VALUATION OF A MEXICAN SUGAR MILL AND DRIVING VALUE FACTORS

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Abstract

This paper includes the methodology used to construct a financial cash flow and perform a valuation using the discounted cash flow analysis for a hypothetical Mexican sugar mill. The objective is to incorporate to the valuation model the most significant variables that are relevant to the sugar production process as well as the operational and financial factors of a common sugar mill which are driven by the current legislation in terms of sugarcane pricing and labor costs. It also includes some macroeconomic variables that determine price for sugar, long term costs and the discount rates. With the financial model determined, we use Monte Carlo simulation in order to obtain a probabilistic distribution for the value of the sugar mill and finally we perform a sensitivity analysis to obtain the main variables that affect the resulting *enterprise value*. The model is constructed on data available for three sugar mills, but the cost structure will not change among other sugar mills, due to regulation and local market conditions; however, the model could be used for any mill by substituting the variables for each case.

Introduction

Mexico's geographical location permits a good production of sugarcane, one of the main crops from which sugar is produced. Sugar is a commodity used by households and industry worldwide, and despite recently health issues on calorie consumption, sugar consumption has been growing at the same rate as global population. Over a third of world's sugar production is made in Brazil and India. There are factors affecting world sugar price, such as the adoption of new sources of energy, such as ethanol that could be made from sugarcane; also climate phenomena affecting crops in this two countries could reduce availability of stocks for net importers of sugar (for example Japan); fuel prices that increase/decrease transportation costs, etc.

Mexican sugar industry has always been considered of public interest due to its contribution to the Mexican economy in terms of labor and local consumption. Sugar industry in Mexico presents certain caveats to valuation, as there are regulations that drive some of the costs and expenses, such as the pricing of sugarcane related to the actual price of sugar. Sugar prices in Mexico are almost 100% higher than international prices, so most production is sold locally and, after NAFTA liberalization of quotas, it is only affordable to export to the United States, where prices are similar to those in Mexico. Additionally, high sugar prices are mostly speculative and do not contribute to efficiency in sugar mills nor in the quality of crops to obtain better sugar yields. Yet, sugar substitutes such as high fructose corn syrup are starting to become an alternative in some industries (mostly soft drinks) due to a more affordable pricing.

These factors, along with a poor legislation have made Mexican mills to remain old and without the incentives to invest into high-end facilities such as in Brazil. There have been two major nationalization processes in order to rescue bankrupt mills to prevail jobs. Although the government has made efforts to plan for the long term and increase Mexican production of sugar and also of sugarcane for alternative uses, members along the production chain do not share the same interests.

The purpose of this study is to create a valuation model for the sugar mills in Mexico and then use Monte Carlo simulation to determine the main factors that affect most the value obtained, therefore, we can determine where should the management's attention should focus. We use a free cash flow to the firm model and incorporate some exogenous variables that also affect value, such as inflation, rates, risk, capital structure, and national sugar prices.

For our analyses, we assume that the general cost structure of all sugar mills in Mexico follow the same structure as the one we obtained from three mills, but further access to information of other mills should enhance the results obtained here.

Background of the sugar industry in Mexico

Mexican sugar industry is one of the most important industries economically and socially speaking. It represents about 2.5% of manufacturing gross domestic product (GDP) and 0.5% of national GDP. It also generates 450,000 direct jobs and 2.2 million indirect jobs, most of them in the rural communities.

Because of Mexican geographical location, sugarcane production is affordable in comparison to US and European sugar beet. Sugar mills were established in Mexico since it as a Spanish colony and remained

relatively few until the 1930s when private institutions ordered the market and provided financial resources.

In the 1960s, the last private sugar mills were constructed and the Mexican government started and expansion program by constructing state-owned sugar mills and by fixing the sugar price. The financial institutions established in the 1930s, such as FINA, were nationalized. In 1988 some state-owned sugar mills are privatized, and the sugar price is freed up allowing international sugar trade. In 1991, a decree that declares sugarcane production of national interest stated that sugarcane price should be calculated from actual sugar price through a series of formulas and relations. In 1993 the decree is modified so that 57% of the sugar price shall be paid to sugarcane producers.

Some controlling groups were heavily indebted with FINA so the government decided to nationalize 27 sugar mills in order to preserve jobs. After several trials and appeals, thirteen of these mills were returned to their owners, three were privatized through bid processes, and eleven are still under government's administration.

Annual national sugar consumption in Mexico has been around 5 million metric tons in the last decade which translates into 47.8 kilograms per capita per year. Consumption per capita has stabilized due to the general adoption of fewer calories in current diet. Consumption is divided in 37.1% for households and 62.9% is for industrial processing.

Since the 1960s, Mexico has been among the top ten producers of sugar, after the United States, Thailand, China and Brazil, representing 3% of global production which is around 150 million metric tons, and has a surplus balance, exporting mostly to the United States due to preferences offered by NAFTA[1]. In the last five cycles, Mexico has produced on average 5.2 million metric tons of sugar.

There are 57 sugar mills in Mexico, distributed in 15 states throughout the mid-southern territory, but three of these states (Veracruz, Jalisco and San Luis Potosi) concentrate 59% of total production and 60.5% of total sugarcane land. These sugar mills are aggregated into 13 private business groups with 76% of national production and the government accounts for the remaining 24%, being the largest individual group, thus with economic power over national sugar prices.

Sugar is abundantly produced from sugar beet and sugarcane, being the latter the one with higher sucrose content, and the one that Mexico produces. Climate has dramatic effects on any agricultural product and thus sugarcane is affected by rain, cold and floods.

