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RESEARCH PAPER

Strategy to Reduce the Trade Balance Deficit for Red Meat in the Kingdom of Saudi Arabia

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ABSTRACT

OBJECTIVES: As the trade balance deficit for red meat continues to increase in Saudi Arabia, this study aims to develop a strategy to reduce it based on published data and quantitative economic analysis.

METHODOLOGY: This study relies on quantitative economic analysis represented by the coefficient of geographical concentration, measured by several indicators, the most important of which is the Hirschman index. In addition, linear programming is used to maximise the value of exports and minimise the value of imports of red meat.

RESULTS: This research shows that the value of imports exceeds that of Saudi exports of red meat, leading to an increase in the trade balance deficit at an annual growth rate of 7.4% during the period 2000-2021. The total amount of red meat exports to nine countries (UAE, India, Bahrain, Yemen, Bangladesh, Egypt, Jordan, Oman, and Djibouti) reached 85.94%, while the total amount of red meat imports from seven countries (Brazil, India, Australia, New Zealand, Pakistan, Ethiopia, and Sudan) reached 92.91% during the period 2017-2021.

By maximising the value of exports and minimising Saudi import value of red meat, the same amount of red meat can be exported and imported. This is in addition to reducing the trade balance deficit for red meat from US$653.76m to US$597.52m, a reduction in the deficit of 8.60%. In light of these results, it is recommended that the geographical distribution of both Saudi exports and imports are restructured so that the trade balance deficit for red meat can be reduced.

KEYWORDS: *Exports and Imports; Red Meat; Linear Programming; Saudi Arabia*

INTRODUCTION

In 2021, Saudi Arabia had livestock of 17.54 million sheep, about 6.1 million goats, 1.39 million camels, and about 354.28 thousand cattle, in addition to 63.37 thousand horses (Ministry of Environment, Water and Agriculture, 2022). Ghanem and Al-Dowais (2018) predicted a decrease in the target production of red meat from 162.86 thousand tonnes in 2018 to 161.76 thousand tonnes in 2030. The target consumption of red meat was expected to increase from 398.5 thousand tonnes in 2018 to 510.3 thousand tonnes in 2030. The target amount of red meat imports is expected to increase from 257.1 thousand tonnes in 2018 to 437.4 thousand tonnes by 2030. The strategic stock of red meat is 189.34 thousand tonnes at the end of the period 2018-2030. In light of expected domestic consumption of red meat of 510.3 thousand tonnes by 2030, the food security coefficient of red meat was estimated at 0.37 at the end of the period 2018-2030.

Due to insufficient domestic production to meet consumer needs, Saudi Arabia imported a quantity of red meat. This increased from 105.12 thousand tonnes, at a value of US$202.49m in 2000, to 152.61 thousand tonnes, at a value of US$789.56m in 2021. The amount of Saudi exports of red meat also increased from 0.68 thousand tonnes, at a value of US$1.17m in 2000, to 23.7 thousand tonnes, at a value of US$57.45m in 2012, and then decreased to 1.88 thousand tonnes, at a value of US$7.55m in 2021. The average import price of red meat by Saudi Arabia was US$3,571.86/tonne, while its export counterpart was US$2,724.49/tonne. Therefore, average import prices are higher than export prices by US$847.37/tonne, an increase of 31.1% during the period 2000-2021 (FAO, 2021).

Due to the higher value of imports over exports, the value of the trade balance deficit for red meat increased from US$201.32m in 2000 to US$782.01m in 2021; that is, the value of the trade

balance deficit for red meat increased at an annual growth rate of 7.4% during the period 2000-2021 (Figure 1).

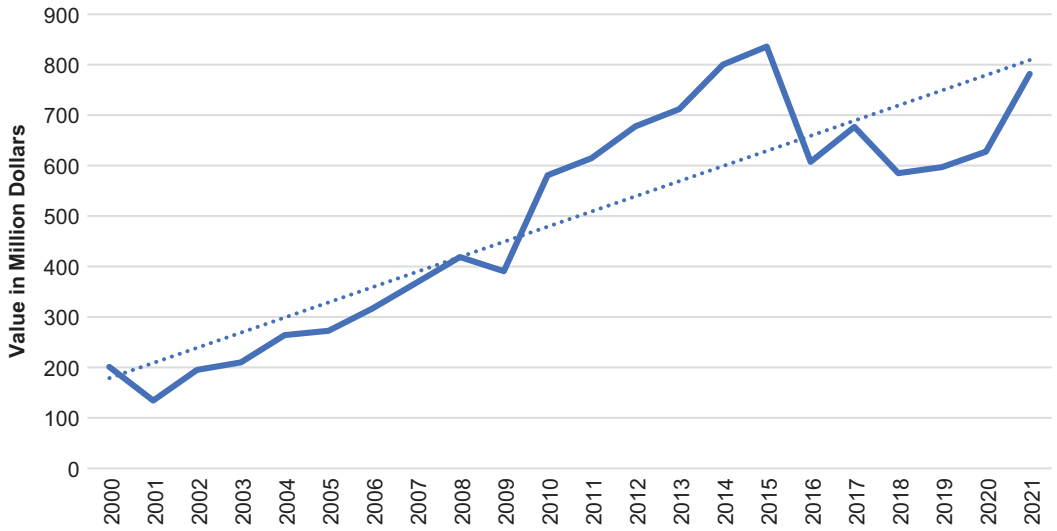

Figure 1: Evolution of the Trade Balance Deficit for Red Meat During the Period 2000-2021
Source: FAOSTAT, 2000-2021

Given the seriousness and worsening value of the trade balance deficit for red meat, the Ministry of Environment, Water and Agriculture announced that the deficit had to be reduced. In this regard, this study raises several questions, the most important of which are:

1. Is the export and import pattern of red meat geographically concentrated?
2. Has the export policy for red meat focused on international markets where Saudi Arabia is competitive?
3. How can the amount of the red meat trade balance deficit be reduced?

Some studies have been concerned with maximising the value of exports. Kamara (2013) studied the economic importance of current and proposed Egyptian production and exports of dry onions, showing that the proposed geographical distribution of Egyptian exports of dry onions requires increasing the quantity exported to Saudi Arabia to reach 160.67 thousand tonnes, at a value of US$36.76m. It is also preferable not to export to the Russian Federation, Romania, the United Arab Emirates (UAE), Oman, Ukraine, or Libya. The value of Egyptian dry onion exports could be increased from US$53.75m to US$55.07m, an increase of US$1.32m, representing 2.5% of the average value of Egyptian dry onion exports during the period 2000-2010. El-Gendy and El-Gendy (2017) studied the optimal economic distribution of Egyptian rice exports. This study showed that

restructuring the geographical distribution of Egyptian rice exports achieved an increase in their value, amounting to 11.8%, 16.5%, and 12.0% according to the models proposed in the study.

