

The role of productivity, wages, demand, and exchange rates on export performance: Evidence from the Turkish manufacturing industry

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Abstract

Purpose — This study explores the determinants of export performance in the Turkish manufacturing industry by examining the effects of productivity, wages, demand, and sector-specific real effective exchange rates from 2006 to 2019.

Methods — Using firm-level export data across 21 manufacturing sectors, the study applies a Fixed-Effects model with Driscoll-Kraay standard errors to address heteroscedasticity, autocorrelation, and cross-sectional dependence. Endogeneity concerns are mitigated using Two-Step System GMM estimation, complemented by Moment Quantile Regression (MQR) for robustness checks across the export distribution.

Findings — The results reveal that higher productivity, increased wages, and stronger external demand significantly enhance exports, while currency appreciation adversely affects export performance. Productivity emerges as the most influential factor.

Implications — Productivity enhancement, stable exchange-rate management, and workforce development support export-driven growth. Targeted policies that strengthen sectoral competitiveness and expand foreign market access are essential for sustaining manufacturing exports.

Originality — This study departs from traditional macro-level analyses by constructing sector-specific indices for real exchange rates and external demand. It offers a more granular and precise understanding of export dynamics. The methodological rigor combines static and dynamic panel estimators to ensure robustness and advance empirical insights into firm-level export behavior.

Keywords — Export performance, Productivity, Real effective exchange rate, External demand, Turkish manufacturing, Sectoral analysis, System GMM.

Introduction

Many countries, including the USA, UK, and Turkey, began implementing supply-side economic policies after the 1980s. In this period, the development of communication and transportation technologies and the decrease in production costs accelerated the globalization of trade. The increase in foreign trade volume has led to a rise in the importance of exports for countries and firms. These changes significantly accelerated trade globalization and deepened national economies' integration into global value chains. Consequently, export performance emerged as a critical driver of economic growth, employment creation, innovation capacity, and competitive advantage for

firms and nations (Abbas et al., 2015). The export-led growth paradigm, particularly in manufacturing sectors, has become a central strategic focus in many national economic agendas.

In this regard, in the early 2000s, theoretical research in international trade began to examine the behavior of exporting and non-exporting firms with heterogeneous firm models (Melitz, 2003; Bernard et al., 2007a; Bernard et al., 2007b; Melitz and Ottaviano, 2008; Eaton et al., 2011; Alvarez et al., 2013; Chaney, 2014; Chaney, 2016; Spearot, 2016; Kim and Osgood, 2019; Boitier, 2022; Aghion et al., 2024; Khasanov and Hiwatari, 2025). Melitz (2003), the basis of these current studies, emphasized the importance of productivity and sunk costs to initiate exporting. According to this model, exporting firms have relatively higher productivity than non-exporting firms. Among the heterogeneous firm models developed later, Eaton et al. (2011) focused on market- and firm-specific heterogeneity in entry costs and demand shocks. Chaney (2016) emphasized the liquidity constraints for heterogeneous firms to initiate exporting. Aghion et al. (2024) investigated how the demand conditions faced by heterogeneous firms in markets affect their innovation decisions. Khasanov and Hiwatari (2025) considered heterogeneity between parent institutions and trading partners and emphasized the role of productivity on exports.

New dimensions have been added to heterogeneous firm models, with the empirical literature developing at the same time (for example Bernard and Jansen, 2004; Dekle and Ryoo, 2007; Greenaway et al., 2007; Alvarez and Lopez, 2009; Fung and Liu, 2009; Dekle et al., 2010; Zhang and Liu, 2012; Abbas et al., 2015; Rashid and Wager, 2017; Van den Berg et al., 2019; Karamollaoglu and Yalcin, 2020; Dincer et al., 2021; Jafari et al., 2023; Fambeu, 2024; Liu et al., 2024; Matthias et al., 2025). Research on firm exporting in theoretical and empirical literature has resulted in several significant findings. First, exporting firms incur sunk costs, such as research, equipment and machinery purchases, and advertising. If a firm can bear these sunk costs, it begins exporting (Campa, 2004). On the other hand, wages have been found to have a dual effect on exports. On one hand, an increase in wages raises firms' production costs, which negatively impacts their exports (Fung and Liu, 2009; Nguyen and Sun, 2012; Cheung and Sengupta, 2013; Rashid and Wager, 2017; Rashid et al., 2021; Dangizer and Dangizer, 2024). On the other hand, higher wages may indicate a more skilled workforce, which can positively affect exports due to the increased productivity and expertise of the labor force (Gourley and Seaton, 2004; Sun, 2009; Abraham and Van Hove, 2010; Greenaway et al., 2012; Zhang and Liu, 2012; Nguyen, 2021).

