Vilnius University Press

Content lists are available at VilniusUniversity Press

Transformations In Business & Economics
2026, Vol. 25 No 1 (67), pp.272-291.

ISSN 1648-4460; E-ISSN 2538-872X
https://doi.org/10.15388/Tibe.2026.25.1.14

IMPACT OF EXTRA-EU EXPORTS ON ECONOMIC NON-EUROPEAN COUNTRIES' GROWTH: PANEL EVIDENCE FROM 140 PARTNERS

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Annotation. This study examines the impact of extra-EU exports on the GDP of trading partners, with a particular focus on the moderating role of export trade efficiency. Using panel data from 140 partners over 22 years (2000–2021), pooled OLS, random effects, fixed effects, and correlated random effects models are employed to assess both short and long-term impact of extra-EU exports on economic growth. Regression analysis reveals a statistically significant positive correlation between extra-EU exports and the GDP of partner countries, demonstrating a dual transmission mechanism: short-term demand-side stimulation through fluctuations in export volume and long-term supply-side structural impacts through the optimisation of export composition and adjustments to trade policy. Further research indicates that the moderating effects of trade efficiency primarily stem from long-term factors, such as the deepening of free trade agreements, the implementation of trade facilitation measures, and improvements in market openness. The study provides critical insights for policymakers and economists, particularly in the new era of trade tensions, where extra-EU exports play a vital role in sustaining global economic recovery.

Keywords: economic growth, extra EU-exports, trade efficiency, panel data, international trade, correlated random effects.

JEL classification: F14, F15, O47, O52.

Introduction

The European Union (EU) is a pivotal pillar of the global economy, with its foundational economic influence primarily manifested in its massive market scale and trade volume (Baldwin, Lopez-Gonzalez, 2021). As the world's largest single market with an economic output of €14 trillion, the EU maintains close trade relations with over 200 countries and territories worldwide, accounting for more than 15% of global

Submitted on January 2025. Accepted on March 2026.

merchandise and service exports (Eurostat, 2023; Tang, et.al., 2023). Particularly noteworthy is the EU's dominant position in high-tech exports, including critical sectors such as precision machinery, pharmaceuticals, and automobiles, which directly enhances the production capabilities of its trading partners (Borin, Mancini, 2023). Empirical research indicates that an increase in EU high-tech exports leads to an improvement in total factor productivity among partner countries, with this effect being particularly pronounced in developing economies (Bloom *et al.*, 2016). At the structural level, the EU shapes the global economic landscape through multiple channels (Hummels, Schaur, 2023; Chackiewicz, Orłowska, 2024; Šimelytė, Čižo, 2024; Išoraitė *et al*., 2024; Ahmed *et al.*, 2024; McPhillips, 2025).

EU producers dominate global supply chains in knowledge-intensive manufacturing and digital services (Belanová *et al*., 2023). Their foreign direct investment promotes industrial upgrading in host countries while potentially reinforcing a 'core-periphery' structure in the international division of labour (Baldwin, Freeman, 2022). Concurrently, the EU's R&D-intensive exports facilitate technology diffusion, thus driving the industrial upgrade in emerging economies and annual growth in manufacturing productivity (Coe, Helpman, 1995; Lai *et al*., 2023, Todorov *et al*., 2024; Hanáčková, Takáč, 2024).

The EU has demonstrated a unique capacity that transcends conventional economic roles. Through its network of trade agreements with countries, the EU systematically reshapes the international trade rule system across multiple dimensions, from digital trade to environmental sustainability (Zecca *et al*., 2023; Werbik, 2024; Chiki *et al*., 2025). This multitiered rule-making capacity positions the EU as a key architect of global economic governance, with its influence penetrating the most strategic development areas of the 21st century, including the digital economy and green transition (Usman *et al*., 2020; Fleacă *et al*., 2023; Chovancová *et al*., 2024; Ruginė, Žilienė, 2024; Sedliačiková *et al*., 2025).The EU generates direct impacts through market scale and continuously shapes the long-term trajectory of global economic development through institutional innovation and regulatory export, exhibiting enduring and profound institutional influence (Bradford, 2020; Papiez *et al*., 2022, Guerreschi *et al*., 2025).

This study constructs a systematic analytical framework to examine the economic spillover effects of extra-EU exports on trading partner countries and their interaction with trade efficiency. Grounded in endogenous growth theory and new institutional economics, the research posits that extra-EU exports influence partner economies through various channels, such as technology transfer and institutional convergence, with trade efficiency determining the extent to which these effects materialise. This study also makes innovative breakthroughs in addressing critical research gaps regarding the impact of extra-EU exports on international trade.

The existing literature exhibits significant limitations. The spatiotemporal constraints of sample coverage are observed, as most studies focus solely on OECD countries or short-term data (e.g., Chen *et al*. 2022 only analyzed 2010-2018 data), making verifying the long-term stability of extra-EU export promotion effects difficult. In addition, there is an insufficient understanding of the moderating mechanism of trade efficiency, particularly institutional trade efficiency.

The innovations of this study are manifested in three aspects. First, a global panel dataset covering 140 countries and territories from 2000 to 2021 is constructed, thus providing the first confirmation of the spatiotemporal stability of extra-EU exports' GDP promotion effects over 22 years. Second, export trade efficiency as a moderating variable, estimating export trade efficiency through stochastic frontier analysis to distinguish between short-term and long-term effects, is innovatively introduced. Finally, a mixed estimation framework, comparing four models: pooled OLS, random effects, fixed effects, and correlated random effects (CRE), to jointly demonstrate both the short-term and long-term impacts of extra-EU exports on economic growth is established.

1. Literature Review

The current research on EU trade primarily revolves around two key dimensions: value chain restructuring effects and regional heterogeneous impacts, with findings demonstrating strong theoretical coherence. A new examination of value flows through global value chains (GVCs) by Wang and Liu (2025) uncovers an asymmetric distribution of gains, with developing economies consistently transferring substantial value-added to developed nations through trade linkages. This persistent imbalance underscores the structural advantages maintained by advanced economies in contemporary international trade systems. The economic effects of extra-EU exports demonstrate pronounced regional and sectoral heterogeneity, with distinct patterns emerging across different trade relationships. Chen *et al*. (2022) identified an inverse relationship between EU member states' trade engagement with China and intra-EU trade volumes. This stands in contrast to the differential impacts observed from other major trading partners: while US imports suppress intra-EU trade, Indian imports appear to stimulate it, revealing complex dynamics in the EU's trade ecosystem.