Other studies have been interested in reducing the value of imports. Sayed *et al*. (2012) conducted the most favourable geographical distribution of Egypt's imports of municipal beans. The study showed that the same quantity of 201.2 thousand tonnes could be imported at about E£718.3m[1], thus saving approximately E£21m, representing 2.8% of the value of Egyptian imports of municipal beans amounting to E£739.3m during the period 2006-2010. Rashdan *et al*. (2021) aimed to try to reach the optimal geographical distribution of Egypt's imports of chicken meat. Their study showed that the proposed models achieved a minimisation of the value of Egyptian imports, thus achieving a saving in the state's trade balance, ranging from 2.67%-23.73%.

From the above, it is clear that previous studies dealt with only one aspect of foreign trade. Some studies aimed at maximising the value of exports, and others aimed at minimising the value of imports. This study is different from previous studies in that it deals with both sides of foreign trade (exports and imports) in preparation for developing a strategy to reduce the red meat trade balance deficit.

Research Objectives

This research aimed to develop a strategy to reduce the trade balance deficit for red meat in the Kingdom of Saudi Arabia (KSA) by studying the following sub-objectives:

1. the current geographical distribution pattern of the quantity and value of the export and import of red meat during the period 2017-2021
2. determining the optimal geographical distribution pattern for exporting and importing red meat to Saudi Arabia;
3. proposing realised scenarios to reduce the trade deficit for red meat.

Research Methodology

In achieving its objectives, this study relied on secondary data issued by government agencies, the most important being the Ministry of Environment, Water and Agriculture, and the General Authority for Statistics; this is in addition to international organisations, the most important being the Food and Agriculture Organization (FAO). This study also relied on quantitative economic analysis represented in the following models:

(1) The coefficient of geographical concentration, measured by several indicators, the most important being the Hirschman index, 1964 (Lapteacru, 2012):

$$C_{jx} = 100 \times \sqrt{\sum \left(\frac{X_{sj}}{X_i} \right)^2}$$

[1] Egyptian Pounds

Whereas:

C_{jx}: Geographic concentration coefficient,

X_{sj}: the quantity and value of exports and imports of red meat to or from a country;

X_i: Total quantity and value of Saudi exports and imports of red meat.

The value of the geographical concentration coefficient lies between zero and one. When this indicator is closer to one, this indicates that exports and imports are distributed over a few international markets. If the value of this indicator is close to zero, this indicates expansion in international markets.

(2) Linear programming used to maximise the value of exports and minimise the value of imports of red meat; the model used to maximise the value of exports can be expressed as follows (Bector and Chandra, 2005):

$$Max\ Z = C\ X$$
$$S.\ to:$$
$$A\ X \leq b$$
$$X \geq 0$$

Whereas: Z represents the value of the target function to be maximised, **C** represents the average export prices of red meat, **X** represents the international markets for red meat, ***b*** represents the restrictions imposed, which is the total quantity of Saudi exports of red meat, in addition to the absorptive capacity of the markets of Saudi exports of red meat.

The model used to minimise the value of imports could be expressed as follows (Bector and Chandra, 2005):

$$Min\ Z = C\ X$$
$$S.\ to:$$
$$A\ X \geq b$$
$$X \geq 0$$

Whereas: Z represents the value of the target function to be minimising, which is to reduce the costs of importing red meat in light of the export capacity restrictions of the countries from which it was imported in 2017-2021. **C** is also a vector of **(nx1)** for the average import prices of red meat for the Kingdom in dollars/tonne, and **X** is a vector of **(nx1)** for the countries from which it was imported. **A** is the matrix of technical coefficients of order **(m x n)**.

RESULTS

First: The Current Geographical Distribution Pattern for the Export and Import of Red Meat to KSA

Current Geographical Distribution Pattern of Red Meat Exports

By studying the current geographical distribution pattern of red meat exports during the period 2017-2021, it is clear from the data contained in Table 1 and Figure 2 that KSA exported a quantity of red meat amounting to 1514.23 tonnes to the United Arab Emirates, representing 34.62% of the average total red meat exports of 4373.42 tonnes during the period 2017-2021. India also exported approximately 14.55% of the average total red meat exports, followed by Bahrain, Yemen, Bangladesh, Egypt, Jordan, Oman, and Djibouti, with percentages of 10.54%, 9.51%, 4.86%, 4.35%, 3.48%, 2.15%, and 1.88% respectively. From the above, it is clear that the total relative importance of the quantity of Saudi exports of red meat to the countries mentioned above amounted to 85.94%, while the relative importance of exporting red meat to the remaining countries does not exceed 14.06% during the period 2017-2021. By calculating the geographical concentration coefficient for the quantity and value of red meat exports, it was found that it was 41.1% and 46.9% during the study period. The coefficient of geographical concentration is considered high if it is above 0.4 from Michael y's point of view (Ghanem, 1998). The average export price of red meat ranged from a minimum of US$679.8 /tonne for Djibouti and a maximum of US$6,004.2 /tonne for Pakistan, with an average of US$2,959.73 /tonne during the period 2017-2021.

Table 1: Geographical Distribution of the Quantity and Value of Red Meat Exports During the Period 2017-2021

Country	Quantity in Tonnes	Value Dollars	Price Dollar/ Tonne	Relative Importance %	
				Quantity	Value
UAE	1,514.23	6,197.2	4,092.6	34.62	41.48
India	636.26	2,263.4	3,557.4	14.55	15.15
Bahrain	460.75	1,781.2	3,865.9	10.54	11.92
Yemen	415.95	745.8	1,793.0	9.51	4.99
Bangladesh	212.61	1,123.6	5,284.8	4.86	7.52
Egypt	190.37	308.4	1,620.0	4.35	2.06
Jordan	151.98	191.4	1,259.4	3.48	1.28
Oman	94.24	314.2	3,334.0	2.15	2.10
Djibouti	82.38	56.0	679.8	1.88	0.37
Pakistan	72.25	433.8	6,004.2	1.65	2.90
Iraq	64.13	241.2	3,761.1	1.47	1.61
Lebanon	53.89	277.4	5,147.5	1.23	1.86
Turkey	43.96	40.0	909.9	1.01	0.27

(continued)

Table 1: Geographical Distribution of the Quantity and Value of Red Meat Exports During the Period 2017-2021 *(continued)*

Country	Quantity in Tonnes	Value Dollars	Price Dollar/ Tonne	Relative Importance %	
				Quantity	Value
Guinea & Guinea-Bissau	42.12	29.2	693.3	0.96	0.20
Tanzania	30.66	148.6	4,846.7	0.70	0.99
Kuwait	29.51	118.8	4,025.8	0.67	0.80
Azerbaijan	29.46	143.4	4,867.6	0.67	0.96
Qatar	28.14	74.2	2,636.8	0.64	0.50
Spain	26.85	143.8	5,355.7	0.61	0.96
Brazil	24.73	87.8	3,550.3	0.57	0.59
Sierra Leone	19.06	13.2	692.5	0.44	0.09
Mauritania	18.65	13.4	718.5	0.43	0.09
Senegal	18.65	13.4	718.5	0.43	0.09
Other countries	112.59	182.2	1,618.3	2.57	1.22
Total	4,373.42	14,941.6	-	100.00	100.00

Source: (1) FAO, website (FAOSTAT), period 2000-2021, (2) General Authority for Statistics, International Trade Statistics Bulletin, 2021