In the case of Turkey, which has undergone significant structural reforms and trade liberalization since the 1990s, the manufacturing industry represents a vital engine of export growth. Yet, comprehensive assessments that account for industry-specific dynamics are relatively scarce. Studies on firm exports typically analyze total exports using macroeconomic variables, often assuming that all observations are homogeneous when analyzing total exports with some variables. In this study, however, we aim to account for sectoral differences, calculate external income using industry-specific weights, and use average export data of exporting firms on an industry-specific basis. This approach acknowledges that assuming homogeneity is not just a preference but a necessity given the constraints of the data, and thus such assumptions are made. Considering existing studies in the literature, this study was intriguing in examining industry-specific factors affecting exports by considering the average number of firms in the sector.

This study addresses this critical gap by examining the export performance of Turkish manufacturing industries from a sector-specific perspective for the period 2006-2019. This study's contributions to the literature are as follows: First, industry-specific real exchange rates and GDP are calculated to examine how these factors affect Turkish manufacturing exports. It is observed that many published papers use the real exchange rate index calculated by central banks as a proxy for relative prices. The real exchange rate index is the weighted geometric average of the host country's price level ratio to the countries with which it does foreign trade. In other words, while it is considered total exports, in this study, it is calculated separately for each sector using sectoral export data. On the other hand, as an indicator of foreign demand, the sum of the Gross Domestic Product (GDP) of countries with a significant share in the world economy or international trade (USA, EU, etc.) is used. In our study, the GDP values of the countries to which Turkey exports and the sum of GDP weighted by the export ratio are used as foreign demand indicators. Secondly,

the method used in the analysis of the study. The Fixed Effects model with Driscoll-Kraay standard errors, which are resistant to problems of heteroskedasticity, autocorrelation, and cross-sectional dependence, is used. In addition to this method, the Moments Quantile Regression (MQR) estimation technique is used to assess the robustness of the estimator.

Methods

Data and Model

The study used firms' exports across 21 sectors, according to the ISIC Rev4 Level 2 classification, covering 2006–2019. It is important to note that data collection ended in 2019, as 2020 and onwards were significantly impacted by the COVID–19 pandemic. Therefore, the study's focus is primarily on pre–pandemic conditions, as the effects of the pandemic on exports are not accounted for in the analysis. Firm export data is calculated by dividing foreign sales by the number of entrepreneurs reported in the income statement of the Turkish Entrepreneur Information System (TEIS) database. In the calculation of the industry-specific real effective exchange rate index, export data were gathered from the Turkish Statistical Institute (TURKSTAT), the annual average buying rate of exchange was obtained from the Central Bank of Turkey Republic (CBRT) database, and Consumer Price Index (CPI) data were got from the IMF's database. GDP data of partner countries, weighted by exports, were taken from the World Bank's database. The seasonal and calendar-adjusted industrial gross wage-salary index is obtained from TURKSTAT, and the seasonal and calendar-adjusted production per hour worked index is collected from the TEIS database.

