

Effects of an increase in Mexican strawberry exports to Canada on the profitability of producers in Mexico

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ABSTRACT

Objective: determine the viability of increasing the exported quantity of Mexican strawberries to the Canadian market.

Design/methodology/approach: Likewise, a simulated scenario was developed with the purpose of carrying out a forecast on the conditions that may occur to have a more accurate knowledge of the operation of the international strawberry trade between Mexico and Canada. To perform this analysis, the international market was represented in a partial equilibrium model.

Results: According to the calculated price flexibility, an increase in the exported quantity of Mexican strawberries to Canada of 50% in one year would cause a positive final effect. With this estimate, it can be established that an increase in the exported quantity of Mexican strawberries to Canada of 50% in one year would be viable in the economic sense. In this simulated scenario, the Benefit/Cost Ratio (B/C R) calculated for the producers of Michoacan, Baja California and Guanajuato would be 1.0865, 1.196 and 0.6856 respectively.

Limitations on study/implications: not all products and all states of Mexico are examined.

Findings/conclusions: The results showed that an increase in strawberry production to export to Canada in Michoacan and Baja California would be profitable for the producer, while an increase in strawberry production for export to the Canadian market in Guanajuato would further decrease profitability.

Keywords: agricultural production; econometric analysis; Agricultural sector.

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INTRODUCTION

To carry out this research work, a descriptive study was developed to show the effects of an increase in Mexican strawberry exports to the Canadian market. In order to do it, the Mexican strawberry market between Mexico and Canada was represented in an

econometric model to calculate the price flexibility of demand and to carry out a partial equilibrium analysis of the international market for a good between two economies [1, 2, 3, 4, 5, 6, 7]. This calculation allows the simulation of an increase in the quantity traded. Thus, it is possible to affirm that the study is explanatory, since to carry it out it is necessary to establish the effect that an increase in the quantity exported of Mexican strawberries to Canada causes on the price. Then, the increase in the quantity exported imply two effects, and it is necessary to determine the final effect. The work is quantitative since the market is represented through an econometric model, considering the relationship between the variables that exist for the international trade of strawberries between Mexico and Canada to take place [8, 9].

MATERIALS AND METHODS

The econometric model that represents the strawberry market between two economies was made up of two main equations: The first one was a demand function for Mexican strawberry imports, in which is the CIF real unit price, and operates as the dependent variable, and was influenced by:

$$PIFMCan_t = \beta_1 + \beta_2 QIFMCan_t + \beta_3 PPFMR_t + \varepsilon_1 \quad (1)$$

The second one was a supply function for strawberry exports in Mexico, in which the real unit price of $PEFM_t$ was the price of strawberry exports in Mexico, and operates as the dependent variable, and was influenced by: $QEFM_t$, which was the quantity exported of strawberries in Mexico, and by $PPFMR_t$, which was the real unit price of the strawberry to the producer in Mexico:

$$PEFM_t = \beta_{20} + \beta_{21} QEFM_t + \beta_{31} PPFMR_t + \varepsilon_2 \quad (2)$$

At this point, it is necessary to say that the method of 3-Stage Least Squares (3SLS) was applied to the simultaneous equations model (supply and demand in the international market) with the purpose of calculating the coefficients β_1 - β_{31} . In this regard, the β coefficients were calculated simultaneously based on the relationship of the variables in the market, and they were represented inside the model [8]. Likewise, it is important to mention that the $PIFMCan_t$, $QIFMCan_t$, $PEFM_t$ and $QEFM_t$ variables were built with data from the Internet Tariff Information System Via Internet (SIAMI, by its Spanish acronym) of the Mexican Ministry of Economy [10], while the variable $PPFMR_t$ was built with information from the Food and Fisheries Information Service (SIAP) of the Mexican Ministry of Agriculture [11].

The partial equilibrium analysis

In order to apply the partial equilibrium model, the following assumptions were established:

1. The international market for a good: Mexican strawberries for export to Canada.

2. An international market between two nations: Mexico as the country that exports strawberries to Canada; and Canada as the importing country of Mexican strawberries.
3. For this analysis, strawberry exports in Mexico were equal to the excess supply in the international market.
4. For this analysis, Mexican strawberries imports in Canada were equal to the excess demand in the international market.
5. Monetary values in Canadian dollars Can\$.
6. Values and prices in real terms.
7. A 50% increase in the quantity of Mexican strawberries imported in Canada in 2022 compared to the quantities imported in 2021.

