Research Article

Product Complexity and Export Competitiveness: Evidence from Türkiye*

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Abstract: This study investigates the determinants of export competitiveness by focusing on various factors, including product complexity, real effective exchange rate (REER), foreign demand, overall competitiveness, and institutional quality. Using the Turkish economy as a case study from 1996 to 2021, we employ the Generalized Method of Moments (GMM) technique to analyze these factors. The findings show that product complexity has a significant and negative effect on Türkiye's export competitiveness, suggesting that high-complexity products pose challenges in Türkiye's export competitiveness. Moreover, exchange rate fluctuations are found to have an insignificant impact. Economic growth in major export destinations and overall competitiveness have positive and significant impacts on export performance. This study provides several policy implications, including enhancing export competitiveness in complex products through cost-effective production, skill development, and a shift toward technology-driven industries. Furthermore, maintaining macroeconomic stability and focusing on innovation and infrastructure are crucial for boosting export competitiveness.

Keywords: International Trade, Export Competitiveness, Product Complexity, Sophistication, Turkish Economy
JEL Codes: F1, F14, F47

Ürün Karmaşıklığı ve İhracat Rekabetçiliği: Türkiye Örneği

Öz: Bu çalışma, ürün karmaşıklığı, reel efektif döviz kuru, yurtdışı talebi, genel rekabet gücü ve kurumsal kalite gibi çeşitli unsurlara odaklanarak ihracat rekabetçiliğinin belirleyicilerini araştırmaktadır. Bu amaçla, Genelleştirilmiş Momentler Yöntemi (GMM) tekniği 1996-2021 dönemi için Türkiye ekonomisi verilerine uygulanmaktadır. Elde edilen bulgular, ürün karmaşıklığının Türkiye'nin ihracat rekabetçiliği üzerinde anlamlı ve olumsuz bir etkiye sahip olduğunu göstermektedir. Bu bulgu yüksek karmaşıklıktaki ürünlerin Türkiye'nin ihracat rekabet gücünde zorluklar oluşturduğuna işaret etmektedir. Bununla birlikte, döviz kuru dalgalanmalarının istatistiki olarak anlamsız bir etkiye sahip olduğu bulgusuna ulaşılmıştır. Ayrıca, yurtdışı talep ile GCI'nin ihracat performansına anlamlı ve olumlu etki ettiği sonucuna ulaşılmıştır. Bu çalışmanın bulgularına dayanarak birçok politika önerisi geliştirilebilir. Bunların arasında maliyet etkin üretimin desteklenmesi ve beceri geliştirme ve teknoloji odaklı endüstrilere geçiş yoluyla karmaşık ürünlerde rekabetçilik gücünün artırılması yer almaktadır. Ayrıca, döviz kuru istikrarını korumak ve inovasyona, altyapıya ve makroekonomik istikrara odaklanmanın ihracat rekabetçiliğini artırmadaki önemi ortaya konmaktadır.

Anahtar Kelimeler: Uluslararası Ticaret, İhracat Rekabetçiliği, Ürün Karmaşıklığı, Sofistikasyon, Türkiye Ekonomisi
JEL Kodları: F1, F14, F47

Cite: Duman, M. C. & Sivrikaya, A. (2025). Product complexity and export competitiveness: Evidence from Türkiye. *Fiscaoeconomia, 9*(2), 785-810. https://doi.org/10.25295/fsecon.1552394

Submitted: 18.09.2024
Accepted: 15.12.2024

* This study is derived from the Ph.D. dissertation entitled "Essays on Export Competitiveness in Türkiye" in the Department of Economics of Hacettepe University Graduate School of Social Sciences.

1. Introduction

As globalization and integration has rapidly increase, countries need to create a strong, inclusive and sustainable growth path while shaping the future panorama with a development focus. Considering the transformation that economies have undergone throughout history, the competitiveness of exports is a significant determinant of their economic performance, in the complex fabric of global trade. Today, in the global economy shaped by the transformative power of trade, comparative advantages for effective production and trade are central preoccupations of most countries (Adriana & Anca, 2009). Competitiveness, in this regard, is of great importance in supporting innovation and productivity within and between industries, ensuring a more effective integration into global markets, and encouraging the intensive use of the latest technologies in production and export, transforming them with an innovative vision. Even in the light of climate change, which is a trend discussion, effects of productivity-increasing projects in the industrial sector have impacts on sustainable development that is closely related to countries' competitiveness (Sivrikaya, 2022). Many studies suggest that competitiveness enhances innovation, creates new ventures and new markets, which enables higher growth performance, high levels of productivity, and improved standards of living (Ahmed, 2010; Amar & Hamdi, 2012; Korez-Vide & Tominc, 2016; Tomizawa, Zhao, Bassellier & Ahlstrom, 2020; Mewes & Broekel, 2022). The link between competitiveness and economic dynamism underscores the imperative for countries to prioritize policies aimed at creating a conducive business environment, fostering innovation ecosystems, nurturing human capital for enhancing not only export competitiveness but also product sophistication, market and commodity diversification (Hämäläinen, 2003; Ailenei & Mosora, 2011; Huggins, Izushi, Prokop & Thompson, 2014; Gardiner, Martin & Tyler, 2012; Petrariu, Bumbac & Ciobanu, 2013; Pilinkiene, 2016).

The concept of globalization has created not only opportunities but also many challenges, especially for developing economies. Whether global trade can be balanced in the face of these challenges has been a subject of intense debate (Yalta & Sivrikaya, 2018). Even though there is no exact recipe for each country, economic complexity can be used as an indicator to shed light on capabilities and competitiveness of countries. Countries with higher economic complexity are also home to a great diversity of productive know-how and sophisticated products since economic complexity is used to explain variations in economic growth, inequality of income, sustainability and diversification patterns (Güneri & Yalta, 2020; Hidalgo, 2023, Farmer & Teytelboym, 2019). At this regard, this study investigates the determinants of export competitiveness in the case of Türkiye over the period from 1996 to 2021.

There are various approaches in the literature for measuring export competitiveness. Some studies evaluate the export competitiveness of countries in different periods within the framework of factors such as the current technological level and comparative advantage (Balassa, 1965; Dalum, Laursen & Villumsen, 1998; Lafay, 1992; Antimiani & Henke, 2007, Donges, Krieger-Boden, Langhammer, Schats & Thoroe, 1982; Amir, 2000; Finger & Kreinin, 1979), many others use changes in export volume (CEV hereafter) (Bruneckiene & Paltaviciene, 2012, Fetscherin et al., 2010, Fetscherin et al., 2012, Hooy, Law & Chan, 2015, Nyeadi, Atiga & Atogenzoya, 2014, Riberio, Carvalho & Santos, 2016, Rahmouni, 2018, Esteves & Rua, 2015, Thorbecke, Chen & Salike, 2021, Lages, Silva & Styles, 2009). One of the most used approaches to measure a country's relative advantage or disadvantage in a specific product category, compared to other countries is Balassa's (1965) Revealed Comparative Advantage (RCA) Index. Dalum et al.'s (1998) Revealed Symmetric Comparative Advantage (RSCA) Index modifies RCA to convert it into a symmetric measure. Donges et al. (1982) Comparative Export Performance (CEP) Index utilizes a country's export performance relative to the world export structure in specific products. Lafay's (1992) Trade Balance Index (TBI) focuses on a product's contribution to trade balance to measure comparative advantage of a country. Finger & Kreinin's (1979)

Export Similarity Index (ESI) shows the degree of similarity between the export structures of two countries.

In this study, export competitiveness is represented by CEV. Considering the focus of this study, this approach offers several advantages over indices such as RCA, RSCA, CEP, TBI and ESI. First of all, RCA, RSCA, CEP and TBI are product-specific indices, focusing on the relative competitiveness for individual products or sectors. ESI is useful for assessing potential competition between two countries. In contrast, CEV can be applied to broadly across all sectors and products, thus offering a comprehensive perspective on a country's export performance in global trade. Moreover, the aforementioned indices require complex calculations and interpretation in terms of particular benchmarks. In contrast, in case of CEV, increasing in export performance is gauged by an absolute or percentage growth in export volume and unlike the other indices it is straightforward to derive and interpret.

To investigate the determinants of export competitiveness, we focus on various factors including complexity of a product. To measure it, we use Product Complexity Index (PCI), developed by Hidalgo & Hausmann (2009). According to Hidalgo & Hausmann (2009), the modern world is shaped by 'productive knowledge', that is, the rapid development of the knowledge used in the production of manufactured products. The PCI is based on the variety of products a country can produce, and ubiquity of those products, which refers to the number of countries that can produce them. Thus, the PCI indicates the diversification and sophistication of countries' export products (Hidalgo & Hausmann, 2009).

