

Financial Development, Financial Globalization and Logistics Performance in Mediterranean Economies: Long-Run and Distributional Evidence

Ioannis Katrakilidis^{1*}, Athanasios Athanasenas¹, Michael Madas², Anastasios Karasavoglou³,
and Constantinos Katrakilidis⁴

Abstract

This paper investigates the relationship between logistics performance, financial development, and financial globalization in a sample of nineteen Mediterranean countries over the period 2007-2022. Logistics performance is measured by the World Bank Logistics Performance Index (LPI), while financial development and financial globalization are proxied by composite indices. Since the global logistics survey index is not observed on a yearly basis but only in irregular intervals, interpolation is used to construct an annual panel.

The most probable case is that our panel captures the medium- and long-run dynamics between the benchmarks and not short-term annual variations.

The empirical specification employs second-generation panel procedures, long-run estimators, Granger-causality tests, and distribution-sensitive approaches. Significant persistence, common stochastic components, and medium- to long-run co-movement are uncovered, providing evidence for the persistent long-term co-movement of logistics performance and financial conditions. Baseline estimates of FMOLS, DOLS, and PMG-ARDL reveal positive long-run relationships for both financial development and financial globalization. Yet, domestic financial development becomes statistically weaker under more flexible treatment of cross-sectional dependence, unobserved common factors, and slope heterogeneity, whereas financial globalization receives relatively stronger support under alternative approaches.

Quantile estimates shed light on further heterogeneity: domestic financial development receives relatively stronger support at the lower and intermediate quantiles and its estimated association with logistics performance monotonically decreases towards the upper end of the distribution, whereas the connection with financial globalization becomes stronger across quantiles.

Overall, the results imply that domestic financial development and financial globalization are related to logistics development via different channels and through different mechanisms. To conclude, the findings highlight the necessity of controlling for common shocks, country heterogeneity and the slowly evolving nature of logistics capability when investigating the finance-logistics nexus among Mediterranean economies.

JEL classification: C23, F36, G15, O18, R41.

Keywords: Logistics performance, Financial development, Financial globalization, Mediterranean economies, Panel cointegration, Quantile regression.

^{1*} Department of Business Organization and Management, International Hellenic University, Greece.

*Corresponding author.

² Department of Applied Informatics, University of Macedonia, Greece.

³ Department of Accounting and Finance, Democritus University of Thrace, Greece.

⁴ Department of Economics, Aristotle University of Thessaloniki, Greece.

1. Introduction

Over the past two decades, logistics performance has come to take on an important function in a country's position in international competitiveness and economic integration. Given certain conditions, the logistics performance of a country (based on the quality and efficiency of logistics) is, perhaps most significantly, likely to help bring down costs and risks of international transactions, broaden access to foreign markets, and help enterprises better tap into regional and global production networks. In addition, transport infrastructure, customs procedures, information technology and supply-chain management have made the concept of logistics increasingly relevant to countries' productive capacity.

The Mediterranean area is especially relevant for the analysis of the factors influencing the evolution of logistics performance. This area occupies a strategic position at the intersection of European, African and Asian major trade routes and constitutes a corridor for maritime and commercial transport. Mediterranean countries differ significantly in income per capita, financial development, economic and financial integration with the international economy, institutional quality and logistics performance.

Some Mediterranean economies boast highly-developed logistics and perform well within the international supply chains, while others continue to face substantial constraints in terms of infrastructure, finance, institutional quality and technology.

Such diversity makes the Mediterranean economies a valuable sample of small and open economies to study the factors favorable to logistics development.

While the effects of logistics on trade and economic performance are well-researched, the financial structure underlying the development of logistics services has not received as systematic an examination. Given that logistics is a capital-intensive activity, this is a surprising finding. Ports, roads, railways, airports, customs modernization, information and communication technologies, traceability, and other supply chain digitalization measures require significant capital in the form of infrastructure investments and connected equipment (terminals, sensors, GPS location tools etc.) that can take a long time to pay back. The financial development dimension points to a potential role of the financial sector in helping to finance those investments.

Second, even more so with a different path: International financial integration. Further financial globalization could facilitate access to external finance, foreign direct investment, skills and technology, and international production networks, especially for countries seeking to upgrade within the supply chain. But the benefits may not be evenly distributed.

They could depend on the level of domestic financial development, institutions, income, and logistics capabilities.

Therefore, domestic financial development and financial globalization could be related to logistics performance by way of similar – though not identical – channels.

Most empirical research on logistics has been centered on its effects on trade, growth, competitiveness, and other macroeconomic variables. Much less is known about the financial environment associated with logistics capability building. There is in particular a lack of evidence on the simultaneous treatment of domestic financial deepening and international financial integration in a geographically and economically heterogeneous area like the Mediterranean. This raises an important empirical puzzle: are domestic financial deepening and financial globalization associated with logistics upgrading in a similar manner, or does their role depend on the level of logistics performance?