Likewise, an increase in the quantity imported of strawberries in Canada was expressed in the international market as a displacement of the excess supply curve from its starting position ES_0 to position ES_1 , as can be seen in Figure 1. This change causes a decrease in the international price from the starting position IP_0 towards position IP_1 , and this, in turn, causes an increase in the quantity traded from IQ_0 towards position IQ_1 . This decrease in the price from IP_0 to IP_1 also causes an increase in the excess demand ED for strawberries in the international market.

Now, the response of a change in price to a change in the quantity traded is given by the price flexibility of demand, which can be calculated as follows:

$$F^{PIFMCan} = (dPIFMCan / dQIFMCan) * (QIFMCan / PIFMCan) \tag{3}$$

Thus, through the price flexibility of demand, the percentage by which the international price decreases when the quantity traded (between both countries) increases by 1% can be calculated. The analysis begins (in the first moment) in the real international market for imported Mexican strawberries in Canada in 2021; in this scenario, the international price of imports is IP_0 while the quantity imported is given by IQ_0 . Now, in a second moment, the simulated 2022 scenario considers a 50% increase in the quantity imported

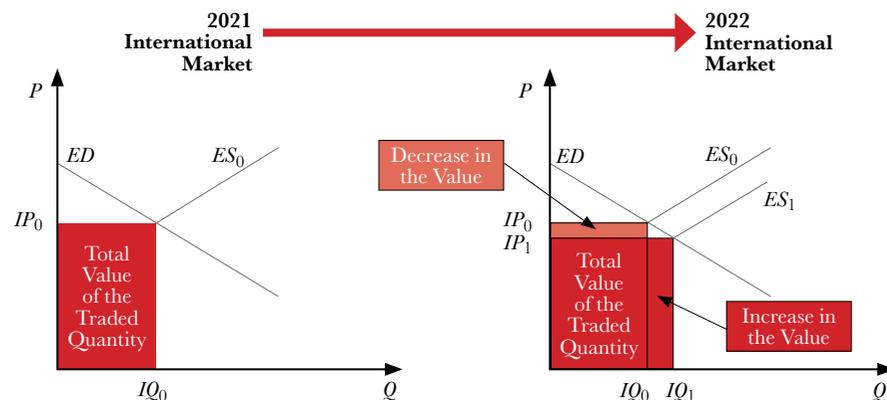


Figure 1. Changes in the total value of the quantity traded in the face of an increase in exports.

of Mexican strawberries in Canada, denoted by IQ_1 in the international market, while the IP_1 price is less than IP_0 (in 2021), in a magnitude determined by the price flexibility of demand. Likewise, it can be established that an increase in the amount imported causes an increase in the value of imports, while, on the other hand, a decrease in the price causes a decrease in the mentioned value (as can be observed in the Figure 1). The combined effects of both impacts on the value of Mexican strawberry imports destined for Canada in the international market cause a final impact. The calculation of these effects can be determined as follows:

The increase in value (due to the increase in the quantity imported):

$$\text{Increase in Value} = (Q_1 - Q_0) * P_1 \quad (4)$$

The decrease in value (due to the decrease in the quantity imported):

$$\text{Decrease in Value} = (P_0 - P_1) * Q_0 \quad (5)$$

The final effect is the result of both impacts combined, *i.e.*, the difference between the increase in value (of total imports of Mexican strawberries in Canada) due to the increase in quantity minus the consequent decrease in value due to the decrease in price; *i.e.*, this final effect can be calculated as follows:

$$\text{Increase in Value} = \text{Decrease in Value} = \text{Final Effect} \quad (6)$$

The calculation of this final effect is the result of the simulated 50% increase in the quantity imported. So, to determine the viability of this increase in the quantity of strawberries traded between Mexico and Canada in the international market, the criteria are: 1. If the Increase in Value is greater than the Decrease in Value, the difference will have a result with a positive sign, which means that the total value of the quantity traded will increase. This result allows us to establish that a 50% increase in the quantity imported of Mexican strawberries in Canada is viable from an economic perspective; 2. If the Increase in Value is less than the Decrease in Value, the difference will have a result with a negative sign, which means that the total value of the quantity traded will decrease. This result allows us to establish that a 50% increase in the quantity imported of Mexican strawberries in Canada is not viable from an economic perspective.

