

Economy-Wide Impact of Food Processing Industry Exports in Iran

Mohammad Ghahremanzadeh^a, Maria Sassi^b, Akram Javadi^a,
Ozra Javanbakht^c, Boballah Hayati^a

ABSTRACT: This paper aims to analyze the economy-wide impact of an increase in the export of food processing industry in Iran and to compare it to the same increase in oil and gas exports as the main economic sector. It uses both demand-driven and supply-driven mixed Input-Output models referred to as 2011 SAM framework purposely designed by authors. The results show that an increase in the food processing industry promotes the production of other sectors and, increases factor employment and household income. The significance of this impact is comparable to a similar shock in the oil and gas sector.

Impacto a nivel económico de las exportaciones de la industria de procesamiento de alimentos en Irán

RESUMEN: Este documento tiene como objetivo analizar el impacto en la economía de un aumento en la exportación de la industria de procesamiento de alimentos en Irán y compararlo con el mismo aumento en las exportaciones de petróleo y gas que es el principal sector económico. Utiliza modelos mixtos input-output basados en la demanda y en la oferta, denominados marco SAM 2011 diseñados específicamente por los autores. Los resultados muestran que un aumento en la industria de procesamiento de alimentos promueve la producción de otros sectores y aumenta el empleo de factores y los ingresos de los hogares. La importancia de este impacto es comparable a un *shock* similar en el sector de petróleo y gas.

KEYWORDS / PALABRAS CLAVE: Food processing industry, Mixed models, Social Accounting Matrix / *Industria de procesamiento de alimentos, Modelos mixtos, Matriz de Contabilidad Social.*

JEL Classification / Clasificación JEL: C67, B41.

DOI: <https://doi.org/10.7201/earn.2020.01.06>.

^a Dep. of Agricultural Economics, Faculty of Agriculture, University of Tabriz, Islamic Republic of Iran. E-mail: ghahremanzadeh@tabrizu.ac.ir; akramjavadi@tabrizu.ac.ir; b-hayati@tabrizu.ac.ir.

^b Dep. of Economics and Management, University of Pavia, Italy. E-mail: maria.sassi@unipv.it.

^c Dep. of Agricultural Economics, Faculty of Agriculture, University of Urmia, Islamic Republic of Iran. E-mail: o.javanbakht@urmia.ac.ir.

Cite as: Ghahremanzadeh, M., Sassi, M., Javadi, A., Javanbakht, O. & Hayati, B. (2020). "Economy-Wide Impact of Food Processing Industry Exports in Iran". *Economía Agraria y Recursos Naturales*, 20(1), 129-146. doi: <https://doi.org/10.7201/earn.2020.01.06>.

Correspondence author: Mohammad Ghahremanzadeh.

Received on September 2019. Accepted on December 2019.

1. Introduction

Iran's economy strongly depends on oil exports, having negative effects on the country's economic, social, and political structure (see Karshenas & Malik, 2011). For instance, Mohaddes & Pesaran (2013) reported that oil income in Iran induced excess inflation, exchange rate volatility, and macro-economic inefficiency associated with negative political and institutional implications. The economic structure in Iran is extremely weak and fragile due to political problems and sanctions in the oil field in international trade. This context makes the sustainability of an adequate livelihood difficult. A possible solution is to increase non-oil exports as a strategy for the country's economic growth and development. In general, implementing such strategies using domestic capacities can provide the basis for the growth and prosperity of countries.

According to a report released by the Iran Customs Administration (ICA) (2017), Iran's non-oil exports are categorized into five general sections: Mineral fuels, chemical and plastic products, agricultural and food processing industry products, other mineral and industrial products, and other products. The major share of non-oil exports (approximately 34 %) belongs to mineral fuels (see ICA, 2017). In fact, they are the primary products of oil and gas, exported at a very low price without creating added value in the country. Chemical and plastic products are the other most important source of foreign revenues (25 %) (see ICA, 2017). These products are exported crudely, with scant processing, and at low prices. The food processing industry and agricultural sector constitute only 13 % of non-oil exports in the country; however, the food processing industry not only plays a major role in the development of agriculture and food security, but also significantly influences employment, GDP growth, and export process in Iran (see Salmani & Abdi, 2013). Food processing can be defined as any method that turns fresh foods into food products (see Monteiro *et al.*, 2010). This includes one or a combination of various processes such as washing, pasteurizing, chopping, fermenting, freezing, cooking, and packaging to name a few (see Floros *et al.*, 2010). Food processing further involves adding ingredients to food, for example, to extend their shelf life (see Weaver *et al.*, 2014).

Iran's geographic location allows for an extensive production of high-quality products such as pistachio and saffron, where the country has a competitive advantage compared to the neighboring countries. The Iranian food processing industry meets the needs of the region. Moreover, this industry employs an approximate 17 % share of the total employment and creates approximately 22 % of the value-added of the non-oil export sector (see ICA, 2017). Therefore, it can be considered as a source of national production growth, employment creation, and foreign exchange earnings.