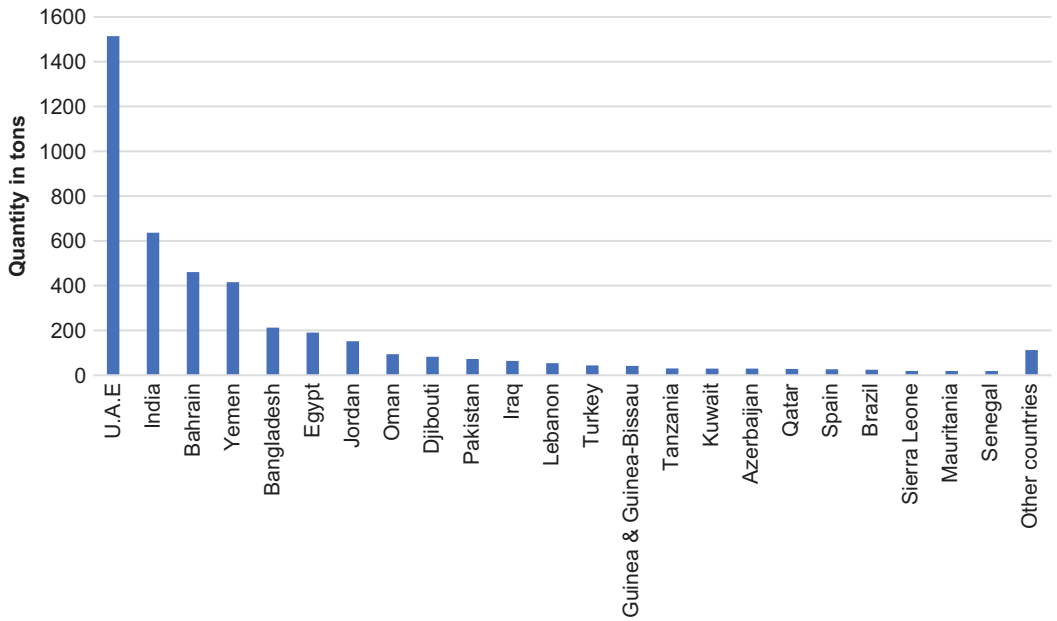

Figure 2: Geographical Distribution of the Quantity of Saudi Exports of Red Meat During the Period 2017-2021

Source: Data from Table 1

Current Geographical Distribution Pattern of Red Meat Imports

By studying the current geographical distribution pattern of red meat imports during the period 2017-2021, it is clear from the data contained in Table 2 and Figure 3 that Saudi Arabia imported a quantity of red meat amounting to 40.25 thousand tonnes from Brazil, representing 29.34% of the average total red meat imports of 137.2 thousand tonnes during the period 2017-2021. Also, a quantity of red meat was imported from India, representing 26.99% of the average total red meat imports, followed by Australia, New Zealand, Pakistan, Ethiopia, and Sudan, with percentages of 17.77%, 6.98%, 6.69%, 4.08%, and 1.06% respectively. From the above, it is clear that the total relative importance of the amount of red meat imports from the seven countries mentioned reached 92.91%, while the relative importance of red meat imports from the remaining countries does not exceed 7.09% during the period 2017-2021. By calculating the geographical concentration coefficient of the quantity and value of red meat imports, it turned out that it amounted to 45.0% and 41.9%, respectively, during the study period. The coefficient of geographical concentration is considered high if it is above 0.4 from Michael y's point of view (Ghanem, 1998). The average import price of KSA for red meat ranged between a minimum of US$3,272.3 /tonne from Poland, and a maximum of US$1,1531.2 /tonne from the Russian Federation, with an average of US$5,934.41/ tonne during the period 2017-2021.

Table 2: Geographical Distribution of Red Meat Import Quantity and Value During the Period 2017-2021

Country	Quantity Thousand Tonnes	Value Million Dollars	Price Dollar/ Tonne	Relative Importance %	
				Quantity	Value
Brazil	40.25	166.10	4,126.3	29.34	24.84
India	37.03	133.57	3,606.9	26.99	19.97
Australia	24.38	162.73	6,673.2	17.77	24.34
New Zealand	9.58	54.73	5,713.0	6.98	8.18
Pakistan	9.18	46.09	5,018.5	6.69	6.89
Ethiopia	5.59	33.50	5,991.6	4.08	5.01
Sudan	1.45	8.62	5,937.1	1.06	1.29
Netherlands	1.34	9.51	7,118.1	0.97	1.42
Kenya	1.17	7.31	6,245.4	0.85	1.09
Spain	1.06	4.77	4,500.9	0.77	0.71
Canada	0.97	10.12	10,439.7	0.71	1.51
America	0.96	7.96	8,260.1	0.70	1.19
Poland	0.96	3.14	3,272.3	0.70	0.47
Colombia	0.90	3.68	4,077.4	0.66	0.55
Russian Federation	0.69	7.97	11,531.2	0.50	1.19

(continued)

Table 2: Geographical Distribution of Red Meat Import Quantity and Value During the Period 2017-2021 *(continued)*

Country	Quantity Thousand Tonnes	Value Million Dollars	Price Dollar/ Tonne	Relative Importance %	
				Quantity	Value
Jordan	0.51	2.87	5,610.0	0.37	0.43
U.A.E	0.39	2.21	5,631.1	0.29	0.33
Paraguay	0.35	1.44	4,073.0	0.26	0.21
Argentina	0.12	0.56	4,787.9	0.09	0.08
Ireland	0.10	0.57	5,750.4	0.07	0.08
Other countries	0.20	1.25	6,258.5	0.15	0.19
Total	137.20	668.70	-	100.00	100.00

Source: (1) FAO, website (FAOSTAT), period 2000-2021, (2) General Authority for Statistics, International Trade Statistics Bulletin, 2021

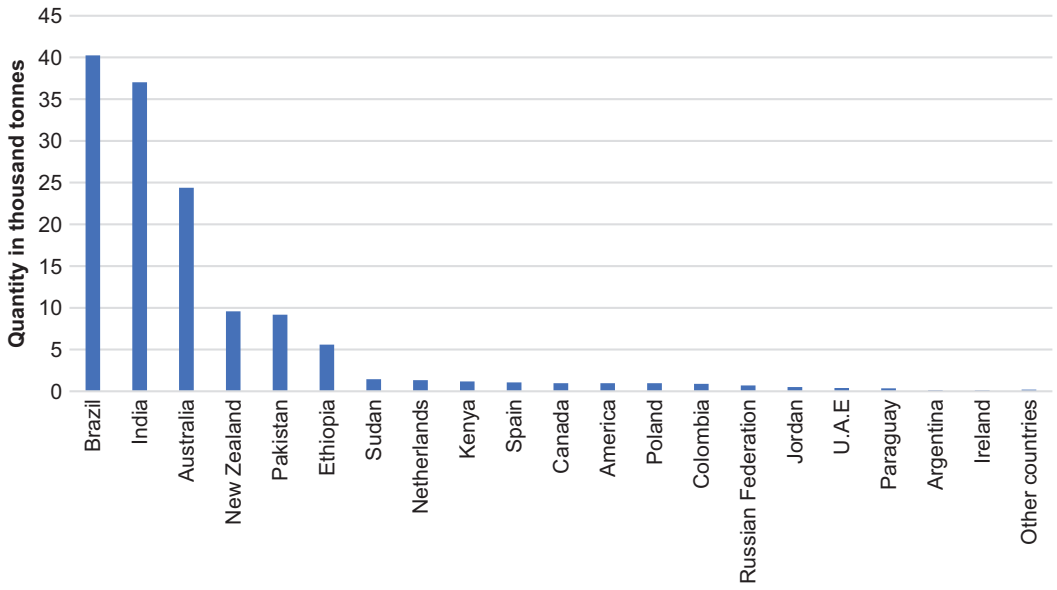

Figure 3: Geographical Distribution of the Quantity of Saudi Imports of Red Meat During the Period 2017-2021

