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Investigating the Factors Affecting the Sugar Stock Surplus and Ways to Get out of it in Iran

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Abstract

Due to the importantance of sugar in daily consumption of Iranian households, governments annually store sugar as a strategic reserve. Therefore, managing and timing adjustment for the inventory of this product is essential in its ability to compete in markets, modifying the temporal and spatial distribution of products and inputs in economic subdivisions. In recent years, at national scale there was extra sugar in warehouses and a few cases of shortages in stock were exception. Higher sugar production along with lower sale, will increase the costs, so the aim of this study was to investigate the factors affecting sugar surplus and its export in Iran data time searies 1991-2017. In this study our results showed that sugar beet and sugar price as product price did not play a decisive role in stock surplus. Therefore, the stock surplus can neither be the result of price policies nor it be resolved through price policies. It seems that the government should adopt other policies, such as adjusting the timing of import decisions, resolving conflicts between government objectives, and providing strategic reserves from domestic products and gradual elimination of imports, support factories for improving and upgrading equipment, and help sugar beet producers to achieve cheaper product rather than using price policies related to sugar and sugar beet prices.

Keywords: Iran, Sugar, Simulation, Stocks

Introduction

Inventory management plays a key role in the competitiveness of foreign markets, modifying the temporal and spatial distribution of products and production inputs in economic subdivisions (Prasad and Parkar, 1996). According to Eden (2001), business cycle shocks often reduce product output and employment levels. Similar situations may occur in agriculture section. Concerning agricultural products, inventory adjustment is one of the policies adopted to maintain an inventory level at an acceptable level aiming to stabilize domestic prices against market shocks (Praskad and Parker, 1996; John and Srinivasan, 2001). However, many factors in the economy can affect the performance of these policies. These factors can be divided into four groups of producer decision variables, demand formation variables, structural factors, and government policies.

In classical models of warehouse management, the producer's decision variables (i.e. shortage cost and surplus and sales value) are the only factors controlling inventory (Booney and Jarab 2011). Pierce and Wisley (1983) and Ian and Dooley (2010) considered two sources affecting the inventory: sales prediction (demand) and expected loss profits. Booney and Jaber (2011) believed that the producers decision making in practice are also a function of other factors such as waste rates, transportation costs and environmental considerations. Phillips *et al.* (2001) stated that production for storage and production for sale are two different categories. They showed that when the purpose

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of production is to store it, firstly, warehousing and storage costs gradually eliminate the importance of exchange and sale in decision. Secondly, when sellers seek to raise prices, their behavior causes a surplus in stock. However, if the goal of production is to sale, the stock surplus is much lower.

Various variables are involved in the formation of demand, including income and market prices of products. However, in inventory modeling, their behavior often is regarded as extrinsic. The reason for this attitude is partly related to the experience of the studies. Mostleman *et al*. (1987) by dividing production approaches into post-demand and pre-demand production approaches and presenting theoretical models showed that stock surplus is not generally affected by consumer behavior and by increasing producer experience, the difference between two approaches will be eliminated over time. In fact, they had no difference with each other. In other words, whether supply follows demand or vice versa, stock surplus is not affected by this relationship.

Market structure has been considered both in terms of pricing power and the existence of monopoly as well as supply chain length as a determinant of supply surplus. Wong (2004) investigated the role of market structure on inventory surplus by mathematical modeling. According to his findings, market structure plays a key role in generating inventory surplus. When the market is comprised of a small number of producers, the market structure enhances the producers' benefits, and the surplus of inventory at the retail level increases as well. Pierce and Wisely (1983) have previously emphasized that retailers tend to make shorter time horizons in decision making than manufacturersand react strongly to price shocks and consequently they drastically reduce the inventory rates. Therefore, it can be concluded that in monopoly structures, in the absence of price shocks, there is a surplus of inventory at the retail level, and in conditions where shocks exist; there is a surplus of inventory at the level of warehouses of manufacturing plants. In other words, theoretically, under the monopoly conditions, the stock surplus is predictable.

Governments influence the surplus of stockpiles through various policies. Despite the reasoning behind the government's actions, it is believed that these measures are ineffective. Ja and Srinivasan (2001) argued that although the purpose of food storage is to stabilize prices, but since global prices have a potential role on domestic prices, national price volatility in trade liberalization scenarios has much less intervention effect than government policies. Many countries use the strategy of import for storage when there is a risk of potential production shortages, including end-products and production factors. According to Prasad and Parkar (1996), imports are performed by either private (and often restricted) or public sectors (often by law) however their costs are high and structural reforms for globalization are far more efficient. Therefore, many studies resulted that encouraging the producers is an appropriate policy which in addition to commercial liberalization, can also reduce production profitability and inventory fluctuations (Prasad and Parkar, 1996; Zhong and Zhou, 2013). However, the structure and methods of storage and the nature of the product play an important role in its success (Matto *et al*., 2015).

In Iran, sugar is one of the products that has strategic reserves and is managed with different import policies, guaranteed purchase price for sugar beet and demand side policies. The procedure of sugar production in Iran from 1971 to 2014 is illustrated in Fig. 1, which shows sugar production has a rising trend. Of the total domestic sugar production, shares of public, ingovermental, governmental and private factories are 14.5%, 52%, 21.5% and 12%, respectively; that represent a monopoly on sugar production industry (Kazemnejad *et al*., 2007).

