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Sugar Taxes: An Economy-Wide Assessment

The Case of Guatemala

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INTRODUCTION

Obesity and associated non-communicable diseases (NCDs) have become a major concern in many countries around the world (WHO 2015a) due to the detrimental health effects for the people directly affected, but also because of the negative impacts on society as a result of lost days of productivity and health care costs. The increasing consumption of sugar and sweeteners has been identified as one of the main causes of this epidemic (Vartanian, Schwartz, and Brownell 2007; Malik et al. 2010; Scientific Advisory Committee on Nutrition 2015; Morenga, Mallard, and Mann 2013; Popkin and Kenan 2016). As a consequence, WHO strongly recommends reducing the lifetime intake of free sugars¹ to less than 10 percent of total energy intake and has suggested a further reduction to below 5 percent of total energy intake (WHO 2015b).

There are different policy instruments that could be used to address consumption of sugar and sugar sweetened beverages (SSB), such as promotion of healthier options through food labelling, food reformulation, and regulatory actions, like taxation or the restriction of direct marketing of sugar-sweetened beverages towards children (Kline et al. 2017).

In particular, taxes have been applied to foods high in sugar and sugary drinks in Hungary; sodas containing added sugar and artificial sweeteners in France; sweets, ice cream and soft drinks in Finland; sugary drinks and high-calorie foods in Mexico, and SSB in Berkeley, California (USA) (Cornelsen and Carreido 2015; World Health Organization 2016) and in Barbados (Alvarado, et al., 2019).

Several types of tax on sugar have been analyzed considering basically the consumption effects. An example is taxes on sugar-sweetened beverages (Gustavsen 2005; Finkelstein et al. 2010; Lin, Smith, and Lee 2010; Lin et al. 2011; Adam and Smed 2012; Finkelstein et al. 2013; Silva et al. 2013; Powell 2014). Others have looked at taxes on caloric sweeteners as inputs in comparison of taxing final products (Miao, Beghin, and Jensen 2012 and Bonnet and Requillard 2011). They argue that the tax on inputs is most efficient to reduce final consumption of products high in sugar while also influencing the composition of products (see also European Consortium for Sustainable Industrial Policy (ECSIP) (2014) and Cornelsen and Carreido (2015)). In general, and as expected, those taxes lead to decreases in the consumption of the product taxed (see Colchero et al. 2015, for the impact of taxes on decrease of consumption of sugary drinks in Mexico, particularly among lower socioeconomic groups).

However, even when consumers respond to a tax by reducing their consumption of the taxed products, they can also switch to some other unhealthy non-taxed products, reducing or even canceling the positive health effects of the tax (Haines 1999; Fletcher, Frisvold, and Tefft 2010; Zhen et al. 2014; Finkelstein et al. 2010; Smed, Jensen, and Denver 2007; Adam and Smed 2012; Alvarado, et al. 2019). Therefore, the literature has expanded its focus trying to capture these substitution effects. Furthermore, because of various substitution patterns, most studies that have tested different schemes agree that taxes that target a broader range of products such as nutrient taxes are much more efficient than the ones taxing only certain categories of products (Smed, Jensen, and Denver 2007; Harding and Lovenheim 2014; Finkelstein et al. 2010; Adam and Smed 2012).

¹ According to WHO “[...] free sugars include monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates” http://apps.who.int/iris/bitstream/10665/149782/1/9789241549028_eng.pdf?ua=1

The emphasis of these studies has been basically on the impact of sugar taxes on consumption, which is important from the point of view of nutrition and health.² At the same time, policy makers are also concerned about a broader range of possible impacts from such interventions on the whole economy, such as GDP, employment, trade, and public sector or fiscal accounts, among other variables. It is then necessary to look at the whole value chain, from the production of sugar to the different productive sectors that use sugar and the final consumer. Moreover, this value chain interacts with other production and consumption activities, with further consequences for the economy. Therefore, this type of analysis requires the use of economy-wide models to evaluate the overall effects of the policy interventions considered.

This study presents an economy-wide analysis for Guatemala, considering several tax options on sugar and SSB and then tracing their differentiated general economic effects. We focus on Guatemala, considering the increasing health burden imposed by obesity and the fact that it is also an important sugar producer and exporter. In the next section we describe the general conditions for sugar production and consumption in Guatemala. We then describe the economy-wide model utilized, the modeled scenarios, and finally, the results of the simulations before concluding.

GUATEMALA: PRODUCTION, EXPORTS AND CONSUMPTION INDICATORS

Sugar Production and Exports

Guatemala is the largest sugar producer in Central America (Table 1), with both area and production amount more than three times larger than the next country in the region.

Table 1: Area (has) and Production (tons) of Sugar (raw centrifuged) (average 2010s)

	Area (Has)	Production (tons)
Guatemala	258,640	2,459,772
El Salvador	75,386	691,819
Nicaragua	67,202	650,996
Honduras	67,372	473,395
Costa Rica	61,468	412,515
Panama	36,703	169,821
Belize	28,183	108,583

Source: FAOSTAT

It is also the fourth larger world exporter of sugar (Figure 1).