Source: Data from Table 2

Second: Optimal Geographical Distribution of Red Meat Exports from KSA

The geographical distribution was made to maximise the value of Saudi exports of red meat in the light of four proposed models, which are as follows:

First Proposed Model

This model specialised in directing red meat exports to international markets where Saudi Arabia is competitive. Those international markets were identified based on the following criteria:

1. Market Penetration Indictor: measures the ability of a commodity to penetrate international markets and indicates the extent to which there is a real market for the commodity; it can be expressed by the following equation (Oral and Chabchoub, 1997):

$$MPR_{ij} = [M_{ij} \div (Q_{ij} + M_{ij} - X_{ij})]$$

Where: MPR_{ij}: market penetration rate, M_{ij}: imports of commodity j by country i, Q_{ij}: production of commodity j in country i, X_{ij}: exports of commodity j by country i. The higher the value of the penetration index in a given market, the wider and easier it is to enter, and therefore this market is more acceptable to the commodity and vice versa. The average market penetration rate for red meat exports approached zero in Brazil, while it increased to 0.93% in Bahrain during the period 2017-2021 (Table 3).

2. Market Share: The market share is calculated by dividing the amount of imports of a country importing a particular commodity from a country by the total quantity of its imports of the same commodity; it can be expressed by the following equation (Badawi, 2012):

$$MSH_{ji} = (X_{jci} \div M_{cwi}) \times 100$$

Where: MSH_{ji}: the market share of country j of commodity i, X_{jci}: the quantity of exports of country j to country c of commodity i, M_{cwi}: the total amount of imports of country c of commodity i. The market share of red meat exports ranged from a minimum of 0.02% in Spain to a maximum of 90.42% in Yemen (Table 3).

In light of the scoring technique for the criteria of market penetration rate and market share to determine the priority of international markets in the export of red meat, it is clear from the data in Table 3 that the State of Djibouti ranks first, followed by Yemen and Bahrain, then the United Arab Emirates and Sierra Leone in joint fourth place, Mauritania, India, and Jordan in joint sixth place, and then the Sultanate of Oman. In joint tenth place are Bangladesh, Pakistan, Lebanon, Guinea and Guinea-Bissau, Tanzania, and other countries. From the above, it is clear that according to the principle of competitiveness, the priority international markets for the export of red meat are Djibouti, Yemen, Bahrain, the United Arab Emirates, Sierra Leone, Mauritania, India, Jordan, and the Sultanate of Oman. The objective and constraints function of the proposed model is as follows:

Table 3: Prioritisation of International Markets According to the Criteria of Market Penetration Rate and Market Share of Red Meat Exports During the Period 2017-2021

Country	Market Penetration Rate %	Market Share %	Scoring Technique			Market Prioritisation
			Market Penetration Rate	Market Share	Total	
UAE	0.53	0.71	80	20	100	4
India	0.01	17.18	10	70	80	7
Bahrain	0.93	2.15	100	30	130	3
Yemen	0.08	90.42	50	100	150	2
Bangladesh	0.05	3.61	30	30	60	10
Egypt	0.02	0.09	10	10	20	21
Jordan	0.12	0.28	60	20	80	7
Oman	0.08	0.28	50	20	70	9
Djibouti	0.72	39.23	90	90	180	1
Pakistan	0.00	10.18	0	60	60	10
Iraq	0.04	0.08	20	10	30	17
Lebanon	0.07	0.24	40	20	60	10
Turkey	0.00	0.24	0	20	20	21
Guinea & Guinea-Bissau	0.03	7.66	20	40	60	10
Tanzania	0.01	9.89	10	50	60	10
Kuwait	0.03	0.06	20	10	30	17
Azerbaijan	0.01	0.36	10	20	30	17
Qatar	0.05	0.06	30	10	40	16
Spain	0.00	0.02	0	0	0	24
Brazil	0.00	0.06	0	10	10	23
Sierra Leone	0.13	3.07	70	30	100	4
Mauritania	0.02	23.31	10	80	90	6
Senegal	0.01	0.36	10	20	30	17
Other countries	0.09	0.09	50	10	60	10

Source: Collected and calculated from FAOSTAT data, 2017-2021

$$\textit{Max:}\ 4092.6.0\ X_1 + 3557.4\ X_2 + 3865.9\ X_3 + 1793.0\ X_4 + 1259.4\ X_7 + 3334.0\ X_8 + 679.8\ X_9 + 692.5\ X_{21} + 718.5\ X_{22}$$

Subject to:

$85370.49 \geq X_1 \geq 1514.23$ $1148.66 \geq X_4 \geq 415.95$ $111.98 \geq X_9 \geq 82.38$

$22638.25 \geq X_2 \geq 636.26$ $22057.9 \geq X_7 \geq 151.98$ $248.00 \geq X_{21} \geq 19.06$

$8022.53 \geq X_3 \geq 460.75$ $13228.53 \geq X_8 \geq 94.24$ $32.00 \geq X_{22} \geq 18.65$

$X_1 + X_2 + X_3 + X_4 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{22} \leq 4373.42$

The first nine restrictions indicate that the amount of red meat exports does not exceed 40% of the average import capacity of these countries, and is not less than the average amount exported to each country during the study period. The last restriction indicates that the total amount of exports for all countries is no more than the average amount of exports for red meat during the study period.

It is clear from the data in Table 4 that the proposed geographical distribution of Saudi red meat exports includes increasing the amount exported to the UAE to 2,494.15 tonnes, with a value of US$10,207.56. Through the proposed geographical distribution, the value of Saudi exports of red meat can be increased from US$14,941.6 to US$15,586.20, an increase of US$644.6, representing 4.31% of the average value of Saudi exports of red meat during the period 2017-2021.