The profitability in the producing areas

Both impacts (50% increase in quantity and the consequent 9.16% decrease in price) can be transferred to the context of strawberry producers in Michoacan, Baja California and, Guanajuato to determine the final effect that a 50% increase in the quantity exported of Mexican strawberries to Canada over the profitability of production. That profitability in production can be expressed through the *Benefit/Cost Ratio* [12] and calculated as follows:

$$B / CR = \text{Benefits} / \text{Costs} \quad (7)$$

In order to determine the profitability for the producer, the first criterion can be expressed as follows:

$$B / CR > 1 \text{ It is profitable} \quad (8)$$

In this sense, equation 8 shows that: to determine the profitability of carrying out a productive activity, the B / CR is greater than 1, this result means that the income is greater than the expenses, so that the performance of the determined activity is profitable. When applied to the case of the 2022 simulated scenario, this result would mean that under the specified conditions, an increase in production with the purpose of increasing the quantity exported of Mexican strawberries to Canada by a magnitude that represents an annual increase of 50% in 2022 compared to 2021, it would be profitable for the producer in Mexico:

$$B / CR = 1 \text{ There are no profits no losses} \quad (9)$$

Now, Equation 9 shows that: to determine the profitability of carrying out a productive activity the is equal to 1, this result means that the income is equal to the expenses, so that the performance of the determined activity does not represent no profit or loss. When applied to the case of the 2022 simulated scenario, this result would mean that under the specified conditions, an increase in production with the purpose of increasing the quantity exported of Mexican strawberries to Canada by a magnitude that represents an annual increase of 50% in 2022 compared to 2021, for the producer in Mexico there would be no profit or loss:

$$B / CR < 1 \text{ It is not profitable} \quad (10)$$

Now, equation 10 shows that to determine the profitability of carrying out a productive activity, the B / CR is less than 1; this result means that the income is less than the expenses, so that the performance of the determined activity is not profitable. When applied to the case of the 2022 simulated scenario, this result would mean that under the specified conditions, an increase in production with the purpose of increasing the quantity exported of Mexican strawberries to Canada by a magnitude that represents an annual increase of 50% in 2022 compared to 2021, it would not be profitable for the producer in Mexico.

RESULTS

Based on the results of the application of 3-Stage Least Squares to the econometric model, the β coefficients were calculated, as can be seen in Table 1.

Based on the results, t-Student tests were accomplished. To carry them out, it is necessary to mention that the critical value of t-Student for a significance level of 0.05 (5%) is equal

Table 1. Coefficients β of the function of demand.

Variable	Coefficient	Value	Standard Error*	t-Student value*	Pr> t
Intercept	1	2490.00200	509.844100	4.88	0.0005 ^{1**}
QIFMCan _t	2	-4.33127	1.880600	-2.30	0.0418 [*]
PPFMR _t	3	0.0000000054	0.000000001174	4.60	0.0008 ^{**}

* Note: It is significant at the level of 0.05. ** Note: It is significant at the level of 0.01.

to 1.7613, while the critical value of t-Student for a significance level of 0.01 (1%) is equal to at 2.6245. In this way, in the hypothesis test, the value of t-Student for the coefficient β_1 was equal to 4.88, therefore, it was greater than 2.6245, so the probability of the respective t-Student test is (0.0005) is less than 0.01**. In the same sense, the t-Student value for the coefficient β_2 was equal to -2.30, that is, it was less than -1.7613, so the probability of the respective t-Student test (0.0418) was less than 0.05*. Likewise, the value of t-Student for the coefficient β_3 was equal to 4.60, that is, it was greater than 2.6245, so it was possible to interpret that the probability of the corresponding t-student test (0.0001) was less than 0.01**. Then, with these results, it can be established that the estimated values of β_1 , β_2 and β_3 were statistically significant. With the estimation of the values of the coefficients β 's, it was possible to build the demand equation:

$$PIFMCan_t = 2490.002 - 4.33127 QIFMCan_t + 0.0000000054 PPFMR_t + \varepsilon_1 \quad (11)$$

In order to calculate the price flexibility of demand, the partial derivative of the demand function (11) was developed with respect to the quantity $QIFMCan_t$

$$(dPIFMCan / dQIFMCan) = 4.33127 \quad (12)$$

With this estimation, price flexibility of demand was calculated:

$$F^{PIFMCan} = (-4.33127)(189.3375 / 4474.207123) = -0.183288751 \quad (13)$$

Thus, it was possible to establish that if the quantity demanded increases 1%, the price decreases 0.18%. So, based on this flexibility, it is possible to affirm that if the quantity demanded increased by 50% for the simulated scenario of 2022 (compared to 2021), this situation would cause a decrease of -9.16% in the price of Mexican strawberries in Canada, compared to the price in 2021, as can be seen in Table 2.