Table 1. The definitions of the variables and the data source

Variables	The Definitions of Variables	Data Source
Lexp	Firm-based export calculated from the income statement in the Turkish manufacturing industry (foreign sales/number of enterprises) (\$)	TEIS
Lreer	Industry-specific real exchange rate (index)	Authors' Calculation
Lgdp	Industry-specific GDP (\$)	Authors' Calculation
Lppw	Production per working hour (index)	TEIS
Lwage	Gross wages (index)	TURKSTAT

To calculate the industry-specific real effective exchange rate index, the 20 countries with the highest shares in Turkiye's industry-specific foreign trade were identified. In the foreign trade weighting calculation, the method used in Saygili et al. (2012) study was applied, while the geometric mean method was used to calculate the industry-specific real effective exchange rate index. Model 1 shows the calculation of the real effective exchange rate index.

$$rer_c^t = \frac{P^{TR}}{P^C X e_{CTR}} \quad (1)$$

In Model 1, rer_c^t refers to the exchange rate of the national currency of country c and the national currency of Turkiye at time t (the real exchange rate index), P^{TR} denotes Turkiye's CPI rate, P^C shows the partner country's CPI rate, and e_{CTR} represents the nominal exchange rate. Calculation of export weight, import weight, and foreign trade weight was implemented according to the models included in the study of Saygili et al. (2012).

$$wx_{ci}^t = \frac{X_{ci}^t}{\sum_{c=1}^N X_{ci}^t}, \quad mt_{ci}^t = \frac{M_{ci}^t}{\sum_{c=1}^N M_{ci}^t} \quad (2)$$

$$wt_{ci}^t = \left(\frac{\sum_{c=1}^N X_{ci}^t}{\sum_{c=1}^N X_{ci}^t + \sum_{c=1}^N M_{ci}^t} \right) wx_{ci}^t + \left(\frac{\sum_{j=1}^N M_{ci}^t}{\sum_{j=1}^N X_{ci}^t + \sum_{j=1}^N M_{ci}^t} \right) mt_{ci}^t \quad (3)$$

$$Reer_i^t = \prod_{c=1}^N (rer_c^t)^{wt_{ci}^t} \quad (4)$$

In Model 2, where wx_{ci}^t represents the export weight of country c in sector i , mt_{ci}^t is the import weight of c country in sector i , and in Model 4, wt_{ci}^t refers to the foreign trade weight of the country c in sector i . Models 2 and 3 X_{ci}^t ile M_{ci}^t denotes Türkiye's exports to 20 countries (c) and imports from 20 countries in sector i at time t , respectively. Model 4 was used to calculate the sectoral real effective exchange rate index. The weighing of selected countries for each sector results in variations in this index across sectors. Model 5, where $Reer_i^t$ is the sectoral real effective exchange rate index, wt_{ci}^t is the weight of foreign trade in the i sector of country c , and rer_c^t is the real effective exchange rate index. To measure the effect of the increase in partner countries' incomes on exports, industry-specific GDP was calculated using a method like the industry-specific real exchange rate index (Fung and Liu, 2009).

$$GDP_{ci}^t = \sum_{c=1}^N (wx_{ci}^t \times GDP_c^t) \quad (5)$$

Model 5, where GDP_{ci}^t is industry-specific GDP, wx_c^i is the export weight of partner countries in sector i , and GDP_c^t is the GDP of partner countries at time t . In other words, this model was calculated using the first 20 countries to which Türkiye exports in sector i . Then the GDP of these 20 countries is multiplied by their export weights.

Econometric Methodology

In this study, the relationship between variables is analyzed with both static and dynamic panel data models. Heteroscedasticity, autocorrelation, and cross-sectional dependence in static panel data models should be checked first. The estimation results may be biased if one or more of these assumptions are violated. In panel data models, it is a basic assumption that the variances of error terms have constant variance between units. The modified Wald test can be used to detect the presence of heteroscedasticity in the fixed effects model (Greene, 2003). For the autocorrelation test, Bhargava, Franzini, and Narendranathan's Durbin–Watson d test and Baltagi Wu's Local Best Invariant (LBI) test are recommended (Hill et al., 2011). In the Baltagi–Wu and Durbin Watson autocorrelation test, if the test value is less than 2, the model has first–order autocorrelation (Gujarati and Porter, 2008). When assumptions of the panel data regression model are violated, robust standard errors should be used to obtain valid results (Hoechle, 2007). Driscoll and Kraay (1998) proposed a standard nonparametric covariance matrix estimator based on large- T asymptotics that is robust to all general types of dimensional and temporal correlation. This method produces robust standard errors instead of biased ones in the presence of heteroscedasticity, autocorrelation, and cross–section dependence in panel data models. It is stated that the method is reliable when N is larger than T or when N and T are finite samples of comparable size (Driscoll and Kraay, 1998). Models 6 and 7 were created for the fixed effects model.

