

An Empirical Analysis of Türkiye's Forest Products Exports: Trends, Markets, and Product Competitiveness

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Abstract: The forest products industry plays an important role in Türkiye's economy, supporting employment, production, and international trade. Although the country has abundant forest resources and has increased its production capacity, especially in wood-based panels, the sector still faces several challenges. Issues such as a fragmented industry structure, limited technological development, and insufficient capital make it difficult for firms to compete effectively in global markets. In this context, this study examines Türkiye's forest products sector's export performance by identifying the most important product groups and key importing countries, with the aim of better understanding its contribution to the national economy. The study uses export data from 2015 to 2024, primarily obtained from the Trademap. The data were analyzed using Python-based tools. A combination of descriptive statistics, trend analysis, market share evaluation, and Compound Annual Growth Rate (CAGR) calculations was used to explore export patterns across different products and markets. The results show that exports increased notably after 2020, despite some short-term fluctuations. Middle Eastern countries, especially Iraq, remain the main importers of Turkish forest products. However, recent trends suggest that exports are gradually diversifying toward European markets, which show the fastest growth rates. At the product level, fibreboard (Product 4411) clearly stands out as the leading export category, followed by builder's joinery and particleboard. Findings suggest that focusing on high-value products and fast-growing markets could further improve export performance.

Overall, the study emphasizes the importance of developing more targeted export strategies that prioritize competitive product groups and emerging markets.

Keywords: Forest Products Industry, Türkiye, Export, Market, Trade

I. INTRODUCTION

Forest products represent one of the key sectors of Turkey's industrial production, encompassing a broad range of operations, including wood processing, furniture production, paper manufacturing, and wood-based panel production. Thus, Turkey has quite rich forest resources; according to Aksu et al. (2011b), Turkey has around 21 million hectares of forests. However, this sector does not perform well in terms of exports, which leads to imbalanced foreign trade relations for the country (Aksu et al., 2011b).

In terms of structural analysis, one can note the fragmented nature of the Turkish forest products industry, which comprises a large number of enterprises, mostly SMEs. Such fragmentation hinders the creation of economies of scale in Turkey, thereby limiting the sector's international competitiveness (Aksu et al., 2011a). There are also several other problems within the sector: technological deficiencies, lack of capital accumulation, poor quality of raw materials, shortage of qualified personnel, etc., all of which have adverse effects on the sector's performance and export ability (Aksu et al., 2011b). Nonetheless, despite all these difficulties, the industry is still considered one of the most significant sources of the Turkish economy's development in terms of employment and output (Bayram, 2020).

As regards the long-term evolution of the sector, one can notice quite an interesting pattern: on the one hand, the production capacity within it has significantly grown, especially in sub-sectors such as wood-based panels, which have led to Turkey becoming one of the global leaders in this area (Yıldırım et al., 2014). Still, competitiveness within the sector is highly differentiated across various groups of products, and some of the sub-sectors – fiberboard, particleboard, as well as certain wood products – demonstrate certain comparative advantages; still, in general, it is low in comparison to what it could potentially be (Akyüz et al., 2020). The differences in competitiveness show that it is necessary to focus on certain product groups rather than all at once.

The importance of foreign trade for economic development, especially in relation to developing countries, cannot be underestimated. For example, Turkey usually runs trade deficits, which is one reason economic development may prove difficult. The forest products sector plays a crucial role in foreign trade; yet imports typically exceed exports, resulting in an imbalance (Gedik et al., 2005). It is therefore vital to increase exports in order to achieve more balanced foreign trade

relations and further develop the economy (Bayram, 2020).

Globalization processes and the intensification of international competition underpin the need to foster trade relations and determine the priority directions for developing them. One of the world's largest economic blocs, the European Union (EU), is one of the main trading partners of Turkey. Analyses of trade relationships between Turkey and EU members show that, although their integration levels are high, Turkey's trade volume in forest products is relatively low (Akyüz et al., 2010a; Akyüz et al., 2010b). The economic size of trading parties, distance, and market structure play a significant role in trade volumes and should be considered when designing export strategies (Akyüz et al., 2010b).

At the same time, selecting importing countries plays a major role in successful exports, as it facilitates more efficient resource allocation and enables more targeted decisions on export strategies. Moreover, variations in the industrial structure and consumer behavior between countries dictate the need for different strategies when exporting particular products (Akyüz et al., 2010a). For these reasons, analysis of trade relations at the level of individual countries will be very helpful to decision-makers.

Another factor influencing decisions on exports is products with high potential to generate foreign currency and help offset trade deficits. Analysis by Bayram (2020) shows that products such as MDF, HDF, particleboard, and industrial roundwood could help improve Turkey's foreign trade deficit. This information indicates the need to focus on products having great export potential to improve foreign trade results.

To sum up, due to being one of the key industries in Türkiye, revealing the significance of forest products exports was identified as the main research goal of this study. In accordance, the objectives include the identification of the main exported product types and countries. This stage is crucial for increasing the sector's contribution to the national economy. To improve foreign trade, it is essential to understand the trade dynamics between markets and exported goods. To evaluate and interpret the above-mentioned, Python and advanced statistical methods were employed, as detailed in the materials and methods section. Based on the conducted literature review, there are some works on the forest industry and the Turkish economy; however, there are not many papers that focus on the industry from a marketing perspective, as the present paper does. Also, while those past papers employed common statistical methods, the present paper is based on the strong mathematical foundations of Python, which is another novelty of this work.

