3,236	3,324	3,416
Total exports	20	20	20	20	20	20	20	20	20	20	20	20
Human dom. consumption	2,260	2,336	2,413	2,485	2,558	2,631	2,705	2,782	2,861	2,940	3,022	3,104
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,260	2,336	2,413	2,485	2,558	2,631	2,705	2,782	2,861	2,940	3,022	3,104
Ending stocks	82	234	254	233	260	265	257	257	267	275	282	292
Other Middle East												
Beginning stocks	1,572	1,587	1,641	1,740	1,721	1,841	1,896	1,916	1,962	2,040	2,118	2,193
Beet sugar production	800	800	800	800	800	800	800	800	800	800	800	800
Cane sugar production	350	350	350	350	350	350	350	350	350	350	350	350
Total sugar production	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Total imports	9,448	10,009	10,473	10,656	11,123	11,471	11,845	12,289	12,753	13,214	13,694	14,198
Total supply	12,170	12,746	13,264	13,545	13,994	14,463	14,891	15,355	15,865	16,404	16,963	17,541
Total exports	1,005	1,167	1,205	1,130	1,086	1,118	1,141	1,136	1,122	1,121	1,128	1,129
Human dom. consumption	9,578	9,938	10,319	10,695	11,068	11,448	11,835	12,257	12,702	13,165	13,642	14,134
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	9,578	9,938	10,319	10,695	11,068	11,448	11,835	12,257	12,702	13,165	13,642	14,134
Ending stocks	1,587	1,641	1,740	1,721	1,841	1,896	1,916	1,962	2,040	2,118	2,193	2,278
Egypt												
Beginning stocks	160	160	297	311	317	333	344	352	362	373	385	396
Beet sugar production	1,100	1,069	1,096	1,124	1,153	1,183	1,213	1,244	1,276	1,308	1,341	1,375
Cane sugar production	920	1,060	1,062	1,065	1,067	1,069	1,071	1,073	1,076	1,078	1,080	1,082
Total sugar production	2,020	2,129	2,158	2,189	2,220	2,252	2,284	2,317	2,351	2,386	2,421	2,457
Total imports	1,200	1,478	1,471	1,498	1,638	1,717	1,768	1,833	1,921	2,006	2,092	2,186
Total supply	3,380	3,766	3,926	3,998	4,175	4,302	4,396	4,503	4,634	4,765	4,898	5,040
Total exports	400	400	400	400	400	400	400	400	400	400	400	400
Human dom. consumption	2,820	3,070	3,216	3,281	3,442	3,558	3,644	3,741	3,861	3,981	4,101	4,231
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,820	3,070	3,216	3,281	3,442	3,558	3,644	3,741	3,861	3,981	4,101	4,231
Ending stocks	160	297	311	317	333	344	352	362	373	385	396	409
Other North Africa												
Beginning stocks	419	419	410	418	426	434	443	451	459	467	475	484
Beet sugar production	350	350	350	350	350	350	350	350	350	350	350	350
Cane sugar production	60	50	50	50	50	50	50	50	50	50	50	50
Total sugar production	410	400	400	400	400	400	400	400	400	400	400	400
Total imports	3,870	3,783	3,872	3,944	4,016	4,088	4,159	4,231	4,303	4,375	4,447	4,519
Total supply	4,699	4,602	4,682	4,762	4,842	4,922	5,002	5,082	5,162	5,242	5,322	5,402