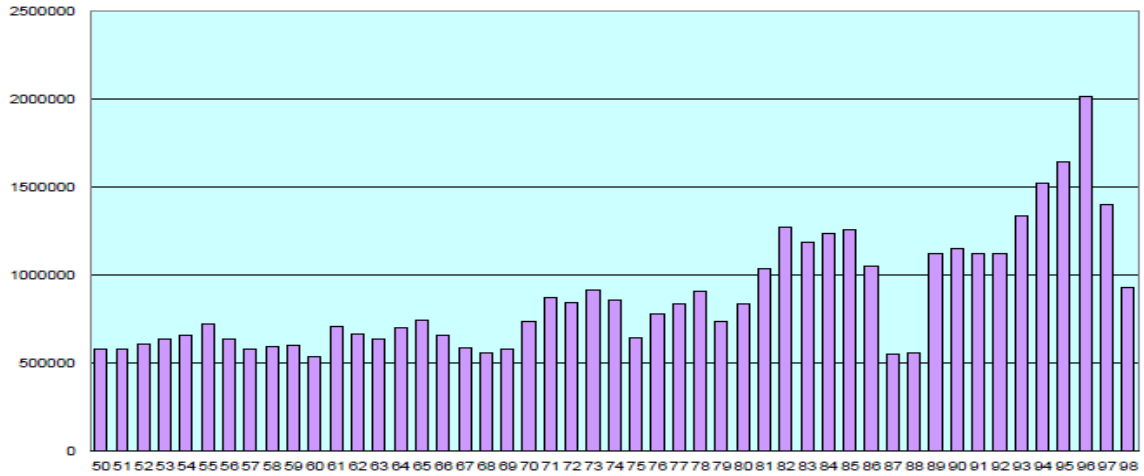

Fig. 1- Total sugar production (ton) from sugar beet and sugar cane during 1971-2019
Source: Iranian Sugar Association

In the last decade sugar consumption per capita shows a decreasing pattern of that per capita consumption rate, which may be due to reducing sugar advertising. Governments generally try to keep sugar stocks at optimum levels by encouraging domestic production. However, some countries that are unable to produce all their needs must import sugar. Statistics show that about 64 percent of domestic demand is supplied by domestic producers and the remainder is supplied through imports (Sugar Association, 2005).

Sugar imports are made by both the private and public sectors as a strategy to keep market prices stable. Sugar imports statistics in the 1980s showed that imports have been increasing until 2013 and the share of private sectors imports was higher than government imports. However, imports have declined dramatically over the past two years. As a result of increasing domestic production in 2014-2015, the country faced a surplus of 1.1 million tons of sugar in its warehouses and the temporary import of sugar was temporarily suspended.

World Bank statistics show that global and domestic sugar stocks have increased in recent years. This increase in sugar inventories in Iran could be due to the excessive increase in private imports, increased sugar beet cultivation, and increased guaranteed purchase prices of sugar beet. Whether through increased production or direct imports of sugar, if direct support policies of other related industries with proper planning and control are not implemented, there will be a surplus of sugar stocks, leading to a surplus in supply and thus a reduction in market prices which can damage domestic the sugar factories. Imports and surpluses playing a greater role than demand-side changes and according to the literature, the possible effective factors include imports, surplus production, and demand shortages. In this study to simulate the sugar industry, consumption is assumed to be exogenously affected by the growth of per capita consumption and population. Imports are determined endogenously by the production of sugar, sugar tariffs and national income. In addition, the supply of sugar is considered a coefficient of sugar cane and sugar beet productions which indirectly depends on the guaranteed purchase price. Given the importance of this strategic commodity, the present study seeks to identify the effective key factors and provide recommendations accordingly to explore the possible sources of the aforementioned surplus.

Materials and methods

In this study, a simulation method was used to determine the contribution of different quantitative and price factors to sugar supply surplus (Clarke *et al.*, 2007) the procedure is to identify the various sources of inventory surplus first and then attempt to quantify the existing descriptive relationships. Finally, by simulating quantitative relationships by an Analytical software, the effect of different quantitative and price scenarios would be investigated and the stock surplus response to different factors is calculated (Clarke *et al*., 2003). Figure 1 illustrates the conceptual model of the factors affecting the inventory changes. The inventory is the difference between the quantity of supplied sugar and its demand quantity, which is directly and indirectly influenced by various factors such as producer behavior, consumer behavior, trade status, general economic conditions of the national economy, the state of the prior markets, and the policies imposed by government.

The conceptual pattern in Fig. 1 did not include all the details, and some are ignored due to the lack of information and statistics, the lack of quantitative relationships and the inability to quantify. For example, the relationship between the sugar industry and the economy as a whole is stated only about trade. While the sugar industry is associated with various back and forth industries, all of which are affected by general economic conditions. This model assumes that policies related to the sugar industry are based on adopted laws and based on the information available from the sugar market and consumer behavior, while policymakers follow greater cautions in practice that were not considered in the model. In this model, only the former industries arrived to sugar beet and sugar cane. However, the energy sector is a very important factor in practice for the costs of sugar factories. Although these simplifications reduce the accuracy of the predictions of this model but given that in practice the implementation of large and complete models is encountered with limited statistics and information, it seems that taking into account price and key factors in providing simulation-based analyzes can at the same time provide the clues for effective decision-making in sugar industry.