II. MATERIAL AND METHOD

The main material in this paper is forest products trade data for Türkiye between 2015 and 2024. The trade-related data was obtained from Trademap. To obtain reliable data, the Turkish Statistical Institute and FAOSTAT (Food and Agriculture Organization Statistics) databases were also investigated. However, the most accurate and well-organized dataset was found in the Trademap database. In the present paper, only the export data was investigated. To examine changes over time and the relationships among importing countries, numerical analysis methods and the Python programming language were employed. For detailed analysis, the downloaded single data sheets were transformed into a panel data set. The database query covers the 10-year period of Türkiye's exports; however, the most recent data goes back to 2024.

The searched product groups and their Trademap codes are as follows: Product: 44: Wood and articles of wood; wood charcoal - Product 4410: Particle board, oriented strand board "OSB" and similar board "e.g. waferboard" of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances (excl. fibreboard, veneered particle board, cellular wood panels and board of ligneous materials agglomerated with cement, plaster or other mineral bonding agent - Product: 4411: Fibreboard of wood or other ligneous materials, whether or not agglomerated with resins or other organic bonding agents (excl. particle board, whether or not bonded with one or more sheets of fibreboard; laminated wood with a layer of plywood; composite panels with outer layers of fibreboard; paperboard; furniture components identifiable as such) - Product 4418: Builders' joinery and carpentry, of wood, incl. cellular wood panels, assembled flooring panels, shingles and shakes, of wood (excl. plywood panelling, blocks, strips and friezes for parquet flooring, not assembled, and pre-fabricated buildings) - Product 4412: Plywood, veneered panel and similar laminated wood (excl. sheets of compressed wood, cellular wood panels, parquet panels or sheets, inlaid wood and sheets identifiable as furniture components) - Product 4407: Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness of > 6 mm.

The downloaded and transformed datasets are too wide to include in this paper; therefore, a sample of each dataset used is provided in this section.

To evaluate export trends, top importers, importers' trends, market shares, total export growth, the top 10 exported products, and similar detailed analyses, the Python programming language and several mathematical and statistical libraries, such as pandas, numpy, scikit-learn, and matplotlib, were employed. Basic descriptive statistical analyses were conducted on the mentioned Python environment. To evaluate the interwoven product-country trade relationship and for a better understanding, several datasets were transformed and combined into a panel dataset. Afterward, the Compound Annual Growth Rate (CAGR) analysis was performed. CAGR is vital for evaluating growth and returns in any market or industry (Talwar et al., 2024). CAGR is a widely accepted metric for average growth rates over longer periods

(Grimm, 2023). Due to its simplicity, the Compound Annual Growth Rate (CAGR) is commonly used in technical valuation and for investment decisions, such as assessing company value (Koller et al., 2005, p. 378; Vayas-Ortega et al., 2020). Additionally, it is applied in various other fields, including technology (Hatton et al., 2017), environmental studies, social and political sciences, and agricultural economics. In finance, CAGR is used to evaluate a company's performance, conduct fundamental analysis to estimate a stock's "fair" intrinsic value, and predict market trends (Grimm, 2023).

The following tables demonstrate the samples of the used data sets (ITC, n.d.).

Table 1. List of importing markets for a product exported by Türkiye (Product: 44 Wood and articles of wood; wood charcoal)

Product: 44 Wood and articles of wood; wood charcoal										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iraq	75556	64497	63434	92579	121834	121550	175185	185516	173904	206464
Morocco	7665	7549	11645	16593	22800	26505	61576	73240	109035	134410
Libya, State of	11399	8717	12235	15857	34942	29984	58545	78512	83487	90246
United States of America	2818	3387	5929	6472	11123	19325	35379	55530	52351	73293
Romania	9689	12586	13695	22126	22689	23731	32678	55144	73481	69757
Georgia	32809	32030	39827	47556	52748	42531	67250	77180	73416	67911
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New Caledonia	0	0	1	0	0	0				
Nicaragua	0	0	1	0	0	0	1			
Saint Kitts and Nevis	0	0	0	0	0	0			90	
Saint Vincent and the Grenadines	0	0	0	0	0	0	3			
Eswatini	0	0	0	0	0	1				

Table 2. List of importing markets for a product exported by Türkiye (Product: 4411 Fibreboard of wood or other ligneous materials...)

Product: 4411 Fibreboard of wood or other ligneous materials...										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iran, Islamic Republic of	112939	113377	143832	63400	33653	29681	23216	22930	17463	16549
Iraq	37910	36639	42049	59735	65841	65567	90735	101077	115213	153270
Turkmenistan	14396	10773	9586	8344	8007	11112	13393	15980	11491	7982
Azerbaijan	14010	6680	6797	8656	10212	12830	16656	12645	11679	10035
Georgia	11181	9989	11280	13788	15898	16791	26595	30995	31677	30159
Albania	6409	6929	9189	9293	8562	9675	10953	14199	13248	12213
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Brazil	0	0	0	0	0	0	35		1	
Bolivia, Plurinational State of	0	0	0	0	16	14	33	17	70	34
Benin	0	15	0	0	2	4		69	4	
Bangladesh	0	0	0	0	89	0		35		
Area Nes	0	0	0	0	0	44		12	8	

Table 3. List of importing markets for a product exported by Türkiye (Product: 4410 Particle board, oriented strand board "OSB" and similar board "e.g. waferboard" ...)