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
						1,000 metric tons, raw value (MTRV)						
Total exports	585	600	600	600	600	600	600	600	600	600	600	600
Human dom. consumption	3,695	3,592	3,664	3,736	3,808	3,879	3,951	4,023	4,095	4,167	4,238	4,310
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	3,695	3,592	3,664	3,736	3,808	3,879	3,951	4,023	4,095	4,167	4,238	4,310
Ending stocks	419	410	418	426	434	443	451	459	467	475	484	492
South Africa												
Beginning stocks	172	362	190	203	172	190	189	177	172	176	179	180
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	2,450	2,287	2,293	2,299	2,305	2,310	2,316	2,322	2,328	2,333	2,339	2,345
Total sugar production	2,450	2,287	2,293	2,299	2,305	2,310	2,316	2,322	2,328	2,333	2,339	2,345
Total imports	225	227	229	232	234	237	240	242	245	247	250	253
Total supply	2,847	2,876	2,712	2,734	2,711	2,737	2,745	2,741	2,745	2,757	2,768	2,778
Total exports	600	786	587	620	557	563	561	540	518	506	493	477
Human dom. consumption	1,880	1,895	1,916	1,938	1,959	1,980	2,002	2,024	2,046	2,068	2,090	2,112
Other disappearance	5	5	5	5	5	5	5	5	5	5	5	5
Total use	1,885	1,900	1,921	1,943	1,964	1,985	2,007	2,029	2,051	2,073	2,095	2,117
Ending stocks	362	190	203	172	190	189	177	172	176	179	180	184
Other Sub-Sahara Africa												
Beginning stocks	2,210	2,242	2,290	2,456	2,447	2,651	2,761	2,816	2,910	3,052	3,192	3,328
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	6,179	6,233	6,279	6,277	6,359	6,361	6,371	6,419	6,475	6,512	6,536	6,556
Total sugar production	6,179	6,233	6,279	6,277	6,359	6,361	6,371	6,419	6,475	6,512	6,536	6,556
Total imports	5,406	5,645	6,102	6,305	6,843	7,141	7,482	7,906	8,343	8,752	9,176	9,636
Total supply	13,795	14,120	14,671	15,038	15,649	16,153	16,613	17,140	17,728	18,316	18,904	19,521
Total exports	1,935	1,969	1,983	1,983	2,009	2,009	2,013	2,028	2,046	2,057	2,065	2,071
Human dom. consumption	9,567	9,810	10,182	10,558	10,939	11,333	11,735	12,153	12,580	13,016	13,462	13,918
Other disappearance	51	50	50	50	50	50	50	50	50	50	50	50
Total use	9,618	9,860	10,232	10,608	10,989	11,383	11,785	12,203	12,630	13,066	13,512	13,968
Ending stocks	2,242	2,290	2,456	2,447	2,651	2,761	2,816	2,910	3,052	3,192	3,328	3,482
India												
Beginning stocks	10,425	9,475	9,704	10,976	9,310	11,088	11,247	10,542	10,389	10,893	11,327	11,645
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	25,450	27,449	27,499	27,916	32,740	32,859	33,273	33,934	34,322	36,414	38,254	40,166
Total sugar production	25,450	27,449	27,499	27,916	32,740	32,859	33,273	33,934	34,322	36,414	38,254	40,166
Total imports	1,800	0	2,220	0	0	0	0	0	2	0	0	0
Total supply	37,675	36,924	39,422	38,892	42,050	43,946	44,520	44,476	44,714	47,308	49,581	51,812
Total exports	2,000	60	0	855	753	1,547	2,166	1,408	0	1,021	1,851	2,341
Human dom. consumption	26,200	27,160	28,446	28,727	30,210	31,152	31,812	32,679	33,820	34,960	36,084	37,309
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	26,200	27,160	28,446	28,727	30,210	31,152	31,812	32,679	33,820	34,960	36,084	37,309
Ending stocks	9,475	9,704	10,976	9,310	11,088	11,247	10,542	10,389	10,893	11,327	11,645	12,161