To implement the conceptual model of Fig. 2 as a simulation model, the relationships between different factors have to be quantified. The conceptual pattern of Fig. 2 is first transformed into the flow of quantitative relations in Fig. 3. Inventory surplus is calculated by inventory, supply value, consumption or demand value, annual strategic reserve, and import value (Fig. 3). Through quantification of the relationships between each of these variables with the price factor as well as some policy scenarios, the impact of different factors on the stock surplus would be quantified and compared.

The quantitative relationships used in this study are a set of statistical, hypothetical, unity and regression relationships. Statistical relationships were derived by statistical methods, and in particular, regression methods. Hypothetical relationships are approximations of real and self-evident relationships. For example, the value of one arbitrary variable per year is equal to multiplication of the product value of the preceding year by the growth coefficient of that year. Now, if an average growth rate is taken into account instead of

annual growth rates, the values predicted by this relationship will be approximations of reality. Unities are also always good relationships emerge from definitions. For example, the amount of production per year is equal to multiplication of the area under cultivation in that year by yield per area unit, and this relationship is very accurate. The production predictions of the simulated model depend on how accurately the model predicts yield and area under cultivation.

The relationships used in this study are listed in Table 1. The dependent variable names, the subordinate form of the relation, the explanations and the accuracy of its simulation are reported in the first, second, third and fourth columns of the table, respectively.

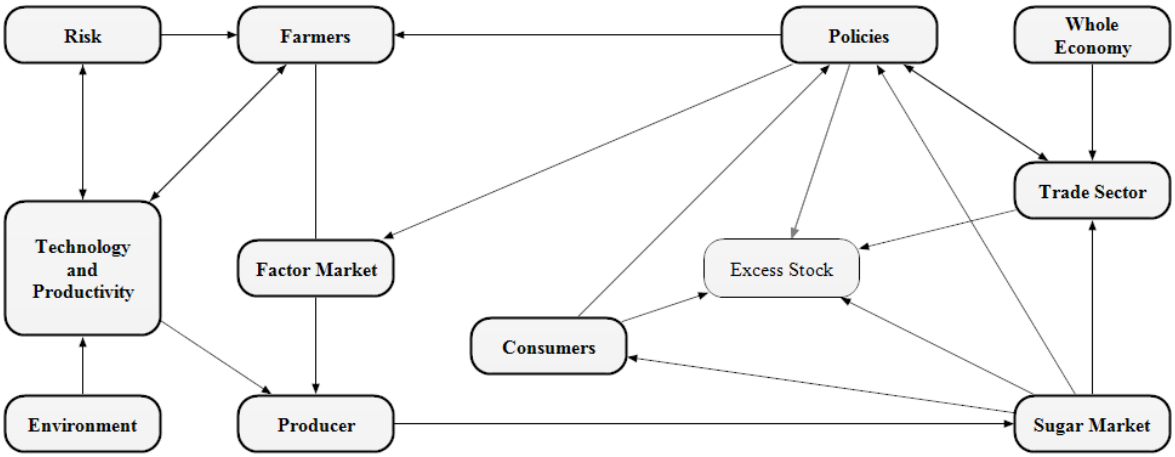

Fig 2. Conceptual model of factors affecting sugar surplus

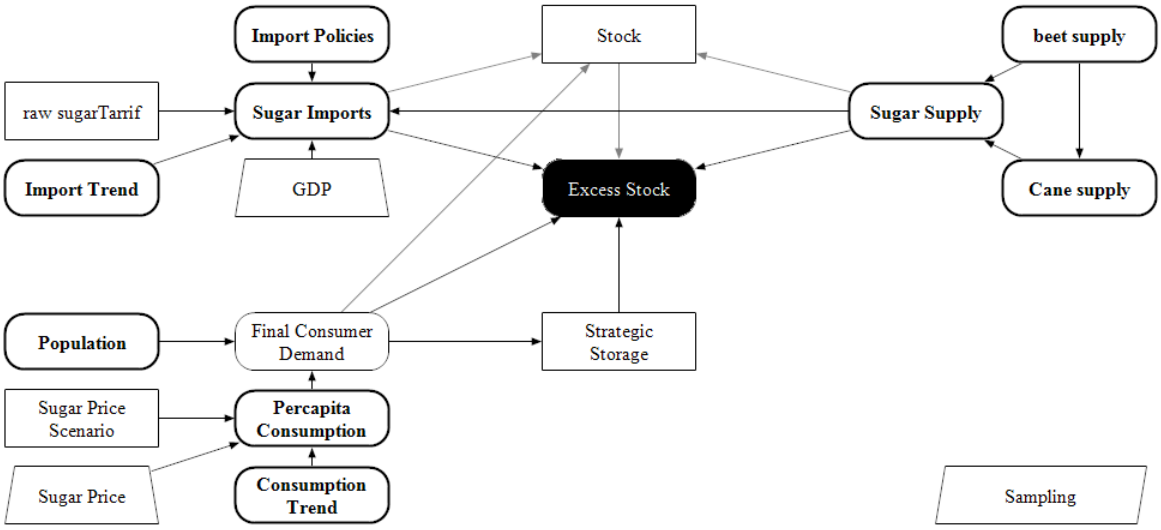

Fig. 3- The flowchart of quantified relationships needed for the model

The accuracy of the simulation can be calculated by comparing the actual time series with the predicted ones. The RMSE[1] calculates the root mean square of the prediction error. The MSD[2] statistic shows the mean deviation of the predicted values from the real values. The MAP[3] statistic calculates the average percentage of model prediction error, which is numerically equal to the ratio of the errors to the true values