Product: 4410 Particle board, oriented strand board "OSB" and similar board "e.g. waferboard"...										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Georgia	16030	17238	22146	25561	25256	19443	32536	37464	32083	31114
Libya, State of	723	1199	3436	3613	7705	5115	12037	20989	22047	23321
Algeria	6532	8398	8134	23187	18565	15744	17400	26911	24507	22076
Lebanon	5039	6853	11646	13022	10745	6969	13650	23036	20812	19176
Montenegro	129	93	3901	6126	7015	6612	11340	17802	11934	17632
Albania	10085	11704	12246	14352	12626	11529	16571	16600	14957	16170
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Burkina Faso	0	0	0	0	1	1	5			
Uruguay	0	0	12	12	0	0				
Venezuela, Bolivarian Republic of	0	0	0	0	81	326	216	86	10	
Yemen	0	0	0	0	107	0				
Zambia	0	0	6	0	1	0				

Table 4. List of importing markets for a product exported by Türkiye Product: 4418 Builders' joinery and carpentry, of wood, incl. cellular wood panels, assembled flooring panels, ...

Product: 4418 Builders' joinery and carpentry, of wood, incl. cellular wood panels, assembled flooring panels, ...										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iraq	27002	18769	14082	16924	22203	19922	25881	34444	29870	30289
United States of America	451	190	1220	2179	2493	5101	5087	9761	16765	19307
Libya, State of	3662	2179	2589	3159	7038	7624	13016	16523	18864	17910
Azerbaijan	12517	4827	3039	3645	4048	4315	3833	6318	8795	9193
United Kingdom	1367	3648	3603	2722	3311	3499	4607	5185	8516	8845
Bulgaria	847	1518	1951	2041	2608	2432	4172	5989	6814	8558
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Saint Vincent and the Grenadines	0	0	0	0	0	0	1			
Seychelles	1	0	0	0	42	0				
Zimbabwe	0	32	0	20	0	0		16		
Trinidad and Tobago	0	11	0	4	4	0	2	28	1	
Zambia	50	82	10	13	138	16	1	71		

Table 5. List of importing markets for a product exported by Türkiye Product: 4412 Plywood, veneered panel and similar laminated wood (excl. sheets of compressed wood, cellular...)

Product: 4412 Plywood, veneered panel and similar laminated wood (excl. sheets of compressed wood, cellular...)										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Bulgaria	597	1212	1500	1219	1482	1074	3876	7027	8702	5688
Romania	87	153	224	297	1221	1420	2982	4669	9039	4449
Serbia	65	158	495	201	229	92	519	2253	4453	4247
Area Nes	0	0	0	0	105	27	33	843	4192	3832
Morocco	214	161	99	346	1716	1403	2385	2996	2237	3712
Poland	2	38	17	126	96	69	214	4703	4301	3507
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...	...	...	...	...	...	...	...	...	...	...
Suriname	0	0	0	0	0	3				
Burkina Faso	0	10	1	0	4	47		386	27	
Venezuela, Bolivarian Republic of	0	0	0	0	0	0			2	
Yemen	0	0	1	0	0	0		85		
Zambia	3	0	0	0	0	0				

Table 6. List of importing markets for a product exported by Türkiye Product: 4407 Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, ...

Product: 4407 Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, ...										
Importers	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iran, Islamic Republic of	1810	2661	4095	4460	8415	13096	17713	17795	21565	22943
Iraq	910	2270	1316	4939	14831	18305	36149	28584	11621	7734
Cyprus	1199	1048	780	897	786	860	1582	2537	2911	2649
Syrian Arab Republic	90	36	313	274	848	1561	3173	1179	1166	1438
India	78	0	0	26	531	1235	1592	958	639	1313
Spain	0	27	0	186	16	3	451	198	1263	844
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...	...	...	...	...	...	...	...	...	...	...
Togo	0	0	0	0	0	10				
Uganda	0	0	0	19	26	0		4	27	
Ukraine	60	26	204	0	13	9	8	43		
Tanzania, United Republic of	0	0	0	84	151	0				
Zambia	0	3	0	0	0	0				

Each mentioned analysis in this section was conducted one by one, and the results and findings were given in the following section.

III. RESULTS AND DISCUSSIONS

To see the general trend of Türkiye's exports in the last decade, a trend analysis was conducted, and the results are shown in the figure below

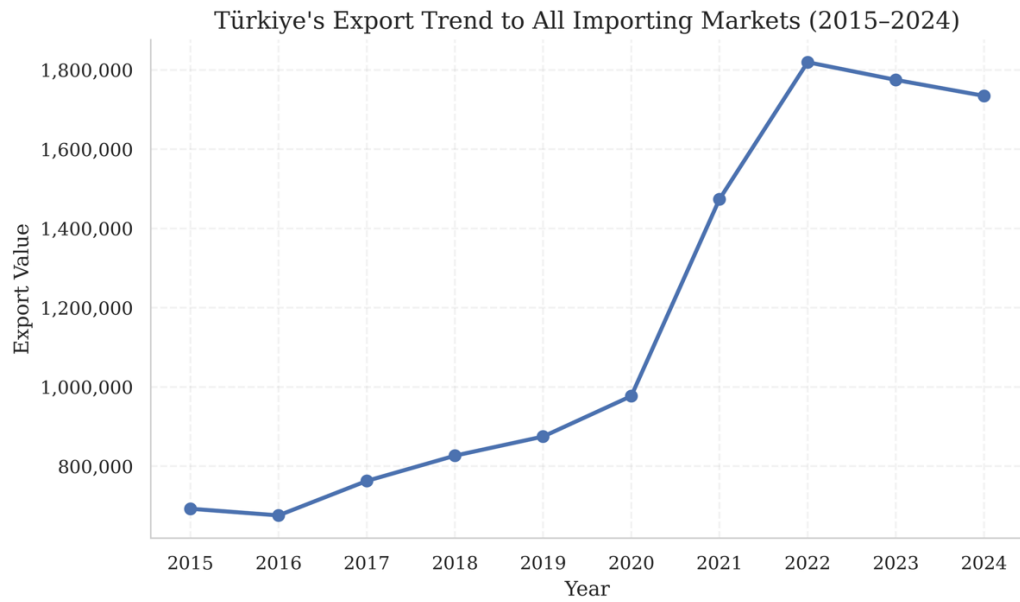


Figure 1. The export trend of Türkiye's all importing markets.