Total industrialized surface dedicated to sugarcane growth in Mexico was 647,937 Ha, with an average yield of 66.94 tons of sugarcane per Ha.

Sugar producing factors in Mexican mills

Sugar production cycle in Mexico lasts on average 170 days beginning in December or January and ending in June or July. After the production cycle is finished, mills are repaired for the rest of the year and sugarcane growing cycle continues.

The general sugar production process begins when raw sugarcane is delivered at the mill; then it is cut with blades through a conveyor which feeds the mills (a linear series of three to five mills); mills crush the sugarcane in order to extract the juice

[1]North American Free Trade Agreement

containing sucrose; the juice is added with lime and other substances to separate impurities; juice enters the "clarification" and "evaporation" processes to eliminate residues and water, obtaining molasses; molasses enter the "crystallization" and "centrifugal" processes to finally obtain raw sugar.

Although there are many factors that derive into the amount of sugar obtained from the elaboration process, the main factors are the following:

Sugarcane Land Available (*ScLand*). This refers to the amount of hectares that are used of sugarcane growing.

Yield of Sugarcane (*ScYield*). This refers to the amount of sugarcane (in metric tons) that can be obtained from each hectare of land. World average is around 65 metric tons per hectare.

Gross Sugarcane (*GrossSc*). The amount of sugarcane harvested and delivered to the mill.

Net Sugarcane (*NetSc*). Gross sugarcane contains strange materials that are not entered into the process, the remaining amount of sugarcane to be processed is called Net sugarcane.

Sugarcane Discount Factor (*ScDisc*). This refers to the percentage obtained by dividing *NetSc* by *GrossSc*.

Sugarcane age. Basically there are three types of sugarcane divided by its age:

- Plantilla. This refers to the sugarcane available to be harvested for the first time, after an average of 18 months for growing.

- Soca. This is the sugarcane which has been harvested for the second time.

- Resoca. Refers to sugarcane that has been harvested for more than two times and could reach twenty cicles.

Sugarcane Fiber (*ScF*). Sugarcane trunk is made of two parts, one is a solid part called fiber, and the other is a liquid part which contains water and sucrose. Sugarcane fiber is measured in percentage of total sugarcane, and lower fiber contents translate into more sucrose content.

Sucrose Content (*SucC*). This refers to liquid part of the sugarcane from which sugar can be extracted and is expressed in percentage. Sugar content is higher for *Plantilla* and will diminish with the years.

Sugarcane Renewal (*ScRen*). As stated before, sucrose recovery diminishes with the times sugarcane is harvested; thus there should be a percentage of *Resoca* that should be replaced with new sugarcane, but incubation time requires 18 months (two cicles) in order to be harvested.

Sugarcane Additions (*ScAdd*). Sugar mills are always trying to attract new growers to their mill in order to produce more sugar and utilize their current capacity. Unfortunately this factor could be negative as the sugar my also lose growers to other mills or crops.

Sucrose Losses (*SucLoss*). During the sugar extraction process, there are losses of sucrose that cannot be transformed into sugar. Sucrose is lost in a) the solid residues or fiber after sugarcane has been crushed (Bagazo), b) in the sugarcane syrup, c) in the syrup residues or mud (Cachaza) and d) undetermined losses. Sucrose losses are measured in percentage.

Juice Purity (*JuPur*). The juice extracted after cane has been crushed may contain strange particles that do not contain sucrose; therefore higher levels of purity translate into better sugar formation. Juice purity is measured in percentage.

Factory Efficiency (*FEff*). This refers to the process efficiency in extracting the available sucrose in the sugarcane. Should the process be flawless, factory efficiency is

100%; in practice this efficiency is between 80% and 90%.

Factory Yield (*FYield*). This is the measure of how much sugar (metric tons) is obtained per metric tons of sugarcane. The amount of sugar is the result of the previous factors, both relating to sugarcane and to the extracting process.

Molasses Brix Yield (*MolYield*). Molasses with an 85° Brix degree are obtained as a by-product of sugar during "crystallization" process. These molasses are also sold to alcohol companies. *MolYield* is calculated as tons or molasses per tons of *GrossSc*.

Financial factors in Mexican sugar mills

Mexican regulation in the sugar industry has heavy financial implications in sugar mills costs. We analyzed three sugar mills from which we were able to obtain financial and operating data and we will assume that other Mexican sugar mills follow the same cost structure. Baiscally, there are four general costs and expenses in a sugar mill, the cost of raw materials or sugarcane, salaries, SG&A and reparation costs.

According to the outstanding law, 57% of the sugar value extracted from sugarcane should be paid to growers, with a down payment of 80% when sugarcane is delivered to the mill and the remaining at the end of the sugar production cycle. There are formulas that were implemented since 1997 to calculate the reference price for sugarcane through KARBE[2] , which take into consideration some of the factors previously listed and establishing minimum operating efficiency factors to mills. The formula for KARBE is:

$$KARBE = SucC * FBaEff * \left(1.085966 - \frac{0.519 * ScF}{100 - ScF}\right) * 1.101843 * \left(1.4 - \frac{40}{JuPur}\right) * \frac{10}{99.4} * NSc \quad (1)$$

Where,

SucC, is the average sucrose content at the end of the production cycle

FBaEff, is the factory base efficiency factor and equals 82.37%

ScF, is the sugarcane fiber content measured as % of total sugarcane processed

JuPur, is juice purity measured by hydrometric methods by the mill

NSc, refers to the net metric tons processed at the mill

In the *KARBE* formula, a mill whose actual Factory Efficiency is less than *FBaEff* will be paying more to the sugarcane producer. In the same token, the formula contemplates a Sugarcane Fiber (*ScF*) factor of 14.21%, so if the actual sugarcane resulted in a higher ScF, the grower will be paid less. This is a compensation formula so both the mill and the grower become more efficient.

