

Predictions of Import and Export Values According to Transportation Types in the Logistics Sector with Trend Analysis Method

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Abstract

As of 2023, when the top 10 countries in terms of economic size are examined, it is observed that these countries are the ones with the largest share in global trade. Turkey ranked 15th in terms of economic size in 2023, and it needs to get a larger share of world trade in order to achieve its goal of being among the top 10 countries in the world in terms of economic size. The importance of logistics activities is also significant in increasing this share. Transportation constitutes the largest expense item within logistics activities. In order for businesses to increase their profitability and gain a competitive advantage in the global market, they need to minimize transportation costs. Transportation constitutes the largest expense item among logistics activities. Businesses need to minimize transportation costs in order to increase their profitability and gain competitive advantage in the global market. Additionally, companies with advanced transportation systems can gain an advantageous position in this sector. In the logistics sector, making predictions of future expenses in terms of import and export in terms of transportation types is very important for businesses to determine their future activities. The aim of this study is to predict import and export values according to transportation types for future periods with the appropriate trend method. In this context, in this study, export and import values between 2013-2023 according to transportation types in Turkey's logistics sector were taken from the Turkish Statistical Institute (TUIK) website and forecast values for the next 4 months (December 2023, January-February-March 2024). While determining the most appropriate trend model for the compiled data set, the Quadratic model with the least error among the existing models (Linear, S-Curve, Quadratic, Exponential) was adopted, and the predictions obtained with the help of this model and the statistics of the model are given in the relevant tables and figures.

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1. Logistics Sector

In ancient times, when there was no money and individuals bartered/exchanged to meet their needs, the concept of logistics emerged due to barter/exchange needs. It is possible to say that the concept of logistics is as old as human history and that logistics has been effective in many areas such as military, economic and social life throughout the historical process (Couturela and Manole, 2013). The word logistics is derived from the Greek word “logisticos”, meaning “the science of calculation” or “skill in calculation” (Voortman, 2004). While the concept of logistics was previously a term used in the military field, its importance increased and developed further after the Industrial Revolution. In particular, with the signing of global and regional commercial agreements such as the General Agreement on Tariffs and Trade (GATT), the North American Free Trade Agreement (NAFTA) and the European Union, the concept of logistics has transitioned from the military field to the commercial field. made; Over time, it has become one of the indispensable sectors for the global economy.

There are many definitions regarding the concept of logistics. However, the most understandable definition is that made by the “Council of Supply Chain Management Professionals”. The council “logistics; It is defined as “effective and efficient planning, implementation and control of the flow of goods, services and related information from the source to the end user in order to meet the demands of consumers” (Bozyiğit, 2016). Turkey’s logistics sector has been developing and growing rapidly in recent years. Geopolitical location has an important place in the development of Turkey’s logistics sector. The most important elements of the development of the logistics sector in recent years are the increase in export and import volume. Against the positive effects of the growth of the sector, factors such as fluctuations in the economy, the increase in freight prices, and the increase in road and toll fees have caused logistics costs to increase in 2022. Despite these increasing costs, Turkey had the opportunity to become an important base for transit transportation during the crisis between Ukraine and Russia.

1.1. Logistics Transportation Types

Transportation and logistics are among the most important foreign exchange-generating service export sectors. A good logistics performance undoubtedly contributes to economic growth (Manavgat and Gökçe, 2021). Transportation constitutes an important issue and the largest expense item of logistics activities. The transportation and logistics sectors are compared to each other because transportation never loses its importance in all stages of

logistics processes. Transportation refers to the delivery of a produced good to the end consumer. Turkish Language Association transportation; “The act of transporting people, goods, etc. from one place to another with various vehicles; It is defined as “shipping, transportation, transport” (TDK, 2023). Since transportation costs constitute the most important and largest expense item of logistics activities, companies aim to increase their profitability and gain competitive advantage in the global market by minimizing these costs and planning for the product to reach the consumer (Akgüngör and Demirel, 2011). Companies with advanced transportation systems have an advantageous position in the sector. In addition, integrating logistics activities with a better transportation system increases logistics efficiency (Yue and Taylor, 2005). The choice of transport type is an important issue and there are many factors affecting this choice. These factors; These are listed as the quality of the products, ensuring reliable transportation, transportation time, regular transportation, and delivery frequency (Waters, 2003). The most commonly used transportation types in transportation are explained below.