As seen from Figure 1, even though there is a decreasing tendency of exports in the last 5 years, the value of exports has increased significantly since 2020. To have a better understanding and to evaluate the latest situation accurately, the top importers of Turkish forest products over the last year have been investigated. The following figure depicts the top 5 importers.

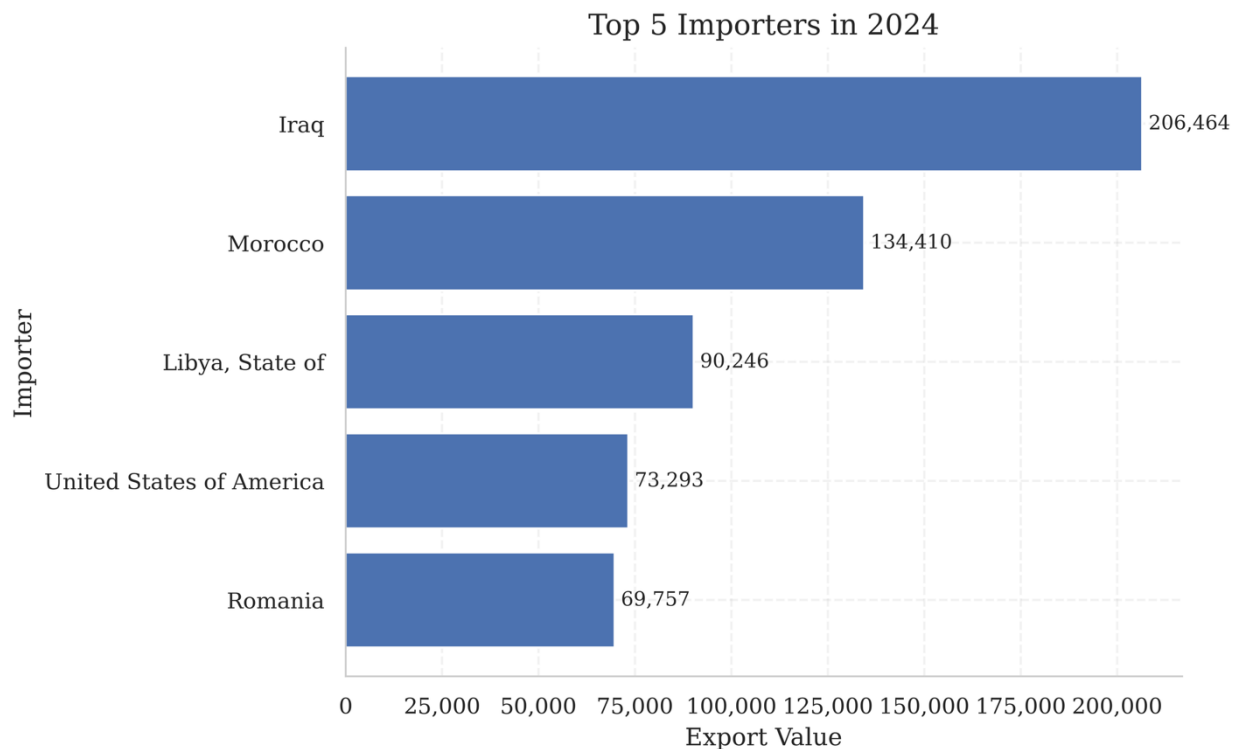


Figure 2. Top 5 importing countries of Turkish Forest Products in 2024.

Based on Figure 2 it is clear that Türkiye's exports are primarily directed toward the Middle East. Given the current situation in the region, along with the ongoing conflict and tensions, we believe that imports may decrease starting in 2026 until peace is restored. To examine the situation in the Middle East and the top 5 importers based on total forest product imports between 2015 and 2024, another trend analysis has been conducted. The following figure shows the changes in these countries' imports over the last decade.