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Pakistan												
Beginning stocks	639	729	763	785	807	830	854	879	905	934	963	995
Beet sugar production	40	40	40	40	40	40	40	40	40	40	40	40
Cane sugar production	4,930	3,965	4,663	5,169	5,090	4,797	4,554	5,214	5,488	5,219	4,997	5,160
Total sugar production	4,970	4,005	4,703	5,209	5,130	4,837	4,594	5,254	5,528	5,259	5,037	5,200
Total imports	10	654	45	0	0	229	585	42	0	286	638	613
Total supply	5,619	5,388	5,511	5,993	5,936	5,896	6,033	6,175	6,433	6,478	6,639	6,807
Total exports	440	0	0	358	173	0	0	0	110	0	0	0
Human dom. consumption	4,450	4,625	4,726	4,829	4,934	5,042	5,154	5,269	5,390	5,514	5,644	5,779
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	4,450	4,625	4,726	4,829	4,934	5,042	5,154	5,269	5,390	5,514	5,644	5,779
Ending stocks	729	763	785	807	830	854	879	905	934	963	995	1,029
Other South Asia												
Beginning stocks	702	702	723	743	763	784	806	828	851	874	898	923
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	290	290	290	290	290	290	290	290	290	290	290	290
Total sugar production	290	290	290	290	290	290	290	290	290	290	290	290
Total imports	2,263	2,344	2,415	2,490	2,566	2,645	2,726	2,809	2,894	2,982	3,072	3,165
Total supply	3,255	3,336	3,428	3,522	3,619	3,719	3,822	3,927	4,035	4,146	4,261	4,378
Total exports	10	0	0	0	0	0	0	0	0	0	0	0
Human dom. consumption	2,543	2,613	2,685	2,759	2,835	2,913	2,993	3,076	3,161	3,248	3,337	3,429
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,543	2,613	2,685	2,759	2,835	2,913	2,993	3,076	3,161	3,248	3,337	3,429
Ending stocks	702	723	743	763	784	806	828	851	874	898	923	949
China												
Beginning stocks	6,790	8,345	6,883	4,160	2,947	3,649	3,687	3,256	3,135	3,315	3,465	3,562
Beet sugar production	1,000	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,284
Cane sugar production	13,800	14,128	14,934	15,270	16,414	16,813	17,190	17,953	18,885	19,656	20,290	20,844
Total sugar production	14,800	15,411	16,218	16,554	17,698	18,097	18,474	19,237	20,169	20,939	21,574	22,127
Total imports	2,800	1,000	0	1,514	3,260	2,955	2,746	2,993	3,176	3,197	3,336	3,741
Total supply	24,390	24,756	23,101	22,229	23,905	24,700	24,906	25,485	26,480	27,452	28,374	29,430
Total exports	45	0	177	0	0	0	0	0	0	0	0	0
Human dom. consumption	16,000	17,873	18,763	19,281	20,256	21,014	21,650	22,350	23,164	23,987	24,812	25,686
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	16,000	17,873	18,763	19,281	20,256	21,014	21,650	22,350	23,164	23,987	24,812	25,686
Ending stocks	8,345	6,883	4,160	2,947	3,649	3,687	3,256	3,135	3,315	3,465	3,562	3,744
Japan												
Beginning stocks	550	549	524	532	531	530	528	527	525	524	522	520
Beet sugar production	600	653	656	659	662	666	669	672	675	678	681	684
Cane sugar production	150	156	156	156	156	156	156	156	156	156	156	156
Total sugar production	750	809	813	816	819	822	825	828	831	834	837	841
Total imports	1,365	1,135	1,195	1,179	1,171	1,163	1,154	1,145	1,136	1,126	1,115	1,105
Total supply	2,665	2,493	2,532	2,527	2,521	2,515	2,508	2,500	2,492	2,484	2,475	2,465