The existence of economic linkages (production, consumption, and income linkages) in the structure of the economy (see Breisinger *et al.*, 2009) augments the production and export of the food processing industry as part of this structure, resulting in positive socio-economic outcomes. Based on the final input-output table published by the Statistical Center of Iran in 2011, this industry uses approximately 63 % of the total agricultural production, 5 % of the service sector, and 5 % of the

production of other sectors as the intermediate input. The country's food processing industry sector generates approximately 3 % income for labor input and about 2 % for capital input. Accordingly, any growth in the production and export of this sector as an exogenous shock might have multiplier effects on the economy. Furthermore, households utilize more than 70 % of the products in this sector. Thus, the main part of the supply is to be the final consumption rather than an intermediate input for other sectors, meaning that increased food processing industry production has the potential to induce consumption and exports.

The Iranian government does not consider the food processing industry as a strategic sector for development, and very few studies have investigated the socio-economic impact of an expansion in this sector, a hiatus covered in the present research.

The main contribution of this study is that we developed an economy-wide mixed Input-Output (I-O) model based on a purposively designed 2011 social accounting matrix (SAM) to evaluate the socio-economic effects of increasing Iran's food processing industry exports. In this regard, we constructed the SAM from the 2011 input-output table of Iran, the latest table published by Iran's Statistics Center, which is employed for the first time in this study. Our research also contributes to the literature through the use of both demand-driven and supply-driven mixed I-O models based on the SAM to investigate a policy impact on the Iranian economy. The advantage of this approach is the possibility to estimate both backward and forward multiplier effects of a shock on the economy and to provide a more thorough assessment of the potential effect of increased food processing industry exports. We also utilize a mixed or supply-constrained I-O model instead of a standard model to consider the existing supply-side restrictions such as those in agricultural production.

In the literature, there exist myriad studies based on SAM, assessing the influence of different policies on economy or technically explaining the input-output and SAM models. For instance, Ehui & Delgado (1999) empirically analyzed the effects of change in productivity in agro-food processing on factors such as employment, trade, growth, and input and output prices in Sub-Saharan Africa. They showed that the augmented productivity of crop and livestock production (agro-food processing) in Africa (1.5 %) resulted in large welfare benefits for the region and a significant diversification of non-agriculture economy (see Ehui & Delgado, 1999). Lekuthai (2007) employed Thailand Input-Output tables to examine the benefits of food industry for the whole economy. Through providing a sector comparison using I-O tables of the years 1980, 1990, and 2000, he revealed that Thai food industry contributed strongly to the economy owing to production and value-added inducement, employment generation, and net foreign exchange earnings (see Lekuthai, 2007). Hartono & Resosudarmo (2008) applied adjusted SAM (mixed model) to analyze the issues related to efficiency and restrictions in energy use and their impacts on the Indonesian economy. They utilized various multiplier effects to observe the impact of these energy policies. An important conclusion drawn from their study is that a policy which improves the efficiency of energy use is relatively better than a policy restricting it (see Hartono & Resosudarmo, 2008). Kerschner & Hubacek (2009) considered the input-output framework supply-driven mixed model (supply-constrained

model) as a powerful tool for studying the potential effects of world oil production reaching a maximum (peak oil) to facilitate the development of adaptation policies. The supply-driven mixed model was used to analyze the quantity dimension of peak oil, based on the data pertaining to the UK, Japanese and Chilean economy (see Kerschner & Hubacek, 2009). Wei *et al.* (2013) discussed the applicability of four techniques, namely the Input-Output model, Social Accounting Matrix, Computable General Equilibrium, and Tourism Satellite Account, all of which are employed in evaluating economic impacts of tourism. They compared and discussed the justification of selecting an appropriate model in estimating the economic impacts of tourism (see Wei *et al.*, 2013). Shelly & Kaur (2015) investigated the contribution of the food processing industry on India's GDP. They concluded that India's food processing industry had a positive and significant impact on its development, significantly promoting its growth process (see Shelly & Kaur, 2015). Kabore (2017) analyzed the effects of increased demand in some agricultural productions in Burkina Faso based on its SAM. He recommended the execution of policies increasing poultry, maize, and rice to better fight poverty, promote inclusive growth, create permanent rural employment, and contribute to food security (see Kabore, 2017). Based on the literature review and from a methodological standpoint, the novelty of the present research is its estimation of both backward and forward multiplier effects of an increase in food processing industry exports on the economy. Furthermore, the literature on analyzing the impact of increased food processing industry exports is rare regarding academic and political interests in Iran. There is only one study by Jafari *et al.* (2014) who examined the effects of increasing Iran's non-oil exports in general. They applied the CGE model to evaluate the impact of increasing the exports uniformly across all sectors by 10, 20 and 30 %. Their findings indicated the positive effect of this increase on different output sectors and economic growth. While our study aims to pay more attention to the food processing industry exports as a non-oil exports in Iran. To highlight the importance of the sector, we compared the impact of an increase in food processing industry exports to the effect of the same increase in oil and gas exports as Iran's main economic sector; moreover, to better understand the position of the food industry in Iran's economy, the results will be compared with some other similar studies. Accordingly, the study results could serve as a flip for the government to design suitable policies for enhancing the food processing industry and its exports. This strategy can be a tool for combating poverty, creating employment, promoting growth, and contributing to food security in Iran.

The paper is organized as follows: The next section describes the mixed I-O models for both demand-driven and supply-driven patterns, describing the 2011 SAM for Iran. The third section discusses the evidence from the empirical analysis. The final section summarizes the paper and the important outcomes and recommends some policies.