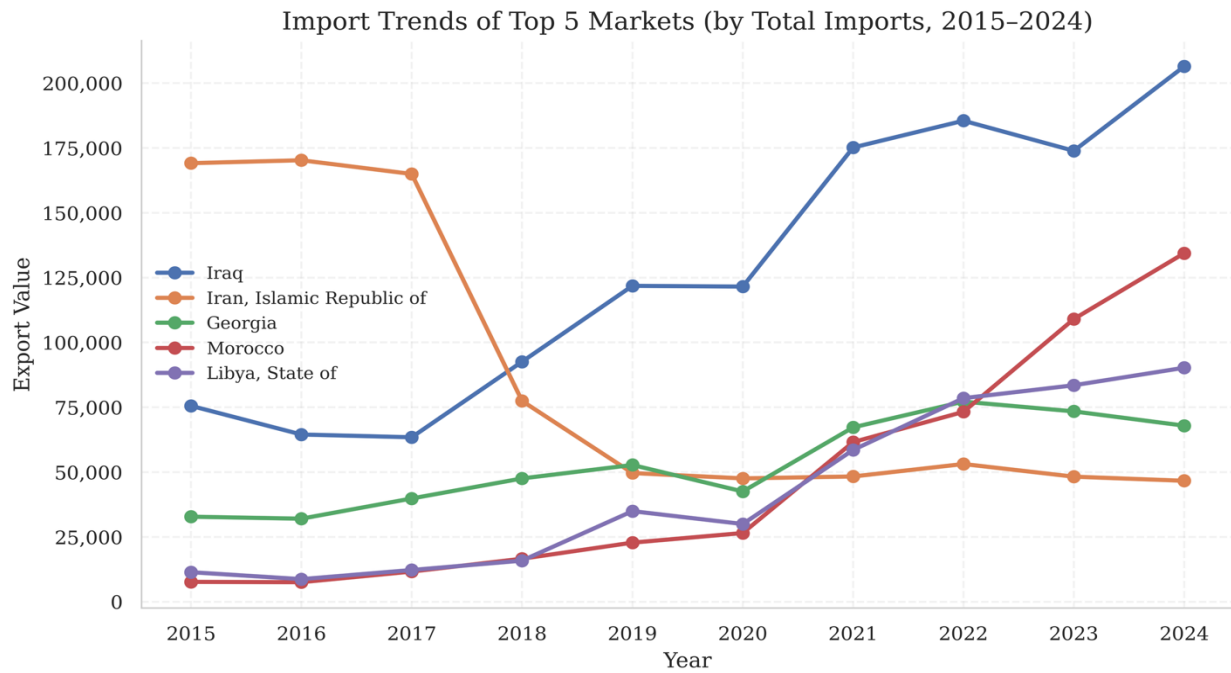


Figure 3. Import Trends of the top 5 Markets in 2015-2024.

From Figure 3, it is evident that Iraq is by far the largest importer from Türkiye since 2019. From 2019 to 2022, Iran, Georgia, Morocco, and Libya had very close import values. However, since 2023, Morocco has significantly increased the volume of imported goods. As researchers, we think that, due to tensions and conflicts in the region, these numbers may change significantly since 2026. As shown in Figure 3, Iran was the largest importer between 2015 and 2019, but due to Iran's problems in international markets beginning around 2018, its trade has consistently decreased. Probably, the ongoing conflict between Iran, Israel, and the United States of America may make it worse for Iran in the long run. Significant changes in global trade, wars, and financial crises can disrupt or cause a decline in activities that countries have planned (Akyüz et al., 2025).

Figure 4 below reveals the growth rate of Turkish exports in the last decade:

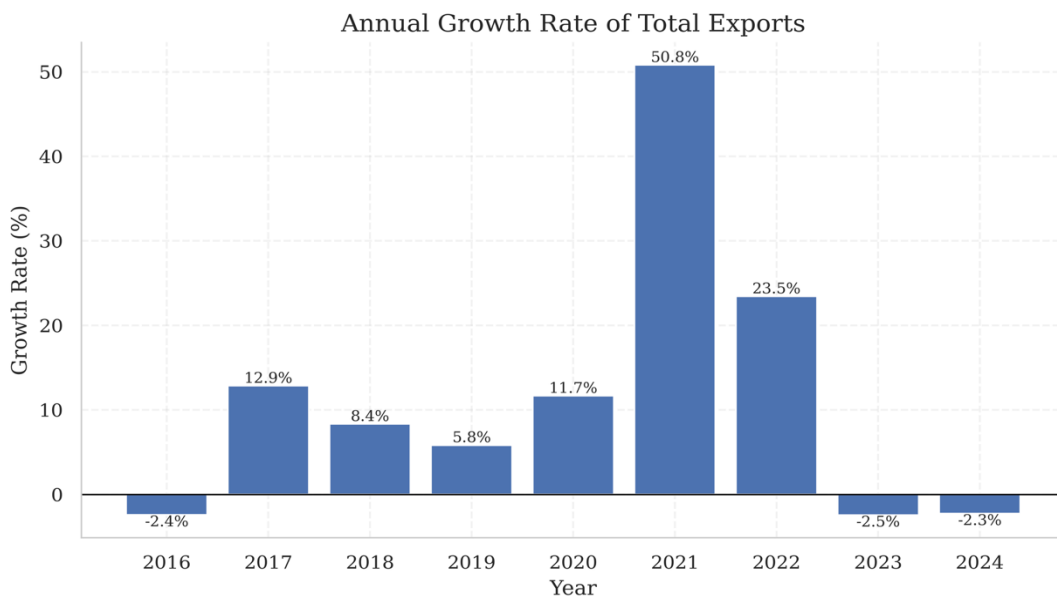


Figure 4. Annual growth rate of Türkiye's total exports.

As shown in Figure 4 above, exports increased significantly in 2021. This can be explained by the Covid19 pandemic and its impact on international trade. It is known that in 2020, the foreign trade was severely affected by the pandemic, and in 2021, many countries performed better.

Figure 5 below demonstrates the top 10 market shares in 2024.