After obtaining KARBE the prevailing sugar wholesale price is applied for the down payment and at the end of the cycle the actual sugar obtained from the sugarcane processed is used to determine the final payment.

The most important operating expense is the salary cost which could range from 5% to 10% of total sales because in its fixed component is between 90% and 98%. Around 70% of the personnel are affiliated to a labor union so their benefits are ruled by a collective contract called *Contrato Ley* which applies to all sugar mills and provides with compensations above the law.

Labor relationships with unions have always been tense with 44 general strikes in the last 80 years. Due to the NAFTA, the

[2]Stands for "kilogramos de azucar recuperable base estandar" or standard sugar kilograms obtainable

Contrato Ley was revised in order to prevent massive firing, but also including efficiency evaluations and reducing the retirement burden.

Other SG&A expenses include petroleum used in caldrons, chemical products, utilities, maintenance, transportation, and containers, among others. Those range from 7% to 11% of total sales and also have a large fixed component, between 90% to 96%, driven mostly by maintenance costs.

During the reparation period, not all workers are needed, but materials and salaries account for around 15% to 20% of total income, also with a fixed component of 84%.

Methodology

Our financial model is based on the FCFF[3] model which determines the value of the firm or of the operating assets through the appropriate WACC[4] and then deducts the net capital expenditures. The time horizon for the model is ten years plus the terminal value calculated at year ten. This time horizon permits flexibility in the model for convergence periods available for some variables.

This model is fit for any Mexican sugar mill and projects cash flow for 20 years because it has starting values based on the last production cycle and converges them to optimal values in a certain time. For comparison analysis, factors are converged to their optimal value in five years. All the economic figures are in Mexican pesos.

For the income part of our model, we first need to determine the amount of sugar our mill produces. First we start with how much Land we have, how this land is divided by sugarcane age; the ScYield for each type of sugarcane; what is the ScAdd and the ScDisc to obtain the NetSc to be processed by the mill. For the base case of our mill we will use the following information:

Table 1. Assumptions for revenue calculations

Factor	Units	Base value (starting year)	Convergence value	Years to convergence	Distribution used*
Land	Ha	7,193.39	N/A	N/A	Formula
Division by sugarcane age	%				
Plantilla		17.52%	N/A	N/A	Fixed
Soca		16.12%	N/A	N/A	Fixed
Resoca		66.36%	N/A	N/A	Fixed
ScYield	Tons/Ha				
Plantilla		69.38	87.77	5	CV,Beta,α=2.16,β=3.46
Soca		64.45	78.91	5	CV,Beta,α=1.82,β=5.10
Resoca		58.46	70.05	5	CV,Beta,α=6.35,β=12.9
ScAdd	%	2.00%	N/A	N/A	BV,Norm,M=0,SD=2%
ScRen	%	18.00%	N/A	N/A	BV,Triang,M=9.88%
ScDisc	%	3.69%	3.00%	5	CV,Norm,SD=0.3%
SucC	%	11.63%	11.90%	5	CV,Beta,α=11.1,β=2.73
SucLoss	%	2.50%	2.27%	5	Lognorm,M=2.36,SD=.23
ScF	%	13.25%	12.68%	5	CV,Beta,α=2,β=3
JuPur	%	77.11%	79.22%	5	CV,TStud,M=79.1%,d.f.=1

[3]Free Cash Flow to the Firm

[4]Weighted Average Cost of Capital

Factor	Units	Base value (starting year)	Convergence value	Years to convergence	Distribution used*
Working days (Days)	Days	134	188	5	CV,NegBinomial,p=0.1604
Time lost in factory (TimeL)	hours	37.11	24.95	5	Lognorm,M=36.1,SD=7.75
FEff	%	N/A	N/A	N/A	Formula
MolYield	Tons/ Tons	33.06	33.40	5	CV,Beta,α=1.57,β=2.31
Discounts	%	3.08%	N/A	N/A	BV,Norm, SD=0.31%
Sugar Price ($Price_{sugar}$)	$/Ton	10,130.38	Variable	5	Formula
Mollases Price ($Price_{molasses}$)	$/Ton	1,000.00	N/A	N/A	Fixed

N/A refers to not applicable

**Distributions are applied to base value (BV) or convergence values (CV). The value in the table is used as mean and Standard Deviation (Std Dev) is a percentage on the mean value.*

Each year, *Land* and is calculated as follows:

$$Land_t = Plantilla_t + Soca_t + Resoca_t \tag{2}$$

Where,

$$Plantilla_t = Land_{t-2} * (1 + ScRen + ScAdd) \tag{3}$$

$$Soca_t = Plantilla_{t-1} \tag{4}$$

$$Resoca_t = Soca_{t-1} - Land_{t-1} * ScRen \tag{5}$$

Values for convergence *ScYield* by each type of sugarcane were obtained from historical data using linear regression analysis, resulting in the following equation:

$$ScYield_{Type} = 96.6267 - 8.86 * Type \tag{6}$$

$$R^2 = 0.4959, F\text{-}Test\ p\text{-}value = 8.1356\text{E-}09$$

Where,

$$Type = \begin{cases} 1\ for Plantilla \\ 2\ for Soca \\ 3\ for Resoca \end{cases}$$