The literature identifies numerous factors beyond product complexity affecting export competitiveness, with real effective exchange rate often emphasized as the key determinant (Paul & Dhiman, 2021). Other important factors include GDP, capital productivity, labor productivity, trade liberalization, cultural similarity, local market structure, regulatory standards, environmental hostility, customer exposure, R&D, FDI inflows and market orientation (Paul & Dhiman, 2021; Sousa, Martinez-Lopez & Coelho, 2008; Esterhuizen & van Rooyen, 2006; O'Cass & Julian, 2003; Balabanis & Katsikea, 2003; Cadogan, Diamantopoulos & Siguaw, 2002; Rose & Shoham, 2002; Muratoğlu & Muratoğlu, 2016).

To investigate the determinants of Türkiye's export performance, our benchmark model includes not only PCI, and the real effective exchange rate (REER) but also their interaction term to take into consideration that sophisticated export goods might be less sensitive to exchange rates fluctuations than less complex goods (Thorbecke et al., 2021). We also use two control variables: foreign demand and Global Competitiveness Index to contextualize Türkiye's position the global trade. We extent our benchmark model to include different technological levels of products. To evaluate model robustness, we adopt alternative specifications with several variables, including square of PCI, trade liberalization, domestic demand, capacity utilization rate, interest rates, R&D, regulatory quality, rule of law, control of corruption, political stability, and dummy variable for crisis years observed in Türkiye. Despite incorporating so many variables into the models, to address potential omitted variable issue and measurement errors, we apply the Generalized Method of Moments (GMM) technique to our panel data. We also develop a dynamic model by incorporating the lagged values of the dependent variables to address potential endogeneity problem, which might stem from incorporating many factors into the models (Abdouli & Hammami, 2017; Abudureheman, Jiang, Dong & Dong, 2022; Öztürk & Topcu, 2024).

Examining a country's export competitiveness is important in terms of strengthening economic growth within the global economic order formed by interconnected economies and establishing strategies to improve the competitive position of the country's exporters in international markets. Thus, our findings highlight the critical roles of factors such as product complexity, economic growth in major export destinations, and overall competitiveness. These insights can guide efforts to improve infrastructure, innovation,

and macroeconomic stability, thereby promoting a more competitive export environment in a country and contributing to its long-term economic prosperity.

Motivated by the need to better understand the dynamics of export competitiveness, this study leverages current data to analyze the opportunities and challenges Türkiye faces in international markets. While several studies have investigated the determinants of Türkiye's export competitiveness, this research offers a broader scope. Aydın and Tetik (2024), for instance, focus specifically on sesame exports, employing Dynamic Least Squares (DOLS) approach. Our study differs from their study by utilizing a holistic approach for 647 types of manufactured export goods from Türkiye to 217 different destinations. Bayar (2022) provides a sectoral export assessment using a very detailed panel data of more than a thousand sectors to determine products as their both technological and complexity structures. Unlike her, we analyze total export volumes across all sectors to provide a comprehensive perspective of overall export performance in Türkiye. Our study, additionally, contributes to the literature by providing detailed evaluation of the determinants of Türkiye's export competitiveness, by addressing potential endogeneity problems with dynamic panel data analysis that strengthens the reliability and validity of its results. Last but not least, by offering a nuanced understanding of the multifaceted factors influencing export success, this research provides valuable perspectives for future research and policymaking, aimed at improving export competitiveness in not only Türkiye but also in other developing economies.

This study comprises several sections. Initially, we present a brief review of existing literature on the factors influencing export competitiveness, with a particular focus on studies relevant to Türkiye. Following this, we provide a comprehensive overview of Türkiye's export landscape to contextualize our analysis. The subsequent sections delve into detailed analyses and evaluations of the determinants of Türkiye's export competitiveness over the period from 1996 to 2021 by utilizing the Generalized Method of Moments (GMM) technique. In the concluding section, we synthesize our findings and develop policy recommendations based on the results of our analyses.

2. Literature Review

Export competitiveness literature has been developing as the number of the studies on the relationship between growth and trade is increasing. One strand of this literature focuses on analyzing the determinants of export competitiveness. Wilson (2000) focuses on Dynamic Asian Economies including Asian Tigers to implement export-led growth policies as a catalyst of structural transformation enhancing export competitiveness as Weldemicael's (2012) examine the effects of foreign direct investments, distance and institutional quality on export performance by applying Ordinary Least Square (OLS), Two-Stage Least squares (2SLS), and GMM techniques. Saboniene (2009) analyzes Lithuanian export competitiveness between 2000-2007 by using revealed comparative advantage approach of Balassa (1965) and export competitiveness index of Amir (2000) and reveals that competitiveness is related with not only cost minimization or price competitiveness but also appropriate strategy in market development. Fetscherin et al. (2010) decompose and evaluate the export competitiveness of Chinese exports with respect to specialization and growth. They find that the relative market share of industries is significantly correlated with competitiveness.

Another strand of the export competitiveness literature offers valuable insights into the relationship between the complexity of exported products and dynamics of economies. Felipe, Kumar, Abdon & Bacate (2012) use Hidalgo & Hausmann's (2009) approach to evaluate product and country complexity for 5107 products and 124 countries. Their results suggest that the richer countries tend to export more complex products whilst export shares of the less complex products decrease with an increase in their incomes. Xu (2010) discusses product quality concept especially in China with stating that the term of sophistication of exports is not directly related with product quality since there could be overestimation of the sophistication, and relatively low average income of

China could cause underestimation of the capability of export basket, thus measurements might be biased for Chinese economy in terms of quality and sophistication. Esteves & Rua (2015) add domestic demand pressure besides foreign demand and the real exchange rate within discussions on export performance for the Portuguese case and show that domestic demand developments are relevant for the short-run dynamics of exports. Fischer (2010) shows the relationship between product quality and export performance within five EU countries and three product categories over the period 1995-2005, indicating quality matters on export performance according to product type. Lages et al. (2009) indicates both product innovation and quality have positive impact on export performance and suggests firms to invest in relationship management to improve product quality and enhance their export performance. Güneri & Yalta (2020) indicates the effect of complexity by diversification and sophistication on lowering output volatility. Moreover, Thorbecke et al. (2021) examine the relationship between product complexity and exchange rate elasticities in China and suggest developing countries to improve export sophistication in order to preserve from challenges such as tariffs, trade wars or volatile exchange rates. The results of many other studies also suggest that production complexity has impact on other indicators of economies such as growth or income inequality (Ferrarini & Scaramozzino; 2016; Hartmann, Guevara, Jara-Figueroa, Aristaran & Hidalgo, 2017).

Export competitiveness has been discussed extensively in Türkiye as well. There are several studies in the literature that measure Türkiye's competitiveness using various sophistication and competitiveness variables over different time periods. Erkan & Yıldırımcı (2015) evaluates the components of economic complexity in terms of revealed comparative advantage over two periods (1993-2002 and 2003-2013) and explains economic complexity with business sophistication, infrastructure, innovation capacity and technological readiness. Jabkowski & Kupsik (2024) declares that comparative advantages of Türkiye in agri-food sectors in the European Union provide a source of a beneficial specialization while Özözen & Polat (2023) and Serin & Civan (2008) also find competitiveness of textile and selected products such as tomato, olive oil and fruit juice, respectively by using both Balassa's (1965) Revealed Comparative Advantage (RCA) Index and Donges et al.'s (1982) Comparative Export Performance (CEP) Index. RCA measures a country's relative advantage or disadvantage in a specific product category, compared to other countries while CEP assess a country's export performance relative to the world export structure. Moreover, Duman's (2024) sectoral analysis states that 75.2 percent of total export between 2015 and 2019 is competitive whilst Erlat & Ekmen Özçelik (2009) examine the export competitiveness of Türkiye in EU-15 market by using the Finger & Kreinin's (1979) Export Similarity Index (ESI), which measures the degree of similarity between the export structures of two countries to evaluate potential competition between countries. By using Dalum et al.'s (1998) Revealed Symmetric Comparative Advantage (RSCA) Index for Turkish exports, which is a modification of RCA to convert it into a symmetric measure, Kavacık (2023), Erkan & Sarıçoban (2014), Topçu & Sarıgül (2015), Şahin (2016), Bashimov (2017), Kathuria (2018), Kılıçarslan (2021), Akdeniz & Kantar (2022) and Yıldız (2022), find that Türkiye has competitiveness in agricultural products, furniture, textile and clothing, iron-steel and vegetables but not in scientific products and electrical machines. Lastly, Hüseyni, İnan, Çelik & İşleyen (2024) and Aslanoğlu, Erdoğan & Deniz (2021) provide analyses with using Hidalgo & Hausmann's (2009) approach and the Atlas of Economic Complexity (Hausmann, Hidalgo, Bustos, Coscia, Chung, Jimenez & Yildirim, 2014) for assessing export sophistication in terms of complexity. Hidalgo & Hausmann's (2009) economic complexity index (ECI) measure the productive capabilities of a country based on the complexity of the products it exports. They also develop product complexity index (PCI) to measure the sophistication and diversity of a product based on the capabilities required to produce it (Hidalgo & Hausmann, 2009). By defining the sophistication as weighted average of product complexity index (PCI), Hüseyni et al. (2024) state Türkiye's weak performance in industrial economic complexity as Arslanoğlu

et al. (2021) state positive effect of sophistication on economic growth. Therefore, the studies investigating the competitiveness of Türkiye's export structure reach many different conclusions regarding the existence of competitiveness and comparative advantage.

