Production of Tomatoes in Mexico and its Competitiveness in the U.S. market

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Abstract. The most dynamic Mexican agrarian export value chains are vegetables (tomatoes, peppers and other fresh vegetables) and fruits (avocado, strawberries, blackberries, blueberries), usually produced under system of contract farming and protected agriculture. The article focuses on quantitative analysis of competitiveness of tomato (*Solanum lycopersicum*) in international trade. Tomatoes are the most important product of Mexican agricultural exports to the United States, with a value of 2.11 billion USD and a volume of 1.75 million tons in 2016. The quantitative analysis is conducted using indicators that present the greatest explanatory power and consistency: Revealed Comparative Advantage and Constant Market Participation.

Keywords: Agrarian Export Value-chains, Revealed Comparative Advantage, Constant Market Participation, Tomatoes, Mexico

1 Theoretical framework

According to Agricultural and Fisheries Information Service (SIAP), the total planted area for tomatoes in Mexico shows a decreasing trend in the last ten years, in this period it declined at an average annual rate of 2%. In 2007, 66,600 hectares were planted and in 2016, it was only about 51,900 hectares [11]. However, it is important to consider that the downward trend in the area planted stems from the decrease of the open field tomato production. Cultivation under protected agricultural conditions (such as greenhouses, shade-houses and tunnels) had been increasing substantially in the last years, going from 1,078 hectares in 2006 to 15,006 hectares in 2016, which means an average annual increase of 30 % [4]. During one decade, the volume of tomato obtained under protected farming conditions has increased, from 6.5% in 2006 to 60.7% in 2016. In 2012, for the first time, the volume of tomatoes obtained in greenhouses, shade-houses and tunnels (56.6%) exceeded that obtained in open field cultivation (43.4%) [4].

The production of tomato in Mexico presents a high geographic concentration: Sinaloa contributed 27.6% of the national tomato production, followed by Michoacán, Baja California, Zacatecas and Jalisco with 7.0%, 6.8%, 5.7% and 4.7% respectively

[11]. The high geographic concentration leads to a greater vulnerability of the production to natural phenomena. The risk reduction response is the introduction of protected agriculture. Producers in Sinaloa and Baja California are widely considered more technologically advanced than other producing states. Central states like Querétaro and the State of Mexico have a higher percentage of greenhouse technology due to colder climatic conditions. [14].

In Mexico, yield levels in tomato production vary depending on the wide range of technologies used by producers, such as open field cultivation, use of shade-houses, basic greenhouses or highly-skilled greenhouses with automated systems and hydroponics, as well as the use of inputs for nutrition and phytosanitary control. Under irrigation conditions, average yields at national level increased from 29.7 tons per hectare in 2000 to 70.8 tons per hectare in 2016 [11]. In the protected agriculture, the yields multiply to those obtained in the open field cultivation: in Sinaloa, State of Mexico, Querétaro and Zacatecas, the highest yields in tomato production are generally obtained, exceeding 200 tons per hectare during the last years. The yields obtained in other areas of the country (Tabasco, Yucatan, Guerrero) are between 15 and 20 tons per hectare [11], which is attributed to a less intensive use of inputs (deficient pest and disease control programs, insufficient plant nutrition).

The world imports of tomatoes are stable with an average amount of 8,773 million of US dollars in 2012-2016; being United States, Germany, France and United Kingdom the main importers of tomato in the world. The most important world exporter is Mexico with 25 percent of share of value in 2016, followed by Netherlands (19%) and Spain (13%), while Mexico's export grew by 15% between 2015-16. In 2016 the 87% of tomatoes imported to USA (in terms of value) come from Mexico, only 14% from Canada and 4% from Dominican Republic. From the Mexican perspective, this dependence of the US market is even more striking: the 99.7% of the exported tomatoes is heading right there [6].

Per capita fresh tomato consumption in the US has a growing trend due to demographic phenomena such as the aging of the population (there is an increase in consumption in people over 70 years of age) and the increase of the Hispanic population (the ethnic group with the highest per capita consumption index). Other factors which promote the growth of fresh vegetables consumption are socio-economic: higher incomes and higher levels of education. There is no linear relationship between the increase of income and increase of consumption of tomatoes (high income elasticity) rather it is a change in eating habits (towards a healthier diet) in people with a higher economic and social status. The current consumption of fresh tomatoes per capita in US is 21.3 kg with an average annual increase of 1.7% in period 2008-16 [15].