1.1.1. Seaway Transportation

Seaway transportation is the transfer of products or people from one place to another by sea. This type of transportation, which has an important share in the globalization of trade, is generally used for the transportation of large volume, time sensitive and low unit price loads. Along with containerization, seaway transportation makes significant contributions to the development of combined transportation. Private maritime transport, visiting ports, factories, terminals, distribution points and markets are included in the maritime transport system (Corbett and Winebrake, 2008). Seaway transportation is the most cost-effective and reliable type of transportation compared to other types of transportation.

1.1.2. Railway Transportation

Railway transportation is a type of transportation used to transport large volumes of goods. In addition, unlike road transportation, it is environmentally friendly. With rail transportation, high volume products reach the end consumer at an affordable cost. For this reason, developed countries are starting to give importance to railway and maritime transportation in their logistics planning by reducing the volume of road transportation (Kaplan, 2019). Railway transportation is less preferred than other transportation methods in export and import transactions in Turkey. Although it is a safe, economical and environmentally friendly type of transportation, its share in

transportation is lower compared to other types of transportation due to the lack of a widespread railway network in our country, the limited number of ports with railway connections, and the lack of the possibility of providing a door-to-door service as in highway transportation (UTIKAD, 2022). However, thanks to the investments made in recent years, interest and demand for railway transportation is increasing. Railway transportation in Turkey is generally used in international transactions, and railway transportation is frequently preferred in Turkey's export and import transactions with its neighboring countries.

1.1.3. Highway Transportation

Highway transportation is one of the frequently used transportation types and refers to door-to-door delivery. As the most preferred type of transportation in Turkey, international road transportation ranks second after international maritime transportation in terms of value and weight. In this type of transportation, products are picked up from the production site and delivered to the delivery address without transfer. In services where delivery time is important, the most reliable way is road transportation. Because there are few external factors that will change the delivery process. In addition, one of the reasons why road transportation is preferred is that it has low investment costs and allows uninterrupted transportation between departure and destination points. As of 2021, 90% of freight transportation in Turkey is done by road (T.R. Ministry of Transport and Infrastructure, 2022).

1.1.4. Airways Transportation

There are two types of services provided in air transportation: transportation of people and products. Airways transportation, which is a service type of logistics activities, is carried out by passenger and cargo aircraft (Keskin, 2015). Air freight transportation is generally used for the transportation of products with the highest unit prices and is preferred for the transportation of loads with high time sensitivity, especially technological products. Airways transportation has an important share in increasing the speed of global trade, as it enables long distances to be covered in a short time. Airways transportation makes significant contributions to country economies, regardless of cargo and passenger transportation. The advantages of airways transportation include having a global airport network, ensuring safety and security at a high level, low risk of damage, allowing transportation in a short time, and being scheduled and planned. However, due to its

limited carrying capacity, it is more costly than other types of transportation (Erdal and Metin, 2009).

1.2. Turkey's International Transportation Activities

Transportation and logistics is one of the most important foreign exchange-generating service export sectors. A good logistics performance contributes to economic growth. Therefore, monitoring global logistics performance becomes an important tool for countries to evaluate their position and take the necessary positions (Manavgat and Gökçe, 2021). Table 1 shows the value of the transportation types used by Turkey in import and export for the last 11 years.

Table 1. Values of Transport Types in Import and Export by Years (Value: Thousand US\$)

Year	Seaway		Railway		Highway		Airway	
	Imports	Export	Imports	Export	Imports	Export	Imports	Export
2013	146 444 550	88 197 732	1 784 905	994 652	43 544 972	57 804 104	32 759 358	13 200 118
2014	147 778 523	88 900 953	1 253 892	964 170	40 577 283	61 133 176	24 889 608	14 388 661
2015	126 868 187	79 762 173	1 434 902	861 740	37 840 932	51 946 113	20 159 751	17 400 190
2016	121 013 276	80 139 270	1 768 602	673 816	36 716 500	49 537 436	23 107 208	17 908 782
2017	138 596 809	93 378 625	1 294 504	699 915	40 374 083	50 988 408	34 439 948	17 217 240
2018	136 737 402	108 802 681	1 299 419	753 544	39 129 380	52 222 468	28 756 745	14 127 905
2019	112 967 845	109 114 264	1 447 897	971 021	37 177 012	54 461 860	29 238 406	14 849 231
2020	114 838 355	100 907 927	2 144 863	1 287 765	41 883 477	53 127 588	39 260 478	12 732 561
2021	157 390 931	133 714 269	2 891 134	1 648 442	48 896 681	68 749 376	26 057 025	18 735 586
2022	193 796 320	150 294 432	2 967 903	2 457 286	59 447 025	78 837 775	38 582 413	20 687 774
2023*	180 455 870	130 263 283	1 857 673	1 831 961	61 234 165	76 219 834	50 112 135	23 012 140

**December is not included in 2023 data.*

Kaynak: Source: Prepared using TUIK data.