2. Methodology

Exogenous demand-side shocks to an economy refer to the changes in investment demand, export demand, or government spending (see Breisinger *et al.*, 2009). This paper analyzes the expansion in the food processing industry in Iran as an exogenous demand-side shock caused by the increase in the world demand for food processing industry production and estimates backward-linked and forward-linked multipliers. For this purpose, the literature suggests two general input-output approaches in a situation without constraints, namely the Leontief's standard demand-driven model and the Ghosh's supply-driven model. They provide a proper framework for calculating the short-run economy-wide effects of final demand or supply shocks. The approaches highlight direct and indirect economic backward-linked (Leontief pattern) and forward-linked (Ghosh pattern) multipliers. However, under certain circumstances, the productive capacity of a sector is constrained for reasons such as weather conditions, policy changes, and sanctions. As suggested by Steinback (2004), the application of the standard Leontief's demand-driven model and Ghosh's supply-driven model in such a case leads to biased calculations of multipliers because the level of sectoral output is determined by the capacity constraints, not the demand (see Steinback, 2004).

In Iran, the agricultural sector is constrained. The major constraint is the water availability for the development of agricultural lands. The irrigation potential, based on land and water resources, has been estimated at 15 million ha (29 % of the cultivable area). However, this would require optimum storage and water use (see Frenken, 2008). Besides, increasing certain crops might require the reallocation of resources away from food crop production, which may not be possible (see Breisinger *et al.*, 2009). Therefore, the application of the abovementioned standard models yields inappropriate results in the Iranian context. We addressed the issue by use of I-O models with mixed exogenous and endogenous variables (supply-constrained) to analyze the economy-wide impact of an increase in food processing industry exports in Iran subject to supply constraint in the agricultural sector. More precisely, in this study, we apply the backward-linked multipliers based on the adjusted Leontief's demand-driven model and forward-linked multipliers based on the adjusted Ghosh's supply-driven model. As highlighted by Kerschner & Hubacek (2009), instead of estimating the sectoral output changes caused by the changes in final demand or value-added, mixed models estimate the impacts of changes on unconstrained sectors given some reduced outputs of supply-constrained sectors. In mixed models, endogenous and exogenous variables are displaced for constrained sectors compared to standard models.

2.1. Constrained SAM multipliers analysis from a demand perspective

Following Defourny & Thorbecke (1984), Leontief's standard demand-driven model can be explained as follows:

$$X - MX = F \quad [1]$$

$$(I - M)X = F \quad [1a]$$

$$X = (I - M)^{-1}F = LF, L = (I - M)^{-1} \quad [1b]$$

$$DIBL = \lambda' L, \lambda' = [1, \dots, 1] \quad [1c]$$

where X is the total demand matrix for each commodity; M is the technical coefficients matrix (input or intermediate shares in production); F is the exogenous components of demand matrix (government, investment, and exports); I is the identity matrix, and $DIBL$ shows both direct and indirect backward-linked effects of final demand. In each sector, X as total demand, is the sum of household consumption demand, intermediate input demand (endogenous), and other final demands.

To understand the above-mentioned relations and their adjustment in certain situations, Equation 1 is written using an n economic sector as follows:

$$\begin{bmatrix} (1-m_{11}) & -m_{12} & K & -m_{1n} \\ -m_{21} & (1-m_{22}) & K & -m_{2n} \\ M & M & O & M \\ -m_{n1} & -m_{n2} & K & (1-m_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ M \\ x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ f_2 \\ M \\ f_n \end{bmatrix} \quad [2]$$

where m_{ij} , x_i , and f_i are components of the above-mentioned matrices M , X and F , respectively.

We can now rewrite Equation 2 as:

$$\begin{aligned} (1-m_{11})x_1 - m_{12}x_2 - K - m_{1n}x_n &= f_1 \\ -m_{21}x_1 + (1-m_{22})x_2 - K - m_{2n}x_n &= f_2 \\ M \\ -m_{n1}x_1 - m_{n2}x_2 - K + (1-m_{nn})x_n &= f_n \end{aligned} \quad [3]$$

Endogenous and exogenous variables for each sector are as follows:

$$\begin{bmatrix} x_1 \\ x_2 \\ x_n \end{bmatrix} = \begin{bmatrix} l_{11} & l_{12} & K & l_{1n} \\ l_{21} & l_{22} & K & l_{2n} \\ M & M & O & M \\ l_{n1} & l_{n2} & K & l_{nn} \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \\ M \\ f_n \end{bmatrix} \quad [4]$$

$$[L_{ij}] = (I - M)^{-1} \quad [4a]$$

$$X = (I - M)^{-1}F \quad [4b]$$

where f_i is an exogenous variable and x_i is an endogenous variable. This equation can be used to analyze policymaking and programming in the short term in unconstrained situations. If this assumption is not true, Equation 4 is inappropriate. We need a different specification for unconstrained sectors. Let us assume that the sector n is the supply constraint (agricultural sector in this study), Equation 3 is specified as follows:

$$\begin{aligned}
 (1-m_{11})x_1 - m_{12}x_2 - K - m_{1n-1}x_{n-1} - 0f_n &= f_1 + 0f_2 + K + 0f_{n-1} + m_{1n}x_n \\
 -m_{21}x_1 + (1-m_{22})x_2 - K - m_{2n-1}x_{n-1} - 0f_n &= 0f_1 + f_2 + K + 0f_{n-1} + m_{2n}x_n \\
 M \\
 -m_{n1}x_1 - m_{n2}x_2 - K - m_{nn-1}x_{n-1} - f_n &= 0f_1 + 0f_2 + K + 0f_{n-1} - (1-m_{nn})x_n
 \end{aligned}
 \tag{5}$$