$$Lexp_{it} = C + \beta_1 Lgdp_{it} + \beta_2 Lppw_{it} + \beta_3 Lwage_{it} + \gamma_i + \varepsilon_{it} \quad (6)$$

$$Lexp_{it} = \vartheta + \delta_1 Lreer_{it} + \delta_2 Lppw_{it} + \delta_3 Lwage_{it} + \gamma_i + u_{it} \quad (7)$$

In the models, i denotes sectors, t represents time, γ_i indicates unit effect and ε_{it} refers to the error term. Industry-specific exports are utilized as the dependent variable, and industry-specific real effective exchange rate, industry-specific GDP, production per working hour, and gross wage are employed as independent variables. Natural logarithms of all variables are taken.

In addition to the Fixed Effect model, the Driscoll-Kraay standard error estimator and a Two-Step system generalized method of moments (GMM) were used to address the endogeneity problem in the variables of the estimated model. The system GMM estimators proposed by Arellano and Bover (1995) and Blundell and Bond (1998) are widely preferred in the literature. Compared to the static panel model, system GMM can account for variables' dynamic effects and mitigate endogeneity arising from the inclusion of lagged terms (Qiu, 2023). On the other hand, this estimator is appropriate for panel data sets with $N > T$. The GMM estimator yields efficient estimates in dynamic models with lagged values of the dependent variable and when the independent variables are not exogenous. Moreover, the estimator also copes with the presence of

unobservable country-specific fixed effects and the presence of heteroscedasticity and autocorrelation (Roodman, 2009).

The instrument set was carefully controlled to avoid the problem of instrument proliferation in the two-step system GMM estimation. We limited the lag range of GMM-style instruments to second and third lags and applied the instrument collapse procedure (Roodman, 2009). As a result, the total number of instruments remained below the number of panel units ($N = 21$), satisfying the recommended rule of thumb. The Hansen test p-value remained at 1.000, but caution is warranted, and a reduced instrument set was tested to ensure robustness.

$$Lexp_{it} = C + \beta_1 Lexp_{it-1} + \beta_2 Lexp_{it-2} + \beta_3 Lexp_{it-3} + \beta_4 Lgdp_{it} + \beta_5 Lppw_{it} + \beta_6 Lwage_{it} + \varepsilon_{it} \quad (7)$$

$$Lexp_{it} = \vartheta + \delta_1 Lexp_{it-1} + \delta_2 Lexp_{it-2} + \delta_3 Lexp_{it-3} + \delta_4 Lreer_{it} + \delta_5 Lppw_{it} + \delta_6 Lwage_{it} + \delta_7 Lwage_{it-1} + u_{it} \quad (8)$$

Variable $Lexp_{it-1}$, $Lexp_{it-2}$, and $Lexp_{it-3}$ represent the first-order, second-order, and third-order lags of industry-specific exports, respectively. $Lwage_{it-1}$ denotes one lag of gross wages.

Results and Discussion

In the first stage of the econometric analysis, descriptive statistics of annual observations of the variables are reported to examine the determinants of Turkish manufacturing industry exports. Table 2 shows the descriptive statistics test results.

Table 2. Descriptive statistics

	Lexp	Lgdp	Lreer	Lwage	Lppw
Mean	6.0843	12.3043	1.9242	2.1752	2.0194
Std. Devition	0.5659	0.2520	0.1721	0.2456	0.0748
Minimum	4.5310	11.4086	1.4747	1.7145	1.8062
Maximum	7.5542	12.9401	2.6078	2.7653	2.3538

When examining Table 2, the *lexp* variable of 21 sectors has a mean of 6.08 and a standard deviation of 0.57, respectively. It is observed that the minimum and maximum values for the *lexp* variable are 4.53 and 7.55, and these values are recorded in Printing and Reproduction of Recorded Media and Motor Vehicle, Trailer, Trailer, and Semi-Trailer manufacturing, respectively. The other transport vehicles manufacturing sector has the highest *lgdp* value, and Tobacco has the lowest *lgdp* value. The Manufacture of Other Non-Metallic Mineral Products and Other Manufacturing sectors have the highest and lowest industry-specific exchange rates, respectively. When the other variables in Table 2 are analyzed, it is noteworthy that there is a significant difference among the sectors. This shows heterogeneity across industries.