Different from the aforementioned studies, this study contributes to the literature of export competitiveness by including both internal and external factors including real sector and financial based factors while analyzing the impacts of product complexity and real effective exchange rate. It also considers the relationship between institutional infrastructure and policy implications. A key contribution is its adoption of a dynamic approach.

3. Key Pillars Shaping Türkiye's Export Landscape

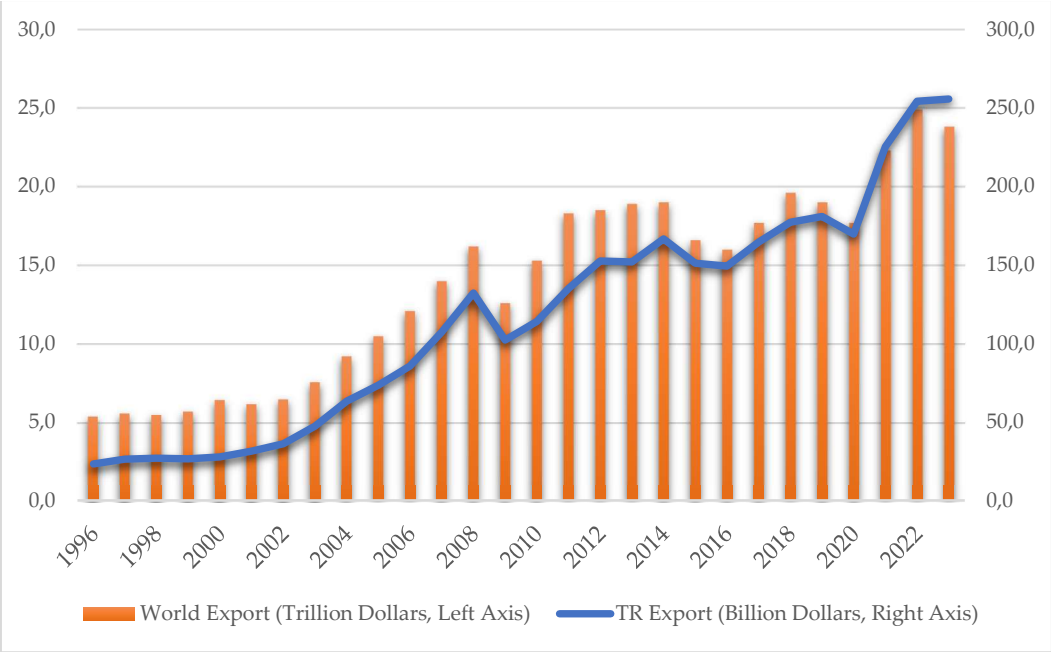
Commercial and economic outlook of Türkiye has witnessed remarkable transformations in the last few decades, especially in the field of foreign trade and export competitiveness. The story of Türkiye's foreign trade, firstly, has been intricately woven with its broader economic history, characterized by periods of liberalization, modernization, and strategic policy reforms. Following the economic turmoil in the 1970s, Türkiye opened up to global markets and strengthened its foreign trade activities with liberalization steps in the early 1980s.

Starting from the 1980s, Türkiye primarily aimed to increase exports and to ensure a development in the structure of exports in favor of industrial products. The government followed a development plan based on the fact that total exports could be increased by developing exports of industrial products faster than agricultural products and increasing the export share of intermediate and investment goods in exports of industrial products (State Planning Organization, 1978). Besides, with the establishment of the foreign expansion of the economy, Turkish economy aimed to implement policies for export products to reach distant markets, to evaluate potential destinations, and to produce exportable goods with incentive measures (State Planning Organization, 1984).

Considering the recent past, the Customs Union Agreement signed with the European Union which can be described as a turning point in the transformation of Türkiye's foreign trade, has not only eliminated trade barriers and customs duties in the trade of industrial products between Türkiye and the EU, but also accelerated regulatory alignment in trade along with the Common Customs Tariff (State Planning Organization, 2000). As a result, Turkish exporters have gained unprecedented access to the vast European market of almost 450 million consumers, more than 40 percent of Türkiye's total exports is realized to the European Union.

This structural development has had static and dynamic effects. The development of trade and prosperity through trade are among the main static effects (Özdemir & Koç Aytekin, 2016) as changes on the economy's production ability, technological progress, competitiveness and investment dynamics in a longer period (Michalopoulos & Tarr, 2004). In this regard, the dynamic effects of the Customs Union appear as a period of strong expansion in Türkiye's trade volume, modernization and integration into export markets. Türkiye's exports increased rapidly with the momentum created by Turkish exporters accessing large and wide European trade markets, which brought about the acceleration of industrial production, investment inflows and economic growth. According to the data of the Turkish Statistical Institute, Türkiye's exports, which increased by 7.3 per cent in 1996, increased by 13.1 per cent in 1997. In the ten-year period following the Customs Union Agreement, Türkiye's exports increased by an average of 13.5 per cent annually (TURKSTAT, 2024). Türkiye's exports, which were 23 billion dollars in 1996, have exceeded the 100-billion-dollar threshold as of 2007 and the 200-billion-dollar threshold as of 2021. Exports of Türkiye, which were 36.1 billion dollars in 2002, increased to 255.8 billion dollars by the end of 2023. In the period between 1996 and 2021, Türkiye's exports differentiated positively from the outlook of world exports. Although global exports have reached 4 times, Türkiye's exports have increased 11 times during this

period. Graph 1 shows that Türkiye's share in global exports, which was 0.43% in 1996, crossed the 1% threshold as of 2021 and reached 1.07% at the end of 2023.



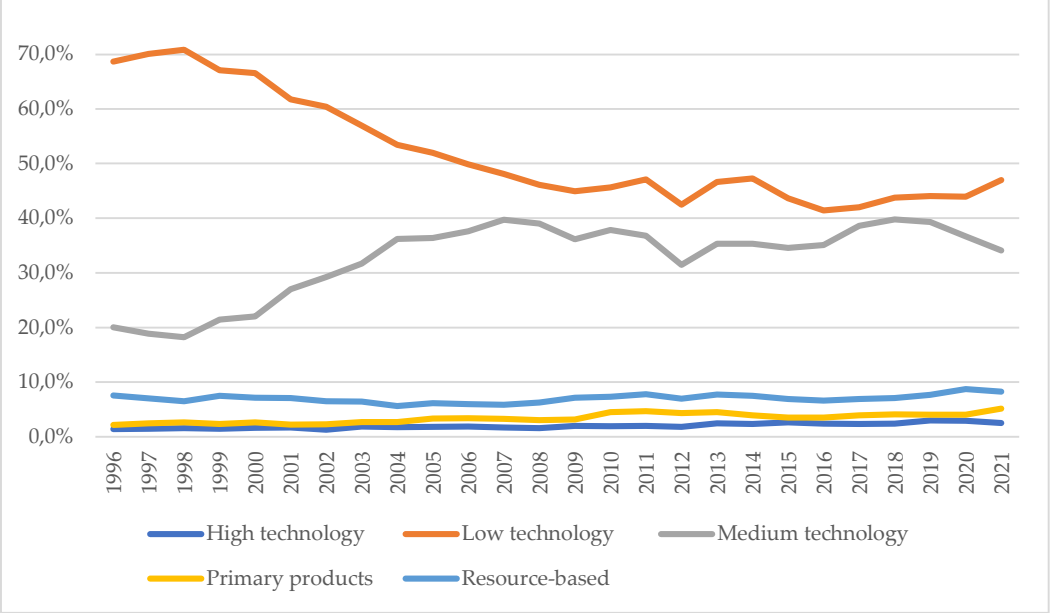
Graph 1. Overview of Türkiye's and World Export during 1996–2023 (**Source:** TURKSTAT and UNCTAD.)

