

## Research Article

# Analysis of the Competitiveness of Egyptian Frozen Strawberry Exports in Major Global Markets

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## Abstract

Despite Egypt's substantial production capacity, its frozen strawberry exports face intense competition in major international markets from key competitors such as Poland, Belgium, China, Morocco, and the United States. This strong competition makes Egyptian exports highly vulnerable to fluctuations in relative prices, exposing them to the risk of significant losses in market share whenever export prices rise compared to those of competing countries. Therefore, this study aims to evaluate the competitive position of Egyptian frozen strawberry exports in major import markets (Germany, New Zealand, Poland, and Japan), estimate the elasticity of substitution between Egypt and its main competitors, and identify the key economic factors affecting export demand. Using the Substitution Elasticity Model and the Market Share Model, the results indicate that Poland, Belgium, and China are Egypt's main competitors in the German market, while Poland is the primary competitor in New Zealand and Morocco is the strongest competitor in the Polish market. In Japan, China and Morocco emerge as the leading competitors. Demand for Egyptian frozen strawberries is highly price-elastic in Germany, New Zealand, and Poland, implying that reducing export prices is an effective strategy for expanding market share. In contrast, demand in the Japanese market is relatively less price-elastic, suggesting that non-price factors, such as quality standards and product specifications, play a more important role in maintaining market share. Furthermore, the Gravity Model reveals that the gross domestic product (GDP) of both Egypt and the importing countries has a strong positive effect on export volumes. Geographical distance, on the other hand, negatively affects trade in the basic model,

## Keywords

Foreign Trade Attraction Model, Substitution Elasticity Model, Market Share Model

## 1. Introduction

Agricultural exports are one of the main pillars supporting the national economy, particularly in developing countries seeking to boost their foreign exchange reserves. Frozen Egyptian strawberries represent an important non-traditional agricultural export commodity in Egypt, and they have witnessed remarkable growth in recent years, both in terms of export volume

and value. Export quantities increased from about 1,780 tons in 2006 to approximately 191,400 tons in 2024, with an average of around 52,060 tons during the period (2005–2024). Similarly, export values rose from approximately \$1.32 million in 2006 to about \$381.30 million in 2024, with an average of nearly \$99.98 million [4].

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This substantial growth has been associated with improvements in production efficiency, processing technologies, and the expansion of export markets, particularly in Europe and Asia. However, these markets are characterized by intense international competition, which makes it essential to analyze the competitiveness of Egyptian frozen strawberry exports, identify the key determinants of external demand, and examine the factors influencing their competitive position in global markets.

In this context, previous studies have extensively analyzed the competitiveness of Egyptian agricultural exports and the determinants of foreign demand using different analytical frameworks. For example, several studies have applied the Gravity Model to agricultural exports, confirming that economic size variables such as GDP and exchange rates positively affect export flows, while geographical distance has a negative impact [1, 2, 9, 10, 15]. Other studies have also highlighted that demand for some Egyptian agricultural exports is often price inelastic, indicating that price changes do not always lead to proportional changes in quantity demanded [1].

In addition, a number of studies have employed the Substitution Elasticity Model and related demand systems to analyze international competitiveness. These studies revealed strong competitive relationships between Egypt and other exporting countries, such as Spain, Morocco, and South Africa, particularly in fruit markets, where relative price changes significantly influence market shares and demand patterns [6, 11]. Furthermore, research based on market share analysis indicated that Egyptian exports tend to perform better in Arab markets compared to European markets, where competition is stronger and market penetration is more difficult [3, 4, 7].

Moreover, recent literature has emphasized that export competitiveness is no longer determined solely by price factors but increasingly depends on non-price factors such as product quality, compliance with international food safety standards, logistical efficiency, and marketing strategies [5, 8, 12, 14]. Although Egyptian strawberry exports have demonstrated a comparative advantage, some studies have pointed out instability in export performance due to price fluctuations and strong international competition [13].

Despite the importance of these contributions, several research gaps remain. First, most previous studies have focused on fresh strawberries or other agricultural commodities such as oranges, potatoes, and aromatic plants, while frozen strawberries have received relatively limited attention despite their increasing importance as a high value-added export product. Second, many studies have analyzed either specific markets or limited regional groups, which restricts the comprehensiveness of competitiveness assessment across global destinations. Third, existing studies are often based on earlier time periods and may not fully reflect recent developments in global trade dynamics, supply chain disruptions, and evolving international market conditions.

Furthermore, most previous research has relied on a single methodological framework, such as the Gravity Model, Market Share analysis, or Substitution Elasticity approaches separately, rather than integrating multiple models. In contrast, this study adopts a more comprehensive analytical framework by combining the Substitution Elasticity Model, Market Share Model, and Gravity Model in order to provide a multidimensional assessment of competitiveness.

