Article

Competitiveness of the Mexican red tomato in the international market: analysis 2003-2017

Iliana Enriqueta Montaño Méndez[§]
Iván Narcizo Valenzuela Patrón
Kennia Valeria Villavicencio López

Higher Technological Institute of Mulegé. Loma de los Frailes s/n, Col. Centro, Santa Rosalía, Baja California Sur, Mexico. CP. 23920. Tel. 615 6890000. (ivan.vp@mulege.tecnm.mx; kennia.vl05@gmail.com).

[§]Corresponding author: iliana.mm@mulege.tecnm.mx.

Abstract

In Mexico, the agro-livestock sector contributes about 3.4% of the national GDP, with horticultural activity standing out with 45% of the exports of the sector, where the red tomato represents 8.41%. Mexico is the main supplier of this product worldwide, with a share of 19% of world exports, above Spain or the Netherlands. The objective is to determine the competitiveness of the Mexican red tomato in the international market through the relative export advantage (RXA) and constant market share (CMS). Competitiveness of the Mexican product in the US market and a high market concentration were found, sending 98% of Mexican red tomato exports to that destination.

Keywords: agricultural product, competitiveness, exports, market.

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Introduction

Agriculture in Mexico is an important activity not only because of food production but also because it generates jobs, foreign exchange and the related links that arise around the activity (Álvarez *et al*., 2017). In Mexico, the agro-livestock sector contributes about 3.4% of the gross domestic product (GDP), generates 13% of employment, registers four million production units (INEGI, 2007), covers an area of 110 million hectares, of which 32 million are for agricultural use (CEDRSSA, 2019) and contributes 1.75% of world agricultural exports.

Fruit and vegetable activity represents 45% of exports, which places it as the most dynamic activity in terms of exports since the signing of the North American Free Trade Agreement (Avendaño and Schwentesius, 2012; Ávila and González, 2012), with the export of products such as avocado (2.4%), lemons (2.86%), onion (2.23%), cucumber (3.31%), pepper (3.90%) and tomato (7.77%) (FAOSTAT, 2021) standing out. The agricultural sector in Mexico maintains a positive trade balance (SADER, 2021), which helps to stimulate the national economy with the generation of jobs and higher incomes.

Mexico contributes 1.70% of world tomato production, below China, Mainland China, India and the United States of America, among others, contributes 19% of the volume of exports worldwide, which places it as the main exporting country above Spain (14%) and the Netherlands (13%) (FAOSTAT, 2020). During the period from 2003 to 2017, an average of 2.5 million tons of red tomato were produced in Mexico and 14 759 million pesos are generated per year (SIAP, 2020).

Mexico has characteristics that have generated favorable conditions for the production and export of vegetables, such as climate, natural resources, availability of labor, geographical proximity to the U.S. market (considered the largest in the world) and use of technological innovations (Bracamontes and Méndez, 2011; Hernández *et al*., 2017; Hernández, 2019). This relates to David Ricardo's comparative advantage, which determines who will produce a good. Krugman and Obstfeld (2006) mentioned that a country has a comparative advantage in the production of a good if the opportunity cost in the production of this good in terms of other goods is lower in this country than it is in other countries.

In addition, Pugel (2004) mentions that a country will have a comparative advantage when it exports those goods and services that it can produce at a lower opportunity cost and will import those goods and services that it would otherwise produce at a higher opportunity cost. For the measurement of export competitiveness in the international market, Vollrath's (1991) revealed comparative advantage index can be used by means of the relative export advantage index and the revealed comparative advantage index. The relative export advantage indicates a country's export advantages over the world (Ramírez *et al*., 2020).

The sources of comparative advantage can be: differences in the endowment of factors of production, technological differences or differences in demand (Macías, 2010). Studies have been carried out to measure the competitiveness of Mexican fruit and vegetable products in the international market, such as avocado (Torres, 2009), strawberry (Ávila and González, 2012;

Ramírez *et al*., 2016), pecan nut (Ávila *et al*., 2020), coffee (Valencia, 2016), grape (Valencia and Duana, 2019), onion (Valencia and Espinoza, 2017), among others, or studies where the competitiveness of agricultural products is estimated, finding that Mexican fruits and vegetables are competitive in the world market (Avendaño and Schwentesius, 2005).