Due to seasonality in production, prices vary distinctly throughout the year: between December and April, the price of tomato in the United States reports the highest levels; it is because the lowest domestic tomato production occurs in this period, when Florida production is low and California is not producing. This gap represents an important market opportunity for Mexico. There is a well-defined pattern in the fluctuation of the volume of imports (see Fig 1). In Mexico tomatoes can be produced during the whole year (under system of protected agriculture) and at

lower production costs (due to lower labor cost and favorable climatic conditions). Tomato production in the United States is mainly (89%) destined to the food industry [4], and the harvest is basically mechanized. In contrast, most of the Mexican tomato exported to USA is for direct consumption, and the harvest is manual [8]. The share of Mexican imports in fresh tomato US consumption was on average 48.1% in 2012-16 and increase annually by 4.2% in this period [4].

Another opportunity presents changing climatic conditions: the droughts in California are forecast to have a major impact on agricultural production in the coming years. An estimated 175,000 hectares of the state of California will stop producing due to lack of precipitation. California is the main producer state: contributes 45 % of US fresh tomato production. Florida, the second producer state, participated with 31 % of the national volume of fresh tomato [16].
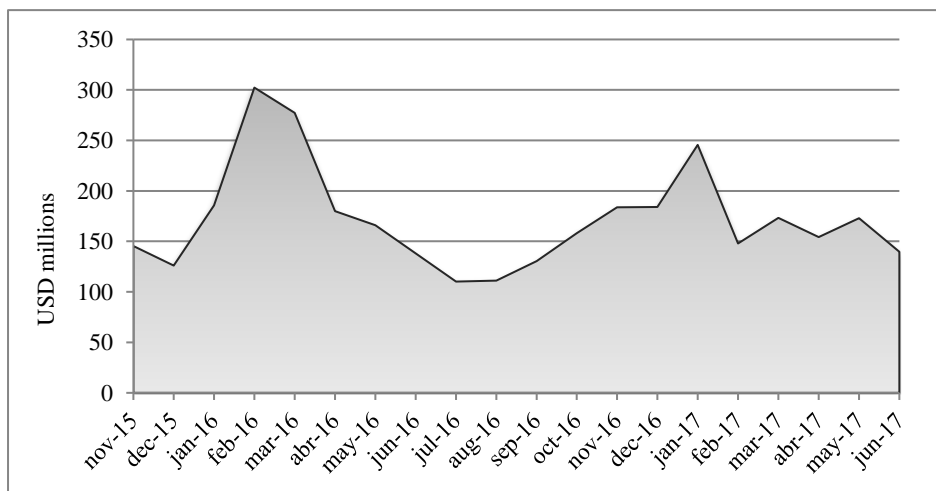
Fig. 1. Fluctuation of tomato imports from Mexico to United States of America [6]

2   Methodology

The competitiveness of international trade has two basic aspects: the relative costs position and the ability to penetrate markets [17]. Competitive advantage is based on relatively (compared to others) low production cost; under this logic countries exploit the production factors with an abundant offer. Nevertheless the ability to export depends equally on transportation costs, marketing costs, quality and degree of product differentiation and the season; as well as on macroeconomic factors like exchange rate and commercial government policies (of both, exporting and importing country). An increase in exports and/or the increase in market share incorporate all the mentioned complex aspects, so we can state that it express greater competitiveness of a product in the international market.

The competitiveness of a country's exports in the international market is usually measured indirectly, for example by Revealed Comparative Advantage (RCA) index.

We will use the formula developed by Vollrath [18], because this formula has been designed for agricultural products and uses statistics dates of trade [1].

$$RCA_{ai} = (EX_{ai} / EX_{ni}) / (EX_{ar} / EX_{nr}) \qquad (1)$$

Where:

RCA_{ai} - Revealed Comparative Advantages of the product a from the county i to the target market.

EX_{ai} - Value of exports of the commodity a from the country i to the target market.

EX_{ni} - Value of the total exports from the country i to the target market, except the exports of the commodity a from the country i to the target market.

EX_{ar} - Value of the total world exports of commodity a, except the exports of commodity a from country i to the world.

EX_{nr} - Value of the total world exports, except the world exports of commodity a and except the total exports of the country i.