Accordingly, this study differs from previous research in several key aspects: it focuses specifically on frozen strawberry exports, considers multiple major international markets simultaneously, employs a more recent time period, and integrates multiple econometric and descriptive models to analyze both demand determinants and competitive performance. This integrated approach allows for a more comprehensive understanding of the factors shaping the competitiveness of Egyptian frozen strawberry exports in global markets and provides deeper insights into their future export potential.

The international Harmonized System (HS) code for frozen strawberries is 081110, this code falls under Chapter 8, which deals with fruits and nuts, and applies to strawberries preserved by chilling or freezing, whether or not sugar or other sweeteners have been added.

## 2. The Study Problem

The research problem lies in the fact that, despite the significant growth in exports of frozen Egyptian strawberries in recent years, they face numerous.

Challenges in import markets, including strong competition from countries such as Poland, China, Belgium, and Morocco, high sensitivity to price fluctuations in global markets, and fluctuations in market share within key markets.

Consequently, the research problem is the extent to which frozen Egyptian strawberries can maintain their competitiveness in global markets amid price fluctuations and international competition.

## 3. Objectives of the Study

The research primarily aims to study the competitiveness of Egyptian frozen strawberry exports in the most important global markets. To achieve this objective, the following objectives were examined:

- 1) Identifying the main features of the export situation for Egyptian frozen strawberries.
- 2) Analysis of Factors Affecting Demand for Egyptian Frozen Strawberry Exports in Major Foreign Markets Using the Substitution Elasticity Model and the Market Share Model.
- 3) Estimation of the attractiveness model for Egyptian frozen strawberry exports in major foreign markets.

## 4. Research Method and Data Sources

To achieve its objectives, the research relied on both descriptive and quantitative statistical analysis methods appropriate to the nature of the data, through the use of mathematical and statistical methods such as arithmetic means, percentages, and regression analysis using the least squares method to estimate the general temporal trend of some of the variables under study. The research also utilized the Substitution Elasticity Model alongside the Market Share Model to measure the demand for Egyptian frozen strawberry exports in their most important foreign markets during the period (2005–2024). The Gravity Model was also estimated.

To achieve its objectives, the study relied primarily on the international information network Trade Map and global trade data from the United Nations Comtrade website and the Food and Agriculture Organization (FAO) website, in addition to relevant references, research, and studies related to the research topic.

## 5. Results

This section examines the main trends in the export performance of Egyptian frozen strawberries during the period 2005–2024. The analysis focuses on three key indicators: export volume, export value, and export price per ton.

### 5.1. Evolution of Export Volume

An analysis of the evolution of the volume of Egyptian frozen strawberry exports during the period (2005–2024), as shown in Table 1, reveals that it ranged from a minimum of approximately 1,780 tons in 2006 and a maximum of approximately 191,400 tons in 2024, representing an increase of 10,652.80% compared to the lowest level recorded during the study period.

The annual average volume of Egyptian frozen strawberry exports during this period was approximately 52,06 tons, indicating a significant expansion in the export capacity of this crop over time, particularly during the final years of the study period, which saw a clear surge from 2018 through 2024.

**Table 1.** Export volume, value, and unit export price of Egyptian frozen strawberries, 2005–2024.

Years	Export Volume (Thousand tons)	Export Value (Million dollars)	Export Price (USD/ton)
2005	2.21	1.55	701
2006	1.77	1.32	746
2007	6.58	6.29	955
2008	10.57	18.62	1,761
2009	7.80	10.84	1,390
2010	10.20	10.77	1056
2011	14.50	16.90	1,165
2012	11.30	20.80	1,838
2013	17.70	25.20	1426
2014	33.50	46.70	1395
2015	26.50	44.70	1,688
2016	26.40	44.50	1,687
2017	34.20	67.30	1971
2018	55.00	119.50	2172
2019	84.40	149.90	1776
2020	78.30	153.60	1962
2021	119.50	244.70	2048
2022	145.50	299.40	2058
2023	163.80	335.80	2050
2024	191.40	381.30	1992
Average	52.06	99.98	1,591.85

Years	Export Volume (Thousand tons)	Export Value (Million dollars)	Export Price (USD/ton)
Minimum	1.77	1.32	701.00
Maximum	191.40	381.30	2,172.00

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) Source: [17]

This continuous increase reflects an improvement in production and processing efficiency, as well as growing external demand for Egyptian frozen strawberries in international markets.

By estimating the general trend equation for the development of the volume of Egyptian frozen strawberry exports during that period, it is evident from Equation (1) in Table 2 there is a statistically significant annual increase of approximately eight, 80 tons, equivalent to about 16.90% of the average export volume during the same period. The coefficient of determination indicates that approximately 78.50% of the changes in export volume are attributable to the influence of factors reflected by the time component.