The objective of this paper is to determine the competitiveness of the Mexican red tomato in the international market by means of the relative export advantage and constant market share. The hypothesis of the document is that Mexico is highly competitive in red tomato exports and maintains a high concentration in the US market.

Production and international trade of red tomato

Tomato production worldwide has shown a significant growth of around 22% per year during the period from 2003 to 2017. The main producing countries are China (23%), Mainland China (22%) and to a lesser extent India (7%), the United States of America (7%) and Turkey (6%) (Figure 1). This group of countries concentrates 64% of the world tomato production. For its part, Mexico contributes 2% of world production and ranks 11th among tomato-producing countries.

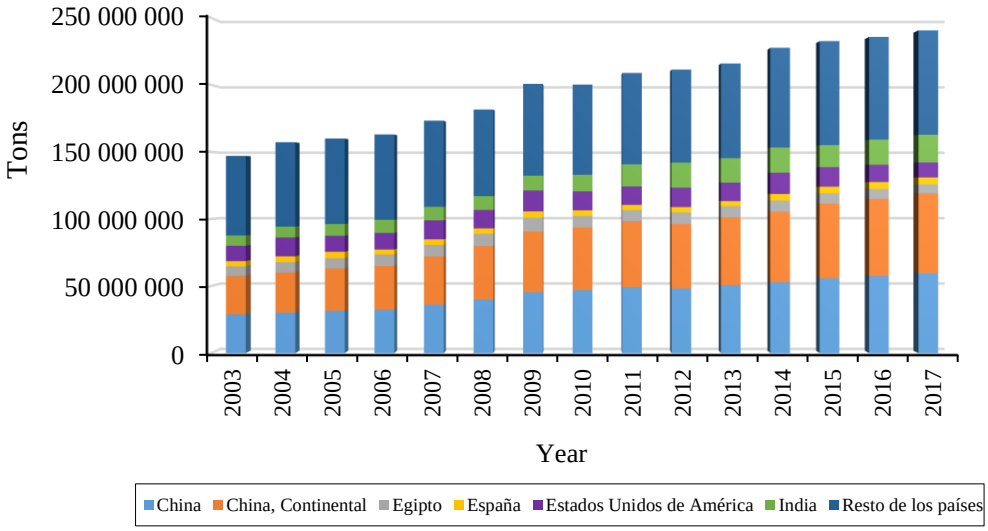

Figure 1. Main producers of red tomato 2003-2017 (tons). Elaboration with data from FAOSTAT.

Trusts Instituted in Relation to Agriculture (FIRA, for its acronym in Spanish), mentions that China and India stand out for their dynamism in world production, and this is partly due to the increase in China's productivity, while in India, a greater part of the area sown was allocated to this vegetable (FIRA, 2017).

World tomato exports have grown, on average, by 4% per year. Mexico ranks as the world's leading exporter of tomatoes, participating with about 19% of the export volume during the period 2003-2017. Behind, Spain and the Netherlands export approximately 13% each (Table 1).

Table 1. Main tomato-exporting countries (tons).

Year	Spain	Jordan	Morocco	Mexico	Netherlands	Turkey	World
2003	946 511	186517	179 804	903 384	690 949	227 400	4 615 576
2004	1 023 028	237 859	107 365	895 126	771 848	235 364	4 950 300
2005	923 907	285 169	166 570	900 767	770 750	250 182	5 072 827
2006	987 260	304 529	192 353	1 03 503	776 496	304 372	5 778 283
2007	880 630	386 968	297 593	1 07 646	834 589	372 094	6 459 293
2008	938 596	393 983	346 222	1 042 727	839 550	439 729	6 547 256
2009	829 540	431 713	410 118	1 136 299	923 954	542 259	6 962 655
2010	738 773	371 257	372 112	1 509 616	943 119	574 279	7 190 079
2011	964 054	434 830	392 435	1 493 316	1 023 496	576 573	7 562 419
2012	908 755	418 516	443 811	1 472 390	977 664	560 430	7 440 702
2013	1 004 009	611 519	457 854	1 535 157	1 013 529	483 046	7 864 153
2014	958 272	517 207	485 421	1 537 946	1 021 484	585 202	8 485 605
2015	949 366	419 287	417 332	1 560 588	1 010 843	541 355	8 137 967
2016	911 106	361 439	524 907	1 748 858	992 601	485 963	8 576 288
2017	809 612	282 271	527 724	1 742 619	1 089 230	522 876	8 258 502
(%) participation	13%	5%	5%	19%	13%	6%	100%
AAGR	-1%	3%	7%	4%	3%	6%	4%

Elaboration with information from FAOSTAT.