RCA is calculated for Mexico, Canada, Dominican Republic, Guatemala and Netherlands (the top five tomato importers to the US market), the commodity is tomato (Tomatoes, fresh or chilled, ITC code 070200), the unit is thousands of USD and the target market is USA. The calculation was performed for the period 2006-2016.

The CMS analysis is an arithmetic breakdown of the growth of a country's market share over a period of time into a structural component, reflecting the impact of specialization by product and geographical area (the structure effect, SE), and other factors reflecting changes in individual market shares (the market share or competitiveness effect, CE). The total effect (TE) also contains a residual term, so-called the interaction effect (IE), which results from the fact that the product and geographical structures are not independent and thus the sum of the product and geographical effects does not match the combined structure effect [9]. The questions the method is intended to answer include whether a country's exports have grown in line with its main competitors (that is, a scale effect) and whether a country's comparative performance reflects a strong presence in highgrowth regions or products (regional and product effects, respectively) or competitive gains in individual markets [2].

The traditional model was first applied to the study of international trade by Tyszynski in 1951 [13] but Richardson in 1971 [10] reviewed the method and pointed out the theoretical and empirical limitations of the model. Several authors have presented improved versions; e. g. Jepma in 1986 [7]. Ahmadi-Esfahani [3] adapted the method to apply it to the case of an agricultural product within a specific market. The contribution of [1] was the synthesis of the method and application on the Mexican agrarian market.

$$TE = SE + CE + IE \qquad (2)$$

$$SE = S_0 * \Delta Q \qquad (3)$$

$$CE = \Delta S * Q_0 \qquad (4)$$

$$IE = \Delta S * \Delta Q \qquad (5)$$

Where:

S - Share (percentage) of a country in total volume of exports from the group of competing countries exporting to the target market.

Q - Volume of exports from the group of competing countries exporting to the target market.

Δ - Change of the variable over time.

0 - Start of the period.

In the analyzed case, the group of competing countries consists of Mexico, Canada, Dominican Republic, Guatemala and Netherlands. The reviewed period is the last decade, so the starting year is 2007. Tons of tomatoes are calculated. Data used for the analysis are of International Trade Center (ITC) and its statistical instrument Trade Map. The supplementary source is statistics of INEGI (Mexican National Institute of Geography and Statistics).