Against this background, the present study investigates the relationship between financial development, financial globalization, and logistics performance in a panel of nineteen Mediterranean economies over the period 2007–2022. Logistics capability is measured using the World Bank Logistics Performance Index (LPI), while financial development and financial globalization are represented by comprehensive indices capturing domestic financial-system development and de facto international financial integration, respectively. The analysis focuses not only on average long-run relationships but also on the possibility that these relationships differ across the conditional distribution of logistics performance.

An important feature of the empirical design concerns the frequency of the LPI data. The World Bank's survey-based LPI is observed only in periodic survey rounds rather than annually. Because the objective of

this study is to investigate medium- and long-run structural relationships rather than short-run fluctuations in logistics activity, values between observed survey benchmarks are interpolated to construct an annual panel. This procedure should not be interpreted as creating new independent information between survey rounds, nor are interpolated annual movements treated as directly observed changes in logistics performance. Instead, interpolation provides a continuous approximation of the underlying trajectory of a relatively slow-moving structural indicator between observed LPI benchmarks and permits its alignment with annually observed financial variables within a common panel framework.

This treatment necessarily requires caution. Interpolation smooths the observed series and may increase measured persistence; consequently, persistence and cointegration results cannot be interpreted independently of the way in which the annual LPI series is constructed. For this reason, the empirical analysis does not rely on a single unit-root test, cointegration statistic, or long-run estimator. Evidence is evaluated jointly across cross-sectional-dependence diagnostics, second-generation unit-root procedures, the Bai–Ng PANIC decomposition, alternative panel cointegration tests, several long-run estimators, heterogeneous panel procedures, and distribution-sensitive estimates. The purpose of this multi-method strategy is not to claim that interpolation eliminates the limitations of the original data frequency, but to assess whether the substantive finance–logistics relationships remain sufficiently consistent across alternative econometric approaches to warrant a cautious structural interpretation.

The econometric strategy thus proceeds in several stages. We first examine cross-sectional dependence, an important feature of Mediterranean economies given their exposure to common regional and global shocks. Second-generation unit-root tests and the Bai–Ng PANIC decomposition are subsequently employed to distinguish persistence associated with common stochastic components from country-specific dynamics. Panel cointegration tests are then used to investigate persistent long-run co-movement among logistics performance, financial development, and financial globalization. Long-run relationships are estimated using Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and the Pooled Mean Group (PMG-ARDL) estimator. Dumitrescu–Hurlin tests are used to examine temporal predictive relationships among the variables, while Method-of-Moments Quantile Regression (MMQR) is employed to investigate whether the finance–logistics relationship varies across different levels of conditional logistics performance.

The paper adds to the literature in four ways. First, it looks at finance as a condition associated with logistics development, rather than treating logistics mainly as an explanation for trade or growth, and considers domestic financial development alongside financial globalization. Second, it studies the Mediterranean, where countries differ markedly in economic development, financial structures, international integration, and logistics capability. Third, the econometric design allows for cross-sectional dependence, common stochastic components, heterogeneous dynamics, and differences across the conditional distribution, rather than depending only on homogeneous panel estimates.

Fourth, and importantly, the study distinguishes between the empirical roles of domestic and international finance. The results do not suggest that all dimensions of finance affect logistics performance with equal strength or robustness. While baseline long-run estimates indicate positive associations for both financial development and financial globalization, the relationship with domestic financial development becomes considerably more sensitive when common factors and slope heterogeneity are explicitly accommodated. Financial globalization receives comparatively stronger support, particularly from heterogeneous common-factor estimators, although its significance is not universal across all specifications. The quantile evidence further indicates that domestic financial development is more relevant at lower and intermediate levels of logistics performance, whereas financial globalization becomes increasingly important toward the upper part of the distribution. This distinction provides a more nuanced interpretation of the finance–logistics nexus than would be obtained from average-effect estimates alone.

The evidence therefore does not support treating domestic financial development as an unconditional, stand-alone determinant of logistics performance. A more restrained interpretation is that domestic finance can act as an enabling condition, with a larger role where financing constraints are more binding. International financial integration, by contrast, shows a more persistent association with logistics capability.

This difference is especially relevant in the Mediterranean, where financial structures, institutional settings, and stages of logistics development vary widely.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the research questions and hypotheses. Section 3 presents the methodological framework and empirical strategy. Section 4 describes the data and variables. Section 5 reports the empirical findings and robustness analysis. Section 6 discusses the results and their broader implications. Finally, Section 7 presents the conclusions, policy implications, limitations, and directions for future research.