However, when estimating the average annual growth rate, it is observed that Morocco and Turkey grew above the world average of tomato exports (4%). The first had a growth rate of 7% and Turkey 6%. For its part, Mexico grew at the same rate as world exports; while Spain showed a 1% decrease in tomato exports (FAOSTAT, 2020).

The main importers of tomatoes during the analysis period were the United States of America (21%), Germany (11%), the Russian Federation (9%), France (8%) and the United Kingdom of Great Britain (6%). While the Russian Federation and the United States of America grew by an annual average of 6% and 4%, respectively (FAOSTAT, 2020). Although the United States of America stands out as one of the main producers worldwide, its demand is higher, so it requires complementing apparent consumption with imports.

Red tomato production in Mexico

In Mexico, most of the states produce red tomatoes, however, eight states concentrate 72.02% of the national production (SIAP, 2020). The main producer is Sinaloa, which, during the period 2003-2017, contributed with more than 32% nationwide (Table 2). Behind, Baja California (8.25%), Michoacán (7.05%), San Luis Potosí (6.62%), Jalisco (5.43%), Zacatecas (4.73%), Baja California Sur (4.54%) and with lower participation Sonora (3.12%) (SIACON, 2020).

Table 2. Mexico: volume of red tomato production, 2003-2017 (tons).

Year	Baja California	Baja California Sur	Sinaloa	Sonora	Michoacan	San Luis Potosi	Jalisco	Zacatecas	Rest of the states	National
2003	251057	122045	742 685	68 377	237454	208 799	102 469	58 939	379 335	2171159
2004	294076	113450	991 113	51 339	162476	125 123	109 930	37 333	429 790	2314630
2005	262458	117954	845 477	47 412	150730	162 053	117 500	70 347	472 316	2246246
2006	216000	114462	783 314	73 096	134178	120 120	87 534	106212	458 516	2093432
2007	196388	132873	827 011	63 609	224898	120 289	141 796	112980	605 559	2425403
2008	206257	112028	782 910	43 994	175703	139 653	122 421	76 199	604 038	2263202
2009	180135	102607	668 303	41 400	140185	112 150	115 544	95 121	588 370	2043815
2010	221626	103212	687 057	60 131	155354	98 093	140 802	144361	667 155	2277791
2011	162325	92 883	345 011	60 718	148081	108 614	136 540	134369	683 941	1872482
2012	189636	106859	1039368	82 324	171039	116 137	156 660	139131	837 217	2838370
2013	196453	108422	983 288	91 856	98 435	141 108	134 437	143905	796 454	2694358
2014	135741	141237	867832	121387	169769	196 011	158 561	151692	932 933	2875164
2015	220848	123032	849342	136045	223678	221 561	161 805	145234	1016785	3098329
2016	226062	135223	924153	128038	235,785	306 621	158 232	191654	1043387	3349154
2017	179574	99379	937796	118526	253576	340 836	219 134	193363	1127524	3469707
AAGR	-2.21	-1.36	1.57	3.74	0.44	3.32	5.2	8.24	7.53	3.17
(%) of participation 2003-2017	8.25	4.54	32.27	3.12	7.05	6.62	5.43	4.73	27.98	100

Elaboration with data obtained from SIAP.

Although the main producer is Sinaloa, it maintains a less significant growth compared to Zacatecas and Jalisco, which had an average annual growth of 8% and 5%. According to Macías (2010), the loss of productivity in Sinaloa is mainly due to water scarcity and pest growth. While Zacatecas has intensified the use of production systems under protected agriculture in an expansive manner (Padilla *et al*., 2008). Similarly, Sonora, Michoacán and San Luis Potosí grew in a smaller proportion than the national average.

While the states of Baja California and Baja California Sur had negative growth rates of 2.21% and 1.36% during the period from 2003 to 2017. These last two states, located in arid zones, have limitations of water resources due to the overexploitation of their aquifers and low rainfall, which cause the availability and quality of water to be insufficient for agricultural production, essential elements for the development of the activity (Velasco *et al*., 2019). Some states such as Baja California, Baja California Sur, Jalisco and Michoacán were established as an operation of Sinaloa's companies that sought to complement the offer, deseasonalize production and greater access of exports to take advantage of the growing North American market (Avendaño, 2008; FIRA, 2019).