The momentum in exports also manifested itself in the strengthening of economic activity; the per capita income in Türkiye, which was around $2,500 before the Customs Union Agreement, increased to $5,500 in the following decade (TURKSTAT, 2024). At the heart of Türkiye's economic growth strategy during this period was the adoption of an export-oriented development model that prioritized the expansion and diversification of export-oriented industries as the engine of growth and employment creation (Akkemik, 2011). Turkish exporters have developed their product portfolios by moving away from traditional low value-added products and turning to relatively higher value-added goods and services. The removal of tariffs and trade barriers under the Customs Union Agreement facilitated market access for Turkish exporters and allowed them to benefit from comparative advantages in key sectors such as textiles, automotive, machinery and electronics (Akkemik, 2011). These sectors have higher shares in total export of Türkiye. Table 1 shows the ranking of the top 10 countries and product groups to which Türkiye exports the most, as of the most up-to-date data, and their shares in total exports, and Graph 2 shows that although there has been a clear shift from a predominance of low-technology products to a more diversified mix of those with medium-low and medium-high technology, the share of high-tech exports remains low.

Table 1. Overview of Turkish Export Structure by Country and Product Group as of 2023

Country	Share	Product Group	Share
Germany	8.3%	Vehicles other than railway or tramway rolling	12.1%
United States	5.8%	Boilers, machineries and mechanical appliances, parts thereof	9.9%
Iraq	5.0%	Mineral fuels, minerals oils and product of their distillation	6.4%
United Kingdom	4.9%	Electrical machinery and equipment, parts thereof	6.0%
Italy	4.8%	Precious stones, precious metals, pearls and articles thereof	5.3%
Russian Federation	4.3%	Plastic and articles thereof	4.1%
France	4.0%	Knitted and crocheted goods and articles thereof	4.0%
Spain	3.8%	Articles of iron and steel	3.9%
UAE	3.4%	Iron and steel	3.5%
Netherlands	3.1%	Non knitted and crocheted goods and articles thereof	3.1%
Others	52.7%	Others	41.6%

Source: TURKSTAT.



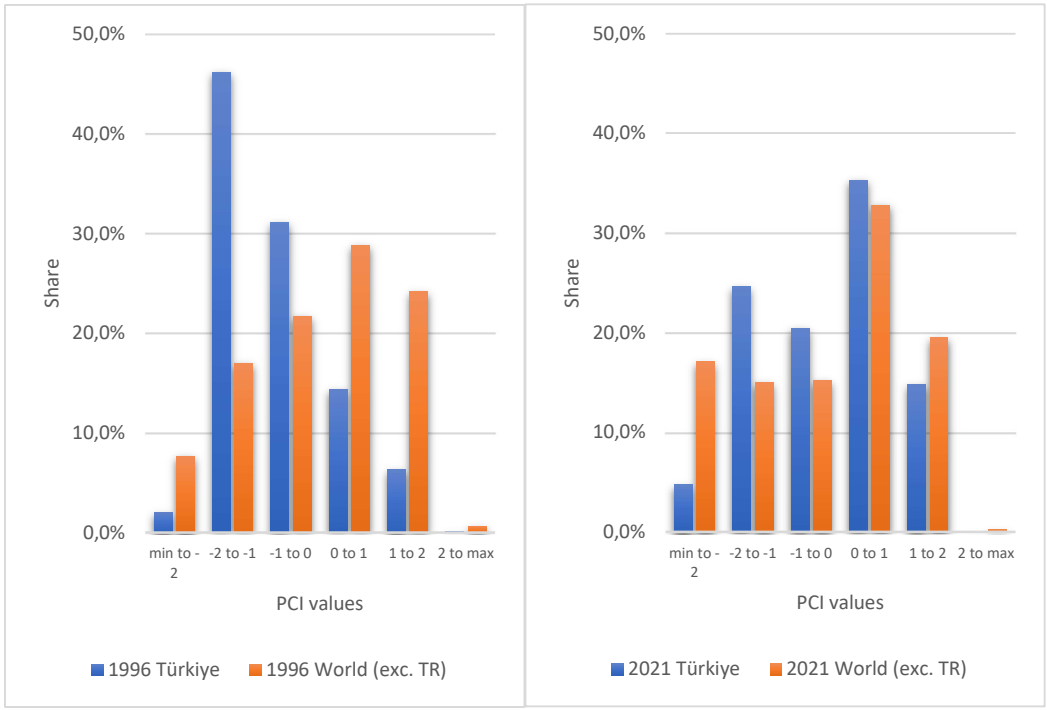
Graph 2. Technological Composition of Türkiye's Exports Between 1996–2021 (**Source:** Gaulier & Zignago (2010), UNCTAD (2017) and authors' calculations.)

Therefore, the qualitative structure of Türkiye's exports, is still a subject of rigorous debate and detailed analysis. While the share of exports of low and medium low technology products in the Turkish manufacturing industry was over 90 per cent in 1996, this rate decreased to 63 per cent in the first decade and approached 50 per cent as of 2020 (Ünlü & Yıldız, 2019; TURKSTAT, 2024). Despite achieving notable momentum in decreasing the share of low technology products in the Turkish manufacturing industry, the transformation in export sophistication has not been observed at the same level. When we examine Türkiye's export sophistication on a unit value basis, the improvement in the ten-year period after 1996 stands out, while the halt of progress in the immediate subsequent period caused the technological progress of Türkiye's exports to go into inertia. This inertia is a result of Türkiye's concentration in sectors with relatively lower unit export values (Çetin & Yılmaz, 2017).

Graph 3 provides an additional analysis for evaluating the sophistication and quality level of Türkiye's export basket. Inspired by the study of the Hong Kong Monetary Authority (2023), we divide the export baskets of the World and Türkiye into six separate sections according to product complexity levels (measured by PCI) and show their shares in total exports in the period between 1996 and 2021 in the following. The graph shows that the sophistication of Türkiye's export basket has improved since 1996. In Türkiye, there had been a transformation from products with complexity values between -2 and -1 that imply relatively less complex products to those with complexity values between 0 and 1 and 1 to 2 which are more complex. The share of the most complex products with index values more than 2 in total exports has decreased both in the world and in Türkiye during this period. Share of the most complex products with index values more than 2 in the World is equal to 0.23 per cent as it is only 0.02 per cent. Thus, although Türkiye's export basket has clearly restructured towards relatively higher complexity segments, Türkiye is still far from the world average in products with complexity values and in production and export of the most complex products (Graph 3).

The issue of competitiveness is in the center of these discussions. There is an ongoing evaluation of whether Türkiye's export competitiveness is driven primarily by price advantages or by the quality and complexity of its products. Additionally, other factors influencing competitiveness, such as innovation capacity, infrastructure, and regulatory environment, are scrutinized. Addressing these issues is essential for Türkiye to enhance its qualitative export structure. Strategic policies aimed at boosting high-tech production,

improving innovation ecosystems, and fostering an environment conducive to high-quality manufacturing are crucial steps toward ensuring Türkiye's competitive edge in the global marketplace.



Graph 3. Distribution of Products by PCI in Türkiye and World Export Basket: 1996 Versus 2021 (**Source:** Gaulier & Zignago (2010), Hidalgo & Hausmann (2009), authors' calculations.)

4. Methodology, Data, and Findings

This section includes data, methodology and findings of the study that analyzes determinants of Türkiye's export competitiveness.

4.1. Methodology

Our benchmark model uses changes in export volume (CEV) as the dependent variable to represent export competitiveness. This model consists of product-based and price based independent variables. Product-based variable is product complexity index (PCI) while price-based variable denotes reel effective exchange rate ($REER_t$). We also incorporate two main control variables, foreign demand, indicated by GDP, and Global Competitiveness Index (GCI), into the model. As Thorbecke et al. (2021) reveals that sophisticated exports are less sensitive to exchange rates than less complex goods, to understand synergistic effects of product complexity on export competitiveness changes at different levels of the exchange rate and capture a possible non-linear relationship, we also include an interaction term, $Inter_t$ $(= PCI\ x\ REER)$ into our benchmark model, given in the following:

$$Exp_t = \beta_0 + \beta_1 Exp_{t-1} + \beta_2 PCI_t + \beta_3 REER_t + \beta_4 REER_{t-1} + \beta_5 GDP_t + \beta_6 GCI_t + \beta_7 Inter_t + \varepsilon_t \quad (1)$$

Exp_t expresses export competitiveness in Türkiye at time t, Exp_{t-1} expresses that at time t-1, and both are in natural logarithm form.