The EU's agricultural trade with African, Caribbean, and Pacific (ACP) countries presents another dimension of heterogeneity. Balogh and Leitao (2019) document how this relationship epitomises classical inter-industry trade, with ACP nations exporting primary agricultural goods to Europe while importing manufactured products in return. Despite the significant volume of exchanges, the near-absence of product category overlap highlights a deeply entrenched, vertically specialised trade pattern that reinforces complementary rather than competitive economic structures. Shifting to high-tech sectors, Drelich-Skulska and Bobowski (2021) highlight the evolving dynamics in EU-Japan automotive trade. Their research underscores the improving trade balance for the EU in this strategic industry and Japan's growing importance as a key European trade partner, illustrating how sector-specific factors can reshape broader trade relationships.

Trade efficiency refers to the capacity to maximise trade flows under given resource constraints, reflecting comprehensive performance in customs clearance speed, logistics costs, and institutional environments. It represents the outcome of the combined effects of trade openness, trade facilitation, and free trade policies. Trade efficiency serves as a crucial moderating variable that significantly influences the transmission intensity of the economic effects of extra-EU exports. Yilmazkuday (2023) estimates country-specific trade elasticities for 40 economies, demonstrating that each country's trade elasticity rises with its trade openness, while the gains from trade decline as openness increases. This indicates that countries experience diminishing gains from trade at higher levels of openness. Moreover, Drelich-Skulska and Bobowski (2021) suggest that trade liberalisation under the EU-Japan EPA encompassing tariff and non-tariff measures could foster further growth in bilateral automotive trade. However, they note that mid to long-term shifts in intra-industry trade flows, including their horizontal and vertical dynamics, will ultimately hinge on the sector's competitiveness and variations in product quality and cost efficiency. The research indicates that the advantages of trade have predominantly favoured wealthier nations. Although trade openness has significantly contributed to the economic growth of developing countries, its impact on human capital has hindered their developmental progress.

Current academic research has made substantial progress in deepening the theoretical comprehension of EU trade patterns, while offering valuable insights for the governance of global value chains and formulating regional coordinated development strategies. Nevertheless, persistent limitations remain concerning the representativeness of selected samples and the integration of theoretical perspectives, with particular deficiencies observed in incorporating emerging influential factors such as geopolitical shifts and strategic realignments. Scholarly investigations ought to prioritise the development of more comprehensive and adaptable analytical frameworks that retain rigorous methodological standards, thereby enhancing the capacity to interpret the continuously transforming EU trade landscape amid the broader reconfiguration of the global economic and political order.

2. Methodology

2.1 Model

The present study aims to evaluate the impact of extra-EU exports and export trade efficiency on countries' GDPs. The panel data covers 22 years from 2000 to 2021 and includes 140 countries. GDP and its components data are sourced from World Bank and International Financial Statistics, while data on extra-EU exports is obtained from the UN Comtrade database. Trade efficiency is calculated using the stochastic frontier model (Prokhorov *et al.*, 2021). The distance data between countries in the stochastic frontier model is sourced from the CEPII database.

The Correlated Random Effects (CRE) panel-data model simultaneously incorporates individual-specific means of all time-varying regressors, alongside their original within-unit deviations to disentangle unobserved heterogeneity from cross-sectional structural variation. By augmenting the random-effects specification with these entity-level means, CRE relaxes the orthogonality assumption between regressors and individual effects, thereby yielding consistent estimates of both within-unit (fixed-effect-like) and between-unit (random-effect-like) parameters without the stringent restrictions of pure fixed or random effects. The fixed effects model accounts for group or time heterogeneity through varying intercepts, while the random effects model captures these differences through the error term's variance components. When such individual or time-specific effects are nonexistent, ordinary least squares (OLS) yields efficient and consistent parameter estimates. The empirical model of the study analyses the impact of the extra EU export on the GDP of different economies.

The model is given as:

$$gdp = f(export, pop, ge, tnr, te) \#(1)$$

It takes the following specified form:

$$\ln gdp_{it} = \beta_0 + \beta_1 lnex_{it} + \beta_2 lnpop_{it} + \beta_3 ge_{it} + \beta_4 tnr_{it} + \beta_5 te_{it} + \beta_6 lnex_{it} * te_{it} + \lambda_i + \nu_t + \varepsilon_{it} \#(2)$$

Where i = 1....N and t = 1.....T, GDP is the gross domestic product, EX is the extra EU-export volume, POP is population, GE is the government expenditure, TNR is the total nature rent, TE is the trade efficiency of exports, λi is a time invariant country i specific effect, vt is the time effect, εit is the stochastic term.

The core idea of the CRE model is to explicitly allow the individual heterogeneity to correlate with the regressors within the random-effects framework, thereby bridging the gap between conventional RE and FE estimators. The Random effect model is:

$$y_{it} = \beta_0 + \beta_1 x_{it} + \mu_i + \varepsilon_{it} \#(3)$$

μi：Individual heterogeneity, assumed as $\mu i \sim N(0, \sigma\mu^2)$ and uncorrelated with Xit (the RE assumption).
εit：random error term， $\varepsilon it \sim N(0, \sigma\mu^2)$.

Mundlak (1978) posits that the individual effect μi can be decomposed into a linear function of the individual-specific means of the time-varying regressors, $\bar{X}$it, plus an independent random disturbance. Substituting this decomposition into the original equation yields the CRE specification:

$$y_{it} = \beta_0 + \beta_1 x_{it} + \bar{x}_{it} + \mu_i + \varepsilon_{it} \#(4)$$

β2 : the coefficient vector of the time-varying variable Xit (within-unit effect);

γ : the coefficient vector of the individual-specific mean $\bar{X}$it (between-unit effect);

μi : Individual heterogeneity, assumed as μi ~ N(0, σμ²) and uncorrelated with Xit (the RE assumption).