3   Results

RCA index compares the national export structure with the world market structure, considering the international market as the space where the pattern of specialization and the comparative advantages are reflected. The higher value of RCA index expresses higher comparative advantage and higher degree of specialization of the country in this product (if the index is less than 1 or negative, the country has a comparative disadvantage). As shown in the Fig. 2 Mexican tomato sector is the most competitive and with a positive trend. Mexico is followed by Guatemala, which has also positive trend, although its RCA index has declined over the past two years. Canada and Dominican Republic have lower competitiveness and are not improving it significantly over the years considered. Netherlands is losing specialization in tomato sector and is giving up its market share in favor of other countries.
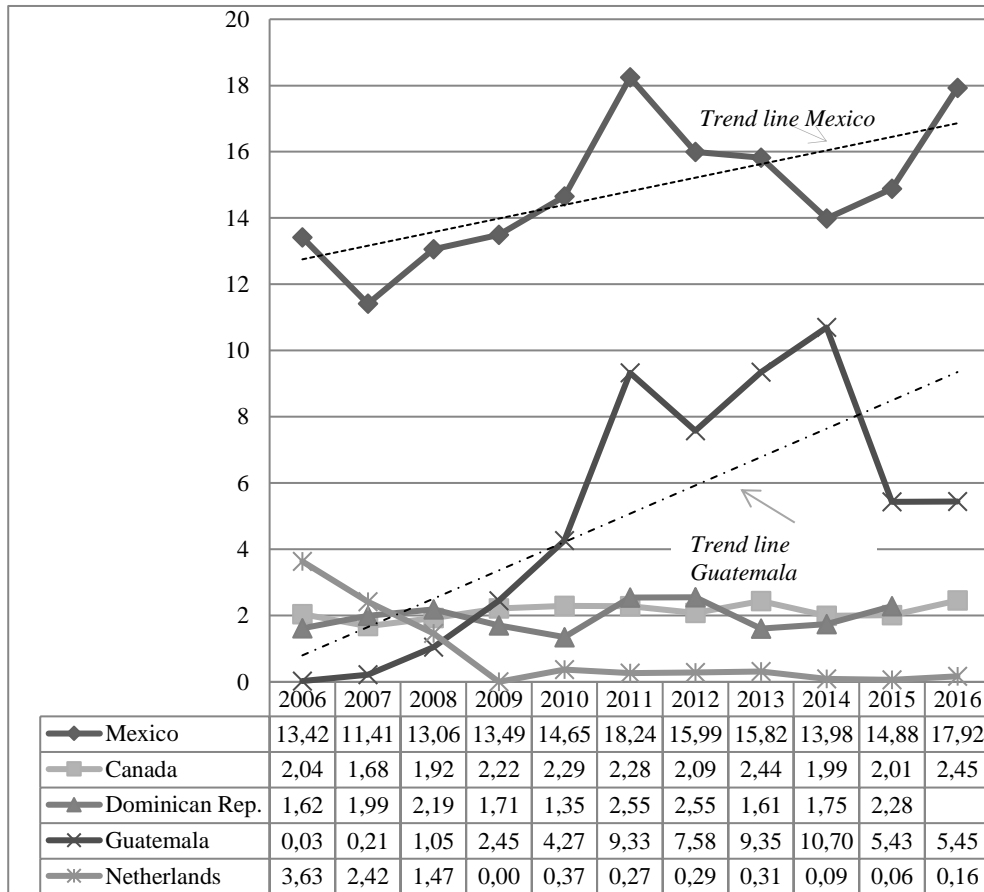
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mexico	13,42	11,41	13,06	13,49	14,65	18,24	15,99	15,82	13,98	14,88	17,92
Canada	2,04	1,68	1,92	2,22	2,29	2,28	2,09	2,44	1,99	2,01	2,45
Dominican Rep.	1,62	1,99	2,19	1,71	1,35	2,55	2,55	1,61	1,75	2,28	
Guatemala	0,03	0,21	1,05	2,45	4,27	9,33	7,58	9,35	10,70	5,43	5,45
Netherlands	3,63	2,42	1,47	0,00	0,37	0,27	0,29	0,31	0,09	0,06	0,16

Fig. 2. Revealed Comparative Advantages index, 2006-16. [6]

Note: No data available for Dominican Republic in 2016.

The base for the CMS analysis is the difference between a country's export growth and the competing countries group export growth. When a country's export growth is higher/lower than the group export growth, that country is gaining/losing market share. The Total Effect has been positive for all the analyzed countries, except Netherlands: Mexico 670,220 tons, Canada 42,677 tons, Dominican Republic 3,597 tons, Guatemala 5,415 tons and Netherlands -4,936 tons.

The Structural effect is positive for all the group of competing countries (see Fig. 3). SE represents the expected change in exports, keeping constant the participation of the countries in the US market. This result indicates that the growth in demand for tomatoes in USA has a positive effect in the growth of exports of the five suppliers, Mexico takes the greatest advantage: 95% of the Total effect represents the Structural

effect. Whereas tomatoes are bulky goods, Mexico has a clear advantage due to its geographical proximity.

Competitiveness effect represents the country change in exports during the decade, keeping constant the volume of US demand. CE is positive for Mexico, Dominican Republic and Guatemala (gain of competitiveness) and negative for Canada and Netherlands (loss of competitiveness). Relatively the largest share has Guatemala (58% of Total effect), in the case of Mexico it is only 3 percent. We can conclude that Guatemala is gaining competitiveness significantly, while Mexico only maintains its position.