1- Root-mean-square error
2- Mean square deviation
3- Mean absolute percentage error

Table 1- Relations used in the simulation

Simulation acuracy	description	equation (subordinate form)	Name
RMSE=407.6 MSD=35.33 MAPE=0.069	hypothetical equation g: Average growth rate The minimum expected price is equal to last year's price and its maximum is at least the minimum expected price	$\ln p_t = \ln(1+g) + \ln p_{t-1}$	Price expectations
RMSE=11.89 MSD=1.92 MAPE=0.057	Research findings	$Y_t = 18.24 + 0.29\, Y_{t-1} + 0.01\, P_t + \varepsilon_t$	Sugar beet yield
RMSE=135.5 MSD=9.3 MAPE=0.20	Research findings	$Y_t = 107.52 + 0.44 Y_{t-1} - 0.08\, P_{t-1} + \varepsilon_t$	The sugar beet area
RMSE=4745000 MSD=817400 MAPE=0.19	Unity	Area under cultivation * yield	sugar beet Supply
RMSE=30.8 MSD=4.35 MAPE=0.09	hypothetical equation	$Y_t = 1.07\, Y_{t-1}$	Sugar Cane Area
RMSE=66.78 MSD=9.25 MAPE=0.12	hypothetical equation	$Y_t = 0.07 - Y_{t-1}$	Sugar Cane yield
RMSE=2823000 MSD=409900 MAPE=0.12	Unity	Area under cultivation * yield	Cane Supply
	Unity	$\frac{(\text{sugar Beet consumption} * \text{Production coefficient} * \text{Grade})}{10000}$	Sugar Supply From beet
		Sugar consumption * Sugar to sugar cane ratio	Sugar Supply From cane
RMSE=972200 MSD=125400 MAPE=00.0	Unity	Sugar Supply from Sugar cane + Sugar supply from Sugar Beet	Sugar Suply
RMSE=2513000 MSD=364800 MAPE=0.39	Obtained from Farazmand et al. (2015) In this equation, the trend is assumed to be random *	$Y_t = lny_t + trend$ $lny_t = 12.91 + 0.77 lny_{t-1} - 0.2\ln(sugar\ supply) + 0.47\ln(GDP) + 0.003(raw\ sugarTarrif)$	Import Demand

RMSE=2273 MSD=358.9 MAPE=0.01		$\ln p_t = \ln(1+g) + \ln p_{t-1}$	Populatio n
RMSE=6.40 MSD=1.01 MAPE=0.04	Research findings In this equation, the trend is assumed to be random *	$C_t = 29.12 - 0.0003 * sugar\ price + trend$	Per capita Consump tion
	Unity	per capita consumption* population	Consume r Demand
	Unity	Last Year Supply + Last Year Import-Last Year Consume	Stock
	90 days stock	$Y_t = 0.25\ consumer\ demand$	Strategic Stock
	Unity	Last year inventory + supply + import - strategic stock consume	Exess Stock
* In fact, the equation estimated by Farazmand *et al.* (2015) has no trend. In this study, a random trend is added to the model assuming the same parameters are constant.			

In addition to equations mentioned in Table 1, To introduce the risk, disruptive components and probable error distributions were also simulated. Given that the mean of the disruptive components of the regression equations is zero, the inclusion of probable risk variables does not change the mean values, but it does cause that the estimated variables and its dependent variables have probable distribution, and their range of variations can be obtained based on probability density curves.

Results and Discussion

Further to the implementation of equations (Table 1) in Analytica software, the impact of different policy scenarios on the stock surplus was examined. Then the stock surplus response to changes in different variables was calculated and finally the impact of these scenarios on the stock surplus response to different factors was investigated.

Sugar Price Scenarios

Fig. 1, shows the surplus response of sugar stocks to different sugar price scenarios. This scenario includes: 1% decrease / increase of sugar prices, 10% decrease / increase of sugar prices as well as no change in sugar prices. It can be concluded (Fig. 4) that prices increase caused inventory surplus to become far from zero, in other words, if there is surplus stock in the economy, the surplus will increase as prices rise. On the other hand, if the economy is faced with a shortage of inventory, rising prices will increase sugar shortages. This finding has a key message in the sugar industry's policy making - that the rise in prices has an undesirable consequence and is solver of problems of overcapacity and shortage of sugar supply.

Source: Research findings

The average elasticity of stock surplus in relation to price is 0.73. Therefore, it is generally expected that the effect of rising sugar prices on the stocks increase will be greater than the effect on increasing sugar shortages. Investigation of the impact of other scenarios on the above-mentioned elasticity indicates that

1- Both increasing and decreasing imports reduce the elasticity.
2- Increasing the price of sugar beet increases the elasticity.
3- Increasing the production efficiency of sugar beet and sugar cane reduces the elasticity.
4- If the adjustment rate of sugar beet growers' increases, the elasticity will decrease.
5- Changes in consumption patterns, either by increasing per capita consumption or by reducing per capita consumption, reduce the elasticity.