² Empirical assessments of the effects of those taxes on weight, body mass and health, as different from impacts on consumption of the product taxed, appear to be less common (Eyles et al, 2012; World Health Organization 2016; and Bonilla-Chacin et al, 2016).

Figure 1: Sugar exports (millions of US dollars; 2016)

Source: FAOSTAT. Note: 2016 is the latest year with comparable data

According to FAOSTAT, sugar is the second agricultural export product for Guatemala after bananas and represented about 8-9% of all merchandise exports during the decade of the 2010s. About 70% of sugar is exported. Sugar is an intermediate input for different food and beverage products, and is also utilized for the production of non-food items such as ethanol.³

The sugar industry is important for employment in Guatemala: the 11 sugar mills part of the Asociación de Azucareros de Guatemala (Asazgua) generate 63,000 direct jobs and another 315,000 indirect jobs, or about 5% of total employment in the country (ASAZGUA 2016). The mills own 60 percent of the land where the crop is cultivated, and the remaining 40 percent is owned by independent agricultural farmers (ASAZGUA 2016).

Soda and sugar-sweetened beverages

In Guatemala, the soda industry includes four companies (Coca-Cola, Pepsico, Big Cola, and the Cervecería Centroamericana, three national bottling facilities (Embotelladora San Bernardino, Embotelladora del Manantial and Embotelladora La India) and other small producers.

According to the latest available data on consumption of beverages⁴ from the Superintendencia de Administración Tributaria, the volume distribution of sodas, syrups and concentrates has increased about 93 percent, from 821.9 to 1587.5 million liters from 2005 to 2018 (Superintendencia de Administración Tributaria 2019⁵). Along the same line, Table 2 presents Euromonitor International estimations for a subset of Latin-American countries, showing that Guatemala placed fourth in the region in 2004 and sixth in 2018 in terms of per capita sales of soft drinks, with sales increasing 25 percent in this period to 195.4 liters per capita (51.62 gallons) (Euromonitor International, 2019).

³ According to the Asociación de Combustibles Renovables (2016) the estimated annual production of ethanol is 180 million of liters. Eighty percent of Guatemalan ethanol production is for export to the US and Europe.

⁴ The Superintendencia de Administración Tributaria in Guatemala collects data on sales because Guatemala has a small specific sales tax for sodas and syrups of 0.18 quetzales per liter (UC & CS AMÉRICA 2010), or about 2% of the current cost of a liter of SSB.

⁵ <https://portal.sat.gob.gt/portal/estadisticas-tributarias-interna/#1506903647232-dff79679-679a>

Table 2: Per capita sales of soft drinks (liters) in selected Latin-American countries

Geography	2004	2018
Argentina	261.6	250.4
El Salvador	191.9	245.4
Mexico	182.8	233.6
Uruguay	96.7	209.9
Chile	129.9	200.8
Guatemala	155.3	195.4
Dominican Republic	103.1	150.7
Paraguay	65.8	140.1
Panama	121.7	138.5
Costa Rica	116.7	127.9
Ecuador	130.7	124.8
Honduras	91.5	124.2
Brazil	86.8	114.6
Colombia	78.6	106.5
Bolivia	45.0	104.2
Peru	47.8	97.0

Source: Euromonitor International 2019

Dietary composition and obesity

Obesity rates in Guatemala have been on the rise as well: WHO (2019) reports that for adult women, obesity increased from 9 percent in 1980 to 26 percent by 2015; it also increased for men, from 3 to 15 percent during the same period. There is evidence that the incidence of obesity is different depending on racial and income characteristics (Martorell 2012).

Studies on dietary composition and obesity in Guatemala have mainly been qualitative, but evidence suggests that poor diets are at least partly responsible for the rise in obesity (see for instance Hidalgo and García (2008), PAHO (2015), Asfaw (2011), and Nagata et al. (2011))

Guatemala's domestic consumption of sugar, which has been growing, is expected to reach 784 million tons for 2016-2017 which equates to an annual per capita consumption of sugar of around 100 pounds (USDA 2017), with 73 percent of it going to direct consumption and the rest to food processing (but, as

noted, also a smaller part goes to non-food items such as ethanol. Therefore, Guatemala seems an interesting case for the analysis of different sugar taxes considering the importance of that product in the economy and the trends in obesity.

METHODOLOGY

We use a dynamic CGE model to simulate different scenarios for alternative economic policies, based on the standard model used by IFPRI (see Lofgren, Harris, and Robinson 2001 and Thurlow 2004).

General considerations

The model is recursive dynamic and is solved in two stages. First, the model determines a within-period equilibrium, given parameters and exogenous variables. Second, some parameters and exogenous variables change over time. The model contains transition equations that determine how the exogenous variables and parameters relate to past solution values for particular endogenous variables or are assumed to grow according to some exogenous path. These transition equations define the values for all exogenous variables and parameters for the next period for the static CGE model, which is then updated and solved for a new within-period equilibrium. Thus, the economy evolves through a sequence of temporary equilibria (see Hicks, 1939 and also Grandmont, 2006).