To examine the effects of technological levels of products on export competitiveness, we introduce $Tech\_Level_t$ as dummy variables to the benchmark model. To this end, they are generated for five different technological levels of products, denoted by *Primary*, *Resource*, *Low Tech*, *Mid Tech*, *High Tech*, according to the concordance tables of UNCTAD.

By adding $Tech\_Level_t$ we obtained five different augmented models, given in Equation (2).

$$Exp_t = \beta_0 + \beta_1 Exp_{t-1} + \beta_2 PCI_t + \beta_3 REER_t + \beta_4 REER_{t-1} + \beta_5 GDP_t + \beta_6 GCI_t + \beta_7 Inter_t + \beta_8 Tech\_Level_t + \varepsilon_t \quad (2)$$

To estimate the benchmark and augmented models, we use the system GMM estimator, introducing additional instrumental variables, specifically the world growth rate and year, along with the lagged value of the dependent variable. This approach allows us to control for potential correlations between the explanatory variables and the error term (Abdouli & Hammami, 2017; Abudureheman et al., 2022; Öztürk & Topcu, 2024).

In this study, the Sargan test introduced by Arellano & Bond (1991) is used for evaluating the validity of the instrumental variables by examining their exogeneity. It both tests if there is no correlation between the model residuals and the independent variables and the null hypothesis that the over-identification constraints are valid. Furthermore, we also test for autocorrelation with the test statistics devised by Arellano & Bond (1991) that helps testing the null hypothesis, which states that the error term is free from autocorrelation.

4.2. Data

Our benchmark model explains export competitiveness in terms of product complexity and price changes, foreign demand and general competitiveness performance of Türkiye. In this study, we use annual data over the period of 1996-2021. We utilize 647 types of manufactured export goods from Türkiye to 217 different destinations, disaggregated at the Harmonized System four-digit level. The series of the export volume of Türkiye is retrieved from UN COMTRADE and Gaulier & Zignago (2010) (called as CEPII database). For product complexity, we use Hidalgo & Hausmann's (2009) product complexity index (PCI), which measures the complexity of a product based on how diversified and sophisticated the countries that export it are. PCI, derived from the Atlas of Economic Complexity database built by the Growth Lab at the Harvard Kennedy School (2019) captures and quantifies the level of sophistication and complexity in the know-how necessary to produce each HS-4 product. We calculate foreign demand variable in our models, indicated by GDP, by weighting per capita incomes of the top 25 export destinations of Türkiye, by their share of Türkiye's total export volume. The other control variable, GCI, is the index value received by Türkiye in the Global Competitiveness Index study prepared annually by the World Economic Forum, which reveals the general competitiveness outlook of countries in terms of the number of pillars. REER is obtained from the database of Central Bank of Turkish Republic (CBRT) and denotes natural logarithm of CPI based real effective exchange rate, and it indicates appreciation of Turkish lira when it increases. We take logarithm of Exp, REER and GDP. Table 2 gives the descriptive statistics of the series.

Table 2. Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Exp	16,499	8.709	2.937	-2.674	16.428
PCI	16,499	0.126	0.929	-2.866	2.972
REER	16,499	4.566	0.178	4.101	4.803
GDP	16,499	9.856	0.133	9.575	10.097
GCI	6,960	4.330	0.111	4.150	4.460

Table 3 shows the correlation between variables. As Table shows, there is a negative correlation between export competitiveness and both product complexity and real

effective exchange rate while there is a positive correlation between product complexity and foreign demand.

Table 3. Correlation Matrix

	Exp	PCI	REER	GDP	GCI
Exp	1.000				
PCI	-0.128	1.000			
REER	-0.020	0.000	1.000		
GDP	0.228	0.013	-0.044	1.000	
GCI	0.063	-0.001	-0.649	-0.192	1.000

The augmented models include dummy variables to capture the effects of technological levels of products (*Primary, Resource, Low Tech, Mid Tech, High Tech)* on export competitiveness. To further assess for robustness, we generate alternative specifications, including industrial production (*Industrial*), capacity utilization rate (*Capacity*), weighted average interest rates applied to commercial loans opened by banks (*Interest Rate*), research and development expenditure [†] (*R&D*), regulatory quality (*Regulatory*), rule of law (*Law*), control of corruption (*Corruption*), and political stability (*Stability*) as institutional quality variables. Additionally, a dummy variable is introduced to account for the crisis years observed in Türkiye[‡]. The sources for these variables and their descriptive statistics are provided in Table 4.

Table 4. Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max	Source
Industrial	16,499	53.481	21.420	27.783	100	TURKSTAT
Capacity	9,484	76.016	3.243	66.980	81.930	CBRT
Interest Rate	12,673	19.443	9.609	8.910	49.160	
Primary	16,499	0.089	0.285	0	1	
Resource	16,499	0.233	0.423	0	1	
Low Tech	16,499	0.363	0.481	0	1	UNCTAD
Mid Tech	16,499	0.252	0.434	0	1	
High Tech	16,499	0.043	0.204	0	1	
Crisis	16,499	0.115	0.319	0	1	Authors' Compilation
R&D	16,499	0.773	0.314	0.362	1.404	World Bank and TURKSTAT
Regulatory (Estimate)	14,584	0.204	0.168	-0.245	0.463	
Law (Estimate)	14,584	-0.112	0.175	-0.458	0.117	
Corruption (Estimate)	14,584	-0.141	0.196	-0.570	0.161	Kaufmann & Kraay (2023)
Regulatory (Upper Bound of 90% Conf.)	14,584	67.627	4.236	54.717	73.934	
Law (Upper Bound of 90% Conf.)	14,584	57.092	4.678	45.283	62.687	
Stability (Upper Bound of 90% Conf.)	14,584	24.222	9.448	7.143	40.777	

4.3. Estimation Results

We start with estimation of the benchmark and augmented models in Equation (1) and (2), whose results are presented in Table 5.

In our GMM analysis, we firstly need to check whether our estimation is valid. For examining the validity of our regression, we assess the presence of first-degree autocorrelation in the error terms of the series and the absence of second-degree autocorrelation. The probability values of AR (1) in all models that are generated and expressed in Table 5 are less than 0.05 whilst that of AR (2) are greater than 0.05 which satisfies both conditions of autocorrelation criterion. Additionally, we use Sargan test to assess whether the model's instruments are valid. As Table 5 shows, its null hypothesis that the instruments are not correlated with the error term cannot be rejected, suggesting them valid.

As Table 5 shows, the lagged value of export volume has positive and significant effect on Türkiye's export competitiveness across all models. The coefficients for *PCI* are

[†] Research and development expenditures are calculated as a percentage of GDP.

[‡] The dummy variable was set to 1 for one technology level and zero for the others. A separate dummy variable is generated for each technology level. The dummy variable is formed as 1 for 2001, 2009 and 2020 and for other years it is zero.

negative and significant at the 5% level in all models, suggesting that Türkiye has less export competitiveness in products that are relatively more complex. This might be caused by several factors such as production costs of more complex goods, necessity for specialized skills and technologies, and lack of penetration international markets. Thus, these findings show us Türkiye has challenges in more complex goods in the context of competitiveness.

Additionally, the analysis reveals that the real exchange rate (REER) does not exert a significant influence on export competitiveness in any of the models. Our results suggest that complexity is a substantial determinant of export competitiveness in Türkiye rather than fluctuations in the exchange rate, whether immediate or delayed. Moreover, it is beneficial to discuss why the appreciation of the domestic currency brings about an increase in export although it is not statistically significant. Tran (2022) indicates that exporters in relatively more import-dependent economies might have competitive advantage for supplying raw materials from abroad for more production and therefore exports. Hence, policies and strategies employed by Turkish exporters to increase the competitiveness might be quality-focused without ignoring to mitigate the effects of exchange rate volatility, such as hedging or establishing stable pricing agreements in international markets.