We also used regression analysis to obtain a formula for FYield as follows:

$$FY = -0.1070 + 0.1313 * FEff + 0.7916 * SucC - 0.0063 * SucF + .0054 * JuPur \tag{7}$$

$$R^2 = 0.9943, F\text{-}Test\ p\text{-}value = 0$$

Where,

$$FEff = 95.9654 - 6.8407 * SucLoss - 0.03255 * TimeL + 0.01757 * Days \tag{8}$$

$$R^2 = 0.8134, F\text{-}Test\ p\text{-}value = 4.8855\text{E-}279$$

From these parameters, each year we calculate the following factors to obtain the amount of sugar produced by the mill:

$$GrossSc = Land * (Plantilla * ScYield_{Plantilla} + Soca * ScYield_{Soca} + Resoca * ScYield_{Resoca}) \tag{9}$$

$$NetSc = GrossSc * (1 - ScDisc) \tag{10}$$

$$Sugar = NetSc * FYield \tag{11}$$

$$Molasses\ 85°\ Brix = GrossSc * MolYield \tag{12}$$

Now we know how much sugar and molasses 85° Brix our mill produces, so we just need to calculate our revenue as follows:

$$Revenue_t = (Sugar_t * Price_{sugar\,t} + Molasses\ 85°\ Brix_t * Price_{molasses\,t}) * (1 - Discounts_t) \tag{13}$$

Where,

$Sugar_t$ = the amount of sugar in metric tons produced in year *t*

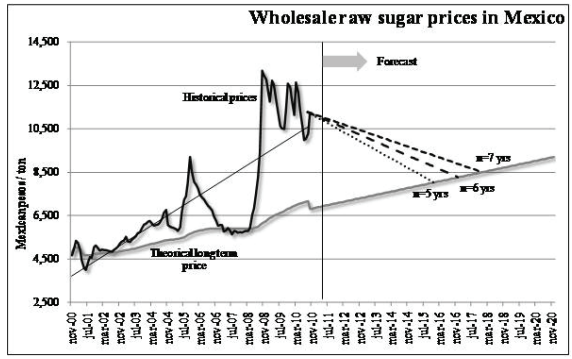
$Price_{sugar\ t}$ = is the price of sugar for year *t*

$Molasses\ 85°\ Brix_t$ = the amount of molasses 85° Brix obtained in year *t*

Price$_{molasses\ t}$ = is the price of sugar for year *t*

Discountst= is the % of discounts applied to *Revenuet* due to price reductions or refunds in year *t*

The variable that we are missing to define thoroughly in the previous assumptions is the price for sugar. The following graph shows the behavior of historical wholesale raw sugar prices in Mexico, which have been very volatile lately, mostly driven by speculation in international markets. We believe that prices in Mexico should not vary much due to the fact that demand nearly equals supply, that the cost structure in Mexico is relative fixed (as shown below), and that the only substitute that is imported is corn syrup. For purpose of our analysis we assume that there is a "theorical" long term price, which is growing but at a smaller pace. In our analysis we start over $10,500 pesos per ton and converge linearly the price to the theorical price after five years. The graph shows other two scenarios where the price converges at year 6 and at year 7. This is going to be a changing variable to determine the impact on the final value.



For the costs and expenses, we have the following parameters:

Table 2. Assumptions for costs and expenses calculations

Factor	Units	Base value (starting year)	Convergence value	Years to convergence	Distribution used
Cost of sugarcane (KSc)	%	57.00%	N/A	N/A	Fixed
Other sugarcane costs (K'Sc)	%	2.49%	N/A	N/A	BV,Norm, SD=0.31%
Petroleum (Petr)	Lts/Ton	4.07	1.37	5	BV,Norm,SD=1
					CV,Norm,SD=0.14
Cost of Petroleum* (KPetr)	$/Lt	3.99	N/A	N/A	BV,Norm, SD=0.4
Containers cost* (KCont)	$/Ton	60.44	N/A	N/A	BV,Norm, SD=6.04
Other materials' cost* (KOM)	$/Ton	22.35	N/A	N/A	BV,Norm, SD=2.24
Labor cost* (KLab)	$/Ton	362.72	N/A	N/A	BV,Norm, SD=36.27
Fixed	%	90.0%	N/A	N/A	Formula
Variable (KLab_v)	%	10.0%	N/A	N/A	BV,Triang,Min=5,Max=20
Reparation Cost (KRep)	%	16.0%	N/A	N/A	BV,Uniform,Range±1.6%
Factory Labor cost* (KFLab)	$/Ton	288.15	N/A	N/A	BV,Norm, SD=28.82
Fixed	%	99.97%	N/A	N/A	Formula
Variable (KFLab_v)	%	3.44%	N/A	N/A	BV,Norm, SD=0.34%
Factory SGA cost* (KFSGA)	$/Ton	245.18	N/A	N/A	BV,Norm, SD=24.52
Fixed	%	97.89%	N/A	N/A	Formula
Variable (KFSGA_v)	%	2.11%	N/A	N/A	BV,Norm, SD=0.21%
Land Labor cost* (KLLab)	$/Ton	77.56	N/A	N/A	BV,Norm, SD=7.76
Fixed	%	99.99%	N/A	N/A	Formula
Variable (KLLab_v)	%	0.96%	N/A	N/A	BV,Norm, SD=0.1%