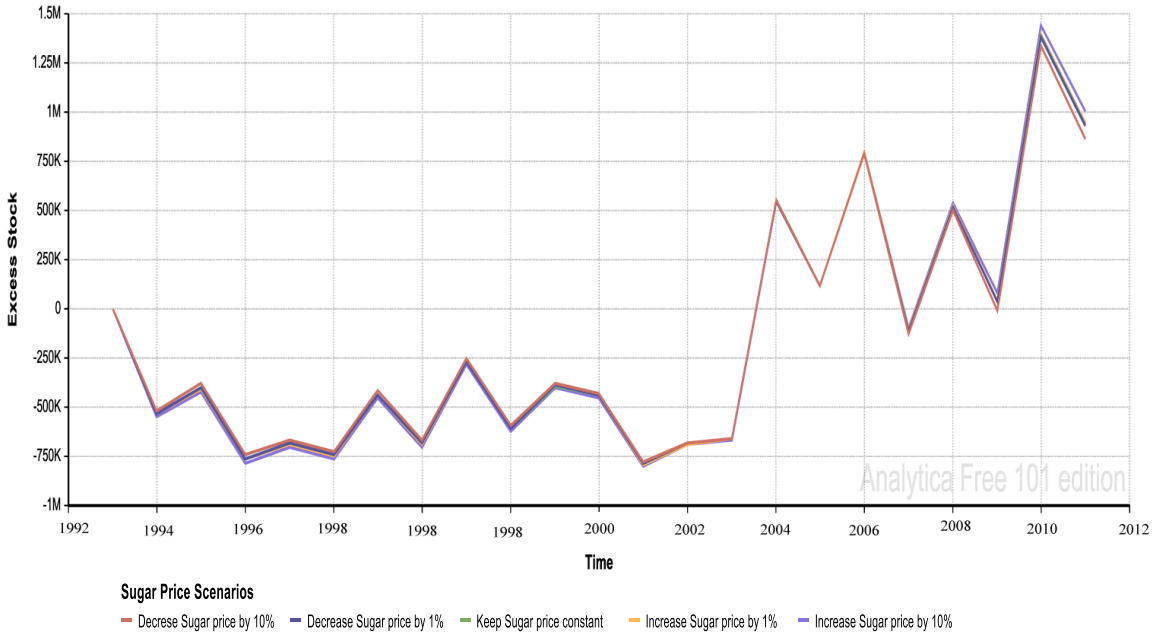

Fig. 4- Impact of sugar price scenarios on surplus of sugar stock

Import scenarios

Fig. 5 shows the impact of different import scenarios on the stock surplus. These scenarios include change of imports as 10% decrease, 10% increase or no change in the current import rate. According to Fig. 5, the stock surplus was potentially affected by the volume of imports so by reducing the amount of imported inventory, surplus was reduced. Eliminating imports will cause sugar shortages in the market. Elasticity of inventory surplus to imports ratio is 1.60. Thus, with 1% increase in imports, the surplus of inventory increases by more than 1%, which in turn can create a high shock in the market and consequently increase prices. Investigating the impact of different scenarios on the import elasticity showed that

1- Increasing the price of sugar beet increases this elasticity.

2- Increasing the production efficiency of sugar beet and sugar cane reduces this elasticity.

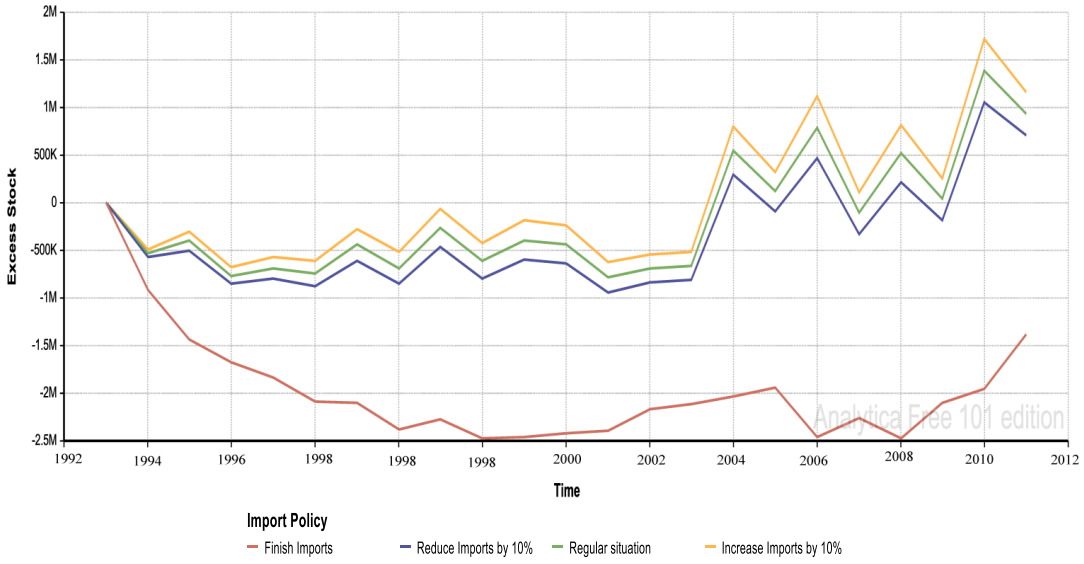

Fig. 5- Impact of imports scenarios on surplus of sugar stocks
Source: Research findings

1- The faster the sugar beet growers adjust their supply, the lower the elasticity.
2- By changing the consumption pattern to higher consumption, the surplus of inventory relative to imports was reduced.
3- With the rise in the price of sugar, the elasticity decreased.