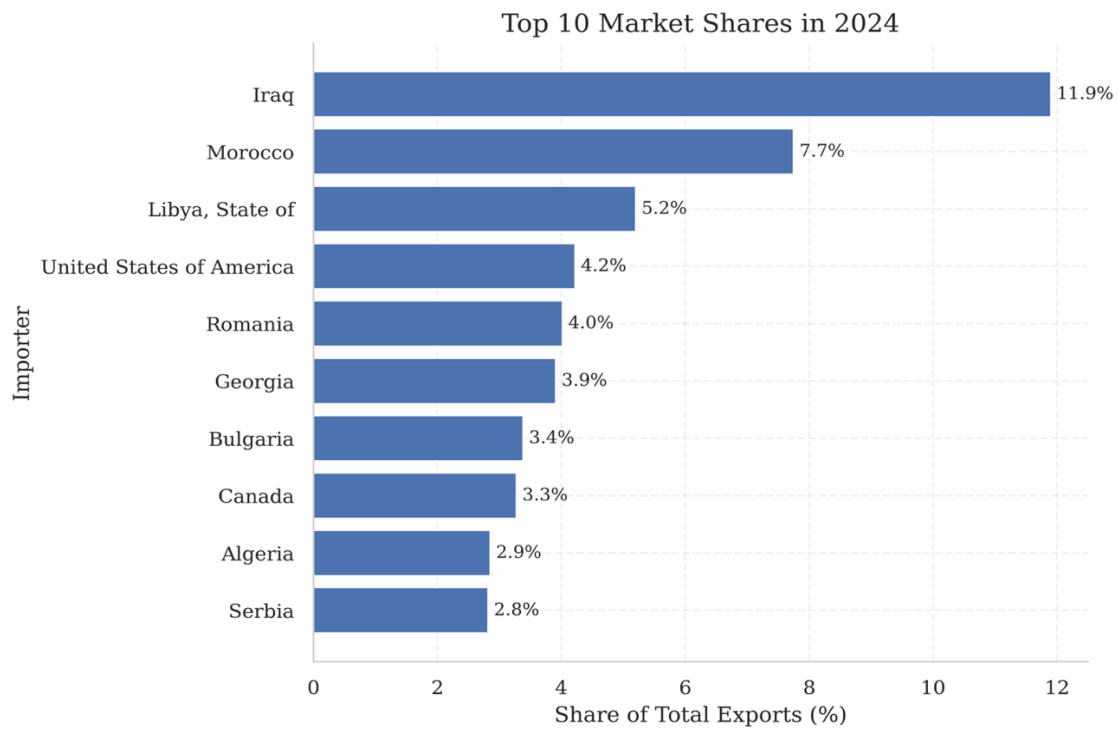


Figure 5. Top 10 market shares in 2024.

Evaluating Figure 5 above, it can be seen that Türkiye's imports are spread across the world and do not have a limited focus on the Middle East in 2024. Neighboring countries and other continents are also demanding Turkish forest products.

To reveal the top 10 importers in the last decade and their import values, a heatmap figure was created. Figure 6 below demonstrates the export values of the top 10 importers between 2015 and 2024.

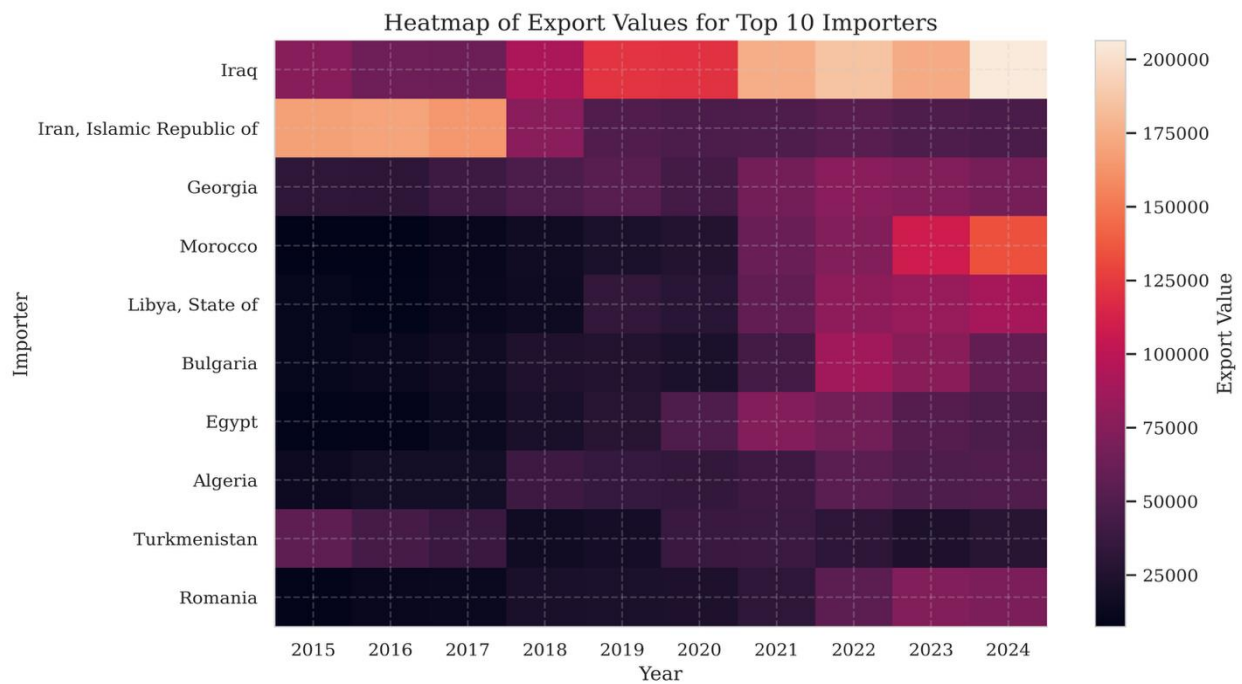


Figure 6. The heatmap of the top 10 importers export value in 2015-2024.

As already mentioned above, the importers of Turkish exported forest products and the importing regions have been shifting from the Middle East to a broader area, and this has been proven by the trend analyses. To identify the top 10 growing markets, a Compound Annual Growth Rate (CAGR) analysis was conducted. The following figure shows the findings of the CAGR analysis.