The model is solved forward in a dynamically recursive fashion, starting on the base year for the data, with each temporary-equilibrium solution depending on current and past values of variables and parameters. It covers ten years for a baseline run (a “business as usual” scenario) and for each one of the different scenarios analyzed in this paper. The assumed behavior of households and firms is based on historical information and model-consistent expectations for the period of the temporary equilibrium.

First Step: The Single-Period Solution

As with all CGE models, it is assumed that each producer maximizes profits under constant returns on scale and perfect competition. There are different factors of production, including labor, land, and capital. Production is related to factor inputs in a constant elasticity of substitution (CES) production function, which allows producers to substitute the different factors until they reach the point where the marginal revenue of each factor equals the factor price (wage or rent). Intermediate inputs are utilized according to fixed coefficients in a Leontief-type input-output matrix. Finally, output prices depend on the value-added (cost of labor, land, and capital), the intermediate inputs, and any relevant taxes and subsidies.

The aggregate output of each good or service may be sold domestically, or it may be exported (**Error! Reference source not found. 2**). The producers’ allocation between domestic sales and exports is specified via a constant elasticity of transformation (CET) function, assuming imperfect transformability between exports and domestic sales.

The producers will sell their products to the market with the highest profitability. The domestic price of the exported good is the international price times the exchange rate plus any possible export taxes or export subsidies. The domestic good is combined with imports to produce the composite good that is utilized internally by the country. The domestically produced and imported goods are imperfect substitutes according to a constant elasticity of substitution (CES) (Armington, 1969).

Figure 2: Flow of goods from producers to the national composite commodity

Source: Lofgren (2001).

In this model there are three institutions—households, government, and the rest of the world—that perform three functions—produce, consume, and accumulate capital. Household income is the sum of salaries, profits, and transfers from the government and the rest of the world. Households save a constant fraction of their disposable income and buy consumption goods with the remainder. Household consumption of goods and services is determined by a linear expenditure system (LES). Government receives taxes, consumes goods and services, and makes transfers to households. The capital account collects the savings from the households, government, and rest of the world, and buys capital goods (investment).

Factor Markets and Macro Closures

The macro closures of a model define the mechanisms that determine how various macro constraints are satisfied by the economic system. Three macroeconomic balances need to be specified: (1) the external balance, which equates the supply and demand for foreign exchange (in flows, given how the data is collected in the SAMs); (2) the fiscal balance, government savings (or deficit) being the difference between government income and expenditures; and (3) the overall savings-investment balance for the economy.

The external balance is attained by movements in the exchange rate, with non-trade international economic flows kept constant. Regarding the other two aspects, this model specifies a balanced macro closure in which aggregate investment and government spending are assumed to be fixed proportions of total absorption, implying that any macro shock affecting absorption will be shared proportionally among government spending, aggregate consumption, and investment.⁶

Factor market closure defines the operation of factor markets. For unskilled labor the levels of employment (and unemployment) are endogenous. For the other labor types, the wage is determined endogenously to clear the labor market.

⁶ The fourth simulation (see below) requires the use of government revenues to invest in R&D, which modifies slightly the closure. However, the levels of investment in all simulations are basically the same.

Second Step: Between Periods

In the second stage, intertemporal equations create the dynamic linkages, updating the variables that drive growth between periods. Those equations provide values for all exogenous variables needed for the next period, and the CGE model is then solved for a new temporary equilibrium. The model is solved forward in a dynamically recursive fashion, with each static solution depending only on current and past variables. As noted, the behavior of the agents is model consistent within each temporary equilibrium. The variables and parameters used as linkages between periods are the aggregate capital stock (which is updated endogenously, given previous investment and depreciation), population, the domestic labor force, and factor productivity (which are updated exogenously, based on historical trends, as discussed below).

The allocation of new capital across sectors is done by adjusting the proportion of each sector's share in aggregate investment as a function of the relative profit rate of each sector compared with the average profit rate of the economy as a whole. Sectors with higher average profit rates will get higher shares of the available investment, and those with lower rates will get lower shares. Once new investment has been allocated to a sector it remains there (i.e. the reallocation of capital due to changes in profitability across sectors takes place only through new investment).

Growth in the labor force by skill class is exogenous and related to population growth projections from national data (as reported by the World Bank, WDI; last accessed 2018). Those additional workers are added to the supply of skilled labor or to the surplus of unskilled labor. For unskilled labor, the total size of the available labor force does not affect the solution in any period because it is assumed that there is an excess of unemployed labor, which is not necessarily absorbed by the end of the simulations.

The growth of capital is determined by the amount of investment, net of depreciation. We also update the rate of disembodied technical change exogenously, based on historical values.

There are other exogenous variables (such as export and import prices, and transfers to and from the rest of the world), policy instruments (for example, import tariffs, several tax rates and subsidies), and other parameters in the model that are maintained exogenously over time.