During the period from 2003 to 2017, it was found that these same states showed a growth in the value of production of approximately 6% and maintained a price paid to the producer above the national average ($6 281.00 t^{-1}), with Baja California standing out, with a price above 50% of the national (Figure 2).

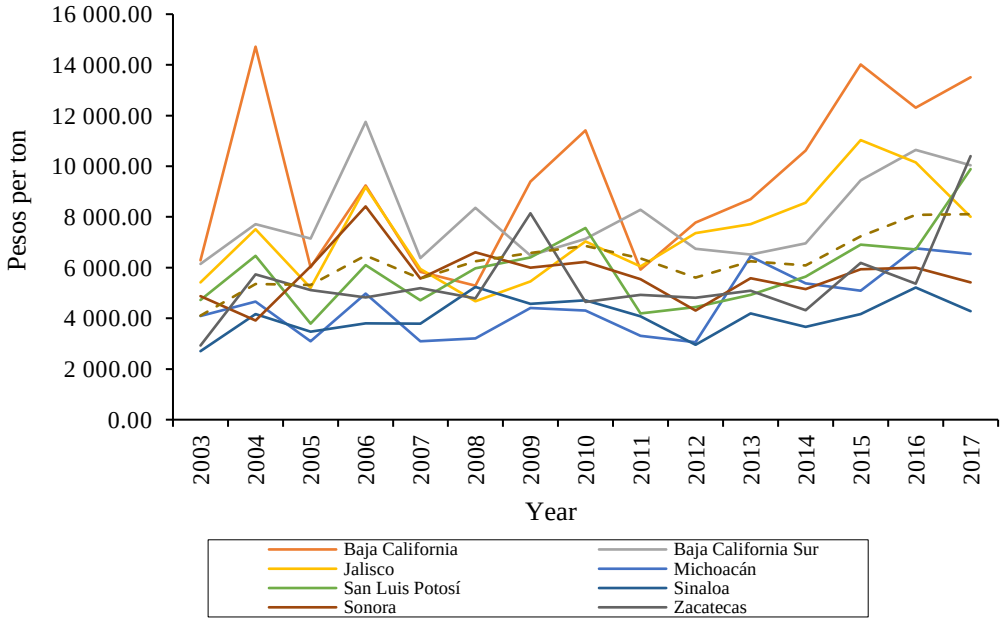

Figure 2. Mexico: average rural price of red tomato, 2003-2017 (pesos per ton). Elaboration with data from SIAP.

Materials and methods

To analyze the competitiveness of the Mexican red tomato in the US. market, two methods were used: the relative export advantage (RXA) index proposed by Vollrath (1989) and the method of constant market share analysis (CMS) according to Ahmadi-Esfahani's (1995) approach. To this end, statistical information was obtained from FAOSTAT and ERS-USDA.

Relative export advantage (RXA) index

The RXA index proposed by Vollrath is actually a rethinking of the index proposed by Ballasa, called revealed comparative advantage (RCA) (Laursen, 1998). The index (RXA) reflects that a given country has a relative export advantage in a product if (RXA) is positive or greater than 1, while if (RXA) is negative or less than 1, it indicates a relative export disadvantage. In general terms, the (RXA) indicates that as its value increases, a country is considered more specialized and more competitive. The RXA index is defined as follows: RXAai= (Xai/Xni)/(Xar/Xnr). Where: RXAai= is the relative advantage of exports of the product a in country i. Xai= is the value of exports of the product a in country i. Xni= is the value of total exports in country I excluding product a. Xar= is the value of the total exports of the product a in the world, excluding country i. Xnr= is the value of total exports in the world excluding product a and country i.

Constant market share (CMS) analysis

The CMS method allows explaining the change in the exports of a given product from its structural and competitiveness components. This method was proposed by Leamer and Stern, later adapted to expand the analysis of export growth (Avendaño, 2008). Ahmadi-Esfahani (1995) decomposes the change in exports into two levels: the first level of decomposition is carried out according to the following equality: $\Delta q = Sj0\Delta Qj + \Delta SjQj0 + \Delta Sj\Delta Qj$. $Sj0\Delta Qj$= structural effect, it reflects the expected change in exports if the country's initial share of the world market and in the destination country remains constant.