When Table 1 is examined, maritime transportation has the greatest value in Turkey's foreign trade activities (both imports and exports) in the last 11 years. Between 2013 and 2023, it is seen that maritime transportation reached the highest value in import transportation in 2022 (\$193 796 320), and the highest value in export transportation in 2022 (\$150 294 432). Road transportation ranks second in terms of value in Turkey's foreign trade transportation. Road transport reached the highest value in imports (\$61 234 165) in 2023 and the highest value in exports (\$78 837 775) in 2022. Air transportation ranks third in terms of value among transportation types. 2023 is the year when the import (\$50 112 135) and export (\$23 012 140) values of air transportation are highest. Railway transportation is the transportation type with the lowest share in Turkey's foreign trade. Railway transportation reached the highest value in import (\$2 967 903) and export (\$2 457 286) transportation in 2022.

1.3. Turkey's Logistics Performance Index

Logistics Performance Index (LPI) is calculated by the World Bank, aims to create a competitive environment among countries and tries to conduct due diligence for countries to improve their logistics performance. LPI provides detailed information about countries' logistics environments, basic logistics processes and organizations, and time and cost performances. It also plays an important role in revealing the logistics problems of countries, reform priorities in public-private sector relations, and the implementation of reforms as soon as possible (The World Bank, 2024). Turkey's logistics performance and sub-indicators were obtained from the World Bank's Logistics Performance Indices reports dated 2007, 2010, 2012, 2014 and 2016, 2018 and 2023. The Logistics Performance Index (LPI) score is calculated based on several sub-indicators including the efficiency of customs processes and procedures (cust), the quality of trade and transportation-related infrastructure (infr), ease of shipping at competitive prices (ship), quality of logistics services (logs), traceability of shipments (track), and on-time delivery (time) (The World Bank, 2024).

In Table 2, the change in Turkey's logistics performance is presented in detail over the years.

Table 2. Turkey's Logistics Performance by Years

Year	Logistics Performance (Score)	Efficiency of Processes (Cust)	Quality of Infrastructure (Infr)	Ease of Shipment (Ship)	Quality of Logistics Services (Logs)	Traceability of Shipments (Track)	On Time Delivery (Time)
2007	3,15 (34)	3 (33)	2,94 (39)	3,07 (42)	3,29 (30)	3,27 (34)	3,38 (52)
2010	3,22 (39)	2,82 (46)	3,08 (39)	3,15 (44)	3,23 (37)	3,09 (56)	3,94 (31)
2012	3,51 (27)	3,16 (32)	3,62 (25)	3,38 (30)	3,52 (26)	3,54 (29)	3,87 (27)
2014	3,5 (30)	3,23 (34)	3,53 (27)	3,18 (48)	3,64 (22)	3,77 (19)	3,68 (41)
2016	3,42 (34)	3,18 (36)	3,49 (31)	3,41 (35)	3,31 (36)	3,39 (43)	3,75 (40)
2018	3,15 (47)	2,71 (58)	3,21 (33)	3,06 (53)	3,05 (51)	3,23 (42)	3,63 (44)
2023	3,4 (38)	3 (47)	3,4 (43)	3,4 (26)	3,5 (38)	3,5 (37)	3,6 (35)

Source: World Bank Global Logistics Performance Index Reports (2007, 2010, 2012, 2014, 2016, 2023; <https://lpi.worldbank.org/international/global> Access Date 28.02.2024)

The values in parentheses in Table 2 show Turkey's position in the world rankings for that year in the relevant index. When comparing 2007 and 2023, the logistics performance (score) index will increase from 3.15 to 3.4; infrastructure quality (infr) index from 2.94 to 3.4; ease of shipping index increased from 3.07 to 3.4; quality of logistics services (logs) index from 3.29 to 3.5; It is seen that the tracking index of shipments increased from 3.27 to 3.5 and the on-time delivery index increased from 3.38 to 3.6. The efficiency index of processes (cust) maintained the same value in both 2007 and 2023.

When the values of Turkey's logistics performance in the world rankings are examined, it was ranked 34th in the logistics performance index in 2007 and fell to 38th place in 2023. It showed its best logistics performance over the years in 2012 and ranked 27th. In the process efficiency index, it decreased from 33 to 47 from 2007 to 2023. The year in which this index performed best was 2012 and it rose to the 32nd place. Considering the quality of infrastructure index, while it ranked 39th in 2007, it fell to 43rd place in 2023 and its best performance year was 2012. While it ranked 42nd in the ease of shipping index in 2007, it rose to 26th place in 2023 and showed the best performance.