The simulations for Guatemala give us the growth path for the economy for 10 years under a number of different policy alternatives. These paths are compared with the one obtained using the baseline simulation (in which no shocks or exogenous policy changes are included).

The Social Accounting Matrix

The Social Accounting Matrix contains specific features for the country, which largely depend on the availability of data and the level of disaggregation contained in the input-output matrix and household surveys. The SAM built by Piñeiro and Elverdin is for 2012 and it is disaggregated into 65 sectors, corresponding to 91 activities, which include 14 agricultural activities. Sugar is identified at the primary level (which is an input to a variety of products as indicated in input-output matrix, including sugar as final consumption product but also as component of other foods and ethanol) then as a processed product for direct final consumption. A limitation is that the SAM does not distinguish SSB within the non-alcoholic beverage sector (i.e. the productive sector includes also beverages that do not contain high concentration of calories). However, it is estimated that sugary sodas represent at least around 60% of that total. Therefore, when the tax on SSB is simulated it is applied to the whole sector.

Labor data is separated by region (rural and urban) and skill level (skilled and unskilled). For this, data of Living Conditions Survey (ENCOVI 2011) were used. The same survey was used to disaggregate household consumption by activity, region (rural and urban), sector and poverty level used (not poor, poor but not extremely so, and extreme poor).

POLICY SCENARIOS

The simulations consider four scenarios. The first scenario imposes a 10 percentage points increase in the sales tax of processed sugar as final direct consumption (it does not include intermediate uses such for as SSB). This scenario will be called “Sugar Tax” in what follows. The level of the tax selected is arbitrary, just to explore the implications of the instrument.⁷

The second scenario (called “SSB Tax”) calculates a 10 percentage points increase in the sales tax of non-alcoholic beverages (which as noted are mainly SSB). The third scenario looks at the production side by increasing the tax on sugar by 10 percentage points, when it is used as input for producing other goods (such as bakery, SSB, processed foods, and others), as well as input for processed sugar used for final consumption. This scenario is labelled “Intermediate Tax”.

The last scenario simulates the case where the government applies a sales tax increase of 10 percentage points on non-alcoholic beverages (as in the second scenario), and uses the extra revenue received by this new tax to increase investments in agricultural R&D for fruits, vegetables, legumes and roots.⁸ Those investments in agricultural R&D are considered to increase productivity in the products targeted.⁹ This scenario is called “SSB Tax + Investment.” Here, additional growth in productivity is assumed to occur only in the targeted subsector for additional R&D investments, while productivity growth in the non-targeted sectors is kept at the levels of the base run. The latter are nonetheless affected through the linkage effects captured in the general-equilibrium economic structure (such as the reallocation of factors/inputs across subsectors, changes in relative prices, and differential changes in domestic market demand or international trade across sectors with increased incomes).

Results

Results are mainly reported as percentage change deviations over time between the baseline simulation run and the policy simulation scenarios. The dynamic simulations cover 10 years starting from a base year that here is labelled “2015.” The results are presented for the whole period in the figures, and the accumulated values for year 5 and for year 10 in the tables shown in the next sections.

Because the taxes considered are not that high and, also, because the productive activity involved (i.e. sugar and its different uses) although not trivial is just a part of a bigger Guatemalan economy, the aggregate impacts found are relatively small in percentage terms. However, they offer an idea of the direction of the changes generated by the simulated taxes and interventions. As noted, higher taxes will lead to larger impacts, but they will be in the same direction.

⁷ In particular, it is not implied here that the simulated tax is “adequate” under any definition of the desired objectives. For instance, the World Health Organization (2016) mentions that “the evidence for meaningful health effects is strongest for taxes on sugar-sweetened beverages, with suggestions that SSB prices would need to be raised by 20%, or more” (page 24). The results can be scaled up considering higher tax rates, but they are relatively proportional to the tax level utilized.

⁸ In what follows we will refer to fruits and vegetables or F&V for simplicity.

⁹ The parameters used are based on Diao et al (2010).

Macroeconomic aggregates

Figure 3 shows the impact on GDP (measured as deviation from the baseline, in percentage points).

Figure 3: GDP Effects (percentage deviation from the baseline values)

Source: Authors worksheets

All three taxes negatively impact total GDP compared to the baseline, but the (relatively) largest impact is from the tax on sugar in all forms which continues to depress further GDP levels from the baseline. Taxes on final consumption of sugar and on SSB have smaller negative impacts on GDP, which are very similar between both instruments. On the other hand, when the revenue from the SSB tax is invested into agricultural R&D for fruits and vegetables, total GDP increases relative to the baseline, and the positive effect continues over time.

Figure 4 shows the evolution of private consumption in the four scenarios considered. As before, the trends are shown in percentage deviations from the level of private consumption in the baseline.

Figure 4: Private Consumption Effects (percentage deviation from the baseline values)

Source: Authors worksheets

The evolution of private consumption shows similar trends as in the case of the GDP: the tax on all forms of sugar use depress private consumption more than the other two tax options (with the tax on SSB depressing private consumption marginally more than the tax on final sugar consumption). The combination of tax on SSB plus investments on R&D in fruits and vegetables helps to recover private consumption almost to the level of the baseline by the end of the decade considered in the simulations. The difference with the more than full recovery of GDP by the end of the period considered (shown in Figure 3) results from the evolution of other components of the GDP aggregate, mainly government consumption (which increases with the new taxes).