Table 5. Regression Results for Export Competitiveness (1)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.050***	1.024***	0.917***	1.018***	1.040***	1.115***
	(0.102)	(0.113)	(0.156)	(0.106)	(0.111)	(0.158)
PCI_t	-1.575**	-1.591**	-1.354*	-1.548**	-1.562**	-1.541*
	(0.694)	(0.692)	(0.712)	(0.683)	(0.684)	(0.787)
$REER_t$	0.780	0.748	0.627	0.674	0.805	0.998
	(0.664)	(0.665)	(0.627)	(0.660)	(0.654)	(0.749)
$REER_{t-1}$	0.937	0.856	1.287	1.104	0.850	1.030
	(1.204)	(1.204)	(1.264)	(1.249)	(1.247)	(1.310)
GDP_t	3.197***	3.123***	2.848***	3.200***	3.121***	3.248***
	(0.880)	(0.860)	(0.905)	(0.870)	(0.893)	(0.966)
GCI_t	1.238*	1.197*	1.605**	1.330**	1.216*	1.322*
	(0.649)	(0.649)	(0.727)	(0.676)	(0.656)	(0.727)
$Inter_t$	0.351**	0.357**	0.308**	0.355**	0.344**	0.344**
	(0.150)	(0.150)	(0.150)	(0.146)	(0.148)	(0.167)
$Primary_t$		-0.904				
		(1.066)				
$Resource_t$			-0.929			
			(0.910)			
$Low\ Tech_t$				0.253		
				(0.403)		
$Mid\ Tech_t$					0.164	
					(0.664)	
$High\ Tech_t$						3.371
						(3.890)
Constant	-45.470***	-43.711***	-43.084***	-45.990***	-44.280***	-48.536***
	(12.771)	(12.732)	(13.261)	(12.797)	(13.422)	(14.634)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.179	0.179	0.188	0.185	0.176	0.198
Hansen	0.778	0.830	0.816	0.717	0.729	0.917
Sargan	0.767	0.758	0.712	0.722	0.702	0.869
Number of Instruments	24	24	24	24	24	24

Furthermore, foreign demand and general competitiveness structure have both positive and significant effect on enhancing Türkiye's export competitiveness. The robust positive relationship with weighted GDP per capita of the top 25 export destinations suggests that higher income levels of Türkiye's export market stimulate demand for

Turkish products, whilst improvements in infrastructure, macroeconomic stability, and innovation, as captured by the GCI, likely enhance the capacity of Turkish firms to compete globally.

We also investigate the effect of the interaction variable, *Inter*, and it emerges as a significant determinant of export competitiveness in Türkiye across all models. Since the coefficients for Inter are positive and significant at the 5% level, the combined effect of product complexity and exchange rate movements positively influences export competitiveness. We can consider a nuanced relationship where increasing product complexity even Turkish lira appreciates could still enhance export competitiveness, despite the individual effect of the complexity. This might occur since firms producing complex goods are better positioned to absorb exchange rate fluctuations or may benefit from a stronger currency when sourcing higher quality inputs from abroad. This relationship also implies that the detrimental impact of higher product complexity on exports may be mitigated by favorable exchange rate conditions. More complex products, furthermore, might command higher prices in international markets, making them less sensitive to exchange rate variations. Despite the individual effects of both complexity and price competitiveness, the significant positive interaction between them highlights the importance of considering both during formulation of strategies to enhance export competitiveness. Policymakers should recognize that increasing product complexity can initially pose challenges, but these could be offset by maintaining a favorable exchange rate environment as they could also focus on implementing policies that enhance the ability of firms to manage volatility or uncertainty risks.

Our findings also show us that policies which try to increase complexity by supporting innovative environment in Turkish industries should be coupled by exchange rate policies that not inadvertently hinder the competitiveness of these advanced products. One of the most effective ways of enhancing export competitiveness of Türkiye is not only trying to increase complexity of export goods individually but also creating a conducive macroeconomic environment that leverages favorable financial conditions.

We also estimate our benchmark and augmented models with eliminating lagged value of REER, and results for lagged value of export volume, PCI, REER, GDP, GCI and Inter are the same where the model is valid as well. The estimation results are shown in Table 6. By excluding the lagged value of REER, we maintain consistency in the significance and directionality of variables. Specifically, the persistent negative impact of PCI on Türkiye's export competitiveness highlights ongoing challenges associated with complex product exports.

Furthermore, the significant and robust interaction effect between PCI and REER emphasizes the strategic importance of favorable exchange rate conditions in mitigating the adverse effects of product complexity on export competitiveness.

Table 6. Regression Results for Export Competitiveness (2)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.012***	0.988***	0.843***	0.983***	0.995***	1.081***
	(0.096)	(0.104)	(0.159)	(0.100)	(0.103)	(0.153)
PCI_t	0.033	0.046	0.066	0.075	-0.002	0.037
	(0.203)	(0.205)	(0.230)	(0.230)	(0.224)	(0.240)
$REER_t$	1.139*	1.116*	0.879	1.048*	1.174**	1.360**
	(0.600)	(0.603)	(0.600)	(0.603)	(0.590)	(0.690)
GDP_t	0.607	0.527	1.120	0.753	0.449	0.710
	(1.171)	(1.167)	(1.290)	(1.220)	(1.211)	(1.262)
GCI_t	2.597***	2.519***	2.233***	2.593***	2.471***	2.662***
	(0.777)	(0.760)	(0.791)	(0.770)	(0.790)	(0.859)
$Inter_t$	1.324**	1.287**	1.792**	1.406**	1.276**	1.410**
	(0.629)	(0.627)	(0.720)	(0.658)	(0.636)	(0.709)
$Primary_t$		-0.825				
		(1.003)				
$Resource_t$			-1.222			
			(0.922)			
$Low\ Tech_t$				0.226		
				(0.395)		
$Mid\ Tech_t$					0.321	
					(0.636)	
$High\ Tech_t$						3.530
						(3.869)
Constant	-39.665***	-37.962***	-37.460***	-40.068***	-37.558***	-42.992***
	(12.155)	(12.043)	(13.394)	(12.227)	(12.738)	(13.856)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.145	0.147	0.176	0.148	0.145	0.162
Hansen	0.455	0.455	0.690	0.403	0.403	0.673
Sargan	0.443	0.406	0.393	0.374	0.378	0.601
Number of Instruments	24	24	24	24	24	24

4.4. Robustness Check

For checking the robustness of our models, we use alternative specifications. The signs and significance levels of the coefficients of our explanatory variables do not change in the models we generate by adding new explanatory variables or replacing the old ones.

Firstly, both validity of the model and the results are the same and consistent with our basic model that is generated in Equation (2) when we add *Trade Liberal* as an explanatory variable for export competitiveness. The variable *Trade Liberal* is defined as the sum of exports and imports divided by the GDP. The results of this alternative model are shown in Table 7.

Table 7. Regression Results for Export Competitiveness

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.057***	1.030***	0.924***	1.026***	1.047***	1.118***
	(0.106)	(0.118)	(0.162)	(0.112)	(0.115)	(0.159)
PCI_t	-1.579**	-1.593**	-1.363*	-1.553**	-1.564**	-1.545**
	(0.700)	(0.695)	(0.712)	(0.688)	(0.690)	(0.788)
$REER_t$	0.416	0.509	0.491	0.462	0.406	0.762
	(0.969)	(0.932)	(0.884)	(0.939)	(0.964)	(1.093)
$REER_{t-1}$	1.647	1.328	1.549	1.520	1.619	1.476
	(2.000)	(1.999)	(1.936)	(1.946)	(2.000)	(2.179)
GDP_t	3.575***	3.375***	3.004**	3.429***	3.524***	3.486***
	(1.194)	(1.163)	(1.212)	(1.176)	(1.197)	(1.293)
GCI_t	1.825	1.586	1.819	1.678	1.862	1.691
	(1.451)	(1.464)	(1.394)	(1.405)	(1.439)	(1.590)
$Trade\ Liberal_t$	-0.023	-0.015	-0.009	-0.014	-0.025	-0.014
	(0.046)	(0.047)	(0.044)	(0.046)	(0.046)	(0.050)
$Inter_t$	0.357**	0.361**	0.311**	0.358**	0.349**	0.348**
	(0.151)	(0.150)	(0.151)	(0.147)	(0.150)	(0.169)
$Primary_t$		-0.863				
		(1.091)				
$Resource_t$			-0.899			
			(0.926)			
$Low\ Tech_t$				0.229		
				(0.414)		
$Mid\ Tech_t$					0.199	
					(0.674)	
$High\ Tech_t$						3.286
						(3.901)
Constant	-52.293***	-48.289**	-45.786**	-50.089**	-51.595**	-52.776**
	(20.215)	(20.315)	(20.236)	(19.715)	(20.344)	(22.188)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.154	0.171	0.186	0.175	0.146	0.183
Hansen	0.765	0.791	0.771	0.682	0.717	0.891
Sargan	0.731	0.708	0.653	0.668	0.662	0.829
Number of Instruments	24	24	24	24	24	24

Secondly, we extend our model with adding different explanatory variables such as square of PCI (Table 8 in Appendix), industrial production (Table 9 in Appendix), interest rate (Table 10 in Appendix), R&D (Table 11 in Appendix) and variables for institutional quality such as rule of law, voice and accountability and government effectiveness (Table 12 in Appendix). The loss of significance of product complexity in an alternative model we include its square suggests a potential non-linear relationship between product complexity and export competitiveness. This finding implies that the impact of product complexity on exports may not be straightforward, potentially involving diminishing returns. Besides, significance of export experience and price competitiveness still holds (Table 9). We also include Türkiye's industrial production as an indicator of domestic demand in another model while robust and significant result of product complexity

assumes that higher product complexity continues to pose challenges for Türkiye's export competitiveness (Table 9).