## 5.2. Evolution of Export Value

An analysis of the trend in the value of Egyptian frozen strawberry exports during the period 2005–2024, as shown in

Table 1, reveals that it ranged from a low of approximately \$1.32 million in 2006 and a maximum of approximately \$381.30 million in 2024, representing an increase of 28,786.40% compared to the lowest value. The overall average for Egyptian frozen strawberries during that period was approximately \$99.98 million.

This reflects the significant growth in export revenues for frozen Egyptian strawberries, driven by increased export volumes and improved prices.

By estimating the general trend equation for the evolution of the value of Egyptian frozen strawberry exports during that period, Equation (2) in Table 2 that there was a statistically significant annual increase of approximately \$18.095 million, equivalent to about 18.10% of the average export value during the same period. The coefficient of determination indicates that approximately 77.6% of the changes in export value are attributable to the influence of factors reflected by the time component.

**Table 2.** Trend equations for export volume, value, and export price of Egyptian frozen strawberries, 2005–2024.

Variable	Equation	R <sup>2</sup>	F	Average	Amount of change	Annual rate of change%
Export volume (thousand tons)	$Y_i = -40.39 + 8.80X_i$ (8.11)**	0.785	65.70**	52.06	8.80	16.90
Export Value (million dollars)	$Y_i = -90.01 + 18.095X_i$ (7.89)**	0.776	62.21**	99.98	18.095	18.10
Export Price (USD/ton)	$Y_i = 892 + 66.57X_i$ (6.949)**	0.728	48.29	1591.85	66.57	4.13

Where:  $Y_i$  = denotes the estimated value of the phenomenon.

$X_i$  = the time factor, where  $E = (1, 2, 3, \dots, 20)$  in years.

( $t$ )The value in brackets below the regression coefficients expresses the calculated ( $t$ ) value.

\*\*Significant at a significance level of 0.01.

Source: Collected and calculated from the data of Table 1.

## 5.3. Evolution of the Export Price Per Ton

An analysis of the evolution of the export price per ton of frozen Egyptian strawberries during the period (2005–2024) shows, as indicated in Table 1, that it ranged from a low of approximately \$701/ton in 2005, and a maximum of approximately \$2,172/ton in 2018, representing an increase of

209.8%. The average export price during the study period was approximately \$1,591.85/ton,

indicating a relative improvement in the market value of frozen Egyptian strawberries in global markets.

By estimating the general trend equation for the evolution of the export price per ton of frozen Egyptian strawberries during that period, Equation (3) in Table 2 shows there was a statistically significant annual increase of approximately

\$66.57/ton, equivalent to about 4.13% of the average export price per ton for the volume of exports during the same period. The coefficient of determination indicates that approximately 72.8% of the changes in the export price per ton are attributable to the influence of factors reflected by the time component.

## 6. External Demand for Egyptian Strawberry Exports: A Substitution Elasticity Analysis

To identify opportunities for increasing the competitiveness of Egyptian frozen strawberries in their most important export markets, the Substitution Elasticity Model was applied between Egypt and its main competitors in the markets currently targeted by Egypt, namely the German, New Zealand, Polish, and Japanese markets, during the period 2010–2024, where the model function takes the following form [6]:

$$QE_{jt} / QC_{jt} = f(PE_{jt} / PC_{jt}).T$$

Where:

QE<sub>jt</sub> = Quantity of Egyptian exports of frozen strawberries QE to the target market j in year t.

QC<sub>jt</sub> = Quantity of frozen strawberry exports to countries competing with Egypt in the target market j in year t.

PE<sub>jt</sub> = Egyptian export price of frozen strawberries PE to the target market j in year t.

PC<sub>jt</sub> = Export price of Egypt's competitor PC in the target market j in year t.

T = time.

The substitution elasticity was estimated directly from the logarithmic function as follows:

$$\ln(QE_{jt} / QC_{jt}) = B_0 + B_1 \ln(PE_{jt} / PC_{jt}) T + et$$

This model is used to estimate the elasticity of trade between two competing countries in a single market.

Where B<sub>1</sub> = the substitution elasticity coefficient. et = the estimation error.

The calculated elasticity reflects short-term and not long-term volatility, because the prices used in the model are calculated.

The necessary conditions in this model are: The income elasticity's of Egyptian exports of the crop with that of other countries in the, and the intersection between both agricultural

and other commodities in the markets of importing countries is equal zero, and without the two preceding conditions, there are other variables that must be included the model.