When the logistics services quality index is examined, while it ranked 30th in 2007, it fell to 38th place in 2023. The best performance was in 2014 with 22nd place. The traceability index of shipments decreased from 34th to 37th place from 2007 to 2023, and the best performance belongs to

2014. Finally, when the on-time delivery index is examined, Turkey ranked 52nd in 2007 and rose to 35th place in 2023. The year in which this index performed best was 2012, with 27th place. As can be seen, there have been different changes and developments in Turkey's logistics performance over time.

2. Method

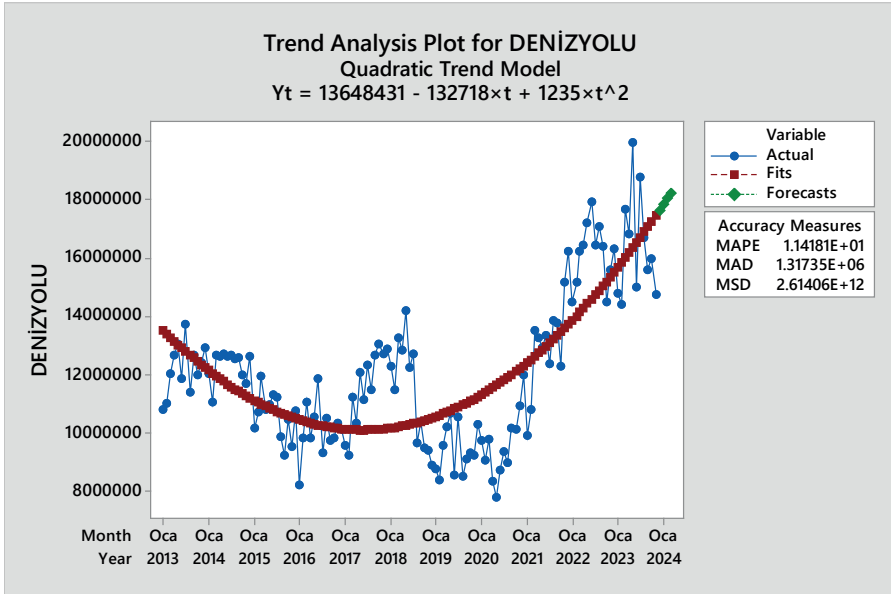
In this study, export and import values between 2013 and 2023 according to transportation types in Turkey's logistics sector were calculated with the Trend analysis method. Data for the years 2013-2023 were accessed from the website of the Turkish Statistical Institute (TUIK). Minitab program was used for trend analysis. Trend refers to the long-term tendency of the term values that make up the time series. Long-term trend of the time series; It may be linearly increasing, linearly decreasing, curvilinearly increasing, curvilinearly decreasing, or it may not be the case for the relevant time series (Saraçlı, 2010). In determining the trend; Techniques such as simple chart technique, moving averages technique and least squares technique are used.

Time series data provides information about the numerical values at which variables are observed consecutively from one period to the next. It is not a necessary condition for the observed data to be sequential in time, but it is important for accurate analysis to follow the development of the sequence at regular time intervals. Time series data is typically collected and compiled at daily, weekly, monthly, quarterly, semi-annual and longer-term intervals. A significant part of economic data constitutes economic statistics measured at equally spaced time points (Sevüktekin and Nargeleçekenler, 2007). While determining the most appropriate trend model in the analysis of the data, the prediction error values of the predictions, namely MAPE (Mean Absolute Percentage Error), MAD (Mean Absolute Deviation) and MSD (Mean Square Deviation), were taken into consideration and the model was chosen at the smallest value among linear, exponential, quadratic and S-curve models. Future period predictions were obtained by adopting the quadratic model (Karabıçak et al., 2018).