Following the descriptive statistics, the relationship between manufacturing exports and productivity, wage demand, and real exchange rates is analyzed. This study used the Fixed-Effect model with Driscoll-Kraay standard error and the Two-Step system GMM to obtain reliable and flexible estimates. The Fixed-Effects model with Driscoll-Kraay standard errors handles heteroscedasticity, autocorrelation, and cross-section dependence. Methodologically, using the Two-Step System GMM, as developed by Arellano & Bover (1995) and Blundell & Bond (1998), allows efficient estimation of dynamic panels with potential endogeneity. Controlling the number of instruments through the collapse procedure, as Roodman (2009) suggested, keeps the estimation results valid and not over-identified, which is essential considering that the p-value of the Hansen test in this model reaches 1,000. Therefore, caution in the selection and number of instruments is critical to ensure the inferential validity of the model. Table 3 shows baseline model results.

Two-Step System GMM estimation results are presented in Table 3. The coefficients of the Hansen test, which tests the null hypothesis of the validity of the instrumental variables, and the non-rejection of the H_0 hypothesis support the selection of instruments. The Sargan test assumes that the

residuals, or error terms, are uncorrelated with the instrumental variables. The validity of the test is established when the H_0 hypothesis, which states that the overidentifying instruments are valid, is accepted. According to the Hansen test, the instrumental variables are valid, and according to the Sargan test, there is no relationship between the error terms and the instrumental variables.

Table 3. Results for the baseline model

	(Two-Step System GMM)	(Two-Step System GMM)	(Driscoll- Kraay Std. Err)	(Driscoll- Kraay Std. Err)	(Driscoll- Kraay Std. Err)	(Driscoll- Kraay Std. Err)
L.lexp	0.974*** (0.09)	0.924*** (0.06)			0.626*** (0.07)	0.633*** (0.07)
L2.lexp	-0.266** (0.10)	-0.199** (0.09)				
L3.lexp	0.286*** (0.06)	0.266*** (0.08)				
Lgdp	0.202* (0.11)		0.077* (0.04)			0.124** (0.05)
L.lgdp	-0.222* (0.11)					
Lwage	0.091** (0.04)	0.633** (0.24)	0.715*** (0.04)	0.725*** (0.04)	0.299*** (0.05)	0.276*** (0.04)
L.lwage		-0.586** (0.25)				
Lppw	0.212** (0.08)	0.219** (0.10)	0.668*** (0.10)	0.666*** (0.10)	0.349*** (0.06)	0.372*** (0.06)
Lreer		-0.043* (0.02)		-0.059 (0.03)	-0.067** (0.02)	
Constant	-0.287 (0.25)	-0.383* (0.18)	2.231*** (0.62)	3.275*** (0.19)	1.082*** (0.31)	-0.608 (0.68)
Observations	231	231	294	294	273	273
Sargan (p-val.)	0.243	0.201				
Hansen (p-val.)	1.000	1.000				
AR (1) (p-val.)	0.008	0.004				
AR (2) (p-val.)	0.998	0.925				

Note: ***, **, and * indicate significant at 1%, 5%, and 10% level.

The estimation results using the Two-Step System GMM approach confirm significant export dynamics in the Turkish manufacturing industry. The results indicate that a one-period lag in Turkish manufacturing exports has a positive impact on exports. This aligns with Melitz's (2003) theory of heterogeneous firms, where companies that have incurred sunk costs to enter the export market tend to maintain their position. Meanwhile, the second lag's negative effect indicates a non-linear medium-term impact, possibly reflecting the dynamics of production or capacity adjustments. This finding is consistent with the results obtained from the Fixed Effect model with Driscoll-Kraay standard error. Furthermore, industry-specific GDP, employment, and wages positively affect exports. On the other hand, the Turkish lira's appreciation results in a 4-6% decrease in exports.