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Total exports	1	0	0	0	0	0	0	0	0	0	0	0
Human dom. consumption	2,115	1,969	2,000	1,996	1,991	1,986	1,981	1,975	1,969	1,962	1,955	1,947
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,115	1,969	2,000	1,996	1,991	1,986	1,981	1,975	1,969	1,962	1,955	1,947
Ending stocks	549	524	532	531	530	528	527	525	524	522	520	518
Other East Asia												
Beginning stocks	706	708	758	774	765	788	795	795	799	810	820	828
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	65	65	65	65	65	65	65	65	65	65	65	65
Total sugar production	65	65	65	65	65	65	65	65	65	65	65	65
Total imports	2,783	2,994	3,017	2,954	3,075	3,086	3,077	3,098	3,146	3,182	3,213	3,254
Total supply	3,554	3,767	3,840	3,793	3,905	3,938	3,937	3,958	4,010	4,057	4,098	4,147
Total exports	423	440	443	434	452	454	452	455	462	468	472	478
Human dom. consumption	2,298	2,444	2,497	2,469	2,541	2,565	2,565	2,579	2,613	2,644	2,672	2,705
Other disappearance	125	125	125	125	125	125	125	125	125	125	125	125
Total use	2,423	2,569	2,622	2,594	2,666	2,690	2,690	2,704	2,738	2,769	2,797	2,830
Ending stocks	708	758	774	765	788	795	795	799	810	820	828	839
Thailand												
Beginning stocks	3,240	2,790	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	10,900	11,035	11,128	10,860	11,268	11,048	10,915	11,098	11,344	11,432	11,436	11,420
Total sugar production	10,900	11,035	11,128	10,860	11,268	11,048	10,915	11,098	11,344	11,432	11,436	11,420
Total imports	0	0	0	0	0	0	0	0	0	0	0	0
Total supply	14,140	13,825	12,628	12,360	12,768	12,548	12,415	12,598	12,844	12,932	12,936	12,920
Total exports	8,700	9,533	8,294	7,985	8,353	8,091	7,918	8,060	8,266	8,313	8,277	8,221
Human dom. consumption	2,650	2,793	2,834	2,875	2,916	2,957	2,997	3,038	3,079	3,119	3,159	3,199
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,650	2,793	2,834	2,875	2,916	2,957	2,997	3,038	3,079	3,119	3,159	3,199
Ending stocks	2,790	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Philippines												
Beginning stocks	887	827	802	816	830	845	859	873	887	901	915	929
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	2,500	2,565	2,645	2,696	2,825	2,904	2,993	3,128	3,292	3,458	3,631	3,817
Total sugar production	2,500	2,565	2,645	2,696	2,825	2,904	2,993	3,128	3,292	3,458	3,631	3,817
Total imports	40	0	0	0	0	0	0	0	0	0	0	0
Total supply	3,427	3,392	3,447	3,512	3,655	3,748	3,852	4,001	4,179	4,359	4,547	4,746
Total exports	350	299	299	309	398	436	485	579	703	830	963	1,109
Human dom. consumption	2,250	2,291	2,332	2,372	2,413	2,454	2,494	2,534	2,575	2,615	2,655	2,694
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	2,250	2,291	2,332	2,372	2,413	2,454	2,494	2,534	2,575	2,615	2,655	2,694
Ending stocks	827	802	816	830	845	859	873	887	901	915	929	943