3. Results

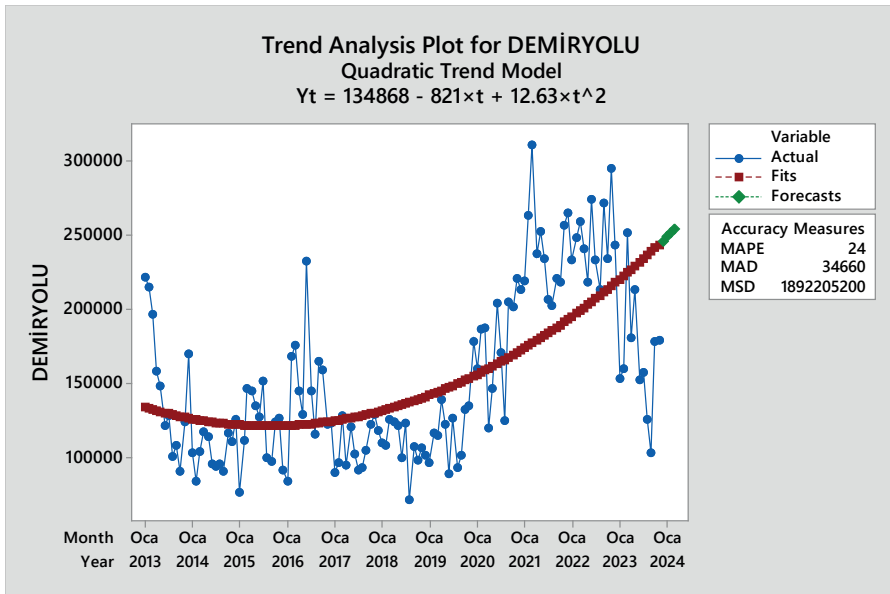
Below are the graphs regarding the results obtained from the trend analysis.

Chart 1. Trend Analysis Result for Seaway Transportation (Import)



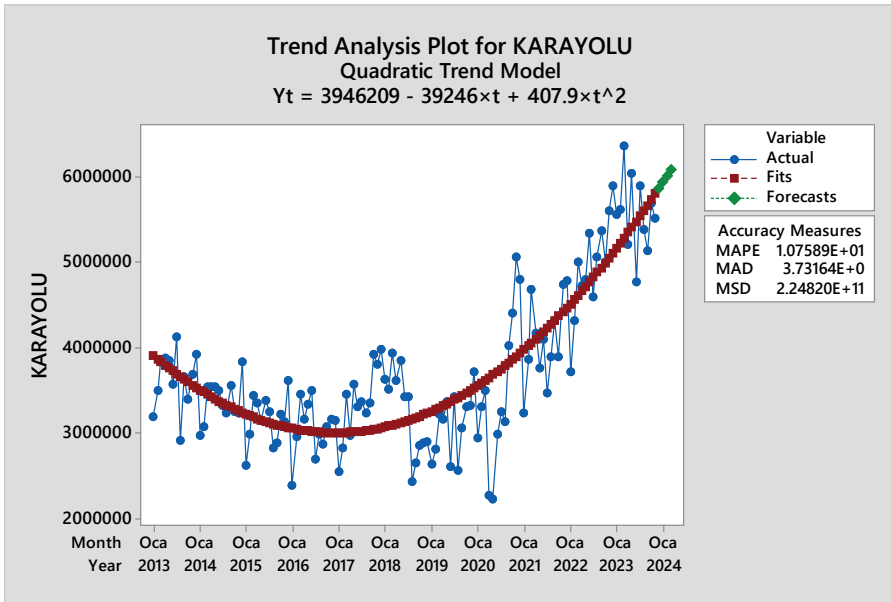
When Graph 1 is examined, the quadratic model is obtained as $Y_t = 13648431 - 132718 \times t + 1235 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. As can be seen from Table 3, the future forecasts for seaway transport imports through the obtained model are 17656030 Thousand \$ for December 2023, 17850705 Thousand \$ for January 2024, 18047851 Thousand \$ for February 2024 and 18247468 Thousand \$ for March 2024.

Chart 2. Trend Analysis Result for Railway Transportation (Import)



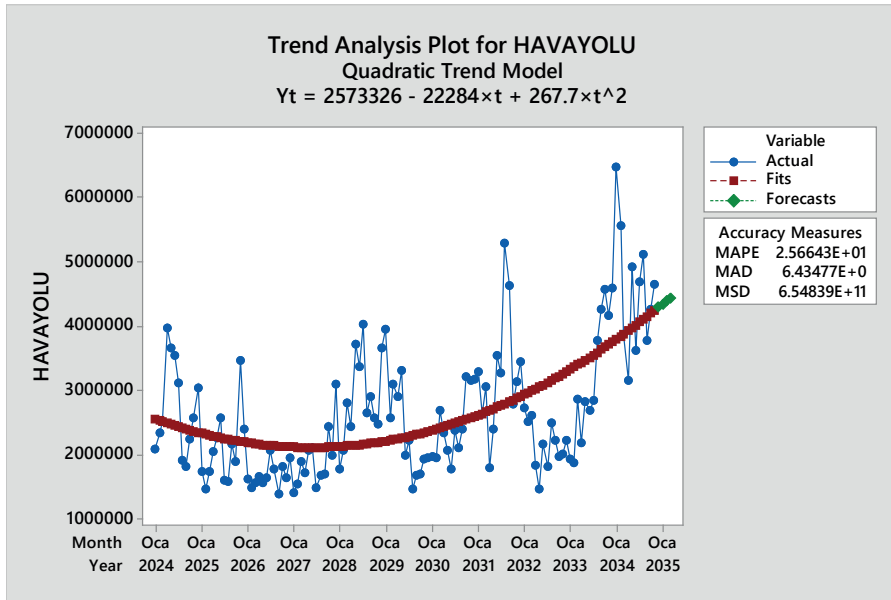
When Graph 2 is examined, the quadratic model was obtained as $Y_t = 134868 - 821 \times t + 12.63 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. Future period projections of railway transport imports through the obtained model, as shown in Table 3, are 246617 Thousand \$ for December 2023, 249144 Thousand \$ for January 2024, 251696 Thousand \$ for February 2024 and 254273 Thousand \$ for March 2024.