εit : random error term, εit~N(0,σμ²).

Estimating this specification with random-effects GLS or MLE yields, in a single step, the "within" coefficient β that is numerically identical to the fixed-effects estimator and the coefficient vector γ that captures between-unit heterogeneity. A Hausman–Mundlak test of H_0: γ = 0 can then be used to assess whether the conventional random-effects specification is consistent. Consequently, CRE retains the efficiency gains of random effects while achieving full equivalence with fixed effects and permits the inclusion of time-invariant regressors.

Trade efficiency is intrinsically linked to the stochastic frontier model. The Stochastic Frontier Model (SFM), introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977), is designed to estimate a "frontier" level of production or trade in the presence of both random noise and systematic inefficiency. Its core idea is to decompose the conventional regression error into a symmetric random term and a non-negative inefficiency component, simultaneously measuring the "potential optimum" and the degree of actual shortfall. The model is given as:

$$exports = f(pgdp, pop, dis) \ \#(5)$$

It takes the following specified form:

$$\ln ex_{it} = \beta_0 + \beta_1 lnpgdp_{it} + \beta_2 lnpgdp_{jt} + \beta_3 pop_{it} + \beta_4 pop_{jt} + \beta_5 dis_{ij} + v_{ijt} - \mu_{ijt} \ \#(6)$$

Where i = 1….N and t = 1…..T, EX is the extra EU-export volume, PGDPi is the gross domestic product of country i per capita, POPi is population of country i, PGDPj is the gross domestic product ofcoountry j per capita, POPi is population of the country i, POP_j is population of country j, dis_{ij} is distance of capitals between country i and j.this paper selects the distance to the capital of the nearest EU country, vijt is the random error term, where vijt~N(0,σ_u^2); uijt is the trade inefficiency term, where uijt~N+(μ,σ_u^2).

The traditional gravity model posits that the trade potential between country *i* and country *j* is:

$$T_{ijt} = f(x_{ijt}, \beta) \ \#(7)$$

In this specification, Tijt denotes the trade potential, that is the maximum feasible level of trade between country i and country j in period t, while Xijt is the vector of key determinants of trade, and β is the parameter vector to be estimated. In reality, however, trade frictions give rise to efficiency losses.

Meeusen et al. and Aigner et al. (1977) propose the stochastic frontier gravity approach, which decomposes the conventional stochastic disturbance term into a random error component and a trade-inefficiency component, so that actual trade flows are given by:

$$T_{ijt} = f(x_{ijt}, \beta) \exp(-\mu_{ijt}), \qquad \mu_{ijt} \geq 0 \ \#(8)$$

Taking natural logarithms on both sides yields:

$$lnT_{ijt} = lnf(x_{ijt}, \beta) + v_{ijt} - \mu_{ijt}, \qquad \mu_{ijt} \geq 0 \ \#(9)$$

vijt and *μijt* together constitute the composite error term of the stochastic frontier gravity model. *vijt* denotes the random error term, which is assumed to be normally distributed with zero mean, while *μijt* represents the trade inefficiency term, assumed to follow a half-normal (truncated-normal) distribution.
μijt =0, signifies frictionless trade, i.e., trade realised at the frontier level:

$$T_{ijt} = f\left(x_{ijt}, \beta\right) \exp\left(\nu_{ijt}\right), \qquad \mu_{ijt} \geq 0 \ \#(10)$$

Trade efficiency TE_{ijt} is:

$$TE_{ijt} = \frac{T_{ijt}}{T_{i*}} \ \#(11)$$

$$TE_{ijt} = \exp\left(-\mu_{ijt}\right), \qquad \mu_{ijt} \geq 0 \ \#(12)$$

TE_{ijt} is the ratio of actual trade flows to trade potential. The larger the value, the higher the trade efficiency.

2.2 Description of Variables

Domestic imports (extra EU-exports in this paper) tend to be established in macroeconomic literature as a growth driver. At the economic level, the contribution of imports to GDP operates through a multi-channel process that converts external supply into endogenous growth. Within the Keynes–Kaldor framework, imports carry a negative sign in the expenditure-based GDP identity; yet when they consist predominantly of capital goods and high-tech intermediates, they directly raise the domestic capital-formation rate via an "investment-goods supply" route and, through technological spillovers, lift total factor productivity. This "imports → productivity → output" sequence is regarded by endogenous growth theory as a paradigmatic "supply-side ignition" mechanism (Coe, Helpman, 1995; Pham, Sala, 2022). Post-Keynesian scholars such as Thirlwall and McCombie further argue that, under balance-of-payments constraints, import expansion coupled with productivity gains lowers the income elasticity of import demand, relaxing external constraints and sustaining long-run growth (McCombie, Thirlwall, 1994). Moreover, the new structural economics school stresses that imported capital and intermediate goods exert a "complementarity effect" on economies lacking a manufacturing base, filling domestic production gaps, expanding effective supply, and amplifying dual multipliers on consumption and exports. The result is a synchronous "imports → value added → GDP" linkage (Hausmann et al., 2007). Consequently, the essential contribution of imports to GDP growth lies in their role as "technology carriers" and "efficiency levers" that trigger dynamic expansionary effects.
Trade efficiency serves primarily as a moderator of the import–growth nexus, grounded in the "efficiency–channel–outcome" chain. It is explained as when efficiency is high, tariffs, logistics, information and institutional frictions are sharply reduced, allowing capital and intermediate goods of the same volume to be absorbed into the domestic production network more rapidly and at lower cost, thereby amplifying their technology-spillover and cost-saving effects. Conversely, inefficient customs, congested ports and cumbersome documentation raise the "post-arrival cost" of imports, dampening or even offsetting their positive impact on productivity and output. This logic resonates with the central findings of heterogeneous stochastic-frontier gravity models. Consequently, treating trade efficiency as a moderator aligns with the dynamic "import–efficiency–growth" pathway and offers a robust theoretical fulcrum for identifying the heterogeneous effects of imports.
Other broader indicators were incorporated, including measures such as a country's population, government expenditure, and total nature rent. Demographic factors, particularly population size, are frequently employed as explanatory variables in economic growth models to account for their substantive influence on macroeconomic performance (Barro, 1990). Concurrently, fiscal policy variables, especially government expenditure, constitute a fundamental element of aggregate demand, with cross-national empirical evidence consistently validating theoretical frameworks that articulate the growth effects of public sector activities (Auty, 1993). Total resource rents are the key indicator of a country's resource dependence. By

isolating the degree of resource dependency in trade partner countries, it enables a more accurate identification of the net effect of extra-EU exports on their economic growth, while mitigating confounding bias arising from resource endowments (Lianos *et al.*, 2023).