Per capita consumption scenarios

Fig. 6 shows the impact of different levels of per capita consumption on stock surplus. Results showed that the effect of per capita consumption on stock surplus is similar to the effect of sugar price on sugar surplus. In other words, with increasing per capita consumption of inventory, surplus or shortage of inventory, both increased. This conclusion is not unexpected as it increases with the increase in per capita consumption. Therefore, the effect of increasing per capita consumption will be similar to the effect of increasing price. The amount of inventory surplus in relation to per capita consumption is -1.72 which means that with 1% increase in sugar consumption, the surplus of inventory decreases by 1.72%. The effect of different scenarios on the elasticity showed that

1. By increasing the sugar beet price, the elasticity decreases.

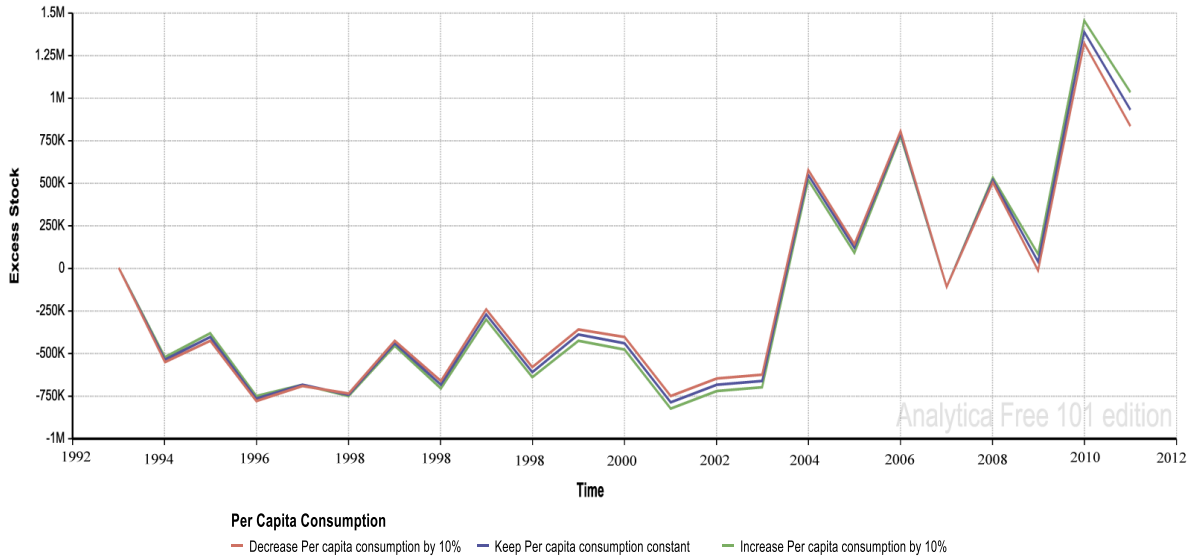

Fig. 6- Impact of consumption pattern scenarios on sugar stock surplus
Source: Research findings

1- Increasing the productivity of sugar beet production increases the elasticity.
2- The faster the sugar beet growers adjust, the greater the elasticity.
3- By increasing sugar price, the elasticity will increase.
4- Change in the volume of imports, either increasing or decreasing, will potentially increase the elasticity.

Guaranteed purchase price scenarios for sugar beet

Fig. 7 shows the impact of different scenarios of sugar beet price on stock surplus. By 10% increase in the price of sugar beet, both the inventory surplus and the shortage of inventory decreased (Fig. 7). On the other hand, the elasticity of inventory surplus relative to sugar beet price was 0.17. In general, it can be concluded that the changes in sugar beet price does not have a significant impact on the stock surplus. Examination of different scenarios on this elasticity also showed that even with changing conditions, this elasticity did not significantly increase or decrease (elasticity was constant). For example, increasing productivity, speeding up the adjustment of sugar beet producers, and increasing sugar price reduced this elasticity, and this change did not exceed 0.5%. Therefore, the policy of guaranteed purchase price cannot have a significant impact on the stock surplus.