In the case of trade, the external deficit (exports minus imports) does not change, given the external closure utilized (see section on Factor Markets and Macro Closures). However, it is possible to analyze the evolution of exports and imports separately. In Figure 5 only exports are presented while the trends are similar in imports.

Figure 5: Exports effects (percentage deviation from the baseline values)

Source: Authors worksheets

The tax on all forms of sugar (the scenario labeled Intermediate Tax) reduces the amount produced of that item (see section on Production), and given the importance of sugar in total exports, the latter decline significantly. The other two taxes also reduce exports, although just marginally, and stay there for the whole period considered. Combining the SSB with investment in R&D, although there is a decline in sugar production and exports, it is estimated to be more than compensated in the aggregate by increased exports of fruits and vegetables and other products.

Fiscal accounts

Another general macroeconomic variable to consider is the fiscal deficit. Table 3 shows the changes in the fiscal deficit as percentage of the GDP generated by the additional tax. A positive number indicates a reduction in the fiscal deficit (i.e. an improvement in fiscal accounts, measured as percentage of the GDP).

Table 3: Fiscal Accounts (Fiscal deficit as percentage of GDP. Percentage deviation from the baseline)

	Improvement in Fiscal Accounts (% GDP; average decade)
Sugar Tax	0.18
SSB Tax	0.18
Intermediate Tax	0.36
SSB Tax + Investment	0.17

Source: Authors worksheets

Obviously, the intermediate tax on sugar (which has the larger tax base) is the one that produces more revenues and, therefore, reduces the fiscal deficit the most (it is approximately double the result of the taxes on processed sugar and on SSB). When the tax is combined with its use in R&D investments, fiscal accounts also improve but less so due to a combination of two factors that work in opposite directions. On the one hand, the SSB collects revenue, improving fiscal accounts. On the other hand, because the additional revenue is fully spent in agricultural R&D, the immediate impact is that fiscal accounts do not improve. However, those investments in R&D also generate more GDP growth than in the baseline, which in turn lead to additional fiscal revenues. The combination of the three effects generates revenues that are somewhat less than if the SSB tax would not have been spent in agricultural R&D.

Production

Table 4 shows the changes in production compared to the baseline for processed sugar, SSBs, fruits and vegetables, and for years 5 and 10 of the simulations.

Table 4: Production (percentage changes from the base simulation for selected years)

	Processed sugar		SSB		Fruits		Vegetables	
	5 years	10 years	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-4.79	-4.92	-0.05	-0.04	-0.06	-0.06	0.00	0.00
SSB Tax	-0.02	-0.01	-7.31	-7.31	-0.02	-0.02	0.03	0.04
Intermediate Tax	-5.94	-6.30	-0.26	-0.29	-0.27	-0.31	-0.06	-0.09
SSB Tax + Investment	-0.09	-0.10	-7.28	-7.26	0.32	0.77	0.26	0.60

Source: Authors worksheets

The impacts of taxes are larger for the volume produced of the targeted products. The two taxes on sugar lead to visible declines in the production of that product compared to the baseline, with the largest drop (around 6%) occurring, as expected, in the case of the broader tax on all sugar ("intermediate

tax”). The tax on SSB also generates falls in its production (a drop of more than 7%). The last simulation, which includes R&D supporting fruits and vegetables, shows increases in the production of those items. It is interesting to note that the taxes on sugar also have a negative (but small) impact on production of fruits, probably because the decline of some products using sugar also include fruits as ingredients (such as jellies, candies, and the like).

Employment

Another aggregate impact that is relevant to consider is employment. The model is run with unchanged levels of employment for skilled labor (the adjusting variable is wages). But for unskilled labor, the simulations consider the possibility of changes in employment (and unemployment). Table 5 shows the changes in that variable for unskilled labor, divided into rural and urban areas, and for years 5 and 10 of the simulations.

Table 5: Employment (percentage changes from the base simulation for selected years)

	Urban Non-Skilled		Rural Non- Skilled	
	5 years	10 years	5 years	10 years
Sugar Tax	-0.31	-0.30	-0.26	-0.25
SSB Tax	-0.32	-0.31	-0.27	-0.26
Intermediate Tax	-0.74	-0.76	-0.55	-0.57
SSB Tax + Investment	-0.20	0.03	-0.19	-0.02

Source: Authors worksheets

Employment of unskilled labor is lower (or unemployment higher) in all scenarios of sugar taxes, in line with what was observed in the macroeconomic story. The impact of the broader sugar tax (“Intermediate tax”) is the one that sees the biggest decrease in employment of unskilled labor, at about double than the other two more limited taxes. The scenario with investments in R&D is estimated to compensate the decline of employment in sugar-related activities with increases in other sector, with the result that the non-skilled urban employment actually increases above the baseline after ten years; the rural equivalent, however, is still marginally below the baseline by the end of the simulation period. As it was noted in the case of the macroeconomic effects, the overall size of the changes simulated is small, in line with the rather modest tax increase modeled and the relatively small incidence of sugar production and employment in the whole economy. Larger taxes, of course, would lead to larger impacts.