## 7. Substitution Elasticity Estimates for Egyptian Strawberry Exports During the Period (2010–2024)

### 7.1. German Market

The data in Table 3 The results of estimating the substitution model for German market imports of frozen Egyptian strawberries from Egypt and its competitor countries during the study period. The results show that Poland, Belgium, and China are Egypt's main competitors in the market, and the regression coefficients (b<sub>1</sub>) for all three countries, and they are all negative in sign, meaning that the relationship is inverse with the dependent variable; that is, an increase in the relative price leads to a decrease in the ratio of the quantity of Egyptian frozen strawberry imports to the quantity of imports from the competing country in the German market. The results also show that Poland is Egypt's largest competitor in the German market, with a substitution elasticity between Egyptian and Polish exports of approximately 1.11. This means that a 1% increase in the ratio of Egypt's export price to Poland's export price leads to a decrease in the ratio of the quantity imported from Egypt to that imported from Poland by approximately 1.11%. Belgium ranks second, with a substitution elasticity of approximately 1.13, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the proportion of imports from Egypt relative to imports from Belgium by about 1.13%, while China ranks third, with a substitution elasticity of 5.46, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the ratio of imports from Egypt to imports from China by approximately 5.46%.

The results also showed that the estimated elasticity coefficients were greater than one for the three competing countries (elastic demand), which reflects that demand for Egyptian frozen strawberries in the market under study is highly elastic to changes in relative prices; that is, a rise in Egypt's relative price may lead to a significant loss of market share to competing countries.

**Table 3.** Substitution elasticity estimates for Egyptian frozen strawberry exports in the German market, 2010–2024.

Competitor Country	Constant	Relative price	R <sup>2</sup>	F- statistic	Elasticity
Poland	2.98	-1.11	0.36	7.15*	-1.11
Belgium	0.77	-1.13	0.47	11.61**	-1.13

Competitor Country	Constant	Relative price	R <sup>2</sup>	F- statistic	Elasticity
China	2.53	-5.46	0.62	20.88**	-5.46

\* Significant at the 5% level. \*\* Significant at the 1% level.

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) (Source: [17])

Given that the determination coefficients (R<sup>2</sup>) ranged from 0.36 to 0.62, it is evident that the price variable explains a moderate to high proportion of the variation in relative market share, particularly in the case of China, underscoring the pivotal importance of the price factor in determining competitiveness within the German market.

## 7.2. New Zealand Market

The data in Table 4 Shows the results of the substitution model estimation for imports into the German market of frozen Egyptian strawberries from Egypt and its competitor countries during the study period. It indicates that Poland, Germany, and Sweden are Egypt's main competitors in the New Zealand market, and the regression coefficients (b<sub>1</sub>) for the three countries, and they are all negative in sign, meaning that the relationship is inverse with the dependent variable; that is, an increase in the relative price leads to a decrease in the ratio of the quantity of Egyptian frozen strawberry imports to the quantity of imports from the competing country in the New Zealand market. The results also show that Poland is Egypt's biggest competitor in the New Zealand market, with the substitution elasticity between Egyptian and Polish exports reaching approximately 1.38, meaning that a 1% increase in the ratio of Egypt's export price to Poland's export

price leads to a decrease in the ratio of the quantity imported from Egypt to the quantity imported from Poland by approximately 1.38%. Germany ranks second, with a substitution elasticity of approximately 1.52, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the ratio of the quantity imported from Egypt to the quantity imported from Belgium by approximately 1.52%, while Sweden ranks third, with a substitution elasticity of 1.78, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the ratio of imports from Egypt to imports from China by approximately 1.78%.

The results also showed that the estimated elasticity coefficients were greater than one for the three competing countries (elastic demand), which reflects that demand for Egyptian frozen strawberries in the market under study is highly elastic to changes in relative prices; that is, a rise in Egypt's relative price may lead to a significant loss in its market share to competing countries.

Given that the coefficients of determination (R<sup>2</sup>) ranged from 0.33 to 0.54, it is evident that the price variable explains a moderate to high proportion of the variation in the relative market share of Egyptian exports, with explanatory power peaking in the case of Germany (0.54), followed by Sweden (0.42), and then Poland (0.33).

**Table 4.** Substitution elasticity estimates for Egyptian frozen strawberry exports in the New Zealand market, 2010–2024.

Competitor Country	Constant	Relative price	R <sup>2</sup>	F- statistic	Elasticity
Poland	1.87	-1.38	0.33	6.38*	-1.38
Germany	0.31	-1.52	0.54	15.33**	-1.52
Sweden	0.54	-1.78	0.42	9.36**	-1.78

\* Significant at the 5% level. \*\* Significant at the 1% level.