Chart 3. Trend Analysis Result for Highway Transport (Import)



When Chart 3 is examined, the quadratic model was obtained as $Y_t = 3946209 - 39246 \times t + 407.9 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. Highway transport import future predictions through the obtained model, as seen in Table 3, are 5873317 Thousand \$ for December 2023, 5942170 Thousand \$ for January 2024, 6011838 Thousand \$ for February 2024 and 6082322 Thousand \$ for March 2024.

Chart 4. Trend Analysis Result for Airway Transportation (Import)

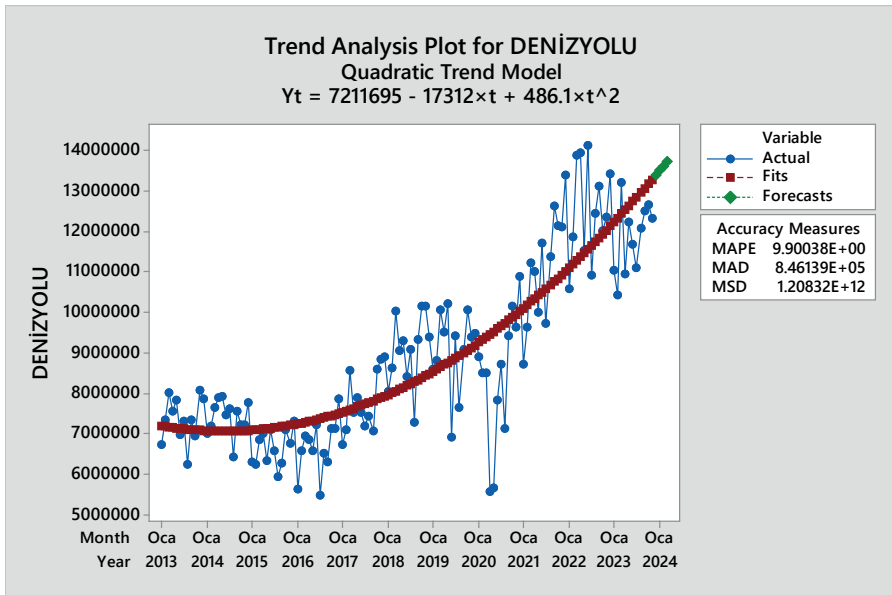


When Chart 4 is examined, the quadratic model was obtained as $Y_t = 2573326 - 22284 \times t + 267.7 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. Airway transport import future forecasts through the obtained model, as seen in Table 3, are 4296617 Thousand \$ for December 2023, 4345279 Thousand \$ for January 2024, 4394476 Thousand \$ for February 2024 and 4444208 Thousand \$ for March 2024.