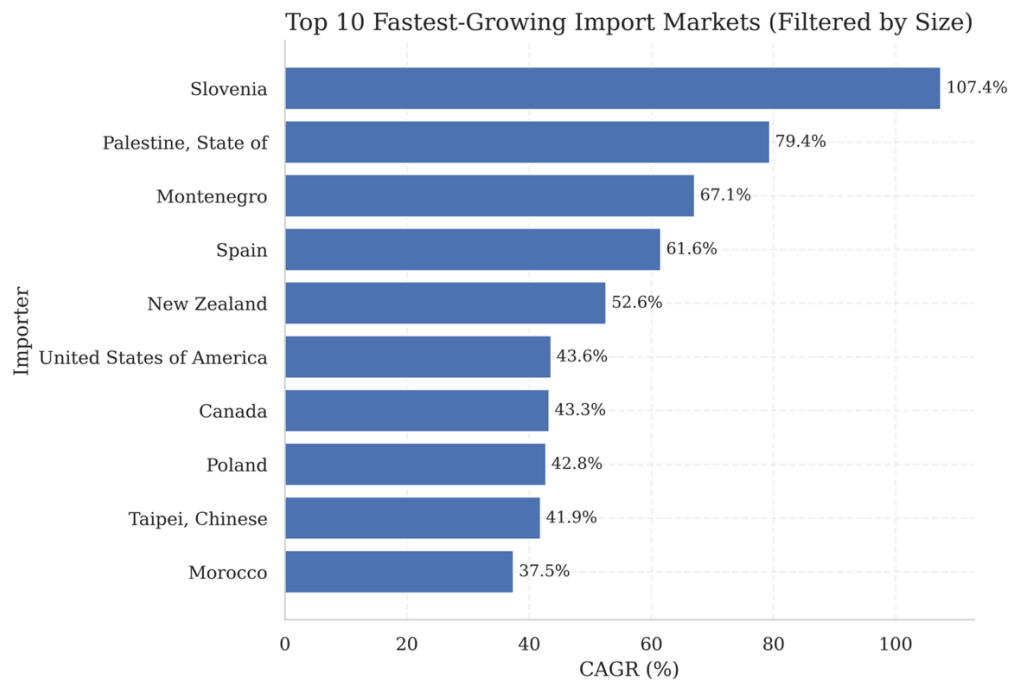


Figure 7. Top 10 fastest-growing import markets (CAGR Analysis).

Based on the CAGR analysis, Europe is the main region with increased demand for Turkish forest products. Slovenia, Montenegro, Spain, and Poland represent the European countries, while the other fast-growing markets are distributed across multiple continents.

We already discussed the importing countries and export value of the Turkish forest products. However, which products have the highest demand? What will be the future of trade in these products? These have not been mentioned yet. Therefore, to reveal product-type-based relations and interpret the industry's future, we also examined product-based trade data, and the following figures demonstrate their situation.

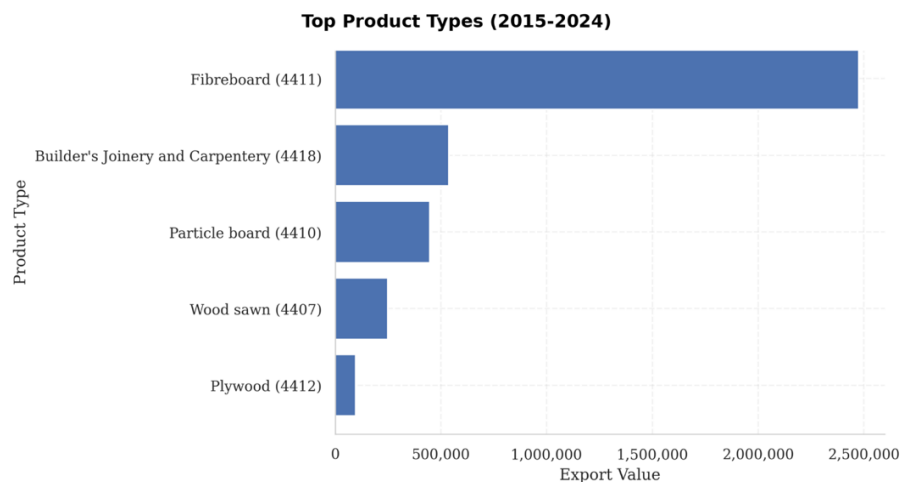


Figure 8. Top product types based on total export value in 2015-2024.

Figure 8 reveals that the fiberboard (product 4411) is the most important forest product exported by Türkiye. Between 2015 and 2024, it was the most valuable exported good by far. Builder's joinery and carpentry goods (product 4418) and particleboard products (product 4410) were listed after fibreboard, but the export value differences of these products and fibreboard are huge. However, their own export values are close to each other. These findings are on par with the findings of a previous study on the international competitiveness analysis of the industrial wood and wood products sector of Türkiye conducted by Kara and his friends (Kara et al., 2019).