If this component is positive, it means that the increase in demand for the product favors the increase in exports. $\Delta SjQj0$= competitiveness effect or residual, it reflects the part of the change in exports that can be attributed to an increase in competitiveness in the analysis period. If this component is positive, it means that competitiveness has increased, while if the sign is negative then it is interpreted as a loss of competitiveness. $\Delta Sj\Delta Qj$= interaction or second-order effect, it reflects the effect of a change in both market share and demand on the change of exports.

The second level of decomposition is performed by obtaining six additional effects from the components described in the first level of decomposition. In this case the equality is as follows: $\Delta q = St0\Delta Qj + (Sj0\Delta Qj - St0\Delta Qj) + \Delta StQj0 + (\Delta SjQj0 - \Delta StQj0) + (QtI / Qt0\text{-}I)(\Delta SjQj0) + (\Delta Sj\Delta Qj - QtI / Qt0\text{-}I)(\Delta SjQj0))$. $St0\Delta Qj$= growth effect, it reflects the part of the increase in exports that is due to an increase in world demand while the share of the exporting country in the world market remains constant.

$(Sj0\Delta Qj - St0\Delta Qj)$ = market effect, it measures the additional change in exports, while the exporter maintains its share of the target market constant. If the sign is positive, it implies a concentration of exports in each market. $\Delta StQj0$= pure residual effect, it reflects the change in exports that would occur due to a change in overall competitiveness. $\Delta SjQj0 - \Delta StQj0$= static structural residual effect, it reflects the change in exports that is attributed to a change in competitiveness in each market. $QtI/Qt0\text{-}I\ (\Delta SjQj0)$= pure second-order effect as it measures the interaction between the change in the exporter's share of the target market and the change in world demand. $\Delta Sj\Delta Qj - (QtI / Qt0\text{-}I)(\Delta SjQj0)$= dynamic structural residual effect, it reflects the interaction between the change in the exporter's share of the target market and the change in the demand of that market.

Results and discussion

The competitiveness of a product in the international market depends on its comparative advantages and is a function of production costs, which include structure, transportation and marketing costs. Considering that this is affected by factors such as product quality, seasonality of production and market, degree of differentiation and government policies of both the exporting and importing country (Contreras-Castillo, 1999). For Sánchez-Gómez *et al*. (2019), Mexico bases its comparative advantages on labor and excess supply of land with productive potential.

During the analysis period 2003-2017, Mexican tomato exports grew by an annual average of 4%, concentrating 98% toward the U S market. The latter being the main importer worldwide, absorbing 21% of world tomato imports (FAOSTAT, 2020). Sánchez-Gómez *et al*. (2019) mention that, in 2013, Mexican tomato exports to the US. market represented 32.61% of total exports.

The RXA index of the Mexican red tomato in the U.S. market had a positive value, that is, it shows competitiveness throughout the period 2003-2017, in addition, red tomato exports showed an average annual growth rate of 6% (Figure 3). Its competitiveness is mainly due to comparative advantage, influenced by factors of geographical proximity, price, quality and the seasonality of tomato production in the United States of America, which decreases in the winter (Hernández *et al*., 2004). In addition, it is derived from the integration process between Mexico and the United States of America (Macías, 2003).