Second Proposed Model

The second model included the distribution of red meat exports to all 24 importing countries, according to the average export price and the minimum and highest quantities exported for each country during 2017-2021. The objective function and constraints of the proposed model are as follows:

Max: $4092.6\ X_1 + 3557.4\ X_2 + 3865.9\ X_3 + 1793.0\ X_4 + 5284.8\ X_5 + 1620.0\ X_6 + 1259.4\ X_7 + 3334.0\ X_8 + 679.8\ X_9 + 6004.2\ X_{10} + 3761.1\ X_{11} + 5147.5\ X_{12} + 909.9\ X_{13} + 693.3\ X_{14} + 4846.7\ X_{15} + 4025.8\ X_{16} + 4867.6\ X_{17} + 2636.8\ X_{18} + 5355.7\ X_{19} + 3550.3\ X_{20} + 692.5\ X_{21} + 718.5\ X_{22} + 718.5\ X_{23} + 1618.3\ X_{24}$

Subject to:

$2550.41 \geq X_1 \geq 296.8$ $300.0 \geq X_9 \geq 111.9$ $60.0 \geq X_{17} \geq 37.3$

$2139.43 \geq X_2 \geq 128.69$ $182.6 \geq X_{10} \geq 4.06$ $115.48 \geq X_{18} \geq 25.21$

$710.24 \geq X_3 \geq 78.62$ $114.75 \geq X_{11} \geq 48.83$ $134.24 \geq X_{19} \geq 0$

$1148.66 \geq X_4 \geq 26.23$ $142.28 \geq X_{12} \geq 7.89$ $106.89 \geq X_{20} \geq 16.77$

$576.45 \geq X_5 \geq 6.5$ $219.8 \geq X_{13} \geq 0$ $50.0 \geq X_{21} \geq 45.3$

$601.01 \geq X_6 \geq 0.29$ $120.0 \geq X_{14} \geq 90.6$ $93.25 \geq X_{22} \geq 0$

$312.87 \geq X_7 \geq 0.51$ $53.3 \geq X_{15} \geq 50.0$ $93.25 \geq X_{23} \geq 0$

$169.17 \geq X_8 \geq 53.01$ $112.99 \geq X_{16} \geq 1.29$ $252.55 \geq X_{24} \geq 3.62$

$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{24} \leq 4373.42$

Table 4: Proposed Models for the Geographical Distribution of the Quantity and Value of Saudi Exports of Red Meat

Country	First Model		Second Model		Third Model		Fourth Model	
	Quantity in Tonnes	Value Dollars	Quantity in Tonnes	Value Dollars	Quantity in Tonnes	Value Dollars	Quantity in Tonnes	Value Dollars
UAE	2,494.15	10,207.56	2,550.41	10,437.81	296.80	1,214.68	3,970.11	16,248.07
India	636.26	2,263.43	128.69	457.80	112.82	401.35	112.82	401.35
Bahrain	460.75	1,781.21	78.62	303.94	78.62	303.94	78.62	303.94
Yemen	415.95	745.80	26.23	47.03	26.23	47.03	26.23	47.03
Bangladesh	-	-	576.54	3,046.90	131.83	696.70	131.83	696.70
Egypt	-	-	0.29	0.47	0.29	0.47	0.29	0.47
Jordan	151.98	191.40	0.51	0.64	0.51	0.64	0.51	0.64
Oman	94.24	314.20	53.01	176.74	53.01	176.74	53.01	176.74
Djibouti	82.38	56.00	111.90	76.07	-	-	-	-
Pakistan	-	-	182.60	1,096.37	282.85	1,698.29	-	-
Iraq	-	-	48.83	183.65	48.83	183.65	-	-
Lebanon	-	-	142.28	732.39	3,253.04	16,745.02	-	-
Turkey	-	-	-	-	-	-	-	-
Guinea & Guinea-Bissau	-	-	90.60	62.81	-	-	-	-
Tanzania	-	-	53.30	258.33	50.00	242.34	-	-
Kuwait	-	-	44.47	179.03	1.29	5.19	-	-
Azerbaijan	-	-	60.00	292.06	37.30	181.56	-	-
Qatar	-	-	25.21	66.47	-	-	-	-
Spain	-	-	134.24	718.95	-	-	-	-
Brazil	-	-	16.77	59.54	-	-	-	-
Sierra Leone	19.06	13.20	45.30	31.37	-	-	-	-
Mauritania	18.65	13.40	-	-	-	-	-	-
Senegal	-	-	-	-	-	-	-	-
Other countries	-	-	3.62	5.86	-	-	-	-
Total	4,373.42	15,586.20	4,373.42	18,234.23	4,373.42	21,897.60	4,373.42	17,874.93

Source: Results of the solution of linear programming of the proposed models using WinQSB2.0

The first 24 restrictions indicate that the amount of meat exported is not more than the maximum amount exported per country. It is also not less than the minimum amount exported for each of them during the study period. The last restriction indicates that the total amount of exports for all countries is no more than the average amount of exports for red meat during the study period.

It is clear from the data in Table 4 that the proposed geographical distribution of Saudi red meat exports includes increasing the amount exported to the UAE to 2,550.41 tonnes, with a value of US$10,437.81. Quantities exported to Bangladesh, Djibouti, Pakistan, Lebanon, Guinea and Guinea-Bissau, Tanzania, Kuwait, Azerbaijan, Spain, and Sierra Leone are also increasing. The proposed geographical distribution also includes reducing the quantities exported to some countries, in addition to not exporting to Turkey, Mauritania, and Senegal. Through the proposed geographical distribution, the value of Saudi exports of red meat can be increased from US$14,941.6 to US$18,234.23, an increase of US$3,292.62, representing 22.04% of the average value of Saudi exports of red meat during the period 2017-2021.

Third Proposed Model

This included directing red meat exports to stable countries that continue to import red meat from Saudi Arabia for three years or more and reached 14 countries. The objective function and constraint of the proposed model is as follows:

Max: $4092.6\ X_1 + 3557.4\ X_2 + 3865.9\ X_3 + 1793.0\ X_4 + 5284.8\ X_5 + 1620.0\ X_6 + 1259.4\ X_7 + 3334.0\ X_8 + 6004.2\ X_{10} + 3761.1\ X_{11} + 5147.5\ X_{12} + 4846.7\ X_{15} + 4025.8\ X_{16} + 4867.6\ X_{17}$

Subject to:

$85370.49 \geq X_1 \geq 296.8$	$80221.92 \geq X_6 \geq 0.29$	$9266.50 \geq X_{12} \geq 7.89$
$128.69 \geq X_2 \geq 112.82$	$22057.92 \geq X_7 \geq 0.51$	$122.61 \geq X_{15} \geq 50.0$
$8022.53 \geq X_3 \geq 78.62$	$13228.53 \geq X_8 \geq 53.01$	$20522.83 \geq X_{16} \geq 1.29$
$141.26 \geq X_4 \geq 26.23$	$282.85 \geq X_{10} \geq 4.06$	$3248.46 \geq X_{17} \geq 37.3$
$131.83 \geq X_5 \geq 6.5$	$3194.59 \geq X_{11} \geq 48.83$	

$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{17} \leq 4373.42$

The first 14 restrictions indicate that the amount of red meat exports does not exceed 40% of the average import capacity of these countries and is not less than the minimum amount exported to each country during the study period. The last restriction indicates that the total amount of exports for all countries is no more than the average amount of exports for red meat during the study period.

It is clear from the data in Table 4 that the proposed geographical distribution of Saudi exports of red meat includes increasing the amount exported to the state of Lebanon to reach 3,253.04 tonnes, with a value of US$16,745.02. The volumes exported to both Tanzania and Azerbaijan

is also increasing. The proposed geographical distribution also includes reducing the quantities exported to the UAE, India, Bahrain, Yemen, Bangladesh, Egypt, Jordan, Oman, Iraq, and Kuwait. Through the proposed geographical distribution, the value of Saudi exports of red meat can be increased from US$14,941.6 to US$21,897.59, an increase of US$6,955.99, representing 46.55% of the average value of Saudi exports of red meat during the period 2017-2021.