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Other Southeast Asia												
Beginning stocks	1,442	2,022	2,080	2,133	2,187	2,240	2,294	2,347	2,401	2,454	2,508	2,561
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	3,305	3,374	3,433	3,483	3,528	3,570	3,609	3,646	3,683	3,718	3,754	3,788
Total sugar production	3,305	3,374	3,433	3,483	3,528	3,570	3,609	3,646	3,683	3,718	3,754	3,788
Total imports	6,849	6,634	6,824	7,024	7,229	7,437	7,647	7,858	8,070	8,283	8,497	8,711
Total supply	11,596	12,031	12,336	12,640	12,944	13,247	13,549	13,852	14,154	14,456	14,758	15,060
Total exports	488	498	507	514	521	527	533	538	544	549	554	559
Human dom. consumption	9,086	9,453	9,696	9,939	10,183	10,426	10,669	10,913	11,156	11,399	11,643	11,886
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	9,086	9,453	9,696	9,939	10,183	10,426	10,669	10,913	11,156	11,399	11,643	11,886
Ending stocks	2,022	2,080	2,133	2,187	2,240	2,294	2,347	2,401	2,454	2,508	2,561	2,615
Australia												
Beginning stocks	83	65	114	117	118	121	122	122	124	125	126	126
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	4,300	4,510	4,600	4,646	4,739	4,772	4,800	4,847	4,896	4,928	4,944	4,951
Total sugar production	4,300	4,510	4,600	4,646	4,739	4,772	4,800	4,847	4,896	4,928	4,944	4,951
Total imports	90	92	93	94	95	96	97	98	99	100	101	102
Total supply	4,473	4,667	4,807	4,858	4,953	4,989	5,019	5,067	5,119	5,152	5,171	5,179
Total exports	3,190	3,302	3,425	3,462	3,541	3,564	3,580	3,615	3,652	3,673	3,679	3,675
Human dom. consumption	1,218	1,251	1,265	1,278	1,291	1,304	1,317	1,329	1,342	1,354	1,366	1,378
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	1,218	1,251	1,265	1,278	1,291	1,304	1,317	1,329	1,342	1,354	1,366	1,378
Ending stocks	65	114	117	118	121	122	122	124	125	126	126	126
Other Oceania												
Beginning stocks	101	101	105	105	105	105	105	105	105	105	105	105
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	220	225	225	225	225	225	225	225	225	225	225	225
Total sugar production	220	225	225	225	225	225	225	225	225	225	225	225
Total imports	313	299	295	295	295	295	295	295	295	295	295	295
Total supply	634	625	625	625	625	625	625	625	625	625	625	625
Total exports	180	175	175	175	175	175	175	175	175	175	175	175
Human dom. consumption	353	345	345	345	345	345	345	345	345	345	345	345
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	353	345	345	345	345	345	345	345	345	345	345	345
Ending stocks	101	105	105	105	105	105	105	105	105	105	105	105
Unrecorded												
Beginning stocks	0	0	0	0	0	0	0	0	0	0	0	0
Beet sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Cane sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total sugar production	0	0	0	0	0	0	0	0	0	0	0	0
Total imports	6,138	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141
Total supply	6,138	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141

—continued

Appendix III—table 1

World sugar supply and use, all countries/regions, base projection, 2013/14-2024/25—continued

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
	1,000 metric tons, raw value (MTRV)											
Total exports	0	0	0	0	0	0	0	0	0	0	0	0
Human dom. consumption	6,138	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141
Other disappearance	0	0	0	0	0	0	0	0	0	0	0	0
Total use	6,138	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141	6,141
Ending stocks	0	0	0	0	0	0	0	0	0	0	0	0
World												
Beginning stocks	43,162	43,379	41,030	40,389	37,376	40,870	41,622	40,823	41,161	42,734	44,252	45,637
Beet sugar production	34,598	36,676	36,787	37,867	39,570	40,090	40,898	41,716	42,242	42,743	43,290	43,784
Cane sugar production	140,228	140,287	146,117	145,431	154,964	155,531	156,502	160,542	165,467	169,167	172,749	177,128
Total sugar production	174,826	176,963	182,904	183,298	194,535	195,621	197,400	202,258	207,709	211,910	216,039	220,912
Total imports	58,678	56,189	59,031	57,860	60,383	61,102	61,842	62,953	64,659	66,480	68,514	70,535
Total supply	276,666	276,532	282,965	281,547	292,294	297,593	300,864	306,034	313,530	321,124	328,805	337,083
Total exports	58,678	56,189	59,031	57,860	60,383	61,102	61,842	62,953	64,659	66,480	68,514	70,535
Human dom. consumption	173,773	178,490	182,723	185,489	190,219	194,046	197,377	201,097	205,314	209,569	213,832	218,298
Other disappearance	836	822	822	822	822	822	822	822	822	822	822	822
Total use	174,609	179,312	183,545	186,311	191,041	194,869	198,200	201,919	206,137	210,392	214,655	219,120
Ending stocks	43,379	41,030	40,389	37,376	40,870	41,622	40,823	41,161	42,734	44,252	45,637	47,428

Source: USDA, Economic Research Service.