The Interaction effect combines the influence of variation in the target market demand with changes in the share in exports. As well as the CE, it is positive for Mexico, Dominican Republic and Guatemala and negative for Canada and Netherlands.
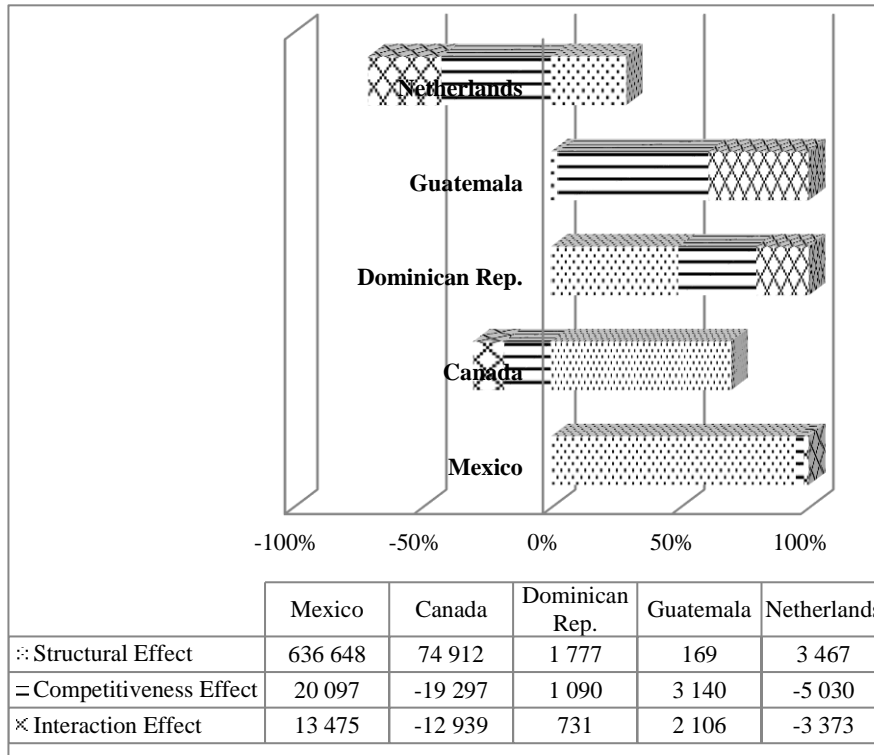

	Mexico	Canada	Dominican Rep.	Guatemala	Netherlands
∷ Structural Effect	636 648	74 912	1 777	169	3 467
═ Competitiveness Effect	20 097	-19 297	1 090	3 140	-5 030
✕ Interaction Effect	13 475	-12 939	731	2 106	-3 373

Fig. 3. Constant Market Share index, 2007-16 (tons) [6]

4   Conclusion

The US market has a favorable trend that allows to expect an increase in exports of tomatoes, especially if no phytosanitary problems occur. Meteorological phenomena

are other risk factor with important impact on the production and price of tomato, nevertheless this impact is reduced by transformation of production technology. The implementation of protected agriculture systems can be considered like a positive trend not only for protect against pests, diseases and adverse climatic conditions but also for water savings: in tomatoes the saving is up to 77% (in the open field production 89 liters per kilogram of tomato are used and in hydroponics it´s only 20 l/kg).

The comparative advantage is based on specialization, which increases the general productivity of an open economy. Notwithstanding, empirical data show that as the underdeveloped countries get richer, production becomes less concentrated and more diversified. The sectoral specialization takes place only in high-income economies (per capita income of Ireland and higher). First, the emerging economies have to acquire skills in a wide range of activities and then specialize. Market prices can not reveal the profitability of non-traditional activities (that do not yet exist), which is the reason why investment in these activities is high risk. Successful examples show that diversification requires state assistance or government intervention (investment in infrastructure and research, preferential credits or guarantees for export).

Mexico has achieved a great differentiation of products, both in production technology (greenhouse, hydroponic, organic etc.) and in the varieties. Current tomato production is mainly based on hybrids that produce higher yields and have greater resistance to pests and other stress factors than native varieties (Saladette, Roma, Cherry). However, as mention Ladewig et al. [8], some consumers prefer tomatoes of non-hybrid varieties, which have different colors, shapes and flavors. In USA they are called Heirloom (criollo, local, traditional or native varieties). In terms of maturation, most commercial tomatoes come from hybrid genotypes that have been developed to be harvested before ripening in the plant to facilitate their transport and distribution. In contrast, the native varieties of tomatoes are harvested in a more mature state or even in complete maturation. Once ripe, the fruits are sold directly in marketplaces and consumers can distinguish a difference in taste (various varieties of Heirloom, for example Goose Creek, Hawaiian Currant, Stupice, Citlale and Ojo de Venado). Another important reason for preference of traditional varieties is the visual appearance: Green Zebra (yellowish green with dark green stripes), Black Krim (dark red to purple), Dixie Golden Giant (yellow to orange), Chino Criollo (shaped like paprika) or Yellow Pear (yellow with a small pear shape).

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