Factor	Units	Base value (starting year)	Convergence value	Years to convergence	Distribution used
Land SGA cost* (KLSGA)	$/Ton	44.41	N/A	N/A	BV,Norm, SD=4.44
Fixed	%	98.42%	N/A	N/A	Formula
Variable (KLSGA_v)	%	1.58%	N/A	N/A	BV,Norm, SD=0.16%
Admin Labor cost* (KAdLab)	$/Ton	191.12	N/A	N/A	BV,Norm, SD=19.11
Fixed	%	100.0%	N/A	N/A	Formula
Variable	%	0.0%	N/A	N/A	Fixed
Admin SGA cost* (KAdSGA)	$/Ton	168.24	N/A	N/A	BV,Norm, SD=16.82
Fixed	%	94.91%	N/A	N/A	Formula
Variable (KAdSGA_v)	%	5.09%	N/A	N/A	BV,Norm, SD=0.51%
Capex (Capex)	%	2.5%	N/A	N/A	BV,Norm, SD=0.25%
Depreciation & Amm (D&A)	%	2.5%	N/A	N/A	BV,Norm, SD=0.25%
Financial Net Income (FinI)	%	1.02%	N/A	N/A	Lognorm,M=.87%,SD=.1%
Working Capital (WC)					
Credit to growers (Cred)	$/Ha	4,844.09	N/A	N/A	BV,Norm,SD=484.4
Clients/Rev (Clients)	%	6.66%	N/A	N/A	BV,Norm,SD=0.67%
Suppliers/Rev (Supp)	%	4.54%	N/A	N/A	BV,Norm,SD=0.45%
Inventory/Rev (Inv)	%	4.96%	N/A	N/A	BV,Norm,SD=0.5%
Other WC/Rev (OthWC)	%	-7.01%	N/A	N/A	BV,Norm,SD=0.7%
Inflation for costs (Inf)	%	3.00%	N/A	N/A	BV,Norm,SD=1%
Tax rate (Tax)	%	30.00%	N/A	N/A	Fixed
Perpetual Growth (Gr)	%	2.30%	N/A	N/A	Fixed
Return on Capital (ROC)	%	12.10%	N/A	N/A	BV,Norm,SD=2%

*N/A refers to not applicable, *Costs that grow with annual inflation in their fixed part*

With this information, we can calculate the cost of goods sold (*COGS*), reparation costs (*RepCost*) and operation costs (*OpCost*) as follows:

$$COGS_t = \frac{KARBE_t}{ScDisc_t} * NetSc_t * Price_{sugar\,t} * KSC_t + Revenue_t * K'Sc_t + Petr_t * KPetr_t * GrossSc_t + Sugar_t(KCont_t + KOM_t + KLab_t) \quad (14)$$

$$RepCost_t = Revenue_t * KRep_t \quad (15)$$

$$OpCost_t = KFLab_t + KFSGA_t + KLLab_t + KLSGA_t + KAdLab_t + KAdSGA_t + D\&A_t \quad (16)$$

$$TotCost = COGS_t + RepCost_t + OpCost_t \quad (17)$$

We now need to calculate or free cash flow to the firm (FCFF) in order to obtain our present value at the weighted average cost of capital (WACC). From (12) and (16) we get our EBIT(1-t)[5].

$$EBIT(1-t) = (Revenue_t - TotCost_t)(1 - Tax) \quad (18)$$

In order to obtain the FCFF, we need to calculate the change in working capital (ΔWC), as follows:

$$\Delta WC = WC_t - WC_{t-1} \quad (19)$$

[5]Earnings Before Interest, Tax, Depreciation and Ammortization and then taking out taxes

Where,

$$WC_t = Cred_t * Land + Revenue_t(Clients_t + Inv_t - Supp_t + OthWC_t) \quad (20)$$

Now from and plus adding depreciation and amortization (*D&A*) which is an expense that is not an actual cash flow and subtracting capital expenditures (*Capex*) we calculate our *FCFF* as follows:

$$FCFF_t = EBIT(1-t)_t + (D\&A_t - Capex_t) * Revenue_t - \Delta WC_t \quad (21)$$

We also need to calculate a terminal value at the end of our time horizon, which represents the present value of a perpetual cash flow once our business has reached a stabilized operation. We assume that perpetual growth (*Gr*) is the potential growth of the local economy, which in the case of Mexico the historical average has been 2.3%. We also assumed that our business reaches a return on capital (*ROC*) of 12.10%, figure that was calculated from a sample over 200 companies in the food industry within the emerging markets. The present value at year ten of our $FCFF_{terminal}$ is calculated as follows:

$$PV[FCFF_{terminal}] = \frac{FCFF_{\text{terminal}}}{WACC_{terminal} - Gr} \quad (22)$$

Where,

$$FCFF_{\text{terminal}} = EBIT(1-t)_{10} * (1 - \frac{Gr}{ROC}) \quad (23)$$

Now, for determine the value for our mill (EV), we need to calculate the present value of the free cash flows obtained from the equations above, using the weighted cost of capital as follows:

$$EV = \sum_{t=1}^{10} \frac{FCFF_t}{(1+WACC)^t} + \frac{FCFFterminal}{(1+WACC)^{10}} \quad (24)$$

The discount rate or WACC is calculated from the cost of equity (*Ke*), the after-tax cost of debt (*Kd*), and the proportion of debt (*D*) and equity (*E*), given by the following formulae:

$$WACC = Ke * \frac{E}{D+E} + Kd * (1 - Tax) * \frac{D}{D+E} \quad (25)$$

The cost of equity is calculated from the CAPM model that incorporates (a) the risk measure of the asset through Beta (β) which was calculated from the average of food companies in emerging markets and adjusted by cash; (b) the risk free rate (*Rf*), which is the current 30-year Mexican Government bond rate; and (c) the market premium over the risk free rate, which was taken from Damodaran's latest calculations. The formula for *Ke* is the following:

$$Ke = Rf + \beta * MktP \quad (26)$$

For the cost of debt we just considered the current rates at which financial institutions are willing to lend to companies in the food sector in Mexico, whereas the debt to equity ratio (*D/E*) is the average calculated from the sample of food companies in emerging markets.