Following Resosudarmo & Thorbecke (1996), matrices 4 can be written as:

$$\begin{matrix}
 \begin{bmatrix}
 (1-m_{11}) & -m_{12} & K & -m_{1n-1} & 0 \\
 -m_{21} & (1-m_{22}) & K & -m_{2n-1} & 0 \\
 M & M & O & M & M \\
 -m_{n-11} & -m_{n-12} & K & (1-m_{n-1n-1}) & 0 \\
 -m_{n1} & -m_{n2} & K & -m_{nn-1} & -1
 \end{bmatrix} & \begin{bmatrix} x_1 \\ x_2 \\ M \\ x_{n-1} \\ f_n \end{bmatrix} & = & \begin{bmatrix} 1 & 0 & K & 0 & m_{1n} \\ 0 & 1 & K & 0 & m_{2n} \\ M & M & O & M & M \\ 0 & 0 & K & 1 & m_{n-1n} \\ 0 & 0 & K & 0 & -(1-m_{nn}) \end{bmatrix} & \begin{bmatrix} f_1 \\ f_2 \\ M \\ f_{n-1} \\ x_n \end{bmatrix} \\
 \text{A} & & & \text{B} &
 \end{matrix}
 \tag{6}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ M \\ x_{n-1} \\ f_n \end{bmatrix} = \begin{bmatrix} l_{11}^* & l_{12}^* & K & l_{1n}^* \\ l_{21}^* & l_{22}^* & K & l_{2n}^* \\ M & M & O & M \\ l_{n1}^* & l_{n2}^* & K & l_{nn}^* \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \\ M \\ f_{n-1} \\ x_n \end{bmatrix}
 \tag{6a}$$

$$[L_{ij}^*] = A^{-1}B
 \tag{6b}$$

Equation 6 reveals the difference between the mixed model and the standard model in Equation 4. In the standard model, f_i and x_i for all sectors are exogenous and endogenous, respectively. In the mixed model, f_i is endogenous and x_i is exogenous only regarding sectors with supply constraint.

2.2. Constrained SAM multipliers analysis from the perspective of a supply aspect

We explained backward-linked multipliers in the demand perspective (Leontief’s model driven from the SAM framework) in the previous section. This section modifies the Ghosh’s supply-driven model to achieve forward effects of increase in food processing industry exports. To illustrate this, Ghosh’s supply-driven model in the usual situation is used (see Kerschner & Hubacek, 2009):

$$X - B'X = W \quad [7]$$

$$(I - B')X = W \quad [7a]$$

$$X = (I - B')^{-1}W = GW, G = (I - B')^{-1} \quad [7b]$$

$$DIFL = G1, 1 = \begin{bmatrix} 1 \\ \cdot \\ \cdot \\ 1 \end{bmatrix} \quad [7c]$$

where X is the total supply matrix for each commodity; B' is the coefficients matrix (activities shares in production); W is the exogenous components matrix of supply (such as factors and imports); I is the identity matrix, and $DIFL$ shows both direct and indirect forward-linked effects of factor inputs. Matrix W , as the factor input, is exogenous for all sectors and X , as production, is endogenous for all sectors. Once again, we use an n sector economy and rewrite Equation 7 as follows:

$$\begin{bmatrix} (1-b_{11}) & -b_{12} & K & -b_{1n} \\ -b_{21} & (1-b_{22}) & K & -b_{2n} \\ M & M & O & M \\ -b_{n1} & -b_{n2} & K & (1-b_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ M \\ x_n \end{bmatrix} = \begin{bmatrix} W_1 \\ W_2 \\ M \\ W_n \end{bmatrix} \quad [8]$$

where b_{ij} , x_i , and w_i are components of the foregoing matrices B' , X and W , respectively.

In Equation 9, we specify endogenous and exogenous variables for each sector as follows:

$$\begin{bmatrix} x_1 \\ x_2 \\ M \\ x_n \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} & K & g_{1n} \\ g_{21} & g_{22} & K & g_{2n} \\ M & M & O & M \\ g_{n1} & g_{n2} & K & g_{nn} \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ M \\ W_n \end{bmatrix} \quad [9]$$

$$(I - B')^{-1} = [G_{ij}] \quad [9a]$$

where w_i are exogenous variables and x_i are endogenous variables in Ghosh's supply-driven model. Similar to the previous section, if the n th sector is in a certain situation, Equation 9 should be modified as follows:

$$\begin{bmatrix} (1-b_{11}) & -b_{12} & K & -b_{1n-1} & 0 \\ -b_{21} & (1-b_{22}) & K & -b_{2n-1} & 0 \\ M & M & O & M & M \\ \hline -b_{n-1} & -b_{n-12} & K & (1-b_{n-1n-1}) & 0 \\ -b_{n1} & -b_{n2} & K & -b_{nm-1} & -1 \\ \hline \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ M \\ x_{n-1} \\ w_n \end{bmatrix} = \begin{bmatrix} 1 & 0 & K & 0 & b_{1n} \\ 0 & 1 & K & 0 & b_{2n} \\ M & M & O & M & M \\ 0 & 0 & K & 1 & b_{n-1n} \\ 0 & 0 & K & 0 & -(1-b_{nm}) \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ M \\ w_{n-1} \\ x_n \end{bmatrix} \tag{10}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ M \\ x_{n-1} \\ w_n \end{bmatrix} = \begin{bmatrix} g_{11}^* & g_{12}^* & K & g_{1n}^* \\ l_{21}^* & l_{22}^* & K & g_{2n}^* \\ \hline M & M & O & M \\ g_{n1} & g_{n2} & K & g_{nm} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ M \\ w_{n-1} \\ x_n \end{bmatrix} \tag{10a}$$

$$[G_{ij}^*] = C^{-1} D \tag{10b}$$

Equation 10 provides forward-linked multipliers in the supply-constrained model¹.

The multipliers were categorized into three categories: Output multiplier, GDP multiplier, and income multiplier. The output multiplier was computed from the sum of the overall increase in the gross output for all sectors. The GDP multiplier is obtained from all the earnings related to the factors generated by the additional production of all sectors. Finally, the income multiplier includes all household’s income obtained from the shock.

2.3. SAM presentation

To apply the above-described models, we require a dataset organized in the framework of a social accounting matrix. A SAM is a square matrix which columns and rows represent the expenditures and receipts of economic agents (see Kabore, 2017). The multipliers based on a SAM are more complete than input-output multipliers. Total multipliers based on SAM include all types of linkages, covering output multipliers, GDP multipliers and income multipliers. This classification makes it possible to elucidate the effects of external shocks on the economy (see Breisinger *et al.*, 2009).

In accordance with the purpose of the study, we designed a 2011 SAM for Iran in order to address a comprehensive view of the economic activities and transactions conducted by different Iranian institutions. This matrix includes 34 accounts (Table 1).

¹ The calculation procedure is thoroughly explained in Miller & Blair (2009) for reference in future studies. Here, we only provided a schematic representation of the models.

TABLE 1
Accounts of Iran social accounting matrix (2011)

Activities	Commodities	Factors	Households	Other institutions	Tax and other accounts
Crop	Wheat	Labor	Urban	Government	Indirect tax
Fruits and vegetables	Rice	Capital	Rural	Governmental enterprises	Tax
Other agriculture	Other crops	Land		Non-governmental enterprises	Subsidy
Food processing industry	Fruits and vegetables				Saving-investment
Other industries-mining	Livestock				Rest of the world
Oil and Gas	Dairy products				
Transportation	Poultry				
	Other agricultural commodities				
	Food processing industry products				
Service	Other industries-mining products				
	Oil and Gas				
	Transportation				
	Service				

Source: Own elaboration.

We disaggregated the production and service activities into eight groups and commodities and services into 13 groups. We assumed that each activity can produce more than one commodity, and each commodity can be produced by more than one activity. Therefore, we separated the commodity accounts from the activity accounts. The value-added section includes labor, capital, and land accounts. In our matrix, the socio-economic institutions are households (including urban and rural groups), government, and governmental and non-governmental enterprises. We separated

tax and subsidy accounts. Other accounts include the rest of the world account and saving-investment account. Table 2 shows our aggregate macro-SAM.

TABLE 2
Iran macro-SAM, 2011 (trillion Iranian Rials²)

	Activities	Commodities	Factors	Households	Government	Enterprises	Tax	Other accounts	Total
Activities		11,083							11,083
Commodities	4,421			3,084	1,339	5		3,173	12,022
Factors	6,600								6,600
Households			5,144	6	457			4	5,611
Government			704				311		1,015
Enterprises			752					282	1,034
Tax	62	28		63		158			311
Other accounts		911		2,458	-781	871		1,008	2,451
Total	11,083	12,022	6,600	5,611	1,015	1,034	311	2,451	

Source: Own elaboration.

We used several data sources to compute the figures in the SAM: Input-output table, the statistics yearbook, the national accounts, the results of the urban and rural household income and expenditure survey, the results of the labor force survey, and the balance sheet and economic report published by the Central Bank.

3. Results

This section analyzes the results from the application of the supply-constrained I-O models driven from the 2011 SAM framework for Iran. We simulated three scenarios to better realize and compare the results based on the two models (demand-driven and supply-driven). The three scenarios are: (i) one billion rial increase in food processing industry exports with constrained agricultural production; (ii) one billion rial increase in oil and gas sector exports under the same conditions, and (iii) one billion rial increase in food processing industry exports considering unconstrained agricultural sector.

² 1 U.S. Dollar = 11,000 Iranian Rial (based on 2011 rate).

3.1. Backward linkages

Table 3 explains the results of backward-linked demand-driven multipliers under three scenarios.