Household Incomes

Given Guatemala's status as a producer and consumer of sugar, is also important to consider the impact on household incomes. Table 6 shows household incomes separated into urban and rural households, and further divided by poverty levels (non-poor, poor, and extreme poor). It also separates impacts at year 5 and year 10 of the simulations.

Table 6: Household income (percentage changes from the base simulation for selected years)

		5 years later	10 years later			5 years later	10 years later
Urban nonpoor	Sugar Tax	-0.29	-0.28	Rural non poor	Sugar Tax	-0.23	-0.22
	SSB Tax	-0.31	-0.3		SSB Tax	-0.26	-0.25
	Intermediate Tax	-0.66	-0.69		Intermediate Tax	-0.42	-0.46
	SSB Tax + Investment	-0.18	-0.01		SSB Tax + Investment	-0.3	-0.34
Urban non extreme poor	Sugar Tax	-0.29	-0.28	Rural non extreme poor	Sugar Tax	-0.27	-0.26
	SSB Tax	-0.31	-0.3		SSB Tax	-0.29	-0.28
	Intermediate Tax	-0.65	-0.68		Intermediate Tax	-0.59	-0.62
	SSB Tax + Investment	-0.18	-0.02		SSB Tax + Investment	-0.21	-0.1
Urban extreme poor	Sugar Tax	-0.29	-0.28	Rural extreme poor	Sugar Tax	-0.29	-0.28
	SSB Tax	-0.31	-0.3		SSB Tax	-0.3	-0.29
	Intermediate Tax	-0.64	-0.67		Intermediate Tax	-0.64	-0.67
	SSB Tax + Investment	-0.18	-0.02		SSB Tax + Investment	-0.21	-0.09

Source: Authors worksheets

The impacts of the different taxes on household incomes follow the macroeconomic story. The broadest tax on sugar has also the largest negative impact on household incomes, resulting from negative employment effects (or wage effects for skilled labor; not shown here). On the other hand, when the SSB tax is combined with investments on R&D for fruits and vegetables, the latter reduces the negative impact, and household incomes return closer to baseline trend values by the end of the simulation period. This is particularly the case for urban households, and to a lesser degree for the rural poor; however, in the case of non-poor rural households, there are no improvements.

Sugar, SSB and Food Consumption

Finally, it is important to estimate how these policies may impact sugar consumption, which, as mentioned, is the focus of much of the literature on the topic. The following tables look at consumption of processed sugar (directly by consumers), at consumption of SSB, and finally at total food consumption, which includes sugar consumed directly and indirectly (the latter as incorporated in other products) but does not consider consumption of SSB. As in the case of household incomes, all tables separate consumption into six socioeconomic groups (urban and rural, each one divided in turn into non-poor, poor, and extreme poor) and show the impacts at year 5 and year 10 of the simulations.

Table 7: Household consumption of Processed Sugar (percentage changes from the base simulation for selected years)

	Urban no poor		Urban poor		Urban extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-5.72	-5.96	-6.45	-6.61	-6.48	-6.64
SSB Tax	0.08	0.09	0.08	0.09	0.13	0.14
Intermediate Tax	-6.83	-7.28	-7.71	-8.08	-7.71	-8.07
SSB Tax + Investment	0.09	0.20	0.11	0.24	0.13	0.25

	Rural no poor		Rural poor		Rural extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-6.08	-6.24	-6.46	-6.62	-6.35	-6.54
SSB Tax	0.08	0.09	0.07	0.07	0.09	0.10
Intermediate Tax	-7.16	-7.52	-7.71	-8.08	-7.57	-7.96
SSB Tax + Investment	0.06	0.11	0.08	0.20	0.09	0.20

Source: Authors worksheets

Taxes on sugar consumed directly and on all uses of sugar are estimated to reduce consumption of sugar in final form by between 6-8% during the period considered in the simulations (in one case because it is taxed directly and in the other case because the unprocessed sugar as an input is taxed, increasing the price of the final product for direct consumption). Obviously, that is the desired effect, which is a combination of the price effect of the tax, but also the employment/income effects of the general equilibrium adjustment.

In the case of taxes on SSB, and particularly when the proceeds go to agricultural R&D for fruits and vegetables, there is a very small increase in final direct consumption of processed sugar (less than 0.1% compared to the baseline values). This is the result of a tax in a particular product (in these two examples a tax on SSB) displacing consumption towards other items.¹⁰

Table 8: Household consumption of SSB (percentage changes from the base simulation for selected years)

	Urban no poor		Urban poor		Urban extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-0.04	-0.04	-0.09	-0.08	-0.03	-0.03
SSB Tax	-7.92	-7.99	-8.85	-8.79	-8.87	-8.79
Intermediate Tax	-0.28	-0.31	-0.39	-0.40	-0.25	-0.27
SSB Tax + Investment	-7.92	-7.90	-8.84	-8.65	-8.89	-8.72

¹⁰ This substitution/displacement effect diminishes marginally the desired effect of reducing consumption of sugar and sugary products.