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) (Source: [17])

## 7.3. Polish Market

The data in Table 5 Shows the results of the substitution model estimation for imports into the Polish market of frozen Egyptian strawberries from Egypt and its competitor countries during the study period. It indicates that Germany, China, and Morocco are Egypt's main competitors in the market, and the

regression coefficients (b<sub>1</sub>) for all three countries, and that they are all negative in sign, meaning that the relationship is inverse with the dependent variable; that is, an increase in the relative price leads to a decrease in the ratio of the quantity of Egyptian frozen strawberry imports to the quantity of imports from the competing country in the Polish market. The results also show that Morocco is Egypt's biggest competitor in the German market, where the substitution elasticity between

Egyptian and Moroccan exports is approximately 1.17. This means that a 1% increase in the ratio of Egypt's export price to Poland's export price leads to a decrease in the ratio of the quantity imported from Egypt to the quantity imported from Morocco by approximately 1.17%. Germany ranks second, with a substitution elasticity of approximately 2.78, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the proportion of imports from Egypt relative to imports from Germany by about 2.78%. China ranks third, with a substitution elasticity of 2.88, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the ratio of imports from Egypt to imports from China by approximately 2.88%.

The results also showed that the estimated elasticity coefficients were greater than one for the three competing countries (elastic demand), which indicates that demand for Egyptian frozen strawberries in the market under study is highly elastic with respect to changes in relative prices; that is, a rise in Egypt's relative price could lead to a significant loss of market share to competing countries.

Given that the determination coefficients ( $R^2$ ) ranged from 0.26 to 0.32, it is evident that the price variable explains a moderate to high proportion of the variation in relative market share, with the highest value recorded for Morocco (0.32), while it stood at 0.26 for both Germany and China.

**Table 5.** Substitution elasticity estimates for Egyptian frozen strawberry exports in the Polish market, 2010–2024.

Competitor Country	Constant	Relative price	$R^2$	F- statistic	Elasticity
Germany	0.49	-2.78	0.26	4.57*	-2.78
China	0.42	-2.88	0.26	4.60*	-2.88
Morocco	0.79	-1.17	0.32	6.00*	-1.17

\* Significant at the 5% level. \*\* Significant at the 1% level.

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) (Source: [17])

#### 7.4. Japanese Market

The data in Table 6 The results of estimating the substitution model for imports into the Polish market of frozen Egyptian strawberries from Egypt and its competitor countries during the study period. The results indicate that China, Morocco, and the United States (US) are Egypt's main competitors in the market, and the regression coefficients ( $b_1$ ) for all three countries, and they are all negative in sign, meaning the relationship is inverse with the dependent variable; that is, an increase in the relative price leads to a decrease in the ratio of the quantity of Egyptian frozen strawberry imports to the quantity of imports from the competing country in the Japanese market. The results also show that China is Egypt's largest competitor in the Japanese market, with a substitution elasticity between Egyptian and Chinese exports of approximately 1.13. This means that a 1% increase in the ratio of Egypt's export price to Poland's export price leads to a decrease in the ratio of the quantity imported from Egypt to the quantity imported from China by approximately 1.13%. The United States (US) ranks second, with a substitution elasticity of approximately 1.80. This means that a 1% increase in the price ratio between the

two countries leads to a decrease in the ratio of imports from Egypt to imports from Germany by approximately 1.80%. Morocco ranks third, with a substitution elasticity of 18.78, meaning that a 1% increase in the price ratio between the two countries leads to a decrease in the ratio of imports from Egypt to imports from China by approximately 18.78%.

The results also showed that the estimated elasticity coefficients were greater than one for the three competing countries (elastic demand), which reflects that demand for Egyptian frozen strawberries in the market under study is highly elastic with respect to changes in relative prices; that is, a rise in Egypt's relative price may lead to a significant loss of market share to competing countries.

Given that the coefficient of determination ( $R^2$ ) ranged from 0.70 to 0.89—high values indicating a very strong explanatory power of the price variable in explaining changes in relative market share—the highest value was recorded for the United States (US) (0.89), followed by Morocco (0.80) and then China (0.70). The F-test values were also high and statistically significant at the 1% level, confirming the significance of the model as a whole and the strength of the explanatory relationship.

**Table 6.** Substitution elasticity estimates for Egyptian frozen strawberry exports in the Japanese market, 2010–2024.

Competitor Country	Constant	Relative price	R <sup>2</sup>	F- statistic	Elasticity
China	2.41	-1.13	0.70	29.70**	-1.13
Morocco	11.43	-18.78	0.80	52.20**	-18.78
United States (US)	2.30	-1.80	0.89	109.19**	-1.80

\*\* Significant at the 1% level.

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) (Source: [17])

## 8. Estimating External Demand for Egyptian Frozen Strawberry Exports: A Market Share Analysis

External Demand for Egyptian Frozen Strawberry Exports: A Market Share Analysis

The demand functions for Egyptian frozen strawberry exports and their main competitors within the target markets currently targeted by Egypt, as previously mentioned, were estimated, where the dependent variable represents the ratio of Egypt's frozen strawberry exports to the total imports of the target market, or what is known as market share, using the following equation [3]:

$$(QE_{jt} / Q_{jt}) = F [(PE_{jt} / P_{ajt}). T]$$

Where:

$QE_{jt}$  = Quantity of Egyptian exports of frozen strawberries QE to the target market j in year t.