TABLE 3
Backward-linked demand-driven multipliers under the three scenarios

	Scenario (i)	Scenario (ii)	Scenario (iii)
	Increased food processing industry exports (constrained agriculture)	Increased oil and gas exports (constrained agriculture)	Increased food processing industry exports (unconstrained agriculture)
Crop-activity	0.00	0.00	0.16
Fruit and vegetable-activity	0.00	0.00	0.05
Other agricultural products-activity	0.42	0.06	0.44
Food processing industry-activity	0.95	0.08	0.97
Other industries-mining-activity	0.41	1.25	0.50
Oil and Gas-activity	0.02	0.39	0.03
Transportation-activity	0.09	0.10	0.11
Service-activity	0.49	0.44	0.61
Total Output Multiplier	2.38	2.32	2.86
Factor-Labor	0.80	0.83	0.99
Factor-capital	0.35	0.53	0.42
Factor-Land	0.00	0.00	0.06
Total GDP Multiplier	1.14	1.35	1.47
Households-Urban	0.72	0.80	0.93
Households-Rural	0.19	0.21	0.25
Total Income Multiplier	0.91	1.01	1.19

Source: Computation by the authors.

The results are presented by the block of accounts: Total output multiplier, GDP multiplier, and income multiplier.

The total output multiplier following a one-unit increase in the food processing industry exports is 2.38. In other words, the overall output of all the sectors increased by more than two-fold due to the expansion of the food processing industry exports to the amount of 1 billion rials. This is even larger than the total output multiplier following oil and gas export expansion (2.32 billion rials). This result indicates that the food processing industry is strongly linked to other sectors in the economy. The

decomposition of the food processing industry's output multiplier shows that the one billion rial increase in the demand of the food processing industry export caused other agricultural activity outputs to increase by 0.42 billion rials, food processing industry activity by 0.95 billion rials, other industrial activities by 0.41 billion rials, and the service activity by 0.49 billion rials. Service sector is affected by this shock more than other sectors. Regarding unconstrained agricultural supply, total output multiplier effect will increase up to 2.86 billion rials, meaning that the effect of this shock would be larger in all other sectors if the agricultural sector was flexible in response to the shocks.

The total GDP multiplier is 1.14 in the first scenario, indicating a growth in the use of production factors owing to the expansion of food processing industry exports. In the second scenario, GDP increases by 1.35 billion rials, implying that the impact of the second scenario is similar to that of the first one. Moreover, the impact of increased food processing industry exports on GDP would be stronger (1.47 billion rials) if agricultural supply was flexible to the shocks (third scenario). This multiplier for capital is lower than that for labor in all scenarios, indicating a labor-intensive economy.

The two household groups (urban and rural) benefit from the increase in the demand for food processing industry export, but the urban household earns more. There is a slight difference between the effects of the food processing industry export expansion and the oil and gas export expansion on the household income. The income of both household groups increase by 0.91 billion rials in the first scenario and by 1.01 billion rials in the second. The income effect of an increase in food processing industry exports would be larger (1.19 billion rials) if agriculture was unconstrained.

3.2. Forward linkages

Table 4 explains the results of forward-linked supply-driven multipliers under the three previously-described scenarios. This model measures the forward-linked effects of one billion rial expansion of food processing industry exports.

Additionally, in this section, results are presented by block accounts.

In the first scenario, the total output multiplier is 2.23 billion Rials. This indicates a one billion rial increase in the food processing industry production, causing a more than two-fold increase in the total output in all sectors. Another important effect of this simulation is that the increase in food processing industry exports result in a higher total output compared to the simulation concerning oil and gas. The same shock exerted on the oil and gas sector increases the output by 0.76 billion rials.

The decomposition of the total output multipliers shows that the food processing industry has larger effects on other industrial sectors and the service sector compared to the effects of the oil and gas on the mentioned sectors. This impact is due to the stimulus provided for the transportation system and the industrial equipment and machinery. Moreover, assuming an unconstrained agricultural supply, the impact from the expansion of the food processing industry export on output would be even larger (2.42 billion rials).

TABLE 4
Forward-linked supply-driven multipliers under the three scenarios

	Scenario (i) Increased food processing industry exports (constrained agriculture)	Scenario (ii) Increased oil and gas exports (constrained agriculture)	Scenario (iii) Increased food processing industry exports (unconstrained agriculture)
Crop-activity	0.04	0.01	0.05
Fruit and vegetable-activity	0.03	0.01	0.03
Other agricultural products-activity	0.13	0.02	0.15
Food processing industry-activity	0.21	0.02	0.23
Other industries-mining-activity	1.02	0.43	1.10
Oil and Gas-activity	0.07	0.08	0.07
Transportation-activity	0.08	0.04	0.08
Service-activity	0.65	0.15	0.70
Total Output Multiplier	2.23	0.76	2.42
Factor-Labor	1.02	0.16	1.10
Factor-capital	0.17	0.03	0.19
Factor-Land	0.02	0.00	0.02
Total GDP Multiplier	1.22	0.20	1.31
Households-Urban	1.03	0.17	1.11
Households-Rural	0.30	0.04	0.32
Total Income Multiplier	1.33	0.21	1.43

Source: Computation by the authors.

The comparison of these results with those from the demand-driven model reveals that the backward-linked effects of the food processing industry are stronger than the forward-linked effects of that in total output multipliers.

Concerning the GDP multiplier, the increase in the food processing industry exports result in a higher economy-wide GDP compared to the simulation targeted to the oil and gas sector. A one billion rial increase in the food processing industry exports increases GDP by 1.22 billion rials; however, the same increase in oil and gas exports augment the GDP by 0.20 billion rials. Moreover, if agricultural supply was unconstrained, the impact of the food processing industry exports on GDP would be even larger (1.31 billion rials).