3. Results and discussions

The study utilises the panel data model to investigate the impact of extra EU exports, population, government expenditures, and total nature rents on the GDP growth of countries with trade efficiency as a moderator variable. The empirical analysis supports the theoretical and conceptual discussion of the results.

3.1 Trade Efficiency Effect

The present study estimates the EU's export flows to 140 partner countries over the period of 2000–2021. To corroborate the robustness of the findings, *Table 1* reports the parameter estimates obtained under both the time-varying stochastic frontier gravity (TVD) specification and its time-invariant (TI) counterpart. Crucially, the time-varying decay parameter η, which captures the temporal evolution of the inefficiency term, is found to be statistically different from zero, thereby providing empirical support for the superior appropriateness of the TVD model.

Table 1. Hypothesis Testing Results

	Constrained model	Unconstrained model	LR	P	Hypothesis testing results
Testing the presence of inefficiency	-1,223.127	-1,204,367	37.52	0	Rejected
Testing the time-invariance of trade inefficiency	-1,204.367	-1,183.211	42.31	0	Rejected

Source: created by the authors.

Table 2. Estimation Results

	TVD	TI
C	156.164***	156.164***
PGDPit	0.770***	0.741***
PGDPjt	0.350***	0.328***
POPit	0.749***	0.764***
POPjt	-4.666***	-7.668***
DISij	-0.264***	-0.275***
σ2	1.054***	0.952***
γ	0.905***	0.893***
μ	1.863***	1.792***
η	-0.006***	
Log-likelihood	-1,183.211	-1,204.367
LR	42.31	37.52

Source: created by the authors.

This study employs maximum likelihood estimation under the stochastic frontier gravity model framework to test for the existence of trade inefficiency and its time-varying characteristics, thereby validating the model's applicability. As shown in *Table 1*, the test results reject the null hypotheses of no trade inefficiency and time-invariant inefficiency, demonstrating that trade inefficiency not only significantly exists but also exhibits evident time-varying patterns.

The time-varying stochastic frontier gravity model specification is confirmed to be valid. The γ parameter estimate of 0.905 (significant at the 1% level) indicates that 90.5% of total variance stems from trade inefficiency rather than random noise, while the η parameter estimate of -0.006 ($p<0.01$) suggests an annual 0.6% decreasing rate of trade inefficiency. Compared with traditional gravity models, this model shows significantly improved goodness-of-fit with a 37.52 increase in log-likelihood value, and all test statistics pass at the 1% significance level, collectively supporting the robustness of these findings. The empirical results indicate the presence of trade inefficiency in extra-EU exports, and the time-varying specification proves more appropriate for this analysis. Thus, the trade efficiency data presented in subsequent sections are estimated using the time-varying stochastic frontier model (*Table 2*).

3.2 Descriptive Analysis

The descriptive statistics provide preliminary insights into the key characteristics of the growth model variables presented in *Table 3*, including their central values and dispersion patterns. The analysis facilitates a foundational understanding of the data structure and its implications for subsequent economic growth investigations. The GDP data exhibit substantial variation, reflecting significant disparities in economic output among the surveyed countries. The statistical analysis reveals a mean growth rate of 23.946, with a relatively stable dispersion pattern indicated by a standard deviation of 2.242. The extra-EU exports variable demonstrates considerable cross-country variation, with a mean value of 20.950 and a standard deviation of 2.30, reflecting moderate dispersion around the central tendency.

Table 3. Descriptive Statistics

Variable	Variable name	Obs	Mean	Std. dev	Min.	Max.
GDP	Gross domestic product	3080	23.946	2.242	17.990	30.809
EX	Extra EU-export	3080	20.950	2.295	12.741	26.918
POP	Population	3080	15.867	1.943	11.304	21.060
GE	Government expenditure % of GDP	3080	26.960	11.877	2.489	108.831
TNR	Total nature rents % of GDP	3080	8.714	11.859	0.000	88.592
TE	Trade efficiency %	3080	22.332	17.995	0.452	91.781
inter-taction	Interaction of export and trade efficiency	3080	0.241	0.469	-0.639	3.558

Source: created by the authors.

The relatively wide range further indicates substantial diversity in export performance among the sample countries. The sample countries exhibit population figures averaging 15.867 (SD = 1.943), thus demonstrating relatively consistent demographic sizes with moderate variation across nations. The government expenditure percentage of GDP has a mean of 26.960, with a high standard deviation of 11.877, indicating a pronounced cross-country heterogeneity in government expenditure. The trade efficiency varies significantly across countries, as indicated by a mean of 22.332 within a substantial range of the minimum and maximum values. The interaction of exports and trade efficiency has a mean of 0.241 with a standard deviation of 0.469.

Table 4 presents the correlation matrix for all study variables. These preliminary associations offer valuable insights into the bivariate relationships between key factors, informing the structural relationships within the growth model specification and establishing foundational knowledge for subsequent regression analysis. Gross domestic product (GDP) shows a positive correlation with extra EU-exports, indicating that higher GDP is associated with higher exports. GDP exhibits a positive relationship with population, emphasising that a higher level of population enhances the level of GDP. GDP exhibits a very low negative relationship with government expenditure, which emphasises that this expenditure is not directly related to productivity.

Table 4. Matrix of Correlation

Variable	GDP	EX	POP	GE	TNR	TE	INTERAC-TION
GDP	1.000						
EX	0.902	1.000					
POP	0.772	0.653	1.000				
GE	-0.003	0.007	-0.244	1.000			
TNR	0.032	0.071	0.046	0.021	1.000		
TE	0.286	0.585	0.085	0.049	-0.029	1.000	
INTERAC-TION	0.050	0.050	-0.1154	0.194	-0.186	0.409	1.000

Source: UN Comtrade, World Bank, International Monetary Fund.