Table 2. Estimates of price flexibility of Mexican strawberry demand in Canada.

Increase in the quantity imported of Mexican strawberry in Canada	Decrease in the price of the Mexican strawberry imports in Canada*
1%	-0.183288751%
50%	-9.164437532%

*Adapted from the results of the Econometric Model.

Now, an increase in the quantity imported of Mexican strawberries in the Canadian market from IQ_0 to IQ_1 causes the value of the quantity traded to increase. However, there is also a second effect, a decrease in price from IP_0 to IP_1 , as can be seen in Figure 1. The result of both effects is an increase in the total value of the quantity traded in Can\$403,542.07 (see in Table 3).

Now, the value of the areas referred to in Figure 1 is estimated, resulting in an increase of Can \$403,542.07 in the total value of the quantity imported of Mexican strawberries in Canada (as can be seen in Table 4).

Then, with these results, the B/CR was estimated to determine the profitability of producing strawberries in Michoacan to export to the Canadian market for the year 2021. It is important to say that, in 2021, 90% of strawberry production in Baja California it was destined for the US market, while 10% was destined for the national market. Likewise, in 2021, the state of Guanajuato allocated 30% of its production to the US market approximately. That is to say, Baja California and Guanajuato did not export strawberries to Canada.

The Table 5 shows that, in 2021, the B/CR of strawberry production in Michoacan was 1.1961, so it was possible to affirm that producing strawberries to export to Canada in Michoacan was profitable. Now, with the purpose of establishing the hypothetical 2022

Table 3. Total value of the Mexican strawberry imports in Canada if the quantity increases 50%.

Qt	Pt	Total Value Qt*Pt
$Q_{2021} = 192.81$	$P_{2021} = 5,772.98$	$Q_{2021} * P_{2021} = \text{Can}\$1,113,116.84$
$Q_{2022} = 289.22$	$P_{2022} = 5,243.92$	$Q_{2022} * P_{2022} = \text{Can}\$1,516,658.91$
Increase		Can\$403,542.07

*Adapted from Sistema de Informacion Arancelaria Via Internet [10]. Ministry of Economy, 2022.

**Adapted from Sistema de Informacion Agropecuaria y Pesquera [11]. Ministry of Agriculture, 2022.

Table 4. Increase in the total value of the Mexican strawberry imports in Canada.

Increase in the value due to the increase in the quantity *	$(Q_{2022} - Q_{2021}) * P_{2022}$	Can\$505,552.97
Decrease in the value due to the decrease in the in the price *	$(P_{2021} - P_{2022}) * Q_{2021}$	Can\$102,010.90
Final increase		Can\$403,542.07

*Adapted from Sistema de Informacion Arancelaria Via Internet [10]. Ministry of Economy, 2022.

Table 5. Determination of the of producing strawberries in Mexico to export to Canada.

State	Quantity* t	Unit price**	Unit cost**	Income	Expenses	B/C R
Michoacán	192.81	MXN19,616.72	MXN16,401.00	MXN 3,782,397.87	MXN 3,162,358.81	1.1961
Baja California	0	MXN31,029.61	MXN16,391.00	0	0	0
Guanajuato	0	MXN12,057.64	MXN15,976.00	0	0	0

*Adapted from Sistema de Informacion Arancelaria Via Internet [10]. Ministry of Economy, 2022.

**Adapted from Sistema de Informacion Agropecuaria y Pesquera [11]. Ministry of Agriculture, 2022.

***Note: Adapted from Agrocostos [13]. Fideicomisos Instituidos en Relacion con la Agricultura, 2022.

scenario with a 50% increase in the quantity exported of Mexican strawberries to the Canadian market, exports equal to 289.22 t were simulated. In this sense, of the total simulated exports, 260.30 t (90%) were assigned to Michoacan; while to include Baja California and Guanajuato in the analysis, which already export strawberries to the US market, 14.46 t (5%) and 14.46 t (5%) were assigned to each state respectively. It is worth mentioning that in order to carry out this scenario, the assumption is a linear function of costs, in this way the cost per t is constant.