Compared to the demand-driven model, in the supply-driven model, the GDP multiplier for labor (1.02 billion rials) is also higher than capital (0.17 billion rials) due to the higher labor-intensity of the economy. Generally, the forward effects of this shock for GDP multiplier are stronger than its backward effects.

Income multipliers indicate an increase in the household income owing to the forward linkage of a sector expansion on the economy. The total income multiplier in the first scenario is larger than in the second scenario (1.33 compared to 0.21). This implies that the forward-linked effects of the food processing industry are stronger than the same effects of the oil and gas sector on the household income. In other words, expansion of the food processing industry exports benefits the household income more than the growth in oil and gas export. Normally, the effects of the same shock on household income would be even larger if agriculture was unconstrained (1.43 billion rials).

Ultimately, the above analysis confirms the fact that the food processing industry has significant production and consumption linkages; therefore, it has larger multipliers on Iran's economy even compared to the oil and gas sector as Iran's main economic sector. Under the backward-linked and forward-linked effects of increased food processing industry exports, this sector has significant economy-wide effects on Iran's economy. The result is in line with some studies conducted in other countries in the literature. For instance, Ehui & Delgado (1999) explained how the increase in the productivity of crop and livestock production in Africa (agro-food processing industry) resulted in large welfare gains for the region and significant economic diversification out of agriculture. Lekuthai (2007) concluded that among various leading industries, the food industry provided the strongest contributions to the Thai economy. Shelly & Kaur (2015) argued that food processing industries were given a high priority in India in terms of their good linkages in the development of many interrelated variables. As clearly indicated by the results of this study, the food processing industry sector has backward-linked and forward-linked effects as strong as the oil and gas sector. Our results are consistent with the findings of Jafari *et al.* (2014) who applied the CGE model based on the SAM 2001 for Iran to analyze the impact of increased non-oil exports on Iran's economy.

4. Conclusion

The aim of this paper was to compare the effects of one billion rial increase in the exports of the food processing industry and the oil and gas sector on Iran's economy. We used demand-driven and supply-driven mixed I-O models based on a SAM framework due to the constrained supply of the country's agricultural sector.

Our empirical analysis suggests four concluding remarks as follows:

First, increasing the food processing industry production, due to the expansion of its exports, promotes growth in the production of other sectors and increases factor employment and household income. In fact, it creates employment opportunities in this sector and relative industries, rural development, and investment in local resources, promotes agricultural production and its quality, achieves efficient marketing, and in general, drives the agricultural economy towards industrialization and enhances the agro-food industry. Second, there is a slight difference regarding multipliers between the food processing industry sector shock and the oil and gas sector shock. In other words, the food processing industry sector can be considered as one

of the most important sectors of Iran's economy contributing to the country's growth and development. Third, this impact is amplified in the case of unconstrained agricultural supply. Finally, the food processing industry has a stronger backward linkage compared with the forward linkage regarding output multipliers. On the contrary, it has a weaker backward linkage compared with the forward linkage in GDP and income multipliers.

In light of these results, our paper suggests some policy recommendations as follows:

Efforts should be made to increase the production and export of food processing industry at the existing capacity levels. Salmani & Abdi (2013) and Salami & Permeh (2001) believed that the weaknesses in the infrastructure of industries and services associated with the food processing industry were the obstacles to expanding the exports in this sector. They further made mention of other constraints in the infrastructure of the food processing industry: Weakness in the transport network, lack of proper electronic infrastructure for ordering, lack of modern technology and world-class machines for a better and more competitive production of the final product, and weaknesses in the customs regulation (see Salami & Permeh, 2001; Salmani & Abdi, 2013). Therefore, to take advantage of the positive effects of growth in the food processing industry and other non-oil sectors, the infrastructure constraints are to be removed by long-term planning and developing budget expenditures. Similarly, as a major input supplier of the food processing industry, the agricultural sector deserves special attention. Moreover, the Iranian agricultural sector has encountered water scarcity due to the weaknesses existing in water management. Most irrigated areas have traditional canals built by farmers, which in many cases lead to water wastage. Accordingly, the management of water resources requires more attention to measures such as construction of dams for irrigation purposes with main and secondary canals called modern systems. In this regard, efforts should be directed towards achieving higher quality standards as requested by the global market.

Owing to the potential positive contribution of the food processing industry to the Iranian economic growth, highlighted in the present study, more effort should be made in assessing the weaknesses and strengths of the agro-food system.

References

- Breisinger, C., Thomas, M. & Thurlow, J. (2009). "Social Accounting Matrices and Multiplier Analysis: An Introduction with Exercises". *Food Security in Practice Technical Guide 5*. Washington D.C.: International Food Policy Research Institute, IFPRI.
- Defourny, J. & Thorbecke, E. (1984). "Structural Path Analysis and Multiplier Decomposition within a Social Accounting Matrix Framework". *The Economic Journal*, 94(373), 111-136. <http://dx.doi.org/10.2307/2232220>.