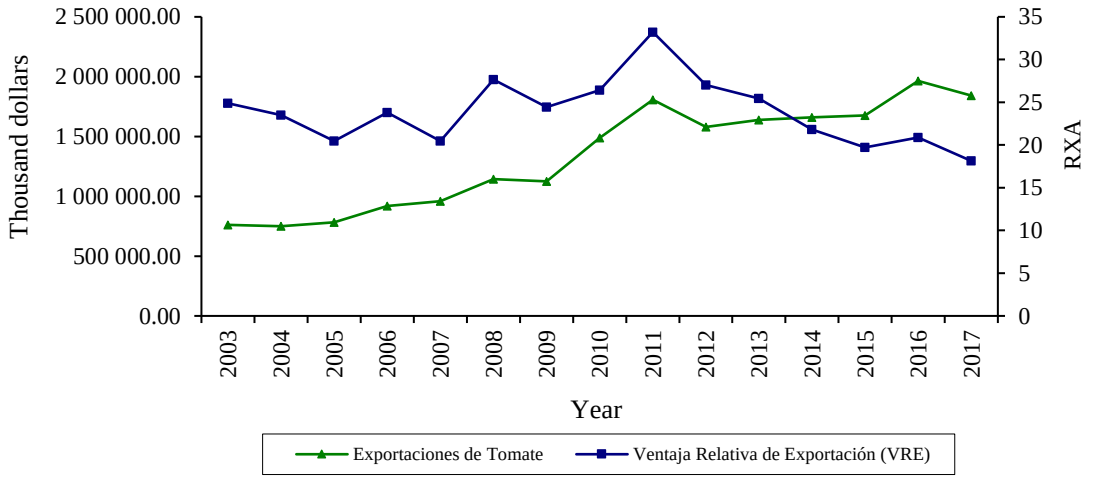

Figure 3. Mexico: tomato exports and relative export advantage index in the U S market, 2003-2017. Elaboration with information from FAOSTAT.

Although the RXA indicator is greater than 1, and the higher it is, the more specialized it is considered, in recent years, since 2011 the competitiveness of the Mexican red tomato in the U.S. market has decreased, with the RXA index going from 33 to 18. Although competitiveness is positive, it shows a downward trend. Which would indicate that Mexico cedes its market share to other countries and that it loses specialization in this subsector. According to Avendaño *et al*. (2006), Canada is specializing in greenhouse tomato production. This may be due to the different trade and phytosanitary policies imposed by the United States of America, for several reasons, the first derived from the fact that in some years there were epidemiological outbreaks associated with fruits and vegetables, including tomatoes.

In response to these outbreaks, in 1997, Produce and Imported Food Safety Initiative was designed (Avendaño *et al*., 2006). The second, caused by the imposition of tariffs on Mexican tomato exports in order to protect producers in Florida, the main tomato-producing area in that country or because of accusations of unfair trade practices, dumping against Mexican tomato producers (Avendaño and Acosta, 2009; CEDRSSA, 2018).

Likewise, Soto (2018) found that Mexico shows competitiveness in tomato exports during the period from 1994 to 2016 when analyzing the revealed comparative advantage index. In addition, he points out that Mexico maintains levels of competitiveness higher than its NAFTA trading partners and China. For their part, Crespo and Plzákova (2018), in their study, conclude that Mexican tomato exports in the U S market are the most competitive and with a positive trend compared to Guatemala, Canada, the Dominican Republic and the Netherlands.

Constant market share (CMS)

The CMS shows the competitiveness and behavior of exports in the destination market. The first and second order of decomposition were estimated for the main exporting countries of red tomato in the market of the United States of America, where Mexico concentrates about 89%. Canada exports approximately 10% and with a smaller share, but during the period, the Dominican Republic, Guatemala and the Netherlands have maintained their exports (Figure 4).

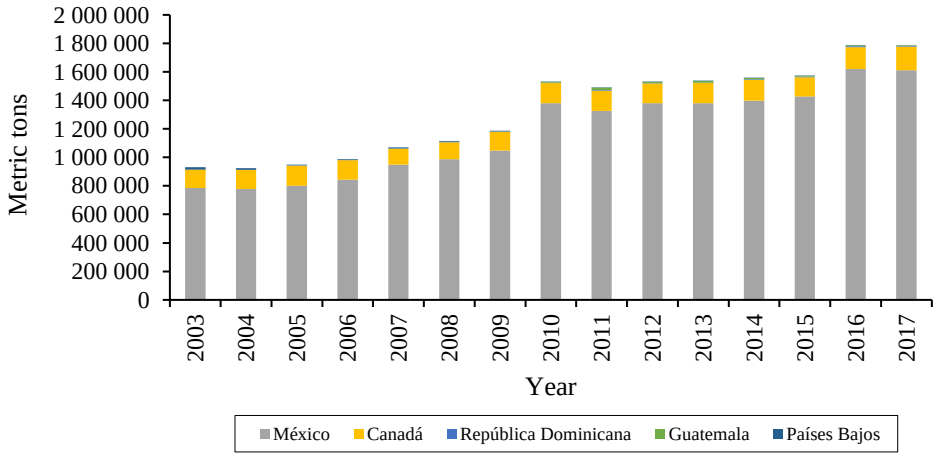

Figure 4. Main tomato-exporting countries to the United States of America, 2003-2017 (metric tons). Elaboration with data from ERS-USDA.

The results of the application of the CMS method are shown in Table 3. The first aspect that stands out is that the change in the volume of exports was positive for Mexico, Canada, the Dominican Republic and Guatemala, while for the Netherlands it is negative.