On the other hand, the correlation between GDP and total resource rents shows that higher dependence on nature resource enhances the level of GDP. The association of the GDP with trade efficiency clearly shows a positive relationship. At the same time, the GDP has significant associations with interactions.

3.3 Pooled OLS vs. Random Effect

The linear regression results demonstrate strong model significance, as evidenced by an F-statistic exceeding 8,049.21($p = 0.000$). These findings indicate that the regression model as a whole provides statistically significant explanatory power, and the set of independent variables collectively exerts a substantial influence on the dependent variable. The extremely small p-value ($p < 0.001$) confirms that at least one predictor variable shows a statistically significant association with the outcome variable. The multicollinearity diagnosis using the Variance Inflation Factor (VIF) revealed a mean VIF of 2.12, substantially below the conventional threshold of 10, confirming the absence of severe multicollinearity that could compromise parameter estimates. The random effects model demonstrated exceptional statistical significance, as evidenced by the Wald chi-squared statistic of 12,733.03 ($p = 0.000$). Furthermore, the Breusch-Pagan (1980) Lagrange Multiplier (LM) test yielded a p-value of 0.000, decisively supporting the adoption of the random effects specification over pooled OLS due to significant individual-specific heterogeneity. This comprehensive diagnostic analysis validates the model's statistical robustness, with all key assumptions satisfactorily met.

3.4 Random effect vs. Fixed Effect

When analysing panel data with inherent heterogeneity, unobserved country-specific effects are likely to be present. The random effects estimator remains efficient when these individual effects are strictly exogenous to the regressors. However, this assumption fails when endogeneity is present, potentially biasing fixed effects estimates. The Hausman test provides a formal mechanism for model selection by testing the critical orthogonality condition between individual effects and explanatory variables. A statistically significant test result ($p < 0.05$) rejects the null hypothesis of exogeneity, indicating that the random effects estimator is both biased and inconsistent due to correlation between unobserved heterogeneity and regressors. In such cases, the fixed effects model emerges as the appropriate specification despite its inefficiency, as it remains consistent by effectively controlling for time-invariant heterogeneity. The Hausman specification test results provide strong evidence in favour of the fixed effects model in this analysis. With a chi-square statistic of 1,431.11 (p = 0.000), which significantly exceeds conventional critical values at the 5% level, the null hypothesis of uncorrelated individual effects is decisively rejected. This indicates substantial systematic differences between the fixed and random effects estimators' coefficients stemming from significant correlation between country-specific heterogeneity and the explanatory variables. Consequently, the fixed effects specification emerges as the appropriate modeling choice, as it yields consistent parameter estimates by effectively controlling for this unobserved heterogeneity, despite the potential efficiency loss compared to random effects.

Table 5 presents the results from three different econometric models: Model 1 (pooled OLS), Model 2 (random effects), and Model 3 (fixed effects). In each model, the dependent variable is the natural logarithm of GDP (LnGDP), and the independent variables include extra EU-exports (lnEX), population (LnPOP), government expenditure percentage of GDP (GE), total nature rents percentage of GDP (TNR), trade efficiency (TE), and the interaction term between exports and trade efficiency (LnEX_TE).

Model 1 demonstrates statistically significant relationships between all independent variables and GDP, indicating their substantial explanatory power in accounting for variations in economic output. The coefficient of extra-EU exports is 0.994 indicating that for each 1% increase in extra-EU exports, the GDP of different economies is expected to increase by 0.994%. It suggests that increased extra-EU export activities contribute substantially to economic growth abroad. These robust findings provide empirical evidence that enhanced extra-EU export performance serves as an important driver of GDP expansion. The coefficient on the interaction term is 0.822, which implies that a unit increase in trade efficiency amplifies the marginal effect of extra-EU exports on partner-country GDP by 0.822. It is statistically significant at the 1% level, suggesting that trade efficiency serves as an effective moderator, significantly enhancing the impact of extra-EU exports on partner country GDP. In other words, in environments characterised by higher trade efficiency, the growth-inducing impact of extra-EU export expansion is significantly stronger than in low-efficiency settings.

Model 2 exhibits the coefficient of extra-EU exports is still significant at the 1% significance level, indicating the persistence of extra-EU exports' impact on the GDP of trading partners. The interaction is also showing a significant impact with the coefficient of 0.647, indicating a positive moderating effect of trade efficiency on GDP in this model.

In Model 3, the export coefficient remains statistically significant at 0.472, although its magnitude shows a substantial reduction compared to earlier model specifications. This suggests that after accounting for country-specific fixed effects, which capture time-invariant unobserved heterogeneity, the persistence of extra-EU exports is less pronounced. The population is showing a highly significant impact with the coefficient of 0.801, indicating a strong positive effect of population on economic growth. This suggests that population has a more pronounced impact on GDP when controlling for unobserved time-invariant heterogeneity across countries. The government expenditure suggests significance at the 1% level with a coefficient is -0.002, indicating a negative effect of government expenditure on GDP, in contrast to Models 1 and 2. The other variables, total nature rents, still show a small but negative effect on GDP with the coefficient of -0.001. The direction of trade efficiency remains negative, and its coefficient becomes larger in the model with a coefficient of -22.306. Its statistical significance weakens, indicating that when controlling for unobserved time-invariant heterogeneity across countries, the influence of trade efficiency over time is less significant. The interaction shows the result with no clear effect on GDP in this model.

Contrast results with the results from Models 1 and 2 indicate that the moderating effect of trade efficiency is absent in Model 3. The impact of exports on GDP does not change in either direction or magnitude as trade efficiency varies. The R-squared value is 0.801, demonstrating substantial explanatory power. Results from all Models suggest that extra-EU exports have a meaningful and positive effect on the GDP of trading partners. The coefficient is persistent. The population suggests a positive impact on the GDP. Government expenditure has different results, showing a positive coefficient in Models 1 and 2, but a negative coefficient in Model 3. The other variables, total nature rents indicate a negative effect on GDP. Extra-EU exports, government expenditure, and total nature rents have a less pronounced impact on GDP when accounting for fixed effects.