- Ehui, S. & Delgado, C. (1999). *Economy-Wide Impacts of Technological Change in the Agro-food Production and Processing Sectors in Sub-Saharan Africa*. Markets and Structural Studies Division (MSSD) Discussion Paper No. 38, November. Washington D.C.: International Food Policy Research Institute.
- Floros, J.D., Newsome, R. Fisher, W., Barbosa-Cánovas, G.V., Chen, H., Dunne, C.P., German, J.B., Hall, R.L., Heldman, D.R., Karwe, M.V., Knabel, S.J., Labuza, T.P., Lund, D.B., Newel-McGloughlin, M., Robinson, J.L., Sebranek, R.L., Shewfelt, R.L., Tracy, W.F., Weaver, C.M. & Ziegler, G.R. (2010). "Feeding the world today and tomorrow: The importance of food science and technology". *Comprehensive Reviews in Food Science and Food Safety*, 9(5), 572-599. <http://dx.doi.org/10.1111/j.1541-4337.2010.00127.x>.
- Frenken, K. (2008). *Irrigation in the Middle East Region in Figures, Iran (Islamic Republic of)*. FAO Water Reports, 34. Aquastat Survey, 185-199.
- Hartono, D. & Resosudarmo, B.P. (2008). "The Economy-wide Impact of Controlling Energy Consumption in Indonesia: An Analysis Using a Social Accounting Matrix Framework". *Energy Policy*, 36(4), 1404-1419. <http://dx.doi.org/10.1016/j.enpol.2007.12.011>.
- Iran Customs Administration (ICA). (2017). "An Analysis of the Composition of the Country's Trade from a Product Perspective". *Moghavemati News*, May 2018 (in Persian).
- Jafari, S., Bakhshi Dastjerdi, R. & Mosavi Mohseni, R. (2014). "Studying the Effects of Non-Oil Exports on Targeted Economic Growth in Iranian 5th Development Plan: A Computable General Equilibrium Approach". *Iranian Journal of Economic Studies*, 3(1), 111-130. <http://dx.doi.org/10.22099/ijes.2014.3114>.
- Kabore, D.P. (2017). "Decomposed Effects of Agricultural Policies: A Social Accounting Matrix Approach in Burkina Faso". *Journal of Asian Scientific Research*, 7(1), 12-21.
- Karshenas, M. & Malik, A. (2011). "Oil in the Islamic Republic of Iran Dependence, Distortions and Distribution". In Collier, P. & Venables, A.J. (Eds.): *Plundered Nations* (pp. 114-150). United Kingdom: Palgrave Macmillan.
- Kerschner, K. & Hubacek, K. (2009). "Assessing the Suitability of Input-output Analysis for Enhancing Our Understanding of Potential Economic Effects of Peak Oil". *Energy*, 34(3), 284-290. <http://dx.doi.org/10.1016/j.energy.2008.07.009>.
- Lekuthai, S. (2007). "The Importance of the Food Industry to the Thai Economy". *Asean Economic Bulletin*, 24(2), 238-253. <http://dx.doi.org/10.1355/ae24-2d>.
- Miller, R.E. & Blair, P.D. (2009). *Input-Output Analysis: Foundations and Extensions*. New York: Cambridge University Press.
- Mohaddes, K. & Pesaran, M.H. (2013). *One Hundred Years of Oil Income and the Iran's economy: A Curse or a Blessing?* The Economic Research Forum (ERF) Working paper, 771, September. Egypt.
- Monteiro, C.A., Levy, R.B., Claro, R.M., Castro, I.R. & Canon, G. (2010). "A new classification of foods based on the extent and purpose of their processing".

- Cad Saude Publica*, 26(11), 2039-2049. <http://dx.doi.org/10.1590/s0102-311x2010001100005>.
- Resosudarmo, B.P. & Thorbecke, E. (1996). "The Impact of Environmental Policies on Household's Incomes for Different Socio-economic Classes: The Case of Air Pollutants in Indonesia". *Ecological Economics*, 17(2), 83-94. [http://dx.doi.org/10.1016/0921-8009\(95\)00113-1](http://dx.doi.org/10.1016/0921-8009(95)00113-1).
- Salami, H. & Permezh, Z. (2001). "Effects of Export Promotion in Agriculture and Manufacturing Sectors on the Economy of Iran: An Analysis in a SAM Framework". *Tahghighat-E-Eghtesadi*, 59, 149-181. (in Persian).
- Salmani, B. & Abdi, H. (2013). "The Impact of Domestic R&D and Imports of Technology on Food and Beverage Industry Exports in Iran". *Journal of Applied Economic Studies*, 10(3), 83-106. (in Persian).
- Shelly, M. & Kaur, K. (2015). "Impacts of Food Processing Industry on Economic Growth, FDI and Exports of India". *Pacific Business Review International*, 7(12), 63-72.
- Steinback, S. (2004). "Using Ready-made Regional Input-output Models to Estimate Backward-linkage Effects of Exogenous Output Shocks". *The Review of Regional Studies*, 34(1), 57-71.
- Weaver, C.M., Dwyer, J., Fulgoni, V.L., King, J.C., Leveille, G.A., MacDonald, R.S., Ordovas, J. & Schnakenberg, D. (2014). "Processed Food: Contributions to Nutrition". *The American Journal of Clinical Nutrition (AJCN)*, 99(6), 1525-1542. <http://dx.doi.org/10.3945/ajcn.114.089284>.
- Wei, C.K., Shuib, A., Ramachandran, S. & Herman, S. (2013). "Applicability of Economic Models in Estimating Tourism Impacts". *Journal of Applied Economics and Business*, 1(4), 5-16.