$Q_{jt}$  = Total quantity of frozen strawberry imports Q in the target market j in year t.

$PE_{jt}$  = Egyptian export price of frozen strawberries PE to the target market j in the year t.

$P_{ajt}$  = Average price of competing countries Pa in the target market j in year t.

T = the time component.

In the short run, the market share elasticity ( $E_i$ ) of Egyptian strawberries relative to the relative price ( $PE_{jt} / P_{ajt}$ ) in competing countries within the market can be calculated as follows [2]:

$$E_i = \gamma b (PE_{jt} / P_{ajt}) / (QE_{jt} / Q_{jt})$$

Where b = the regression coefficient of the variable ( $PE_{jt} / P_{ajt}$ ) in the previous equation at the averages of both the relative price ( $PE_{jt} / P_{ajt}$ ) and the market share ( $QE_{jt} / Q_{jt}$ ) for the import market during the study period, and this elasticity This elasticity equals the price elasticity of demand for Egyptian frozen strawberry exports, assuming Q is constant; that is, changes in total imports of Egyptian frozen strawberries into market i are considered negligible relative to minor changes in the price of market i's imports of Egyptian frozen strawberries,  $P_1$ .

## 9. Results Market Share Estimates for Egyptian Frozen Strawberry Exports

### 9.1. German Market

The data in Table 7 show: the results of estimating the market share model for exports of frozen Egyptian strawberries to the German market during the study period. The results indicate that the sign of the relative price coefficient is negative, consistent with economic theory, reflecting an inverse relationship between the relative price of Egyptian exports and their market share.

This coefficient was also statistically significant, confirming the strong explanatory power of the price variable. The elasticity coefficient was greater than one, indicating that demand for frozen Egyptian strawberries in the German market exhibits a high degree of price elasticity. This means that a 1% decrease in the relative price of Egyptian exports leads to an increase in their market share of approximately 2.3%, meaning that lowering the export price is the appropriate policy to increase the market share of Egyptian frozen strawberry exports to the German market.

**Table 7.** Market-share model estimates for Egyptian frozen strawberry exports in selected foreign markets, 2010–2024.

Market	Constant	Relative Price Coefficient	R <sup>2</sup>	F - statistic	Elasticity
Germany	1.88	-2.34	0.80	48.69**	-2.34

Market	Constant	Relative Price Coefficient	R <sup>2</sup>	F - statistic	Elasticity
New Zealand	2.11	-2.67	0.71	31.64**	-2.67
Poland	1.67	-1.87	0.48	11.74**	-1.87
Japan	0.46	-0.63	0.74	36.65**	-0.63

Where: ( )The value in brackets below the regression coefficients expresses the calculated (t) value.

\* Significant at the 5% level. \*\* Significant at the 1% level.

Compiled and calculated from data from: World Trade Map website, [www.trademap.org](http://www.trademap.org) (Source: [17])

## 9.2. New Zealand Market

The data in Table 7 shows: the results of estimating the market share model for Egyptian frozen strawberry exports to the New Zealand market during the study period. The results indicate that the relative price coefficient is negative and consistent with economic theory, reflecting an inverse relationship between the relative price of Egyptian exports and their market share.

This coefficient was also statistically significant, confirming the strong explanatory power of the price variable.

The elasticity coefficient was greater than one, indicating that demand for frozen Egyptian strawberries in the German market exhibits a high degree of price elasticity. This means that a 1% decrease in the relative price of Egyptian exports leads to an increase in their market share of approximately 2.67%, meaning that lowering the export price is the appropriate policy to increase the market share of Egyptian frozen strawberry exports to the New Zealand market.

## 9.3. Polish Market

The data in Table 7 shows: the results of estimating the market share model for Egyptian frozen strawberry exports to the Polish market during the study period. The results indicate that the relative price coefficient is negative and consistent with economic theory, reflecting an inverse relationship between the relative price of Egyptian exports and their market share.

The significance of this coefficient was also statistically proven, confirming the strong explanatory power of the price variable.

The elasticity coefficient was greater than one, indicating that demand for frozen Egyptian strawberries in the German market exhibits a high degree of price elasticity; this means that a 1% decrease in the relative price of Egyptian exports leads to an increase in their market share of approximately 1.87%. In other words, lowering the export price is the appropriate policy for increasing the market share of Egyptian frozen strawberry exports to the Polish market.