Thus, in the simulated 2022 scenario, Table 6 shows that the *B/CR* for the producers of Michoacan, Baja California and Guanajuato are 1.0865, 1.7196 and 0.6856 respectively. With these results, it was possible to establish that, for producers in Michoacan and Baja California, it would be profitable to produce strawberries to export to Canada in the face of an annual increase in quantity. On the other hand, producing strawberries to export to Canada in Guanajuato would not be profitable, since in the simulated 2022 scenario, given an annual increase of 50% in the quantity exported, the *B/CR* gets even worse.

Table 6. Determination of the of producing strawberries in Mexico to export to Canada in the simulated scenario.

State	Quantity* t	Unit price**	Unit cost**	Income	Expenses	B/C R
Michoacán	260.30	MXN17,818.96	MXN16,401.00	MXN4,638,279.21	MXN4,269,184.40	1.0865
Baja California	14.46	MXN28,185.92	MXN16,391.00	MXN407,600.12	MXN237,032.30	1.7196
Guanajuato	14.46	MXN10,952.63	MXN15,976.00	MXN158,387.28	MXN231,030.93	0.6856

*Adapted from Sistema de Informacion Arancelaria Via Internet [10]. Ministry of Economy, 2022.

**Adapted from Sistema de Informacion Agropecuaria y Pesquera [11]. Ministry of Agriculture, 2022.

***Adapted from Agrocostos [13]. Fideicomisos Instituidos en Relacion con la Agricultura, 2022.

CONCLUSIONS

Canada is the third strawberry importer in the world, mainly from the USA. Mexico is the fourth producer, the second exporter in the world, and the second exporter of strawberries to the Canadian market. The results showed that the price flexibility of the demand for Mexican strawberries in Canada was equal to -0.1833% . With this estimate, the simulated scenario showed that an increase of 96.41 t in the quantity exported of strawberries to Canada in 2022 (compared to 2021) would cause a decrease of Can\$529.06 per t in the price and causing an effect on income of the producer. The results showed that the final impact on total income would be an increase of Can\$403,542.07, therefore, it is possible to establish that the application of mechanisms that increase the quantity exported of Mexican strawberries in Canada in a magnitude that represents annual increases of 50%, would be viable from an economic perspective. Then, transferring the effects calculated in the simulated scenario 2022 to the producer context in Mexico, the results showed that the *B/CR* for producers in Michoacan, Baja California and Guanajuato would be equal to 1.0865, 1.7196 and 0.6856, respectively. Based on these results, it is possible to affirm that an increase in strawberry production to export to Canada that represents a growth rate of 50% in one year would be profitable for producers in Michoacan and Baja California.

Thus, in Michoacán, strawberry exports to the Canadian market were already carried out, while Baja California exports more than 90% of its production to the US market, since

it has the characteristics and quality in the product to obtain Animal and Plant Health Inspection Service (APHIS) certification, an essential requirement to export strawberries to this market. Both states have the technological capabilities to increase the quantity exported; while, regarding Guanajuato, the results show that, for the producer, exporting strawberries to the Canadian market is not profitable, and an increase in the quantity exported in a magnitude that represents 50% in one year would cause that the B/CR got even worse.

Likewise, it is necessary to improve the technological conditions for production of strawberries with the organoleptic and quality characteristics that allow the production developed in Guanajuato to be suitable for entering the Canadian market. In this sense, the technological resources that must be implemented to improve production conditions must include improved seed, fertilizer, adequate mechanisms to combat pests, a controlled environment, as well as the necessary infrastructure for the correct post-harvest handling (food safety, packing and packaging) with the purpose of guaranteeing that the product reaches its destination in optimal conditions, and complying with the demands of the consumer in the international market. Finally, through a partial equilibrium analysis a scenario was built to simulate specific conditions in the market with the purpose of determining effects on the international market, on the economy of the countries, as well as on the technical efficiency for the production and its profitability in the different productive areas. In this way, it is possible to make a forecast of the repercussions of encouraging exports to a specific market and, in this way, determine the feasibility of making the decision to encourage that increase.

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