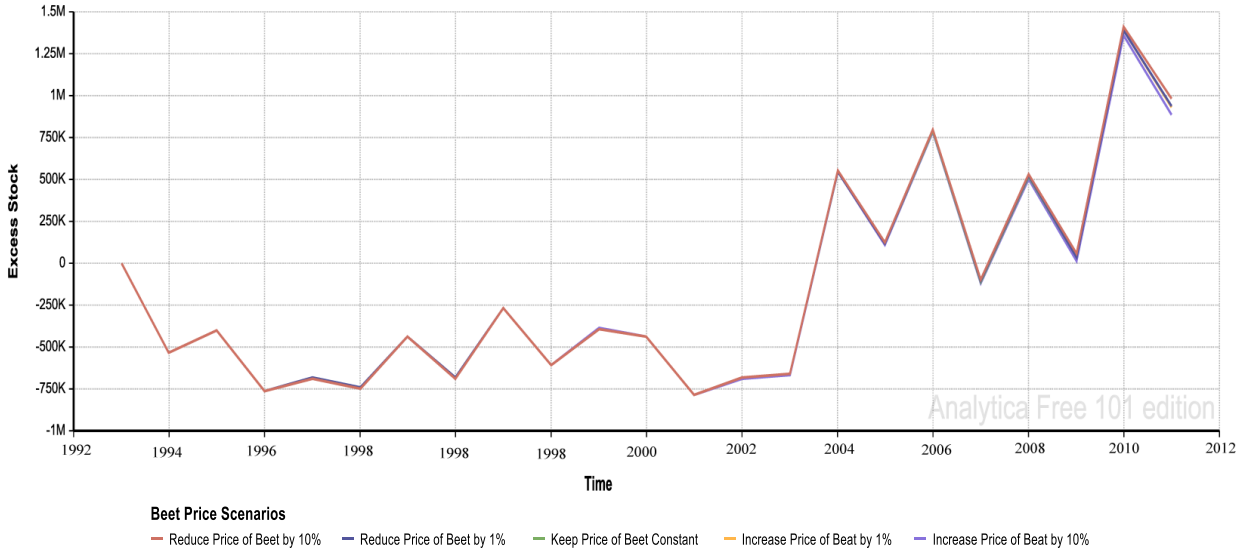

Fig. 7- Impact of Guaranteed sugar beet Price Scenarios on Stock surplus
Source: Research findings

Environmental and technical scenarios

Fig. 8 shows the impact of technical and environmental shocks on the stock surplus. For this reason, these shocks are called environmental and technical shocks that can basically increase or decrease the yield. In fact, because yield is a function of environmental and climatic, technological and productivity factors, the yield changes are considered as scenarios of technology change and environmental factors. These shocks are yield-related and introduced into this model (Fig 5). As their origin was not precisely quantified, quantitative values of elasticity did not provide much information on the impact of technology and productivity. However, comparing the impact of yield changes with the surplus inventory of other variables may indicate the importance of technical and environmental factors on the farm productivity. As shown in Fig. 5, there is a potential increase in the inventory surplus with increased productivity of sugar cane and sugar beet.

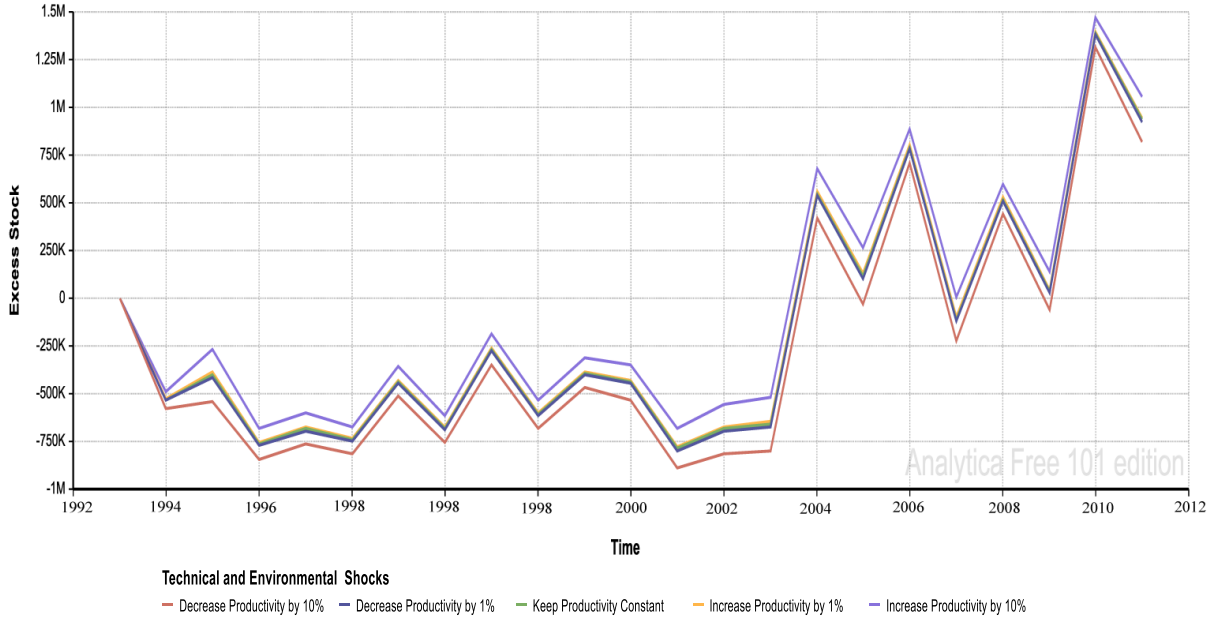

Fig. 8- Impact of yield shocks (technical and environmental shocks) on stock surplus
Source: Research findings

Conclusion

Sugar plays an important role in the daily consumption of households, so the government annually stores sugar as a strategic reserve. This stock is equivalent to 90 days of people's consumption and is used to regulate the market. Logically, if the supply and demand of sugar were equal, the surplus stored sugar supply in the warehouses should be equal to the strategic reserve of the government. However, in recent years there has been surplus of sugar supply in warehouses and a few shortages in some exceptional cases. Given that increasing sugar production imposes cost on sugar factories, failure to sell part of the product will increase their costs. In this study, we have tried to determine the role of different quantitative and price factors in generating inventory surplus by simulating the quantitative and price relationships related to sugar production, imports and consumption.