Table 3. Constant market share of red tomato exports in the market of the United States of America, 2003-2017.

Concept	Mexico	Canada	Dominican Republic	Guatemala	Netherlands
		First-order effect			
Change in exports	757 106.78	21 857.21	5 648.55	5 139.44	-13 564.91
Structural effect	654 934.65	108565.28	17.52	1.08	12 668.53
Competitiveness effect	53 229.55	-45 173.11	2 933.65	2 676.97	-13 667.08
Second-order effect	48 942.57	-41 534.97	2 697.38	2 461.38	-12 566.36

Concept	Mexico	Canada	Dominican Republic	Guatemala	Netherlands
Second-order effect					
Growth effect	400 927.52	58 338.34	202.82	10 070.85	306 647.53
Market effect	254 007.13	50 226.94	-185.3	-10 069.77	-293 979
Pure residual effect	57 158.4	-9 127.17	2 174.57	3 373.38	-53 579.17
Static structural residual effect	-3 928.84	-36 045.93	759.09	-696.4	39 912.09
Pure second-order effect	37 875.05	-32 142.55	2 087.42	1 904.78	-9 724.69
Dynamic structural residual effect	11 067.52	-9 392.42	609.97	556.60	-2 841.67

Elaboration with data from FAOSTAT and ERS-USDA.

At the first level of decomposition, the structural effect is positive for all countries, reflecting growth in tomato demand that favors exports, mainly for Mexico. Crespo and Plzákova (2018) conducted a study selecting the same countries, obtaining that the structural effect is positive for all countries, where Mexico has the greatest advantage given its geographical proximity to the U.S. market. In another study, Avendaño and Acosta (2009) found that the structural effect is positive for tomato-exporting countries that were selected for the U S market (Canada, Spain, Israel, Mexico and the Netherlands) and they point out a positive impact on world tomato demand.

In the case of the competitiveness effect, the sign is positive, mainly for Mexico and in less impact for the Dominican Republic and Guatemala, showing a loss for Canada and the Netherlands. The second-order effect shows the influence of market share and changes in demand for red tomato exports, it is positive for Mexico, the Dominican Republic and Guatemala, derived from the behavior in competitiveness. The increase in world demand for red tomatoes grew on average 4% per year of the volume of imports (FAOSTAT, 2020), causing a positive impact on the growth effect for all countries during this analysis period.

Avendaño and Acosta (2009) indicate similar results, finding that the growth effect is positive for all countries, mainly favoring the Netherlands; however, exports its exports and Mexico's exports have been displaced by Canada. The market effect is positive for Mexico and Canada, which shows that both concentrate their exports toward a single market. In the specific case of Mexico, it exports about 98% of the volume of red tomatoes to that destination. While, for Guatemala, the Dominican Republic and the Netherlands, the sign is negative, related to market diversification; for instance, Guatemala, in 2017, exported to El Salvador 44 073 tons and only 6 221 tons to the United States of America. More than 90% of exports to the US. market are concentrated in Mexico, generating vulnerability to Mexican producers when subjected to the market conditions of the United States of America, changes in purchasing and consumption patterns and the country's economic situation.

The pure residual effect is positive for Mexico, Guatemala and the Dominican Republic, showing an increase in competitiveness. Despite this, the static structural residual effect shows a positive sign for the Dominican Republic and the Netherlands, indicating an improvement in their

competitiveness, generating greater participation in the world market. Finally, the pure second-order effect and the dynamic structural residual effect show a positive sign for Mexico, the Dominican Republic and Guatemala, which means that tomato-exporting countries have been able to increase their share of the U S market, at the same rate as world demand and demand in the destination market were growing.

Conclusions

Mexico is a highly competitive country in the export of red tomato in the market of the United States of America, derived from its geographical location, the use of technological innovations, availability of land, labor, among other factors that are related to comparative advantage. The little market diversification of Mexican tomato exports shows a vulnerability as they are subject to tariff and non-tariff barriers imposed by the destination market to support and protect local producers.

Although Mexico has shown competitiveness during the period of analysis, it is important to design marketing strategies that allow it to explore new destinations and maintain the share of exports. To do this, it is suggested that Mexican producers take advantage of the trade agreements that have been signed with different countries, product differentiation through its varieties and forms of production, in addition to entering the market of processed tomato products.

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