The effect of industry-specific GDP on manufacturing exports is positive. This finding indicates that higher GDP of partner countries increases demand for Türkiye's manufactured products. This result may be related to a country's domestic consumption increasing as its income grows. As a result, demand for imports from other countries will likely rise, particularly as commodity demand increases. The results reported in the literature support this finding, as reported by Bernard & Jansen (2004), Rashid & Wager (2017), Cil and Dülger (2018), Karamollaoglu & Yalcin (2020), Rashid et al. (2021), and Aslan & Akpiliç (2024). However, the negative effect of GDP lag in the short run highlights

the potential for a lag in the transmission of global demand to the domestic manufacturing sector, a phenomenon also discussed in the context of trade adjustment by Chaney (2016).

In addition, the depreciation of the national currency has a positive impact on exports. Theoretically, when the national currency depreciates, domestic products are more competitive in international markets, which positively affects exports. This result is similar with the previous study by Bernard & Jansen (2004); Dekle & Ryoo (2007); Greenaway et al. (2007); Alvarez & Lopez (2009); Fung & Liu (2009); Dekle et al. (2010); Greenaway et al. (2012); Zhang & Liu (2012), Karamollaoglu & Yalçın (2020); Ekanayake & Dissanayake (2022); Blecker (2023); Joshi et al. (2023); Palazzo (2024); and Urgessa (2024). This emphasizes the need for an exchange rate policy conducive to export stability.

The effect of the wage increase on exports can be explained in two ways. Firstly, an increase in wages may raise the firm's production costs, leading to reduced competitiveness and lower exports. Secondly, an increase in wages may indicate that firms employ a more qualified labour force, and exports may be expected to increase as a result. As a result of the analysis, a positive relationship was found between gross wages and exports. It is believed that the increase in wages indicates that firms employ a more qualified labour force, thereby having a positive effect on exports. This result supports the studies of Gourley & Seaton (2004), Greenaway et al. (2012), Zhang & Liu (2012), and Nguyen (2021).

On the other hand, productivity positively affects exports. Increased firm productivity may reduce the cost per product by lowering production costs. This reduction in production costs leads to an increase in exports. This relationship is supported by the previous study by Bernard & Jansen (2004), Monreal-Perez et al. (2012), Karamollaoglu & Yalcin (2020), Rashid et al. (2021), Ciarli et al. (2023), Nguyen & Le Pham (2025). This finding also strengthens the quality-upgrading model in exports, where improvements in internal firm competencies translate into international competitiveness.

In the second stage, the baseline model was analyzed using the Moments Quantile Regression (MQR) estimation technique to assess the robustness of the estimator. In the literature, Rufael and Weldemeskel (2022), Emekwe and Emodi (2022), and Pham et al. (2024) prefer the MQR estimator for the robustness of Driscoll-Kraay results. The MQR estimator is assumed to produce more consistent results in controlling for heterogeneity and endogeneity, and in handling asymmetric relationships among the determinants of panel data regression models (Ma et al., 2023). Table 4 shows robust analysis results.

Table 4. The robust analysis results for the baseline model

	Model I			Model II		
	0.25	0.50	0.75	0.25	0.50	0.75
Lgdp	0.939*** (0.000)	0.899*** (0.000)	0.845*** (0.000)			
Lreer				0.204 (0.301)	0.092 (0.602)	-0.041 (0.842)
Lwage	0.566*** (0.000)	0.547*** (0.000)	0.522*** (0.002)	0.758*** (0.000)	0.691*** (0.000)	0.612*** (0.000)
Lppw	0.968** (0.031)	1.151** (0.010)	1.394** (0.017)	0.813 (0.183)	1.181** (0.029)	1.616** (0.011)
Constant	-8.947*** (0.000)	-8.530*** (0.000)	-7.978*** (0.000)	2.078** (0.049)	2.014** (0.033)	1.938* (0.080)

Note: ***, **, and * mean rejection of null hypotheses of cross-sectional independence at 1%, 5%, and 10% level.