Fourth Proposed Model

The fourth proposed model included directing red meat exports to traditional international markets (markets for which the total amount of Saudi exports amounts to 85% of the total quantities exported during 2017-2021). There were eight traditional international markets (UAE, India, Bahrain, Yemen, Bangladesh, Egypt, Jordan, and Oman). The objective and constraint function of the proposed model is as follows:

Max: $4092.6\ X_1 + 3557.4\ X_2 + 3865.9\ X_3 + 1793.0\ X_4 + 5284.8\ X_5 + 1620.0\ X_6 + 1259.4\ X_7 + 3334.0\ X_8$

Subject to:

$85370.49 \geq X_1 \geq 296.8$ $141.26 \geq X_4 \geq 26.23$ $22057.92 \geq X_7 \geq 0.51$

$128.69 \geq X_2 \geq 112.82$ $131.83 \geq X_5 \geq 6.5$ $13228.53 \geq X_8 \geq 53.01$

$8022.53 \geq X_3 \geq 78.62$ $80221.92 \geq X_6 \geq 0.29$

$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{17} \leq 4373.42$

The first eight restrictions indicate that the amount of red meat exports does not exceed 40% of the average import capacity of these countries and is not less than the minimum amount exported to each country during the study period. The last restriction indicates that the total amount of exports for all countries is no more than the average amount of exports for red meat during the study period.

It is clear from the data in Table 4 that the proposed geographical distribution of Saudi exports of red meat includes increasing the amount exported to the UAE to reach 3,970.11 tonnes, with a value of US$16,248.07. The proposed geographical distribution also includes reducing the quantities exported to the remaining countries (India, Bahrain, Yemen, Bangladesh, Egypt, Jordan, and Oman). Through the proposed geographical distribution, the value of Saudi exports of red meat can be increased from US$14,941.6 to US$17,874.93, an increase of US$2,933.33, representing 19.63% of the average value of Saudi exports of red meat during the period 2017-2021.

Third: Optimal Geographical Distribution of Red Meat Import to KSA

The geographical distribution of the minimisation of the value of Saudi imports of red meat was carried out in the light of four proposed models. These are described below.

First Proposed Model

The first model is known as the restriction-free model. This is leaving the process of importing red meat from the lowest-priced countries, so that the amount imported from any country does not exceed 40% of its export capacity, in addition to the import capacity of Saudi Arabia. The objective function and constraint of the proposed model is as follows:

Min: $4126.4\ X_1 + 3606.9\ X_2 + 6673.2\ X_3 + 5713.0\ X_4 + 5018.5\ X_5 + 5991.6\ X_6 + 5937.1\ X_7 + 7118.1\ X_8 + 6245.4\ X_9 + 4500.9\ X_{10} + 10439.7\ X_{11} + 8260.1\ X_{12} + 3272.3\ X_{13} + 4077.4\ X_{14} + 11531.2\ X_{15} + 5610.0\ X_{16} + 5631.1\ X_{17} + 4073.0\ X_{18} + 4787.9\ X_{19} + 5750.4\ X_{20} + 6258.5\ X_{21}$

Subject to:

$X_1 \leq 593.16$	$X_7 \leq 4.80$	$X_{13} \leq 153.85$	$X_{19} \leq 185.42$
$X_2 \leq 445.35$	$X_8 \leq 201.16$	$X_{14} \leq 11.02$	$X_{20} \leq 172.34$
$X_3 \leq 638.72$	$X_9 \leq 4.53$	$X_{15} \leq 6.94$	$X_{21} \leq 456.20$
$X_4 \leq 384.95$	$X_{10} \leq 93.10$	$X_{16} \leq 0.98$	
$X_5 \leq 24.74$	$X_{11} \leq 150.62$	$X_{17} \leq 18.27$	
$X_6 \leq 6.30$	$X_{12} \leq 397.39$	$X_{18} \leq 109.51$	

$X_1 + X_2 + X_3 + X_4 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{22} \geq 137.20$

The first 21 restrictions indicate that the amount of red meat imports is no more than 40% of the average export capacity of these countries. The last restriction indicates that the total amount of imports from all countries is no more than the average amount of Saudi imports of red meat during the study period.

It is clear from the data in Table 5 that the proposed geographical distribution of Saudi imports of red meat includes the import of red meat from Poland due to its low prices. Through the proposed geographical distribution, the value of Saudi red meat imports can be minimised from US$668.7m to US$448.96m, a decrease of US$219.74m, representing 32.86% of the average value of Saudi red meat imports during the period 2017-2021.

Table 5: Proposed Models for the Geographical Distribution of the Quantity and Value of Saudi Imports of Red Meat

Country	First Model		Second Model		Third Model		Fourth Model	
	Quantity Thousand Tonnes	Value Million Dollars	Quantity Thousand Tonnes	Value Million Dollars	Quantity Thousand Tonnes	Value Million Dollars	Quantity Thousand Tonnes	Value Million Dollars
Brazil	-	-	38.21	157.67	38.21	157.67	38.21	157.67
India	-	-	49.17	177.35	32.55	117.40	57.26	206.53
Australia	-	-	21.48	143.34	21.48	143.34	21.48	143.34
New Zealand	-	-	7.62	43.53	7.62	43.53	7.62	43.53
Pakistan	-	-	7.53	37.79	7.53	37.79	7.53	37.79
Ethiopia	-	-	5.09	30.50	5.09	30.50	5.09	30.50
Sudan	-	-	0.01	0.06	0.01	0.06	0.01	0.06
Netherlands	-	-	1.18	8.40	1.18	8.40	-	-
Kenya	-	-	0.42	2.62	0.42	2.62	-	-
Spain	-	-	0.48	2.16	0.48	2.16	-	-
Canada	-	-	0.49	5.12	0.49	5.12	-	-
America	-	-	0.21	1.73	0.21	1.73	-	-
Poland	137.20	448.96	1.68	5.50	21.80	71.34	-	-
Colombia	-	-	1.7	6.93	-	-	-	-
Russian Federation	-	-	-	-	-	-	-	-
Jordan	-	-	0.03	0.17	0.03	0.17	-	-
UAE	-	-	0.1	0.56	0.10	0.56	-	-
Paraguay	-	-	1.72	7.01	-		-	-
Argentina	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-
Other countries	-	-	0.08	0.50	-	-	-	-
Total	137.20	448.96	137.2	630.94	137.20	622.39	137.20	619.42

Source: Results of the solution of linear programming of the proposed models using WinQSB2.0

Second Proposed Model

This included the import of red meat from all 21 countries from which it was imported, according to the average import price and the minimum and highest quantities imported from each country during the period 2017-2021. The objective function and constraints of the proposed model is as follows:

Min: $4126.4\ X_1 + 3606.9\ X_2 + 6673.2\ X_3 + 5713.0\ X_4 + 5018.5\ X_5 + 5991.6\ X_6 + 5937.1\ X_7 + 7118.1\ X_8 + 6245.4\ X_9 + 4500.9\ X_{10} + 10439.7\ X_{11} + 8260.1\ X_{12} + 3272.3\ X_{13} + 4077.4\ X_{14} + 11531.2\ X_{15} + 5610.0\ X_{16} + 5631.1\ X_{17} + 4073.0\ X_{18} + 4787.9\ X_{19} + 5750.4\ X_{20} + 6258.5\ X_{21}$

Subject to:

$41.36 \geq X_1 \geq 38.21$	$1.66 \geq X_8 \geq 1.18$	$1.98 \geq X_{15} \geq 0$
$49.17 \geq X_2 \geq 32.55$	$2.19 \geq X_9 \geq 0.42$	$1.28 \geq X_{16} \geq 0.03$
$28.55 \geq X_3 \geq 21.48$	$1.62 \geq X_{10} \geq 0.48$	$0.96 \geq X_{17} \geq 0.10$
$14.55 \geq X_4 \geq 7.62$	$1.38 \geq X_{11} \geq 0.49$	$1.72 \geq X_{18} \geq 0$
$10.37 \geq X_5 \geq 7.53$	$1.44 \geq X_{12} \geq 0.21$	$0.37 \geq X_{19} \geq 0$
$6.40 \geq X_6 \geq 5.09$	$1.68 \geq X_{13} \geq 0.07$	$0.28 \geq X_{20} \geq 0$
$5.23 \geq X_7 \geq 0.009$	$3.05 \geq X_{14} \geq 0$	$0.25 \geq X_{21} \geq 0.08$

$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + X_{24} \geq 137.20$

The first 21 restrictions indicate that the amount of meat imports does not exceed the maximum amount imported from each country. It is also not less than the lowest quantity imported from each country during the study period. The last restriction indicates that the total imports from all countries do not exceed the average amount of Saudi imports of red meat during the study period.

It is clear from the data in Table 5 that the proposed geographical distribution of Saudi imports of red meat includes increasing the quantity imported from India to 49.17 thousand tonnes, with a value of US$177.35m. Imports from Poland and Colombia are also increasing. The proposed geographical distribution also includes reducing the quantities imported from other countries, in addition to not importing from the Russian Federation, Argentina, and Ireland. Through the proposed geographical distribution, the value of Saudi imports of red meat could be reduced from US$668.7m to US$630.94m, a decrease of US$37.76m, representing 5.65% of the average value of Saudi imports of red meat during the period 2017-2021.

Third Proposed Model

This included limiting the import of red meat from countries that continued to export red meat to KSA annually without interruption and amounted to 15 countries during 2017-2021. The objective function and constraints of the proposed model are as follows:

Min: $4126.4\ X_1 + 3606.9\ X_2 + 6673.2\ X_3 + 5713.0\ X_4 + 5018.5\ X_5 + 5991.6\ X_6 + 5937.1\ X_7 + 7118.1\ X_8 + 6245.4\ X_9 + 4500.9\ X_{10} + 10439.7\ X_{11} + 8260.1\ X_{12} + 3272.3\ X_{13} + 5610.0\ X_{16} + 5631.1 X_{17}$

Subject to:

$593.16 \geq X_1 \geq 38.21$	$6.30 \geq X_6 \geq 5.09$	$150.62 \geq X_{11} \geq 0.49$
$445.35 \geq X_2 \geq 32.55$	$4.80 \geq X_7 \geq 0.009$	$397.39 \geq X_{12} \geq 0.21$
$638.72 \geq X_3 \geq 21.48$	$201.16 \geq X_8 \geq 1.18$	$153.85 \geq X_{13} \geq 0.07$
$384.95 \geq X_4 \geq 7.62$	$4.53 \geq X_9 \geq 0.42$	$0.98 \geq X_{16} \geq 0.03$
$24.74 \geq X_5 \geq 7.53$	$93.10 \geq X_{10} \geq 0.48$	$18.27 \geq X_{17} \geq 0.10$

$$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots X_{13} + X_{16} + X_{17} \geq 137.20$$

The first 15 restrictions indicate that the amount of red meat imports does not exceed 40% of the average export capacity of these countries and is not less than the lowest amount imported from each country during the study period. The last restriction indicates that the total amount of imports from all countries does not exceed the average amount of Saudi imports of red meat during the study period.

It is clear from the data in Table 5 that the proposed geographical distribution of red meat imports includes increasing the amount imported from Poland to 21.80 thousand tonnes, with a value of US$71.34m. Through the proposed geographical distribution, the value of Saudi imports of red meat could be reduced from US$668.7m to US$622.39m, a decrease of US$46.31m, representing 6.93% of the average value of Saudi imports of red meat during the period 2017-2021.

Fourth Proposed Model

The fourth model included directing imports of red meat from traditional international markets (markets of which the total amount of Saudi imports is 92.91% of the quantities imported during 2017-2021). There were seven traditional markets (Brazil, India, Australia, New Zealand, Pakistan, Ethiopia, and Sudan). The objective function and constraints of the proposed model are as follows:

Min: $4126.4\, X_1 + 3606.9\, X_2 + 6673.2\, X_3 + 5713.0\, X_4 + 5018.5\, X_5 + 5991.6\, X_6 + 5937.1\, X_7$

Subject to:

$593.16 \geq X_1 \geq 38.21$	$384.95 \geq X_4 \geq 7.62$	$6.30 \geq X_6 \geq 5.09$
$445.35 \geq X_2 \geq 32.55$	$24.74 \geq X_5 \geq 7.53$	$4.80 \geq X_7 \geq 0.009$
$638.72 \geq X_3 \geq 21.48$		

$$X_1 + X_2 + X_3 + X_4 + X_5 \ldots\ldots X_{13} + X_{16} + X_{17} \geq 137.20$$

The first seven restrictions indicate that the amount of red meat imports does not exceed 40% of the average export capacity of these countries and not less than the lowest amount imported from each country during the study period. The last restriction indicates that the total amount of imports

from all countries does not exceed the average amount of Saudi imports of red meat during the study period.

It is clear from the data in Table 5 that the proposed geographical distribution of red meat imports includes increasing the quantity imported from India to reach 57.26 thousand tonnes, with a value of US$206.53m. Through the proposed geographical distribution, the value of Saudi imports of red meat could be reduced from US$668.7m to US$619.42m, a decrease of US$49.28m, representing 7.37% of the average value of Saudi imports of red meat during the period 2017-2021.