To evaluate the export trend of these product types, trend analysis was conducted and the results were given in the figure below:

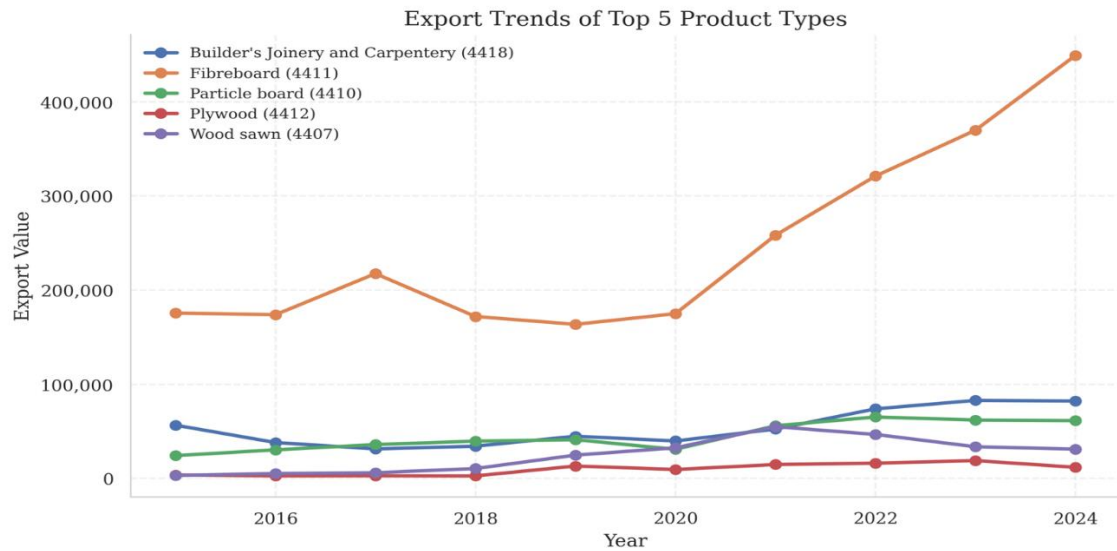


Figure 9. Export trends of products in 2015-2024.

As shown in Figure 9 above, the fibreboard (Product 4411) has consistently led in export value from 2015 to 2024. The export value of other product groups has increased slightly; however, they have shown a consistent, stable rise. Based on these findings, the most important product type in exported Turkish forest products is the fibreboard. The significance of fibreboard among exported products was noted in a 2006 study (Akyüz, 2006), and the present study has also confirmed this. Therefore, the findings are consistent with the literature.

Finally, to reveal the relation between products and importing countries, a heatmap figure was used. The heatmap is based on the top importing countries between 2015-2024 and the investigated forest product types. Figure 10 below shows the product and country relation.

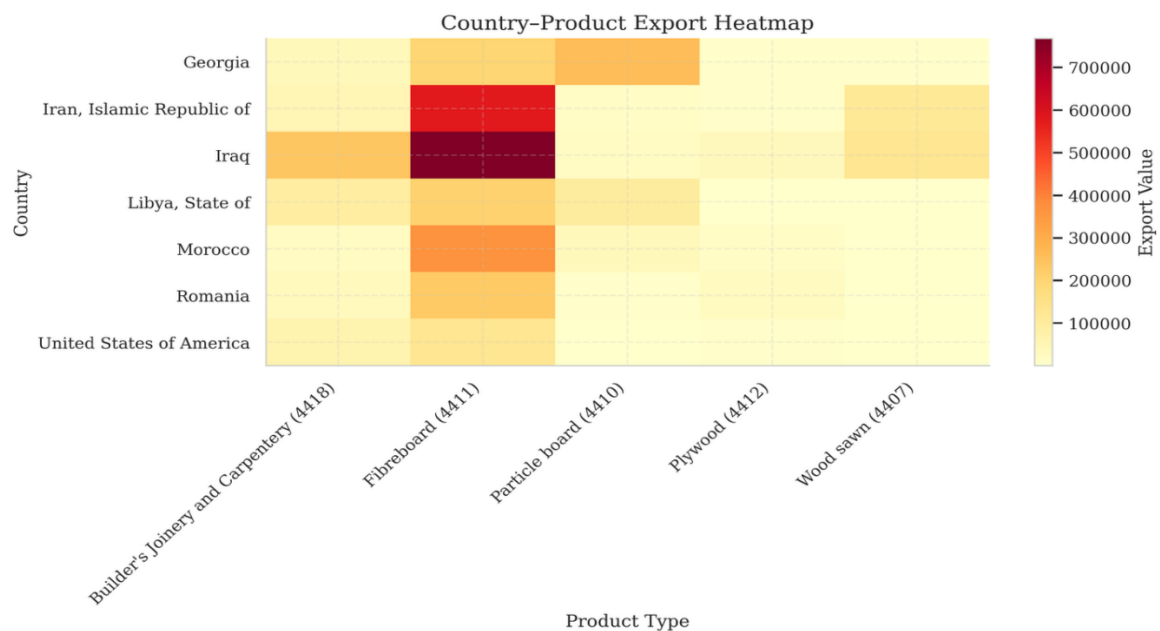


Figure 10. Product and top importing countries relation heatmap.

IV. CONCLUSION

Türkiye's forest products exports have shown overall growth since 2020, despite short-term fluctuations. The sector remains heavily dependent on Middle Eastern markets, particularly Iraq. Export destinations are gradually diversifying, with European countries emerging as fast-growing markets. Fibreboard (Product 4411) is the dominant export product, significantly outperforming other categories. Targeting high-value products and expanding into growing markets can improve export performance. Strengthening competitiveness through technology and scale is essential for long-term sector development. Future research may focus on how to create high-value-added products across subsectors, implement cutting-edge technologies in the forest products industry, and market these products.

DECLARATIONS

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Supporting Institutions: This research received no external funding.

Ethical Approval: This study does not involve human or animal participants. All procedures followed scientific and ethical principles, and all referenced studies are appropriately cited.

Plagiarism Statement: This article has been evaluated for plagiarism, and no instances of plagiarism were detected.

Use of AI Tools: The authors declare that no Artificial Intelligence (AI) tools were used in the creation of this article.

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