The following parameters are used to obtain the *WACC* and the $WACC_{terminal}$.

Table 3. Assumptions for weighted average cost of capital calculations

Factor	Base value	Distribution used
Beta (β)	1.53	Fixed
Risk free rate (*Rf*)	7.38%	Normal, SD=0.74%
Market Premium (*MktP*)	6.90%	Fixed
Cost of Debt (*KDebt*)	11.87%	Normal, SD=1.19%
Debt/Equity ratio (*D/E*)	48.54%	Normal, SD=4.85%
WACC Terminal ($WACC_{terminal}$)	10.54%	Fixed

Simulation and results

For the base case scenario, we obtain the following figures for the sugar production in the sugar mill and the resulting FCFF from which we calculate the present value (PV) to obtain our valuation (EV).

	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Land	Ha										
Plantilla		1,295	1,295	1,439	1,439	1,439	1,467	1,491	1,510	1,532	1,554
Soca		1,260	1,295	1,295	1,439	1,439	1,439	1,467	1,491	1,510	1,532
Resoca		4,638	4,604	4,604	4,578	4,675	4,754	4,814	4,882	4,954	5,025
Total		7,193	7,193	7,337	7,455	7,552	7,660	7,772	7,884	7,997	8,112
GrossSC	000Tons	442	462	492	520	547	575	584	592	601	609
NetSC	000Tons	426	445	475	503	530	558	566	574	583	591
SucLoss	%	2.50	2.45	2.41	2.36	2.31	2.27	2.27	2.27	2.27	2.27
TimeL	Hrs	37.11	34.68	32.25	29.81	27.38	24.95	24.95	24.95	24.95	24.95
Days	Days	134	145	156	167	178	189	189	189	189	189
FEff	%	80.01	80.60	81.19	81.78	82.37	82.95	82.95	82.95	82.95	82.95
SucC	%	11.63	11.68	11.74	11.79	11.85	11.90	11.90	11.90	11.90	11.90
SucF	%	13.25	13.14	13.02	12.91	12.79	12.68	12.68	12.68	12.68	12.68
JuPur	%	77.11	77.53	77.95	78.38	78.80	79.22	79.22	79.22	79.22	79.22
FYied	%	9.35	9.47	9.60	9.72	9.84	9.97	9.97	9.97	9.97	9.97
MolYield	Ton/ton	32.20	32.50	32.80	33.10	33.40	33.40	33.40	33.40	33.40	33.40
KARBE	000Tons	41.66	43.87	47.14	50.30	53.33	56.57	57.41	58.23	59.06	59.91
Sugar	000Tons	39.81	42.17	45.58	48.92	52.15	55.62	56.45	57.25	58.07	58.91
Molasses	000Tons	14.24	15.00	16.13	17.22	18.27	19.21	19.50	19.78	20.06	20.35

Table 5. Free cash flow and valuation calculations – base case scenario. Figures in million pesos.

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Term
Revenue											
Sugar	403.31	394.41	390.92	381.53	419.04	460.07	480.21	500.59	521.45	542.85	
Molasses	14.24	15.00	16.13	17.22	18.27	19.21	19.50	19.78	20.06	20.35	
Discounts	12.86	12.61	12.54	12.28	13.47	14.76	15.39	16.03	16.68	17.35	
Total	404.69	396.80	394.52	386.47	423.84	464.52	484.32	504.34	524.83	545.86	
COGS	266.05	260.37	258.35	252.79	274.19	298.84	311.84	325.01	338.53	352.43	
Expenses											
Reparation	66.81	65.51	65.13	63.80	69.97	76.69	79.95	83.26	86.64	90.11	
Operation	42.10	42.86	43.84	44.68	46.93	49.33	51.03	52.77	54.56	56.40	
Total	108.90	108.36	108.97	108.48	116.89	126.02	130.99	136.03	141.20	146.51	

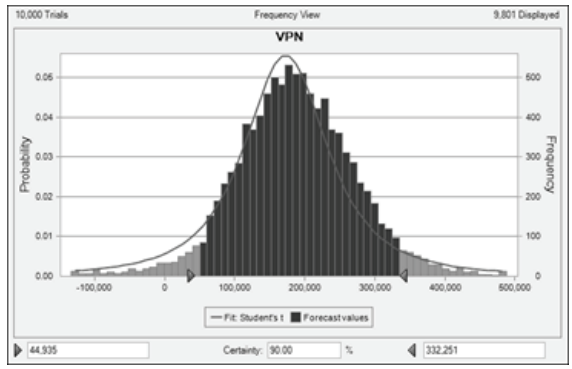
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Term
Financial Income	4.24	4.16	4.13	4.05	4.44	4.87	5.08	5.29	5.50	5.72	
EBIT	33.97	32.23	31.33	29.25	37.20	44.53	46.58	48.59	50.61	52.64	
EBIT(1-t)	23.78	22.56	21.93	20.48	26.04	31.17	32.60	34.01	35.42	36.85	37.70
D&A	10.44	10.24	10.18	9.97	10.93	11.98	12.49	13.01	13.54	14.08	
Capex	10.44	10.24	10.18	9.97	10.93	11.98	12.49	13.01	13.54	14.08	
ΔWC	0.06	1.04	1.81	1.75	1.74	1.87	1.95	2.03	2.12	2.21	
FCFF	23.72	21.52	20.11	18.73	24.30	29.30	30.65	31.99	33.31	34.63	30.53
PV	23.72	19.00	15.68	12.89	14.77	15.73	14.53	13.38	12.31	11.30	120.85
EV = ∑PV	**274.17**										

The *EV* obtained corresponds to the operating assets valuation and in order to obtain the equity value (value of the shares), we should deduct the outstanding market value of financial obligations.