This study results showed that sugar beet price as input and sugar price as product price do not play a decisive role in stock surplus. Therefore, the stock surplus can neither be the result of price policies nor can it be resolved through price policies. Therefore, it seems that the government should adopt other policies instead of using price policies related to sugar and sugar beet prices. The recommendations of this study are as follows:

1- Modifying the timing of the decision on imports: The results of this study showed that imports play an effective role in determining the surplus of inventory. Every year the government tries to import the gap between production and consumption, providing precautionary quantities by estimating the amounts of needed sugar and domestic production. However, the government calculations appear to be insufficiently accurate and each year, the government exceeds the imports than the required amount. It is therefore proposed that the government delay its decision-making time and import sugar with more comprehensive and accurate information.

2- Resolving conflicts between government goals: The findings of this study showed that the growth rate of sugar per capita consumption in Iran was negative and the country's demand for sugar has been declining. At the same time, the government was seeking to increase domestic sugar production by raising the guaranteed purchase price of sugar beet, while importing excessive quantities. Given the decrease in demand and the increase in production, the amount of import should be limited each year and the amount of strategic reserve should be reduced.

3- Providing strategic stocks from domestic production and gradual removal of imports from purchase basket of government: Since domestic sugar prices are higher than its world price, providing strategic stocks from imports is a costly way of regulating the sugar market. However, as the results of this study showed, the problems of sugar surplus and shortages were caused by low planned imports and the continuation of the purchase of imported sugar was a continuation of this problem. Furthermore, these imports increased producers' costs (by not selling part of the product) and impede the growth of domestic production.

4- Supporting domestic sugar factories for equipment upgrades: The results of this study indicated that productivity and technology play a major role in increasing sugar production. Technology improvement results in greater sugar production, improved production quality, or reduced production costs. In all these cases, domestic production has the potential to grow, and the government will effectively counteract the surplus and shortage of the sugar market by substituting it for imported sugar.

5- Government support from sugar beet producers to produce cheaper: One of the ways to support the Iranian sugar industry is to support the agricultural sector, especially sugar beet and sugar cane producers. If producers can sell their crops to sugar factories at a lower price, sugar factories will expand their activity range and sustain farmers income as demand for sugar beet and sugar cane increases. This method can be a good substitute for guaranteed purchase prices and mandatory sugar beet purchase laws. This is because both farmers and sugar factories in the sugar beet market will reach equilibrium.

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بررسی عوامل موثر بر مازاد موجودی انبار شکر و راه‌های برون رفت از آن در ایران

نازنین محمدرضازاده[۱]، محمد قربانی[۲]*، آرش دوراندیش[۳]

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چکیده

به دلیل نقش و اهمیت شکر در مصرف روزانه خانوارها، هر ساله دولت‌ها مبادرت به ذخیره مقادیری شکر به عنوان ذخیره استراتژیک می‌نمایند. از این رو مدیریت و تنظیم موجودی انبار این محصول نقش اساسی در قدرت رقابت آن در بازارها، اصلاح توزیع زمانی و مکانی محصولات و نهاده‌ها تولید در زیربخش‌های اقتصادی را ایفا می کند. در سال‌های اخیرمازاد عرضه شکر در انبارها و در برخی موارد استثنایی کمبود در موجودی انبار را داشته‌ایم. با توجه به این‌که افزایش تولید شکر سبب تحمیل هزینه به کارخانجات تولیدکننده شکر می‌شود، عدم فروش قسمتی از محصول به منزله افزایش هزینه‌های آن‌ها خواهد بود، لذا هدف از این مطالعه بررسی عوامل موثر بر مازاد موجودی شکر و راه‌های برون رفت از آن در ایران می‌باشد. نتایج مطالعه نشان داد، قیمت چغندرقند به عنوان نهاده و قیمت شکر به عنوان قیمت محصول نقش تعیین کننده را در مازاد موجودی انبار بازی نمی‌کنند. بنابراین مازاد موجودی انبار نه می‌تواند نتیجه‌ی سیاست‌های قیمتی باشد و نه از طریق سیاست‌های قیمتی می‌تواند حل شود. از این رو، به نظر می‌رسد که دولت می‌بایست به جای استفاده از سیاست‌های قیمتی مربوط به قیمت شکر و قیمت چغندرقند، از سیاست‌های دیگری نظیراصلاح زمان تصمیم در مورد واردات، حل تعارضات بین اهداف دولت، تامین ذخیرا استراتژیک از تولیدات داخل و حذف تدریجی واردات، حمایت از کارخانجات برای نوسازی و بهسازی تجهیزات و حمایت از تولیدکنندگان چغندرقند برای تولید محصول ارزانتر استفاده نماید.

واژه‌های کلیدی: ایران، شکر، شبیه‌سازی، موجودی انبار

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