	Rural no poor		Rural poor		Rural extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-0.06	-0.06	-0.13	-0.12	-0.11	-0.09
SSB Tax	-8.47	-8.48	-8.86	-8.80	-8.65	-8.62
Intermediate Tax	-0.18	-0.20	-0.40	-0.41	-0.36	-0.37
SSB Tax + Investment	-8.52	-8.49	-8.85	-8.70	-8.67	-8.54

Source: Authors worksheets

The impact of the direct SSB tax on consumption of those products is visible: the increase in 10 percentage points in the SSB leads to an 8-9% decline in their consumption, which, again, is the effect wanted. As before, this is a combination of the price and income effects of the simulation.¹¹

The other types of sugar taxes also reduce consumption of SSB, but marginally: obviously, the largest impact of those two options is when the tax also includes sugar as an input (which raises the cost of SSB). In the case of the tax on final consumption (which does not affect directly the cost of SSB) the small reduction in consumption is due to the (also small) general reduction of household income (due mainly to less employment), which marginally compensates for the possible substitution effect¹² over the period of the simulations. It should be noted that the percentage reduction in the consumption of SSB is larger in the case of the poorer households (see for instance Colchero et al 2016 for Mexico, who also find larger negative impacts on lower income consumers¹³).

The next table looks at the impacts on food consumption in general (does not include SSB).

Table 9: Food Household consumption (percentage changes from the base simulation for selected years)

	Urban not poor		Urban poor		Urban extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-0.19	-0.20	-0.37	-0.38	-0.49	-0.51
SSB Tax	0.05	0.06	0.05	0.06	0.10	0.11
Intermediate Tax	-0.33	-0.38	-0.57	-0.62	-0.66	-0.72
SSB Tax + Investment	0.08	0.20	0.09	0.24	0.12	0.25

¹¹ As a comparison Claro RS, et al. (2012) estimate an own-price elasticity of SSB for Brazil of -0.85. Recent estimates for Guatemala in Chacon et al (2018), show own-price elasticity of -1.39, and income elasticity of 0.99.

¹² Other studies find substitution effects as well (see for instance, Alvarado et al 2019).

¹³ However, several of the studies reviewed by Eyles et al. 2012 suggest that lower income groups would then also benefit more in terms of health outcomes. This in turn could have positive income effects on the poor that would more than compensate for the direct economic burden of the sugar tax.

	Rural not poor		Rural poor		Rural extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Sugar Tax	-0.38	-0.39	-0.63	-0.66	-0.77	-0.80
SSB Tax	0.06	0.06	0.04	0.05	0.06	0.07
Intermediate Tax	-0.46	-0.51	-0.85	-0.92	-0.99	-1.08
SSB Tax + Investment	0.06	0.13	0.08	0.21	0.09	0.22

Source: Authors worksheets

The two taxes on sugar (limited and broad) lead to declines in the aggregate food consumption, mainly because of drops in direct sugar consumption and in products with incorporated sugar (other than SSB), as shown above. But there are also small declines in the consumption of other food products (not shown here) because of lower employment and household incomes (as discussed before). The tax on SSB decreases significantly consumption of SSB (as shown before in Table 8), and this seems to shift overall consumption towards food items, which increases in both scenarios, and particularly when the proceeds of the tax are used to invest in agricultural R&D for fruits and vegetables (with its positive impact on employment and incomes).

The detailed results from the simulations also show that while the three scenarios with sugar taxes have negligible effects on consumption of fruits and vegetables, the fourth one, which expands R&D for those products, leads to increases in their consumption (Table 10).

Table 10: Food Household consumption of F&V under the SSB Tax + Investment (percentage changes from the base simulation for selected years)

	Urban not poor		Urban poor		Urban extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Fruits	0.32	0.82	0.36	0.93	0.39	0.95
Vegetables	0.17	0.42	0.20	0.48	0.22	0.49

	Rural not poor		Rural poor		Rural extreme poor	
	5 years	10 years	5 years	10 years	5 years	10 years
Fruits	0.31	0.78	0.35	0.89	0.35	0.89
Vegetables	0.15	0.36	0.18	0.45	0.19	0.45

Source: Authors worksheets

CONCLUSIONS

This paper has tried to extend the analysis of different forms of taxes on sugar and SSB beyond only the impact on the consumption of the goods taxed. Although the focus on consumption is very important from the point of view of health and nutrition, policy makers are also concerned about impacts on other variables such as growth, employment, incomes, trade and fiscal accounts. Looking at this broader range of possible impacts requires the use of economy-wide models that capture the systemic linkages across all those variables, as it is done in this paper.