Financial environment is considered as one of the key determinants of export competitiveness. Hence, we incorporate the weighted average interest rates applied to commercial loans opened by banks as an explanatory variable and it still does not change the negative and significant coefficient of product complexity, and positive and significant coefficient of interaction term. Although the interest rate has a negative but insignificant coefficient, implying it does not directly impact export competitiveness, its role in the broader economic context should not be overlooked. These findings show us the importance of managing financial environment to enhance export competitiveness, even as traditional financial indicators like interest rates show limited direct influence (Table 10).

It is a fact that R&D consumption on production improves the sophistication and quality of goods, and we consider this as an explanatory variable shown in Table 11. As we predict, R&D has significant and positive effect on export competitiveness such that increased investment in R&D likely fosters innovation, improves product quality, and enhances the ability to compete in international markets. Our fundamental findings still hold whilst boosting R&D can significantly bolster Türkiye's export performance, particularly when complemented by favorable exchange rate conditions (Table 11).

Last but not least, we also examine effect of institutional quality on export competitiveness. We both include estimate values ranging from approximately -2.5 to 2.5 and upper bound of 90 percent confidence values from 0 to 100, with higher values corresponding to better outcomes (Kaufmann & Kraay, 2023). The results of alternative models show that development on regulatory quality, rule of law, control of corruption and political stability obtain increase in export competitiveness, but their effects are not statistically significant. Furthermore, significance of export experience, product complexity and price competitiveness hold in this alternative model as well (Table 12).

In addition to all these, we include dummy variable for crisis (that are determined as 2001, 2009 and 2019 in our study) and this does not change our findings since it has negative impact for all product groups on the export competitiveness of Türkiye.

5. Conclusion

This study examines the determinants of Türkiye’s export competitiveness. To this end, we evaluate the effects of various factors, including product complexity, real effective exchange rate, GCI, foreign demand, domestic demand, and institutional quality on export competitiveness of Türkiye over the period between 1996 and 2021 by applying the GMM technique.

This study finds that Türkiye's export competitiveness in products with high levels of complexity is weak, presenting challenges rather than opportunities for its current export structure. This negative relationship can be attributed to high production costs, the need for specialized skills, and barriers to entering international markets with complex products. The results of this study also indicate that exchange rate-based changes do not have a statistically significant effect on Türkiye's export competitiveness. Instead, Türkiye's export competitiveness is shaped by structural economic conditions and global demand. Besides, both development of export destinations and general competitiveness structure of Türkiye consistently have positive impact on improving export performance. Thus, this finding suggest that more developed export market has a growing demand for Turkish products, and advancements in infrastructure, macroeconomic stability and innovation strengthen the international competitive capacity of Turkish companies. Moreover, R&D and business environment have also significant impact on export competitiveness of Türkiye.

This study offers several policy recommendations. Firstly, the persistent negative relationship between product complexity (PCI) and export competitiveness signals an urgent need for a national strategy to elevate Türkiye's technological and production capabilities. To avoid Türkiye's risking being left behind in the race for export dominance in high-value global markets, decisive reforms to restructure Türkiye's need to include designing and following qualified export-targeted policies that will increase competitiveness in complex products. This could be achieved through measures such as lowering production costs, developing production skills and competencies to overcome market entry barriers, improving brand perception in foreign markets, and transitioning towards a technology-oriented production and export structure. In the light of the significant impact of R&D on export performance, additionally, financial and structural support for R&D for firms that encourage skill development and support technology transfer to produce cutting-edge, complex products could boost qualified exports.

Second, impact of real effective exchange rate on export competitiveness is found insignificant. The results suggest that Turkish exporters deal with the fluctuations in the REER by using financial derivative instruments, allowing them to maintain high export values. However, stable REER might promote both economic performance and trade flows, by reducing the need for those costly hedging instruments (Guzman, Ocampo & Stiglitz, 2018, Mayer & Steingress, 2020; Sweidan, 2013; Chinn, 2006). At this point, facilitating a conducive financial environment specifically tailored to firms producing high-complexity goods could also enhance export competitiveness while securing Turkish exporters' place in dynamic international markets.

The robust positive influence of foreign demand on export competitiveness underscores the importance of Türkiye's integration into global markets. Thus, it is vital for policymakers to focus on leveraging foreign demand and strategic partnerships by negotiating favorable trade agreements and enhancing logistics and supply chain capabilities. Overall, elevating Türkiye's export competitiveness requires a synergistic approach—innovative industrial policies, robust infrastructure investments, and unwavering support for high-complexity products that embody future market trends.

Based on the findings in our study, possible future research could examine the non-linear relationship between product complexity and export competitiveness, considering potential threshold effects or diminishing returns. Additionally, researchers could also investigate the role of sector-specific policies in enhancing particularly competitiveness of high-tech and complex products. Moreover, differentiating effects of both complexity and real exchange rate on export competitiveness could be goal of future studies by considering the import dependency ratios of sectors' exports. We believe that future studies, together with the findings that we have covered in our study, will make a great contribution to the design and implementation of more comprehensive strategies to better understand Türkiye's export dynamics and strengthen Türkiye's export competitiveness in the rapidly developing global economy.

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Conflict of Interest: None.

Funding: None.

Ethical Approval: None.

Author Contributions: Mert Can DUMAN (50%), Ayşen SİVRİKAYA (50%)

Çıkar Çatışması: Yoktur.

Finansal Destek: Yoktur.

Etik Onay: Yoktur.

Yazar Katkısı: Mert Can DUMAN (%50), Ayşen SİVRİKAYA (%50)

APPENDIX

Table 8. Regression Results for Robustness Check (square of PCI)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.042***	1.006***	0.913***	1.016***	1.022***	1.122***
	(0.103)	(0.118)	(0.163)	(0.105)	(0.118)	(0.174)
PCI_t	-1.379	-1.266	-1.406	-1.419	-1.268	-1.627
	(0.951)	(1.004)	(0.885)	(0.920)	(0.980)	(1.242)
$REER_t$	0.807	0.787	0.611	0.700	0.862	1.000
	(0.673)	(0.673)	(0.658)	(0.677)	(0.667)	(0.755)
$REER_{t-1}$	0.992	0.933	1.287	1.127	0.864	1.011
	(1.211)	(1.227)	(1.264)	(1.249)	(1.257)	(1.315)
GDP_t	3.146***	3.024***	2.847***	3.166***	2.990***	3.275***
	(0.895)	(0.885)	(0.906)	(0.885)	(0.936)	(1.053)
GCI_t	1.300*	1.293*	1.603**	1.364**	1.288*	1.300*
	(0.675)	(0.688)	(0.725)	(0.686)	(0.675)	(0.771)
$Inter_t$	0.319*	0.306	0.316*	0.333*	0.293	0.358
	(0.184)	(0.190)	(0.172)	(0.181)	(0.192)	(0.228)
PCI_sq_t	-0.090	-0.151	0.029	-0.060	-0.131	0.040
	(0.266)	(0.283)	(0.301)	(0.272)	(0.292)	(0.384)
$Primary_t$		-1.061				
		(1.075)				
$Resource_t$			-0.973			
			(1.046)			
$Low\ Tech_t$				0.232		
				(0.425)		
$Mid\ Tech_t$					0.286	
					(0.725)	
$High\ Tech_t$						3.575
						(4.248)
Constant	-45.463***	-43.394***	-42.972***	-45.943***	-43.383***	-48.726***
	(12.765)	(12.907)	(13.274)	(12.818)	(13.690)	(15.147)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.182	0.189	0.188	0.186	0.179	0.201
Hansen	0.752	0.828	0.773	0.679	0.736	0.904
Sargan	0.713	0.720	0.639	0.656	0.642	0.827
Number of Instruments	24	24	24	24	24	24