## 9.4. Japanese Market

The data in Table 7, mentioned earlier, shows the results of

estimating the market share model for Egyptian frozen strawberry exports to the Japanese market during the study period. The relative price coefficient was approximately 0.63, with a negative sign consistent with economic theory, and its significance was statistically proven. The elasticity coefficient was approximately (less than one), meaning that for every 1% decrease in the price ratio of Egyptian frozen strawberry exports relative to the average price of competing countries, the market share of Egyptian strawberries in the Japanese market increases by 0.63%. Therefore, lowering the export price in the Japanese market will result in only a slight increase in exports of frozen Egyptian strawberries to that market. As for raising the price, it will not cause a significant decrease in the quantities demanded; rather, it will lead to an increase in the value of exports, but with a greater emphasis on quality and compliance with specifications to suit consumer tastes.

## 10. Attractiveness Analysis of Egyptian Frozen Strawberry Exports in Major Markets

Model Description:

The Gravity Model of international trade is based on the law of gravity. The Gravity Model is fundamentally based on Isaac Newton's law (1687), which states that the gravitational force between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them [1]:

$$(\text{Newton})F=G \frac{M_1 M_2}{D^2} \quad (1)$$

Jan Tinbergen subsequently applied this concept to international trade, resulting in the following equation

$$(\text{Jan Tinbergen}) Y_{ij} =G \frac{M_i M_j}{\text{Dist}_{ij}} \quad (2)$$

Equation (2) was then reformulated to become an exponential equation in the following form:

$$Y_{ij} =B_0 \text{GDP}_i^{B_1} \text{GDP}_j^{B_2} \text{Dist}_{ij}^{-B_3} \quad (3)$$

Taking the logarithm of both sides' results in a linear equation in the form of a logarithmic function as follows:

$$Y_{ij} = B_0 + B_1 \ln GDP_i + B_2 \ln GDP_j - B_3 \ln DiStij + e_{ij} \quad (4)$$

Where: Gross Domestic Product in the two countries Gap & Dip

The geographical distance between the two countries Dist<sub>ij</sub>  
The random error e<sub>ij</sub>

This equation (4) is referred to as the "Basic Gravity Model" (BGM)

Then, the economist [Linneman] added the populations of the two countries to the basic model equation and called it the Augmented Gravity Model (AGM).

$$\ln Y_{ij} = B_0 + B_1 \ln Pc GDP_i + B_2 Pc GDP_j - B_3 \ln Dist_{ij} + e_{ij} \quad (5)$$

The Gravity Model relies on cross-sectional data representing the number of countries and time series representing the years, and the application of the model is subject to a fundamental condition: the number of cross-sectional data points (S) must not exceed the number of years in the specified time series (T).

The study used two gravity models: the basic model and the modified model. When estimating the basic model, the following data were entered: the gross domestic product (GDP) of

the exporting country (Egypt), the GDP of the importing countries, and the geographical distance between the capitals of those countries and Egypt.

When estimating the modified model, data on per capita GDP in Egypt, as well as per capita GDP in the importing countries, were used, in addition to the geographical distance between the capitals of those countries and Egypt.

To estimate the attraction model for Egyptian frozen strawberry exports in the most important foreign markets, the most significant countries in terms of the volume of Egyptian frozen strawberry exports were selected, using an average for the period (2015–2024).

The Common Constant method was used via the Pooled Regression Model (PRM), as this method assumes homogeneity of the data set and no differences between country segments—i.e., a single segment represents all countries—and does not reduce the independent variables to the random error term.

A heteroskedasticity test was also conducted: Breach–Pagan–Godfrey, which is known as the test for heteroskedasticity of random errors, to detect the problem of varying variance in model errors. It was found that during the period (2015–2024), the F–statistic value for both the basic and adjusted gravity models was approximately 0.70, 2.26 with a probability value of F (3.86) of approximately 0.56 and 0.09, respectively, which is greater than 0.05. Therefore, we accept the hypothesis that neither model suffers from a problem of heteroscedasticity in the random errors.

**Table 8.** Basic and augmented gravity model estimates for Egyptian frozen strawberry exports, 2015–2024.

Variable	Equation	R <sup>2</sup>	F
1- Basic Model	$\ln y = -4.00 + 0.27 \ln x_1 + 2.49 \ln x_2 - 0.51 \ln x_3$ (2.35)* (5.09)** (-2.17)*	0.29	11.49**
2- The Modified Model	$\ln y = 1.78 + 0.75 \ln w_1 + 1.95 \ln w_2 - 0.19 \ln x_3$ (2.67)** (3.17)** (0.98)	0.21	7.48**

Where:

\*\* Significant at the 0.01 level \* Significant at the 0.05 level.

() The numbers in parentheses refer to the calculated value of "t".