This exercise used the case of Guatemala, a country suffering from increased levels of obesity while being at the same time an important producer and exporter of sugar. The paper contributes to the literature by a) providing a simulation of the economy-wide effects of sugar taxes, and b) by differentiating the impacts according several types of sugar and SSB taxes.

Four scenarios were considered: a 10 percentage points increase in the sales tax of processed sugar as final direct consumption; a 10 percentage points increase in the sales tax of non-alcoholic beverages (which are mainly SSB); an increasing the tax on all sugar uses by 10 percentage points; and a final scenario in which the government applies a sales tax increase of 10 percentage points on non-alcoholic beverages (as in the second scenario), and use of the extra revenue received by this new tax to increase investments in agricultural R&D mainly for fruits and vegetables.

As expected, the results show that all taxes achieve the objective of reducing consumption of the taxed good, be that sugar or SSB. However, the two taxes on sugar also slightly reduce consumption of all foods (a broad category that includes sugar but does not include SSB). This small effect on all food consumption is related in part to the fact that the aggregate includes sugar and in part to the reduction in households' incomes due to negative but small employment effects. On the other hand, the tax on SSB leads to a small increase in all food consumption (the negative income effects are more than compensated by the substitution/displacement effect). And finally, the combination of the SSB tax and investment in R&D for fruits and vegetables leads to more consumption of the latter products and a small increase in all food consumption.

Achieving the desired effect of reducing sugar consumption comes also with additional effects on other variables. The more direct effect is that the taxes on sugar and SSB also lead to drops in the production of the items targeted, which generates further effects on the whole economy. The broad tax on sugar has the largest negative impact on GDP, employment, and exports, but it helps to reduce fiscal deficits the most. On the other hand, the combination of the SSB tax with the use of that revenue to expand investments in R&D for fruits and vegetables leads, over time, to improvements in GDP, private consumption, employment, and exports, although fiscal accounts, which improve, do less than in the other scenarios in which taxes are not used to expand expenditures. The taxes on directly consumed sugar and on SSB show results that fall between the two previous cases.

It is also important to note that the taxes simulated may lead to product reformulation, which in turn may influence consumption with further implications to the economy.¹⁴ We did not consider that possibility here.

The simulations suggest the importance of analyzing these interventions with an economy-wide view, that includes but also extend beyond the immediate consumption effects. It is true that, as noted, the

¹⁴ Product reformulation is likely to occur depending on the design of the tax and it could have important impacts on global sugar intake and health outcomes (Tedstone, Targett, and Allen 2015; Cornelsen and Carreido 2015; Harding and Lovenheim 2014; ECSIP consortium 2014).

broader impacts simulated are small, given that the taxes are modest and affect only a small segment of the economy. Therefore, some may argue that those results may be ignored. But at the same time, the simulations show that there are broader impacts on GDP, employment, trade and fiscal outcomes, and they will be larger the more important is the restructuring of diets desired.

Much depends on the use of those additional fiscal resources by the public sector. The increase in public revenues could be utilized to reduce debt, cut other taxes, or expand expenditures, all of which have further rounds of impacts on the economy. In the fourth scenario we assumed an explicit use, which appears to have positive impacts on all macro variables, plus leads to larger consumption of fruits and vegetables.

It also illustrates a well-known result of public policy: if there are two objectives (in this case reduction of consumption of sugar while not affecting incomes and employment) at least two instruments are needed (the tax combined with investments in agricultural R&D in this case). This is just one possible combination of instruments. There are other possible uses of that additional revenue, some of which may have larger and more direct positive effects on variables of interest for policy makers, such as investment in infrastructure and other productive support for the affected activities (in this case sugar), expanded safety nets, nutrition and health interventions, and so on. We hope to analyze these and other options in subsequent work. Of particular importance would be the calculation of the costs of the productive restructuring needed to achieve SDGs goals both for health and nutrition, but also for employment and poverty reduction.

A key factor that also needs further study is the general channel of causality from reductions in consumption of certain foods to combat obesity and ends in the expected improvements in health. There are at least two possible effects that may lead to improvements in the economic variables discussed before: one is the potential improvement in fiscal accounts due to reduction in the costs of treating non-communicable diseases¹⁵; and the second, and perhaps more important, is the increases in potential growth from improved human capital linked to better nutrition and health, if these results effectively occur as a result of the policies implemented. We did not include these two effects in the simulations presented. It may well be the case that including these two channels lead to improvements in the macroeconomic and employment variables analyzed here, even without considering the investments in R&D simulated, or any other investment using the resources collected. At the same time, these two effects (fiscal improvements and accelerated growth due to better human capital) may take longer to play out than the 10-year period considered in this paper.

All these important considerations are left for further analyses.

¹⁵ See for instance Gortmaker et al. (2015) who argue that a tax on sugar-sweetened beverages will not only have a great reach among the population but may also save more in health care costs than the cost to implement. At the same time, as noted in footnote 2, while the impact of these taxes on consumption is documented (and this paper also finds those effects), the influence they may have on health outcomes is less clear; for instance Bonilla-Chacin et al, 2016 did not find changes in BMI in Mexico from the imposition of SSB taxes.

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