2. Literature Review, Research Questions and Hypotheses

2.1 Logistics Performance and Financial Development

The performance of logistics management has evolved into an important factor closely associated with international competitiveness and economic integration. Theories suggest that effective logistics systems are expected to contribute to lower transportation and transaction costs, greater promptness and reliability of supply chains, and to increase the ability of firms to participate in international markets. The World Bank's Logistics Performance Index (LPI) measures and reflects on the efficiency of logistics in a country, focusing on customs, infrastructure, international shipments, logistics competence, tracking and tracing, timeliness (World Bank, 2009).

However, logistics capabilities cannot be attained without significant and sustained investment. Transport infrastructure, ports, warehousing, information and communication technologies, tracking systems, and supply-chain digitalization require capital investments. As such, development of the logistics sector involves physical as well as institutional conditions but also macroeconomic factors such as financial resources.

Financial development is said to impact the logistics performance through multiple interrelated mechanisms.

The finance-growth literature, for example, emphasizes the importance of financial institutions and markets in generating savings, channeling capital, alleviating information asymmetries, providing access to external capital, and improving the monitoring of new investments (Beck et al., 2000; Levine, 2005). The above functions are particularly relevant for logistics because the majority of logistics-related investments have high fixed costs and long-term investments and often require external financing.

A more advanced financial system should ease the financing constraints faced by firms and infrastructure providers and thus create better access to finance needed for investments in transport equipment, warehousing capacity, digital technologies, modernization of customs and other procedures, and supply-chain infrastructure. Financial development can spur logistics upgrading by driving investment and improving resource allocation to productive logistics activities.

Furthermore, financial development is multidimensional. Financial depth, access and efficiency cover different aspects of financial institutions and markets, which may affect the real economy via separate channels (Čihák et al., 2012; Svirydzienka, 2016). This confirms the motivation for using a broad composite indicator instead of a single banking or credit variable. With regard to logistics, the choice of an aggregate measure seems especially justified, as logistics investment can be financed by different sectors of the financial system rather than by bank credit alone.

The predicted positive effect of financial development on logistics performance may not be so high in all economies. If financial constraints are more binding in some economies, improvements in domestic financial intermediation are likely to be more closely related to logistics competitiveness. On the other hand, where financial development as well as logistics performance is already high and the existing financial and logistics system is consolidated, further financial deepening may generate diminishing marginal returns to logistics capacity. For this reason, it is important to investigate heterogeneity at different levels of logistics performance rather than only the average effect.

2.2 Logistics Performance and Financial Globalization

Financial globalization is one possible mechanism by which financial conditions could be connected to logistics development. Financial market integration encourages flows of funds across borders and makes it easier for countries to obtain financial resources from outside the country. Financial liberalization and financial market integration are thought to promote investment and capital accumulation by giving the economy access to international finance (Bekaert et al., 2005). Growth in cross-border positions of assets and liabilities were substantial as noted in Lane and Milesi-Ferretti (2007) showing the need to consider this form of integration.

The potential benefits of financial globalization are not restricted to capital flows alone. Kose et al. (2009) also identify several transmission channels through which financial integration with international capital markets can foster growth, including physical and human capital accumulation, technology transfer, managerial expertise, and institutional development. Many of these routes are also relevant to logistics upgrading, since higher quality, more modern logistics require advanced technological and digital infrastructure, managerial knowledge, and integration into international production and distribution networks.

Financial globalization may therefore boost logistics improvement by easing the flow of foreign capital, external project finance, expertise, and technology.

It may also promote logistics performance indirectly, by encouraging trade and production integration and increasing participation in global value chains, thereby enabling better leverage of advanced logistics technology and infrastructure.

However, it is also evident that there might be disparities in the benefits of financial globalization between countries. As suggested by Lane and Milesi-Ferretti (2007), Kose et al. (2009), domestic economic factors, especially economic openness, institutional quality, absorptive capacity, and development would be important determinants of the ability of countries to enjoy the benefits of financial integration. Financial globalization should therefore not be considered as an automatically beneficial factor and its impact on logistics performance may not be identical across the countries and will as well largely depend on the ability to translate international capital and knowledge into efficient logistics investment.

This is especially relevant for the Mediterranean economies which are quite heterogeneous along dimensions like financial openness, institutional characteristics, economic development and logistics capabilities. Indeed, financial globalization may have a relatively small impact in countries with weak absorptive capacity while countries with high levels of logistics capabilities could be more able to harness international capital, technology and global production networks thus offering an additional motivation to study the relationship between finance and logistics along the distribution of the logistics performance.

2.3 Empirical Evidence and Research Gap

A substantial empirical literature has examined the economic consequences of logistics performance. Much of this research focuses on international trade, competitiveness, and economic growth. Hausman et al. (2013), for example, examine the importance of trade-related infrastructure and logistics conditions for international trade, while Martí et al. (2014) and Gani (2017) provide evidence linking improvements in logistics performance to stronger trade outcomes. Other studies associate logistics capability with broader macroeconomic and structural conditions, emphasizing its role in facilitating economic activity and international integration (Zaman and Shamsuddin, 2017).