Table 3. Trend Analysis Results for Import Data

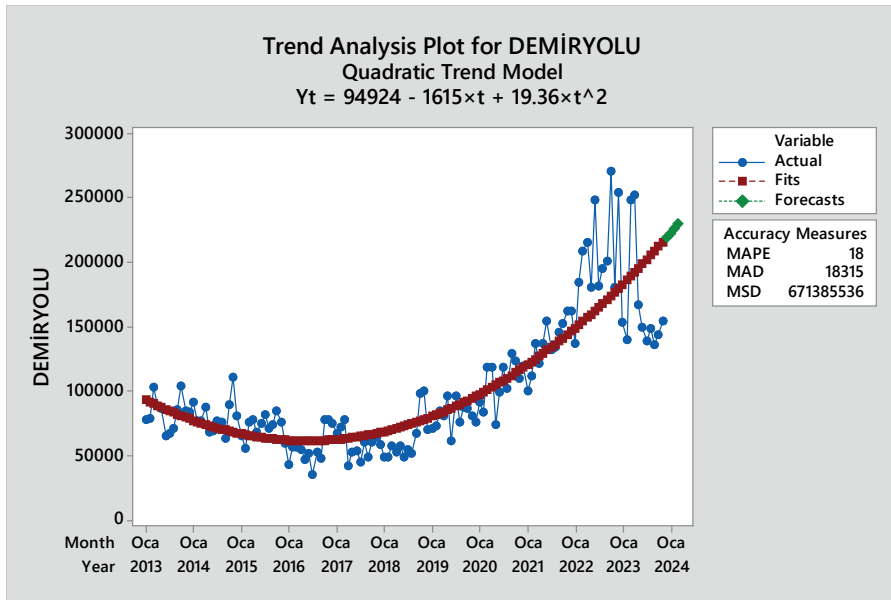
Transport Type	Forecast Values				Performance Criteria		
	December 2023	January 2024	February 2024	March 2024	MAPE	MAD	MSD
Scaway	17656030	17850705	18047851	18247468	1.14181E+01	1.31735E+06	2.61406E+12
Railway	246617	249144	251696	254273	24	34660	1892205200
Highway	5873317	5942170	6011838	6082322	1.07589E+01	3.73164E+05	2.24820E+11
Airway	4296617	4345279	4394476	4444208	2.56643E+01	6.43477E+05	6.54839E+11

Chart 5. Trend Analysis Result for Seaway Transportation (Export)



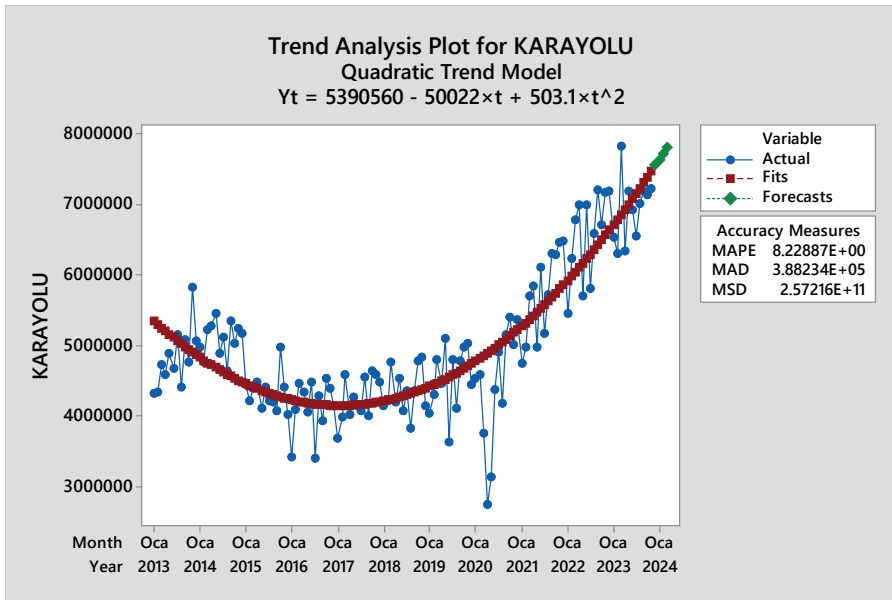
When Chart 5 is examined, the quadratic model is obtained as $Y_t = 7211695 - 17312 \times t + 486.1 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. As can be seen from Table 4, the future forecasts for maritime transport exports through the obtained model are 13395776 Thousand \$ for December 2023, 13507272 Thousand \$ for January 2024, 13619741 Thousand \$ for February 2024 and 13733181 Thousand \$ for March 2024.

Chart 6. Trend Analysis Result for Railway Transportation (Export)