Now, we are interested in running a Monte Carlo simulation by changing each of the variables that include a probabilistic distribution mentioned in the tables above. For this simulation we ran 10,000 trials. Examples of some trials may be consulted in the appendices of this paper.

In each trial, we obtain a value for *EV*. The following graph shows the resulting distribution of *EV*, which is best fitted by a *Student's t* distribution. The mean value is $172.5 million pesos and the median is $184.5 million pesos, both values below the base case scenario. The 90% range is between $44.9 million pesos and $332.3 million pesos. We also calculated a 2.86% probability of *EV* being less than zero.

$$p(EV < 0) = 0.286 \tag{27}$$



The second phase of the simulation process consists on determining the variables that contribute with the greatest variance to *EV*, thus being the most sensitive in the model. For this phase, we ran 250 simulations for each variable while maintaining the base value for all other variables and measured the size of the range (maximum - minimum) obtained for *EV* in each case.

The following table summarizes the results of the 40 most important variables ranked by the range size obtained for *EV*.

Rank	Variable	Range	Rank	Variable	Range
1	ScAdd	59.87	21	ScDisc	7.99
2	KRep	55.51	22	KAdLab	7.51
3	Inf	50.74	23	D/E	7.35
4	SucLoss	49.25	24	KAdSGA	6.97
5	Resoca	41.30	25	KDebt	6.37
6	JuPur	23.63	26	ScF	6.35
7	SucC	22.51	27	Rf	5.99
8	Days	16.29	28	KLab_v	5.13
9	KLab	15.99	29	ROC	4.83
10	Discounts	14.99	30	FinI	4.83
11	KOM	14.78	31	KPetr	4.67
12	KFLab	12.13	32	Petr_CV	3.91
13	K'Sc	12.12	33	KCont	3.76
14	Plantilla	12.10	34	KLLab	3.11
15	Soca	11.05	35	Petr_BV	3.08
16	Capex	10.72	36	KLSGA	1.77
17	KFSGA	9.85	37	D&A	1.45
18	ScRen	9.64	38	OthWC	1.25
19	MolYield	8.67	39	Clients	1.19
20	TimeL	8.03	40	Cred	0.99

It is important to highlight that although the main factors are a combination of factors regarding sugar production, factors regarding costs and expenses, and factors regarding macroeconomic factors, those regarding sugar production are predominant with six of them in the first ten.

Conclusions

Sugar production process involves variables for obtaining more and better sugarcane, as well as variables in the production process for extracting more sucrose. However, also the relative high cost structure requires that Mexican sugar prices remain also high for a sugar mill to be financially viable. It should be considered that these results and interpretations are from a financial stand point and that the author is not a specialist in the sugar industry, nor in the production process.

Considering actual pricing and economical conditions, our hypothetical sugar mill valuation was positive, however a much more introspective analysis showed that the most sensitive factors driving this value are related to the sugar production process (including sugarcane). Therefore, considering that the cost structure will remain unchanged in the short term, sugar mills' owners should devote more resources to a) increase sugarcane land by attracting and financing more growers or buying land on their own; b) increase sugarcane yield and sucrose content either with more effective fertilization or irrigation mechanisms, as renovation of *Resocas* to *Plantilla* resulted less effective; c) enhance factory efficiency by reducing sucrose losses, increasing working days, and increasing juice purity.

As we stated early, we assumed that cost structure remains almost fixed, so cost factors resulted in the least important when determining value. Nevertheless, some important costs that should be considered are a) the reparation cost, which is commonly no high in Mexican sugar mills, and this translates into lower factory efficiencies; b) discounts in the final price to some actors in the commercialization chain; c) and the labor costs, which are mostly negotiated with unions and regulated in the general collective contract (*Contrato Ley*). Regarding economic factors, inflation does impact in valuation as it increases fixed costs.

As we mentioned earlier, *KARBE* (from equation (1)) is used to calculate the final pricing for sugarcane, which then is granted the 57% of final sugar wholesale price. *KARBE* is the amount of sugar that the sugar mill should produce given the sugarcane factors and efficiency factors of

that particular mill. In our example, sugar calculated from *KARBE* is greater than that actually produced causing *COGS* to increase. The most effective way to revert this is by increasing the sucrose content in the sugarcane and reducing sucrose losses in the process.

This model could be modified to calculate a specific multiple for the industry using the methodology of the REEVAM model[6], by comparing the driving factors related to the sugarcane supply and sugar production process.

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[6]See Business Intelligence Journal of July 2010

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Value Line (http://www.valueline.com)