Table 5. Results of Pooled OLS, Random and Fixed Effects Models

	OLS	RE	FE
EX	0.994***	0.729***	0.472***
	(116.588)	(63.118)	(9.976)
POP	0.192***	0.585***	0.801***
	(23.273)	(24.503)	(5.253)
GE	0.003***	0.004***	-0.002***
	(3.044)	(3.297)	(-0.628)
TNR	-0.005***	-0.010***	-0.001***
	(-5.953)	(-9.216)	(-0.275)
TE	-4.918***	-5.291***	-22.306***
	(-55.926)	(-22.124)	(-9.753)
INTERACTION	0.822***	0.647***	0.008
	(32.943)	(11.312)	(0.030)
_cons	0.946***	0.399***	6.377**
	(32.943)	(1.166)	(2.229)
R^2	0.940		0.801
N	3080	3080	3080

Note: Robust standard errors are indicated in parentheses. ***, **, and * indicate p values significant at 1%, 5% and 10% levels, respectively.

Source: created by the authors.

In contrast, population and trade efficiency have a more pronounced impact. The moderating effect of trade efficiency is heterogeneous across model specifications. Models 1 and 2 reveal a small but significant effect: higher trade efficiency markedly amplifies the EU-export channel's contribution to the GDP of trading partners. By contrast, Model 3 reports an insignificant coefficient, indicating that this amplification disappears once stricter unobserved heterogeneity is controlled.

3.5 Correlated Random Effects

The fixed-effects model purges all time-invariant individual heterogeneity through the within-transformation. Consequently, when trade efficiency displays only minimal within-unit variation over time, its direct effect, and any interaction term in which it appears, risks being wholly absorbed by the entity-specific fixed effects, thereby forfeiting its explanatory power. Moreover, the resulting multicollinearity between the (nearly) time-constant regressor and the fixed effects inflates standard errors, rendering the moderating influence statistically indistinguishable from zero. To reconcile the insignificant fixed-effects estimates with the significant random-effects findings documented in prior studies, this paper adopts the Correlated Random Effects (CRE) model, operationalised via Mundlak's specification. By augmenting the random-effects estimator with the individual-specific means of trade efficiency, the CRE model simultaneously controls for unobserved heterogeneity, relaxing the orthogonality assumption required by conventional random effects, and retains the cross-country structural variation that is otherwise discarded by the within transformation. This dual strategy yields consistent and efficient estimates of trade efficiency's moderating role in the EU-import–partner-GDP nexus, even when the regressor exhibits scant within-unit variation.

Table 6. Regression Results: Correlated Random Effects Model

	Coefficient	std. err.	z	P>z	[95% confinterval]	
EX_within	0.686***	0.044	15.45	0.000	0.599	0.773
EX_mean	1.025***	0.132	7.73	0.000	0.765	1.285
EX_TE_within	0.346	0.316	1.09	0.274	-0.274	0.966
EX_TE_mean	1.445***	0.312	4.63	0.000	0.833	2.057
TE	-8.236***	1.711	-4.81	0.000	-11.590	-4.882
POP	0.428***	0.099	4.33	0.000	0.234	0.622
GE	0.003	0.004	0.86	0.392	-0.004	0.011
TNR	-0.010***	0.003	-3.78	0.000	-0.015	-0.005
_cons	-2.833***	1.198	-2.36	0.000	-5.181	-0.485
sigma_u	0.445					
sigma_e	0.251					
rho	0.759					
R^2	0.743					
N	3080					

Note: Robust standard errors are indicated in parentheses. ***, **, and * indicate p values significant at 1%, 5%, and 10% levels, respectively.

Source: created by the authors.

Table 6 presents the regression results of the CRE model. The impact of extra-EU exports on the GDP of trading partners is robustly positive in both the short and long run, with the long-run structural advantage (between) slightly exceeding the instantaneous shock (within). After controlling for individual fixed effects, the within estimate indicates that a 1% increase in contemporaneous exports significantly raises current GDP by 0.686% ($p < 0.01$). The between estimate reveals that a 1% rise in the long-run export level increases GDP by 1.025% ($p < 0.01$). The elasticity within the time dimension (within) is significant, indicating that short-term export expansion exerts an immediate and strong pull on economic growth. Conversely, the elasticity of the structural dimension (between) is higher, suggesting that the long-term growth dividend driven by exports is embodied in cross-country differences in institutions, scale, and infrastructure. This finding is consistent with previous studies. The study shows that both the direct bilateral trade index and shared exposure to "third" countries are significantly correlated with GDP co-movement by drawing on data from 134 countries, and discovers an additional channel through which GDP fluctuations propagate indirectly via trade networks. When trade is increasingly composed of intermediate inputs, synchronisation among high-income countries strengthens; for lower-income economies, trade in final goods is the crucial determinant of synchrony (de Soyres, Gaillard, 2022). Another paper finds an important channel that bilateral trade increases fossil energy consumption by promoting economic development, considering trade costs and economic scales into analysis of the impact of bilateral trade on fossil energy consumption (Chen *et al.*, 2021).

In the time dimension (within), the coefficient of interaction is insignificant, indicating that trade efficiency exerts virtually no moderating effect on the export-to-GDP relationship in the short run. By contrast, the coefficient in the structural dimension (mean) is 1.445, implying that each 1% increase in long-run trade efficiency boosts the marginal effect of exports on GDP by an additional 1.445% at 1% significance level. This finding is consistent with the study by Kumari and Bharti (2021). In their study, trade rises markedly as the quality of logistics improves, but the LPI's trade-boosting effect is weakest in large countries, moderate in small countries, and strongest in medium-sized economies; yet, the GDP-growth payoff from this trade expansion is smaller for small countries than for large ones. In short, trade efficiency influences both trade volumes and GDP, but its magnitude is shaped by population size.