Table 9. Regression Results for Robustness Check (Industrial Production)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.034***	1.016***	0.870***	1.001***	1.025***	1.102***
	(0.101)	(0.109)	(0.169)	(0.106)	(0.110)	(0.160)
PCI_t	-1.415**	-1.452**	-1.110	-1.385**	-1.404**	-1.364*
	(0.694)	(0.692)	(0.730)	(0.683)	(0.685)	(0.808)
$REER_t$	2.346*	2.088	2.536**	2.254*	2.364*	2.729*
	(1.276)	(1.306)	(1.228)	(1.259)	(1.273)	(1.543)
$REER_{t-1}$	2.916	2.556	3.811	3.108	2.826	3.203
	(2.304)	(2.277)	(2.335)	(2.311)	(2.309)	(2.504)
GDP_t	2.199**	2.288**	1.538	2.191**	2.131**	2.158*
	(0.998)	(1.027)	(1.069)	(0.983)	(1.018)	(1.222)
GCI_t	0.374	0.469	0.609	0.459	0.356	0.381
	(0.919)	(0.931)	(0.928)	(0.926)	(0.924)	(1.082)
$Inter_t$	0.315**	0.325**	0.255*	0.319**	0.309**	0.304*
	(0.150)	(0.151)	(0.154)	(0.146)	(0.148)	(0.172)
$Industrial_t$	0.025	0.021	0.031	0.025	0.025	0.027
	(0.021)	(0.021)	(0.020)	(0.021)	(0.021)	(0.024)
$Primary_t$		-0.725				
		(1.033)				
$Resource_t$			-1.120			
			(0.940)			
Low $Tech_t$				0.259		
				(0.394)		
Mid $Tech_t$					0.155	
					(0.643)	
High $Tech_t$						3.598
						(3.973)
Constant	-49.845***	-47.784***	-48.016***	-50.424***	-48.706***	-53.535***
	(14.211)	(14.000)	(14.940)	(14.254)	(14.721)	(15.938)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.217	0.214	0.235	0.226	0.213	0.239
Hansen	0.791	0.830	0.910	0.749	0.741	0.952
Sargan	0.787	0.757	0.778	0.747	0.722	0.900
Number of Instruments	24	24	24	24	24	24

Table 10. Regression Results for Robustness Check (Interest Rate)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.045***	1.017***	0.917***	1.013***	1.037***	1.114***
	(0.101)	(0.111)	(0.154)	(0.105)	(0.109)	(0.159)
PCI_t	-1.484**	-1.495**	-1.274*	-1.456**	-1.473**	-1.440*
	(0.702)	(0.701)	(0.717)	(0.691)	(0.692)	(0.805)
$REER_t$	0.269	0.201	0.142	0.160	0.295	0.455
	(0.800)	(0.815)	(0.748)	(0.791)	(0.794)	(0.872)
$REER_{t-1}$	0.895	0.805	1.235	1.063	0.817	0.989
	(1.198)	(1.201)	(1.258)	(1.245)	(1.241)	(1.317)
GDP_t	3.564***	3.508***	3.211***	3.568***	3.493***	3.651***
	(0.961)	(0.943)	(0.979)	(0.947)	(0.974)	(1.054)
GCI_t	0.606	0.520	0.987	0.696	0.590	0.639
	(0.753)	(0.761)	(0.821)	(0.775)	(0.756)	(0.878)
$Inter_t$	0.330**	0.335**	0.289*	0.334**	0.324**	0.321*
	(0.152)	(0.152)	(0.151)	(0.148)	(0.150)	(0.171)
$Interest\ Rate_t$	-0.030	-0.032	-0.028	-0.030	-0.030	-0.032
	(0.024)	(0.024)	(0.023)	(0.024)	(0.024)	(0.028)
$Primary_t$		-0.974				
		(1.040)				
$Resource_t$			-0.898			
			(0.898)			
$Low\ Tech_t$				0.255		
				(0.398)		
$Mid\ Tech_t$					0.148	
					(0.649)	
$High\ Tech_t$						3.570
						(4.029)
Constant	-43.309***	-41.271***	-41.095***	-43.825***	-42.252***	-46.366***
	(12.536)	(12.517)	(12.997)	(12.582)	(13.151)	(14.595)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.186	0.186	0.191	0.191	0.184	0.209
Hansen	0.806	0.883	0.830	0.756	0.755	0.960
Sargan	0.788	0.793	0.740	0.747	0.723	0.898
Number of Instruments	24	24	24	24	24	24

Table 11. Regression Results for Robustness Check (R&D)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.067***	1.040***	0.965***	1.038***	1.059***	1.119***
	(0.107)	(0.117)	(0.160)	(0.111)	(0.115)	(0.150)
PCI_t	-1.298*	-1.307*	-1.157	-1.275*	-1.287*	-1.295
	(0.745)	(0.743)	(0.740)	(0.731)	(0.735)	(0.818)
$REER_t$	3.177**	3.215**	2.837*	3.056**	3.194**	3.142*
	(1.538)	(1.509)	(1.524)	(1.505)	(1.523)	(1.706)
$REER_{t-1}$	3.311*	3.295*	3.353*	3.447*	3.227*	3.175
	(1.834)	(1.832)	(1.800)	(1.849)	(1.875)	(1.941)
GDP_t	3.184***	3.102***	2.921***	3.186***	3.115***	3.227***
	(0.881)	(0.862)	(0.903)	(0.870)	(0.888)	(0.946)
GCI_t	1.918**	1.894**	2.132***	1.998**	1.896**	1.926**
	(0.794)	(0.795)	(0.815)	(0.812)	(0.801)	(0.869)
$Inter_t$	0.307**	0.313**	0.279*	0.311**	0.301*	0.305*
	(0.156)	(0.156)	(0.154)	(0.152)	(0.154)	(0.169)
$R\&D_t$	1.871*	1.928*	1.696*	1.855*	1.867*	1.704
	(1.010)	(0.989)	(0.993)	(0.990)	(1.007)	(1.085)
$Primary_t$		-0.989				
		(1.072)				
$Resource_t$			-0.702			
			(0.916)			
$Low\ Tech_t$				0.238		
				(0.404)		
$Mid\ Tech_t$					0.148	
					(0.669)	
$High\ Tech_t$						2.771
						(3.699)
Constant	-72.428***	-71.325***	-68.104***	-72.676***	-71.290***	-72.542***
	(20.391)	(20.406)	(20.628)	(20.198)	(20.955)	(21.959)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
Group	ALL	Primary Products	Resource Based Products	Low Technology Products	Medium Technology Products	High Technology Products
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.138	0.136	0.148	0.144	0.135	0.156
Hansen	0.943	0.969	0.925	0.919	0.916	0.979
Sargan	0.925	0.936	0.893	0.905	0.891	0.954
Number of Instruments	24	24	24	24	24	24

Table 12. Regression Results for Robustness Check (Institutional Quality)

	Estimate			Percentile Rank of Upper Bound of 90% Confidence		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Exp_{t-1}	1.043***	1.043***	1.036***	1.045***	1.042***	1.047***
	(0.100)	(0.100)	(0.101)	(0.101)	(0.099)	(0.101)
PCI_t	-1.535**	-1.536**	-1.459**	-1.552**	-1.540**	-1.571**
	(0.697)	(0.687)	(0.690)	(0.711)	(0.694)	(0.698)
$REER_t$	0.789	0.748	1.183	0.755	0.743	0.438
	(1.031)	(0.956)	(0.863)	(0.956)	(0.930)	(1.123)
GDP_t	3.033***	3.042***	2.730***	3.048***	3.066***	2.924***
	(1.040)	(0.909)	(0.888)	(0.954)	(0.937)	(0.743)
GCI_t	0.735	0.813*	0.643	0.667	0.761*	0.902**
	(0.525)	(0.442)	(0.479)	(0.678)	(0.430)	(0.451)
$Inter_t$	0.342**	0.342**	0.327**	0.346**	0.342**	0.349**
	(0.150)	(0.148)	(0.148)	(0.153)	(0.149)	(0.150)
$Regulatory_t$	0.102			0.007		
	(0.671)			(0.031)		
Law_t		0.128			0.005	
		(0.593)			(0.021)	
$Corruption_t$			-0.286			
			(0.615)			
$Stability_t$						0.007
						(0.012)
Constant	-37.267***	-37.463***	-35.617***	-37.457***	-37.776***	-35.414***
	(5.714)	(5.790)	(6.150)	(5.848)	(6.093)	(5.779)
Observations	6,896	6,896	6,896	6,896	6,896	6,896
Number of products	647	647	647	647	647	647
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.151	0.154	0.131	0.153	0.158	0.164
Hansen	0.756	0.755	0.758	0.759	0.752	0.762
Sargan	0.725	0.726	0.728	0.729	0.726	0.743
Number of Instruments	24	24	24	24	24	24