Fourth: The Proposed Scenarios for Reducing the Trade Balance Deficit for Red Meat

The value of the trade balance deficit for red meat has been reduced through three main scenarios:

1. Restructuring the geographical distribution of exports only, in light of the fact that the import policy for red meat remained the same during 2017-2021. In this area the export value of red meat has been maximised, using four proposed models. The value of Saudi exports of red meat ranged from a minimum of US$15.59m for the first proposed model to a maximum of US$21.90m for the third proposed model. In light of the stability of the value of Saudi imports of red meat, it was possible to reduce the value of the trade balance deficit for red meat at rates ranging from a minimum of 0.1% for the first proposed model to a maximum of 1.06% for the third proposed model (Table 6).
2. Restructuring the geographical distribution of imports only, while the export policy for red meat remains the same during 2017-2021. In this area, the import value of red meat was minimised using four proposed models. The value of Saudi red meat imports ranged from a minimum of US$448.96m for the first proposed model to a maximum of US$630.94m for the second proposed model. In light of the constant value of Saudi exports of red meat, it was possible to reduce the value of the trade balance deficit for red meat at rates ranging from a minimum of 5.78% for the second proposed model to a maximum of 33.61% for the first proposed model (Table 6).
3. Restructuring the geographical distribution of both Saudi exports and imports of red meat. In this regard, a number of 16 adjustments and reconciliations were made between the models of maximising exports and their proposed counterpart to minimise imports of red meat. The value of the trade balance deficit for red meat ranged from a minimum of US$427.06m, for both the third proposed model of exports with its first proposed counterpart of imports, to a maximum of US$615.35m, for both the first proposed model of exports with its second proposed counterpart of imports. The value of the trade balance deficit for red meat was reduced by rates ranging from a minimum of 5.88% for the first proposed model of exports, with its second proposed counterpart for imports, to a maximum of 34.68% for the third proposed model of exports, with its first proposed counterpart for imports (Table 6).

Table 6: Proposed Scenarios for Reducing the Trade Deficit for Red Meat in KSA

Scenario	Exports		Imports		Trade Balance Deficit	
	Value Million Dollars	Increasing Rate %	Value Million Dollars	Decreasing Rate %	Value Million Dollars	Decreasing Rate %
Current situation	14.94	-	668.70	-	653.76	-
Restructuring the geographical distribution of exports in light of the import policy remaining the same during the period 2017-2021:						
exp (1)	15.59	4.31	668.70	-	653.11	0.10
exp (2)	18.22	22.04	668.70	-	650.48	0.50
exp (3)	21.90	46.55	668.70	-	646.80	1.06
exp (4)	17.87	19.63	668.70	-	650.83	0.45
Restructuring the geographical distribution of imports in light of the export policy remaining the same during the period 2017-2021:						
imp (1)	14.94	-	448.96	32.86	434.02	33.61
imp (2)	14.94	-	630.94	5.65	616.00	5.78
imp (3)	14.94	-	622.39	6.93	607.45	7.08
imp (4)	14.94	-	619.42	7.37	604.48	7.54
Restructuring the geographical distribution of exports and imports together:						
exp (1) + imp (1)	15.59	4.31	448.96	32.86	433.37	33.71
exp (1) + imp (2)	15.59	4.31	630.94	5.65	615.35	5.88
exp (1) + imp (3)	15.59	4.31	622.39	6.93	606.80	7.18
exp (1) + imp (4)	15.59	4.31	619.42	7.37	603.83	7.64
exp (2) + imp (1)	18.22	22.04	448.96	32.86	430.74	34.11
exp (2) + imp (2)	18.22	22.04	630.94	5.65	612.35	6.28
exp (2) + imp (3)	18.22	22.04	622.39	6.93	604.17	7.59
exp (2) + imp (4)	18.22	22.04	619.42	7.37	601.20	8.04
exp (3) + imp (1)	21.90	46.55	448.96	32.86	427.06	34.68
exp (3) + imp (2)	21.90	46.55	630.94	5.65	609.04	6.84
exp (3) + imp (3)	21.90	46.55	622.39	6.93	600.49	8.15
exp (3) + imp (4)	21.90	46.55	619.42	7.37	597.52	8.60
exp (4) + imp (1)	17.87	19.63	448.96	32.86	431.09	34.06
exp (4) + imp (2)	17.87	19.63	630.94	5.65	613.07	6.22
exp (4) + imp (3)	17.87	19.63	622.39	6.93	604.52	7.53
exp (4) + imp (4)	17.87	19.63	619.42	7.37	601.55	7.99

Source: Data from Tables 4 and 5

DISCUSSION

The research investigated how to reduce the value of the trade balance deficit for red meat, as it increased at an annual growth rate of 7.4% due to the superiority of the value of imports over their counterparts for exports during the period 2000-2021. By studying the geographical distribution pattern of the quantity and value of exports and imports of red meat, it found that KSA exported a quantity of red meat to several countries (Qatar, Yemen, Egypt, Jordan, Turkey, Mauritania, Senegal, Guinea, Guinea-Bissau, Sierra Leone, Djibouti, and some other countries), amounting to 1123.85 tonnes, representing 25.7% of the average total exported quantities, at prices lower than the average export price of US$2,959.73 /tonne during the period 2017-2021. KSA also imported from several countries (the Russian Federation, Canada, the USA, the Netherlands, Australia, and some other countries) a quantity of red meat amounting to 36.75 thousand tonnes, representing 26.8% of the average total imported quantities, at prices exceeding the average import price of US$5,934.41 /tonne during the period 2017-2021. This justifies moving forward with the economic planning procedure for the export and import of red meat, so that the value of exports is maximised and the value of imports is minimised; therefore, the trade balance deficit for red meat can be reduced.

The value of Saudi red meat exports was maximised using four proposed models. It was possible to increase the export value of red meat at rates ranging from a minimum of 4.31% for the first proposed model to a maximum of 46.55% for the third proposed model. The low rate of increase in the export value of the first proposed model is because it was specialised in directing red meat exports to markets where Saudi Arabia is competitive. The high rate of increase in the value of exports for the third proposed model is due to the targeting of red meat exports to stable countries that continued to import from Saudi Arabia during 2017-2021.

The value of Saudi imports of red meat was also minimised using four proposed models. The value of imports of red meat was reduced by rates ranging from a minimum of 5.65% for the second proposed model to a maximum of 32.86% for the first proposed model. The high rate of decrease in the value of imports for the first proposed model is due to the restricted freedom of the model to leave the process of importing red meat from the lowest price countries (Poland) so that the amount imported from any country does not exceed 40% of its export capacity during the period 2017-2021. According to the first proposed import model, 137.20 thousand tonnes, with a value of US$448.96m, are imported from Poland; this trend carries many risks and cannot be applied to the policy of importing red meat to Saudi Arabia.

Through the permutations and combinations of the proposed models to maximise the value of exports, with its proposed counterpart to minimise the value of imports, it was possible to reduce the trade balance deficit for red meat at rates ranging from a minimum of 5.88% for the first proposed model of exports with its second proposed counterpart of imports, to a maximum of 34.68% for the third proposed model of exports with its first proposed counterpart of imports.

CONCLUSIONS AND RECOMMENDATIONS

In light of the exclusion of the first proposed model for imports, because its application is not accepted, the best approach to reduce the trade balance deficit for red meat is to apply the third proposed model for exports, with its fourth proposed counterpart for imports. Through this approach, the same amount of red meat can be exported and imported, in addition to reducing the value of the trade balance deficit for red meat from US$653.76m to US$597.52m, i.e., reducing the trade balance deficit for red meat by an average of 8.60%. In light of the results of this study, it recommends the need to restructure the geographical distribution of Saudi exports and imports so that the value of the trade balance deficit for red meat can be reduced.

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