The population size coefficient is 0.428, indicating that a 1 % increase in population raises GDP by 0.428% on average. This finding aligns with the results that analyse the "old EU" sample finds that population size exerts a statistically significant and positive effect on GDP growth: the expansion of the labour force and consumer base sustains aggregate demand and investment, thereby driving overall economic output steadily upward (Zarkovic *et al*., 2021). The study by Lianos *et al*. (2023) examines the economic performance of countries of varying sizes during periods of population decline, systematically analysing the evolutionary trends of core indicators including total GDP, per capita GDP, unemployment rate, and labour force participation rate. The research finds that population decline may coexist with the following economic phenomena: sustained GDP growth, steady increase in per capita GDP, along with positive labour market changes characterised by rising participation rates and declining unemployment (Lianos *et al*., 2023).

The government-expenditure coefficient is 0.003 and is statistically insignificant, showing that larger government size has no discernible impact on GDP. The finding is consistent with research that the "government-spending neutrality or weak-effect" has been documented in the literature. The article studies the long-run impact of Saudi Arabia's government spending on health, education, and other sectors, differentially affecting GDP growth. The findings reveal that education spending significantly boosts economic growth, while health expenditures show no measurable impact, with other spending falling between these extremes. These results demonstrate that spending composition critically influences growth outcomes, suggesting policymakers should prioritise high-return education investments and reassess health spending efficiency (Alam *et al*., 2022).

The total natural-resource-rent coefficient is –0.010, implying that each one-unit increase in total natural-resource rents reduces GDP by 0.010. This supports the "resource-curse" hypothesis: excessive dependence on natural resources may suppress economic growth through institutional erosion and the crowding-out of manufacturing sectors. The core proposition of the Resource Curse theory posits that natural resource abundance may paradoxically hinder economic development, a phenomenon first systematically articulated and termed the "resource curse" in Auty's (1993) seminal study. Research demonstrates that when resource rents exceed the 15% of GDP threshold, their impact on economic growth turns from positive to negative, primarily through three mechanisms: (1) Dutch disease effects causing manufacturing sector contraction; (2) commodity price volatility exacerbating economic instability; and (3) resource rents triggering rent-seeking behaviour that weakens institutional quality. Subsequent cross-national empirical study by Sachs and Warner (1995) confirmed that resource-dependent countries experience on average 1–2% lower growth rates than resource-scarce nations. However, Mehlum *et al*. (2006) identified institutional quality as the critical moderating variable, as sound governance (rule of law index >0.6) can transform the resource effect from negative to positive.

With ρ = 0.759, roughly 76 percent of the total error variance stems from individual-level random heterogeneity, indicating that long-run cross-country differences strongly explain the export–GDP relationship and confirming the necessity of the CRE specification. R^2 of 0.743 shows that the model accounts for 74 percent of the variation in GDP, reflecting a good overall fit and sound variable selection. The CRE–Mundlak test yields $p < 0.01$, indicating that the individual effects are significantly correlated with the regressors. Consequently, the CRE specification demonstrates strong explanatory power for this model.

4. Robustness Checks

To further address endogeneity, we add two additional specifications to the model: (1) lagging the core explanatory variables by one year, and (2) employing instrumental-variable estimation (*Table 7*).

Table 7. Robustness Checks

	lag.1	IV
EX_within	0.648***	0.381***
EX_mean	1.020***	1.038***
EX_TE_within	0.207	0.906***
EX_TE_mean	1.401***	0.564***
TE	-7.797***	-5.117***
POP	0.397***	0.155***
GE	0.003	0.003
TNR	-0.004***	-0.005***
_cons	-2.244***	0.184***

Source: created by the authors.

In the test of lagging the core explanatory variables by one year, all results are consistent with the baseline regression, except that the within-group term of the interaction term and government expenditure are not statistically significant. All other results confirm the robustness of the main findings. In the instrumental variable approach, the between-group term of export volume is instrumented with a combination of bilateral distance and oil prices. In contrast, the within-group term of export volume is instrumented with a combination of EU GDP and the country's share of total EU exports. The results obtained are consistent with the main regression. Therefore, it can be concluded that the findings of this study are robust.

Conclusions

This study employs the Correlated Random Effects (CRE) model proposed by Mundlak (1978) to analyse the dynamic causal relationship between extra-EU exports and trading partner economies, with export trade efficiency incorporated as a moderating variable. The framework is applied to panel data covering 140 countries and territories from 2000 to 2021 (22 annual observations). While traditional estimators (pooled OLS, random effects, and fixed effects) consistently confirm the positive economic impact of extra-EU exports on recipient countries, they yield inconsistent estimates of trade efficiency's moderating effect. Significant estimation challenges possibly stem from the upward bias inherent in the OLS estimator, which remains unresolved even with larger cross-sectional datasets due to its inability to account for fundamental regressor correlation. Furthermore, the documented interdependence among explanatory variables renders the random effects model inappropriate for estimation. Although the Hausman test suggests that the fixed effects estimator is appropriate, the fixed effects (FE) model fully controls for time-invariant unobserved heterogeneity (e.g., country-specific characteristics) through within-group demeaning, relying solely on time-varying variation for estimation. However, this approach may underestimate the long-term effects of trade efficiency due to the elimination of between-group variation. In contrast, the Correlated Random Effects (CRE) model, which is a hybrid approach bridging FE and Random Effects (RE), allows for correlation between unobserved individual effects (e.g., country or firm heterogeneity) and explanatory variables. By incorporating within-group means of the explanatory variables, the CRE model mitigates endogeneity concerns while retaining the ability to estimate time-invariant effects.

This study employs a multi-country, multi-year panel model to validate the growth-promoting effect of EU exports on trading partner economies, with findings consistent with established trade theories while providing more robust empirical support through broader sample coverage and updated data cycles. The regression analysis reveals a statistically significant positive correlation between extra-EU exports and the GDP of partner countries, demonstrating a dual transmission mechanism: a short-term demand-side stimulation through fluctuations in export volume, and long-term supply-side structural impacts through the optimisation of export composition and adjustments to trade policy. Further research identifies that trade efficiency's moderating effects primarily stem from institutional factors, including the deepening of free trade agreements, implementation of trade facilitation measures, and market openness improvements, representing policy-driven long-term mechanisms. These results not only corroborate the trade-growth theoretical framework proposed by Helpman and Krugman (1985) but also quantitatively reveal differentiated temporal effects, offering new empirical evidence for understanding the dual effects of EU trade policy that simultaneously addresses short-term market expansion and long-term institutional building.