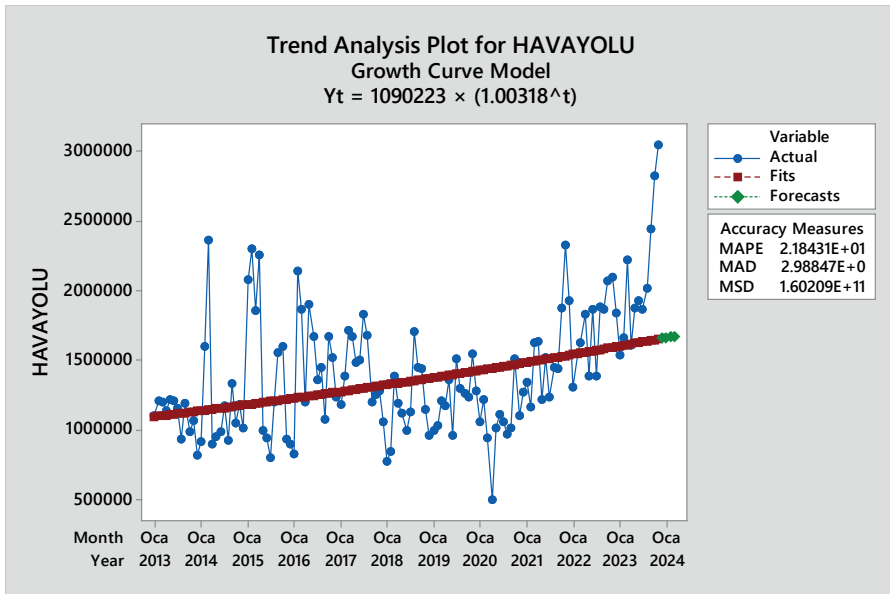
When Chart 6 is examined, the quadratic model was obtained as $Y_t = 94924 - 1615 \times t + 19.36 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. The future forecasts of railway transport exports through the obtained model are 219049 Thousand \$ for December 2023, 222565 Thousand \$ for January 2024, 226119 Thousand \$ for February 2024 and 229711 Thousand \$ for March 2024, as shown in Table 4.

Chart 7. Trend Analysis Result for Highway Transportation (Export)



When Chart 7 is examined, the quadratic model was obtained as $Y_t = 5390560 - 50022 \times t + 503.1 \times t^2$, and the MAPE, MAD and MSD values of the model are seen. Road transport export future predictions through the obtained model, as seen in Table 4, are 7554215 Thousand \$ for December 2023, 7637524 Thousand \$ for January 2024, 7721838 Thousand \$ for February 2024 and 7807159 Thousand \$ for March 2024.

Chart 8. Trend Analysis Result for Airway Transportation (Export)



When Chart 8 is examined, the quadratic model was obtained as $Y_t = 2573326 - 22284 * t + 267.7 * t^2$, and the MAPE, MAD and MSD values of the model are seen. Airway transport export future forecasts through the obtained model, as seen in Table 4, are 1657314 Thousand \$ for December 2023, 1662581 Thousand \$ for January 2024, 1667864 Thousand \$ for February 2024 and 1673164 Thousand \$ for March 2024.

Table 4. Trend Analysis Results for Export Data

Transport Type	Forecast Values				Performance Criteria		
	December 2023	January 2024	February 2024	March 2024	MAPE	MAD	MSD
Seaway	13395776	13507272	13619741	13733181	9.90038E+00	8.46139E+05	1.20832E+12
Railway	219049	222565	226119	229711	18	18315	671385536
Highway	7554215	7637524	7721838	7807159	8.22887E+00	3.88234E+05	2.57216E+11
Airway	1657314	1662581	1667864	1673164	2.18431E+01	2.98847E+05	1.60209E+11

Conclusion

Logistics activities are of great importance in effectively managing export and import processes. The logistics sector has a great potential as a logistics base due to the country’s geographical location, and this makes a significant

contribution to the development of foreign trade. In recent years, Turkey's foreign trade volume has increased rapidly and the logistics sector has been positively affected by this development. Carrying out logistics activities quickly, safely and economically has increased Turkey's export and import volume. In the development of the logistics sector in Turkey; Along with the port, airport and highway infrastructure required for the transportation of export and import cargo, logistics companies that provide services at international standards have an important place. When Turkey's foreign trade activities (both imports and exports) for the last 11 years are examined, seaway transportation has the greatest value. Highway transportation ranks second in terms of value in Turkey's foreign trade transportation. While airway transportation ranks third among transportation types in terms of value, railway transportation ranks fourth with the lowest share.

In this study, export and import values between 2013 and 2023, according to transportation types in Turkey's logistics sector, were taken from the Turkish Statistical Institute (TUIK) website and forecast values for the next 4 months (December 2023, January-February-March 2024) were calculated with the Trend analysis method. According to the results of this analysis (as can be seen from Table 3); Turkey uses seaway transportation the most in imports, and when the forecast values of seaway transportation are examined by month, it is seen that the month with the highest value is March 2024 (\$18247468). When the forecast values of railway, highway and airway transportation were examined by month, the month with the highest value was again March 2024. When export values are examined according to transportation types (as can be seen in Table 4), it is seen that seaway transportation is the most used transportation type. When the prediction values were examined by month, the month with the highest value in all transportation types was March 2024.

As a result, Turkey can increase its foreign trade performance by further developing its potential in the logistics sector. In order to increase foreign trade performance, ports, highways, airports and railways need to be modernized and improved.

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