Appendix I

Example of simulation results

Trial#	6134	2621	5430	7701	8191	4537	8780	181	1952	8258
VPN	**128,577**	**194,165**	**300,590**	**141,435**	**101,904**	**198,598**	**65,142**	**185,777**	**267,829**	**39,306**
Capex	2.71%	2.42%	2.69%	2.40%	2.52%	2.04%	2.41%	2.72%	2.52%	2.18%
Clients	5.82%	7.20%	6.70%	6.11%	6.98%	6.99%	7.02%	6.79%	6.71%	8.74%
Cred	4,396.63	5,364.01	5,427.99	4,784.13	5,080.28	4,103.88	5,139.43	4,140.95	4,575.61	4,649.53
D&A	2.28%	2.05%	2.54%	2.43%	2.15%	2.53%	2.33%	2.61%	2.44%	2.64%
D/E	44.88%	50.69%	41.72%	44.77%	42.62%	51.45%	50.34%	51.54%	44.43%	47.38%
Days	113	105	163	92	108	117	185	121	113	103
Discounts	2.91%	3.69%	2.78%	3.40%	3.23%	2.88%	3.48%	3.55%	3.25%	2.97%
Finl	0.84%	0.95%	0.95%	0.99%	1.05%	1.03%	0.87%	0.80%	0.92%	0.84%
Inf	3.22%	1.91%	1.61%	3.90%	2.83%	4.18%	3.60%	3.75%	3.45%	2.01%
Inv	5.79%	4.78%	4.82%	4.96%	4.22%	4.51%	4.77%	4.43%	5.79%	5.09%

Trial#	6134	2621	5430	7701	8191	4537	8780	181	1952	8258
JuPur	79.11%	82.87%	78.46%	83.44%	82.65%	81.11%	82.08%	79.66%	78.42%	85.96%
KAdLab	190.62	214.94	216.46	217.09	156.89	212.44	186.85	216.70	171.58	207.81
KAdSGA	192.48	175.67	146.50	168.38	178.84	185.41	178.25	162.95	164.84	158.47
KAdSGA_v	5.18%	4.05%	4.29%	5.22%	5.55%	4.85%	4.43%	5.33%	4.53%	5.25%
KCont	59.88	55.41	55.83	55.32	56.20	58.30	61.05	59.67	64.09	51.92
KDebt	11.87%	13.18%	13.28%	11.48%	10.95%	10.67%	9.64%	12.10%	12.17%	12.05%
KFLab	279.96	329.88	288.59	255.64	286.10	253.21	289.05	275.87	241.00	361.34
KFLab_v	3.88%	3.55%	3.53%	3.22%	3.28%	3.84%	3.52%	3.66%	3.32%	3.06%
KFSGA	270.41	307.15	220.26	255.67	272.11	232.33	233.24	243.54	226.58	230.08
KFSGA_v	1.75%	1.88%	2.35%	1.93%	2.02%	1.62%	2.15%	2.10%	2.35%	1.94%
KLab	373.04	366.57	350.99	380.73	402.35	384.70	355.28	383.05	313.77	411.30
KLab_v	12%	9%	11%	11%	8%	10%	11%	10%	12%	15%
KLLab	70.03	88.55	76.46	89.78	82.75	80.03	72.97	64.85	86.57	86.35
KLLab_v	0.92%	0.93%	1.05%	0.80%	0.93%	0.90%	1.01%	0.98%	1.07%	0.90%
KLSGA	44.76	43.35	53.10	39.09	46.26	46.01	43.09	40.87	49.35	48.42
KLSGA_v	1.48%	1.51%	1.40%	1.47%	1.38%	1.54%	1.54%	1.91%	1.60%	1.65%
KOM	23.88	23.17	22.93	22.16	25.53	20.45	20.46	23.43	21.67	24.22
KPetr	4.25	3.47	3.90	3.96	4.46	3.86	4.38	3.74	4.28	3.73
KRep	15.77%	14.49%	14.47%	17.01%	17.01%	16.14%	15.03%	14.54%	14.55%	15.46%
K'Sc	2.40%	2.44%	2.22%	2.36%	2.65%	2.77%	2.47%	2.37%	2.46%	2.51%
MolYield	33.07	32.34	31.47	30.58	34.45	31.64	33.75	33.26	34.12	34.25
OthWC	-6.86%	-6.83%	-8.14%	-6.51%	-6.85%	-8.01%	-6.74%	-7.93%	-6.47%	-6.56%
Petr_BV	1.31	1.16	1.21	1.32	1.28	1.23	1.35	1.39	1.21	1.41
Petr_CV	3.82	3.32	2.58	4.08	4.52	2.58	5.04	3.59	5.52	3.93
Plantilla	81.06	85.81	95.25	97.82	81.12	87.12	76.23	80.39	88.56	84.26
Resoca	66.91	73.44	71.42	77.55	68.65	70.91	70.55	76.94	68.31	65.60
Rf	7.22%	7.96%	7.35%	6.10%	7.73%	6.84%	6.89%	7.69%	7.36%	6.15%
ROC	12.66%	10.08%	9.70%	13.40%	14.61%	10.70%	11.88%	13.00%	11.45%	12.41%
ScAdd	-3.26%	-1.36%	-0.96%	2.35%	1.78%	1.06%	-5.47%	-1.99%	2.50%	-5.00%
ScDisc	3.15%	3.09%	3.23%	3.20%	2.10%	2.76%	2.53%	3.53%	3.10%	3.50%
ScF	13.09%	11.89%	12.52%	12.02%	11.90%	11.90%	12.57%	12.92%	12.63%	12.43%
ScRen	21.02%	20.31%	19.56%	16.09%	15.61%	10.04%	9.54%	10.18%	17.02%	13.53%
Soca	92.53	83.00	72.31	87.38	74.40	74.53	88.59	75.46	88.39	67.97
SucC	12.69%	12.56%	12.35%	12.15%	12.27%	11.96%	11.42%	12.69%	11.80%	11.53%
SucLoss	2.31%	2.27%	2.28%	2.42%	2.60%	2.15%	2.51%	2.24%	2.48%	2.34%
Supp	4.60%	4.59%	3.74%	5.15%	4.78%	4.01%	4.47%	4.05%	3.80%	5.43%
TimeL	58.74	40.97	33.32	30.52	34.16	36.02	33.23	31.37	28.08	31.13