Y = Volume of Egyptian exports of the crop in thousands of tons

x<sub>1</sub> = Gross Domestic Product (GDP) of importing countries in billions of dollars GDP<sub>j</sub>

x<sub>2</sub> = Egypt's GDP in billions of dollars (GDP<sub>i</sub>)

x<sub>3</sub> = Distance between Egypt and the importing countries in kilometers

w<sub>1</sub> = Per capita GDP of importing countries in thousands of dollars Pc GDP<sub>j</sub>

w<sub>2</sub> = Per capita GDP of Egypt in thousands of dollars Pc GDP<sub>i</sub>

Source: Compiled and calculated from data:

1- Central Agency for Public Mobilization and Statistics, International Information Network [www.capmas.org](http://www.capmas.org) (Source: [16])

2- World Trade Organization, International Information Network [www.comtrade.org](http://www.comtrade.org) (Source: [19])

3- World Bank World Development Indicators Database, available at: <https://data.worldbank.org> (Source: [18])

The results of the basic gravity model for the major importers of Egyptian strawberries—namely Germany, China, Russia, the Netherlands, Poland, the United States (US), Saudi Arabia, Japan, Belgium, Italy, and France—during the period

2015–2024, as shown in Table 8, that the model is statistically significant at the 0.01 significance level, with an F–value of approximately 11.49, reflecting the model's suitability for ex-

plaining the relationship between the economic variables influencing the flow of Egyptian exports of frozen strawberries to the countries under study. The adjusted coefficient of determination ( $R^2$ ) was approximately 0.29, indicating that the independent variables in the model explain about 29% of the variation in the volume of Egyptian frozen strawberry exports to those countries, while the remaining variation in export volume is attributed to other factors not measured by the model, and that a 1% increase in the gross domestic product (GDP) of countries importing Egyptian strawberries will lead to a 0.27% increase in the volume of Egyptian exports of frozen Egyptian strawberries to these countries. The results indicate that a 1% increase in Egypt's GDP will lead to a 2.49% increase in the volume of Egyptian exports of frozen strawberries to countries importing Egyptian Frozen Strawberry, and that a 1% increase in the geographical distance between Egypt and these countries will lead to a 0.51% decrease in the volume of Egyptian exports to these countries.

The results of the modified gravity model for the major importers of Egyptian strawberries mentioned above during the same period and shown in the same table indicate that the model is statistically significant at the 0.01 significance level, with an F-value of approximately 7.48, indicating a statistically significant relationship between the independent variables and the dependent variable. The adjusted coefficient of determination ( $R^2$ ) was approximately 0.207, which indicates that the variables included in the adjusted model explain approximately 20.7% of the variations in the volume of Egyptian exports of frozen Egyptian strawberries to the countries under study, while the remaining variations in export volume are attributed to other factors not measured by the model, and that a 1% increase in the per capita GDP of countries importing Egyptian strawberries will lead to a 0.75% increase in the volume of Egyptian exports of frozen strawberries to these countries, and that a 1% increase in per capita GDP will lead to a 1.95% increase in the volume of Egyptian exports of frozen strawberries. The results of the study in the modified model indicate that the Geographical distance variable does not always retain its traditional negative effect as assumed by gravity models; the study found a positive coefficient of approximately 0.19, though it is not statistically significant. This can be explained by the development of transportation and international supply chains, or by the fact that trade with the countries under study depends more on demand and income factors than on geographical distance.

Comparing the two models, it is clear that the baseline model has relatively higher explanatory power compared to the modified model, as the coefficient of determination recorded a higher value, and the geographical distance variable was consistent with economic theory in the baseline model, whereas its effect was not statistically significant in the modified model. Nevertheless, the modified model provides a complementary explanation based on per capita income and purchasing power in trading partner countries, which may be more closely linked to patterns of demand for agricultural exports.

In general, the results of both models confirm the relative importance of both the size of the economy and the income level in importing countries and the Egyptian economy in determining the volume of Egyptian exports, which is consistent with the basic assumptions of the gravity model in international trade.

*In light of these results, the study recommends the following:*

- 1) Work to increase strawberry exports by focusing on product quality and adhering to international standards, particularly in developed markets.
- 2) Work to enhance the market access of frozen strawberry exports to importing markets, whether by improving price competitiveness or by studying and strengthening non-price competitive advantages such as contracts, taste, export timing, and international protocols.
- 3) Work to reduce production costs to increase price competitiveness.
- 4) Focus on agricultural processing and freezing to increase added value.
- 5) Diversify export markets to mitigate risks.
- 6) Work to support export policies and overseas promotion.

## Abbreviations

GDP Gross Domestic Product

## Author Contributions

**Mohamed Refaat Mohamed:** Conceptualization, Data curation, Formal Analysis, Methodology, Resources, Writing – original draft

**Shimaa Masoud Bedair:** Supervision, Validation, Writing – review & editing

**Manal Raafat Zakaria:** Validation, Writing – review & editing

**Mohamed Mehana Abd Eltawab:** Data curation, Investigation, Writing – review & editing

## Conflicts of Interest

The authors declare that there is no conflict of interest related to the conduct, analysis, or publication of this study.

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