Population size has a significant positive impact on economic development, a conclusion supported by both classical theories and recent empirical research. In terms of classical research, Kremer (1993) proposed the "population size-technological progress" hypothesis, demonstrating that larger population sizes significantly promote long-term economic growth by increasing the pool of potential innovators and accelerating the diffusion of technology. Recent empirical studies have further validated this mechanism. Bloom *et al*. (2018) found that after controlling for institutional quality and technological level, a 1% increase in population size could raise per capita GDP growth by 0.15–0.3 percentage points, with this effect being more pronounced in knowledge-intensive industries. However, researchers also emphasise that realising this positive relationship requires complementary human capital investment and effective market mechanisms as supporting conditions.

Government expenditure has an insignificant positive impact on economic development. The seminal study by Aschauer (1989) demonstrated that productive public expenditure (such as infrastructure investment) generates sustained growth promotion by enhancing total factor productivity, with findings indicating an output elasticity of public capital stock reaching 0.39. Research by Acemoglu *et al*. (2007) further showed that after controlling for institutional quality, a one percentage point increase in productive government expenditure can raise long-term economic growth by 0.12–0.18 percentage points, with this effect being more pronounced in developing countries. Notably, both studies emphasise the critical importance of structural efficiency in government expenditure: only investments in productive areas, such as infrastructure and education, can generate sustained growth effects, while consumptive expenditure may lead to crowding-out effects. The empirical findings of this study also support the resource curse hypothesis. The groundbreaking research by Sachs and Warner (1995), published in the *American Economic Review*, demonstrated that a 10-percentage point increase in the ratio of natural resource exports to GDP leads to a one percentage point decrease in the annual economic growth rate. This negative effect is particularly pronounced in countries with weak institutional frameworks.

Overall, the regression model identifies both short-term and long-term economic promotion effects of extra-EU exports on trading partner countries, as well as the moderating influence of trade efficiency in the long run. Variables including population size and resource rents all demonstrate statistical significance, with population showing positive effects, while resource rents exhibit negative impacts. Government expenditure did not show a significant influence.

Policy Implications

Empirical evidence demonstrates that extra-EU exports drive economic growth, but this must be coupled with enhanced efficiency to maximise benefits. The EU should therefore continuously improve its export competitiveness through structural reforms. In the short term, priority should be given to supporting stable growth in demand-driven industries, such as machinery manufacturing and pharmaceutical chemicals, to ensure export volumes effectively stimulate trading partner economies. From a long-term perspective, focused efforts should be made to promote exports of high-value-added products, such as green technologies and digital services, thereby strengthening the supply-side's sustained contribution to economic growth through optimised export structures. Such structural adjustments will both consolidate the EU's advantages in traditional sectors and foster future-oriented emerging industrial competitiveness.

Institutional optimisation serves as the key breakthrough for enhancing trade efficiency. On the one hand, accelerated implementation of digital customs procedures like single window systems can substantially reduce trade costs. On the other hand, deeper free trade agreements with emerging economies are needed to institutionalise and sustain trade facilitation measures. Simultaneously, tariff barriers in key sectors such as agricultural products and automobiles should be progressively reduced to unleash trade potential through higher-level openness policies. These institutional reforms can effectively amplify the economic spillover effects of extra-EU exports.

The EU should adopt differentiated strategies for trading partners at various development stages. For developing countries, the emphasis should be placed on improving trade infrastructure including ports and logistics to enhance their capacity to absorb extra-EU exports. For developed economies, efforts should focus on advancing deeper cooperation in product standard mutual recognition and regulatory alignment to build tighter industrial value chains. This categorised approach ensures a more complete realisation of EU export dividends.

A comprehensive monitoring and evaluation mechanism must be established during policy implementation. Panel data analysis tools should be employed to dynamically track the differential impacts of extra-EU exports across regions and industries, with particular attention to potential distributional effects. For significantly affected groups or regions, timely compensatory policies such as vocational training and industrial transition support should be implemented to ensure inclusive and sustainable trade growth. This refined policy package constitutes crucial safeguards for maximising trade benefits.

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EKSPORTO ĮTAKA NE EUROPOS ŠALIŲ EKONOMIKOS AUGIMUI: PANELINIAI 140 PARTNERIŲ DUOMENYS

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Santrauka. Tyrime nagrinėjama eksporto už ES ribų įtaka prekybos partnerių BVP. Ypatingas dėmesys skiriamas eksporto prekybos efektyvumo moderacijai. Siekiant ištirti trumpalaikę ir ilgalaikę eksporto už ES ribų įtaką ekonominiam augimui, buvo pasitelkti 140 partnerių per 22 metų laikotarpį (nuo 2000 m. iki 2021 m.) surinkti duomenys ir pritaikyti jungtinių mažiausių kvadratų (angl. *pooled OLS*), atsitiktinių efektų, fiksuotų efektų ir susijusių atsitiktinių efektų modeliai. Regresinė analizė parodė statistiškai reikšmingą teigiamą ryšį tarp eksporto už ES ribų ir partnerių šalių BVP. Tai leidžia išskirti dvigubą poveikio mechanizmą: trumpuoju laikotarpiu eksportas skatina paklausą per apimties svyravimus, o ilguoju laikotarpiu veikia pasiūlą – per eksporto struktūros optimizavimą ir prekybos politikos koregavimą. Kiti tyrimai rodo, kad moderuojančią prekybos efektyvumo įtaką lemia ilgalaikiai veiksniai, pavyzdžiui, laisvosios prekybos susitarimų gilinimas, prekybos palengvinimo priemonių įgyvendinimas ir rinkos atvirumo didinimas. Tyrimas suteikia svarbios informacijos politikos formuotojams ir ekonomistams, ypač naujoje prekybos įtampų eroje, kai eksportas už ES ribų yra itin reikšmingas palaikant pasaulinį ekonomikos atsigavimą.

Reikšminiai žodžiai: ekonominis augimas; eksportas už ES ribų; prekybos efektyvumas; paneliniai duomenys; tarptautinė prekyba; susiję atsitiktiniai efektai.