According to the MQR estimation results in Table 4, industry-specific GDP, productivity, and wages increase exports across all quantiles. According to the estimation results, productivity is the factor that most affects exports. In contrast to these findings, the results reveal that the industry-specific exchange rate does not impact exports. This indicates that these factors affect sectors with high export shares and have structural significance in smaller sectors, supporting the

findings of Pham et al. (2024) and Ma et al. (2023) regarding the importance of robust estimators for capturing distributional heterogeneity in panel data.

Conclusion

The findings of this study provide insights into the factors influencing firm-based exports in the Turkish manufacturing industry. Employing the Fixed Effects model with Driscoll-Kraay standard errors and two-step system GMM estimators, the analysis reveals significant relationships between various variables and firm exports. A two-stage strategy was implemented to assess the validity of the baseline model. In the first stage, the robustness of the model's economic theory was thoroughly examined. This involved scrutinizing the model to ensure it aligns with established economic principles and theoretical expectations. During the model's robustness analysis, diagnostic tests were conducted on both the alternative model and the alternative estimator to assess autocorrelation, heteroscedasticity, and cross-sectional dependence. These tests aimed to assess the reliability of the results and determine if any issues could impact the validity of the findings. Upon reviewing the robustness of the results, it was observed that the coefficients demonstrated both economic and statistical similarities to the study's main findings. This further strengthens the credibility of the baseline model, as it suggests that the relationships between the variables remain consistent and reliable across different estimation approaches.

Firstly, the industry-specific real exchange rate positively affects firms' exports. This suggests that changes in the relative value of the Turkish currency play a crucial role in determining the competitiveness of firms in international markets. Therefore, a stable exchange rate policy is vital for promoting export growth in the manufacturing industry. Secondly, the industry-specific GDP exhibits a significant positive relationship with firm exports. This implies that an increase in foreign income and demand for Turkish goods in importing countries positively affects firm-based exports. Policymakers should focus on enhancing trade relations and expanding market access to leverage the potential of foreign demand for Turkish goods. Moreover, the production per working hour demonstrates positive effects on firm exports. This suggests that productivity improvements enhance a firm's export capabilities. Efforts to boost manufacturing productivity and efficiency through technological advancements, innovation, and workforce training can foster export-oriented growth. Lastly, gross wages show a positive association with firm exports. This suggests that higher wages might incentivise workers and improve export performance. These findings highlight the importance of exchange rates, external demand, productivity, and export wages. Policymakers should consider implementing strategies to promote a stable exchange rate environment, stimulate foreign demand, increase productivity, and reward workers to improve the competitiveness of Turkish manufacturing firms in global markets.

In the context of developing countries such as Türkiye, promoting export-oriented manufacturing remains a critical policy priority. Evaluating the results holistically, policymakers are responsible for implementing a stable exchange rate policy, producing goods that meet the demands of importing countries as the growth of foreign income increases, enhancing productivity in the production process, and fostering the training and employment of a qualified workforce to improve production efficiency.

Future research could extend this analysis by incorporating post-pandemic trade dynamics, exploring firm heterogeneity more deeply, and integrating digitalization factors that increasingly shape global trade competitiveness.

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Appendix A**Table A1.** Estimator's decision

	Unit Effect		Time Effect		Unit and/or Time Effect	
	Coefficients	P value	Coefficients	P value	Coefficients	P value
F Test	391.84***	0.000	0.730	0.730	---	---
ALM	1198.42***	0.000	0.000	1.000	---	---
LR	683.12***	0.000	0.000	1.000	901.59***	0.000
Score Test	1.5e+05***	0.000	0.000	1.000	---	---
Hausman	13.56***	0.008	---	---	---	---

Note: ***, **, and * mean rejection of null hypotheses of cross-sectional independence at 1%, 5%, and 10% level.

Table A2. Basic assumptions in the fixed effects model

	Modified Wald Test	
	Coefficient	P value
Heteroscedasticity	1039.70***	0.000
	DW Test	
Autocorrelation	Coefficient = 0.556	
	LBI Test	
	Coefficient = 0.891	

Note: ***, **, and * mean rejection of null hypotheses of cross-sectional independence at 1%, 5%, and 10% level.