The World Bank's work on the LPI has also highlighted the close relationship between logistics performance and countries' broader development characteristics (World Bank, 2009; Arvis et al., 2018). Differences in infrastructure quality, institutional capacity, income, and trade facilitation contribute to substantial cross-country variation in logistics outcomes. This literature establishes the economic importance of logistics and provides a strong basis for treating logistics capability as an important dimension of national competitiveness.

However, the empirical literature has devoted much less attention to the financial conditions underlying logistics development. Most studies examine logistics as an explanatory factor for trade, growth, or competitiveness, or focus on conventional determinants such as infrastructure, institutional quality, and

income. The specific role of domestic financial development in supporting logistics capability remains comparatively underexplored, despite the capital-intensive nature of transport, warehousing, digital infrastructure, and supply-chain modernization.

The gap is still clearer for financial globalization. Although the broader literature identifies international financial integration as a potential channel for capital accumulation, foreign investment, technology transfer, and participation in international production networks, comparatively little empirical work directly examines whether these mechanisms are associated with national logistics performance. As a result, the respective roles of domestic financial capacity and international financial integration in logistics development are still not well understood.

Domestic and international finance are conceptually different, and that difference is important here. Domestic financial development reflects the capacity of national financial institutions and markets to mobilize and allocate resources, whereas financial globalization captures a country's effective integration into international financial markets. The two may thus support logistics upgrading through different mechanisms and may not exhibit the same degree of empirical robustness.

Another limitation of the existing literature is that finance–logistics relationships are generally not examined from a distributional perspective. The effect of domestic financial development may be stronger in economies where logistics capabilities remain relatively constrained and access to finance constitutes an important bottleneck. Conversely, international financial integration may become more relevant at higher levels of logistics performance, where countries are better able to absorb international capital, technologies, managerial expertise, and opportunities arising from participation in global value chains. Average-effect models may conceal these differences.

These gaps are especially relevant in the Mediterranean region. The countries considered in this study vary substantially in financial development, international financial integration, economic development, and logistics capability. This heterogeneity offers an appropriate setting for examining not only whether financial conditions are associated with logistics performance, but also whether the relative importance of domestic and international finance changes across different levels of logistics development.

In this setting, this study contributes to the literature by jointly examining domestic financial development and financial globalization as potential financial dimensions of logistics performance and by explicitly allowing their relationships with logistics capability to vary across the conditional distribution. Instead of assuming that financial development and financial globalization exert homogeneous effects across Mediterranean economies, the analysis investigates whether their empirical relevance differs according to the level of logistics performance.

Based on the preceding discussion, the study addresses the following research questions:

RQ1: What is the nature of the long-run relationship between financial development and logistics performance in Mediterranean economies?

RQ2: To what extent is financial globalization associated with logistics performance in the long run?

RQ3: Do the relationships between financial development, financial globalization, and logistics performance differ across the conditional distribution of logistics performance?

Drawing on the theoretical mechanisms and empirical evidence discussed above, the following hypotheses are formulated:

H1: Financial development is positively associated with logistics performance in Mediterranean economies.

H2: Financial globalization is positively associated with logistics performance in Mediterranean economies.

H3: The relationships of financial development and financial globalization with logistics performance vary across the conditional distribution of logistics performance, reflecting heterogeneity in countries' stages of logistics development.

Table 1: Selected Studies on Financial Development, Financial Globalization and Logistics Performance

Authors	Focus	Main Findings	Relevance to the Present Study
Beck, Levine and Loayza (2000)	Financial development and economic growth	Financial development improves resource allocation and investment efficiency.	Provides the theoretical basis for linking financial development to logistics upgrading.
Levine (2005)	Finance and economic growth	Efficient financial systems facilitate capital accumulation, productivity, and long-run development.	Supports the potential role of financial development in facilitating logistics investment.
Čihák et al. (2012)	Financial development indicators	Financial systems can be assessed through dimensions such as depth, access, efficiency, and stability.	Provides the conceptual foundation for multidimensional measures of financial development.
Svirydzienka (2016)	IMF Financial Development Index	Develops a comprehensive index capturing financial institutions and financial markets.	Supports the use of a composite measure of financial development.
Bekaert, Harvey and Lundblad (2005)	Financial globalization and growth	Financial liberalization is associated with investment and economic growth.	Provides a theoretical and empirical basis for a potential link between financial globalization and logistics investment.
Lane and Milesi-Ferretti (2007)	International financial integration	Documents the substantial expansion of international financial integration through cross-border asset and liability positions.	Supports the measurement and interpretation of international financial integration.
Kose et al. (2009)	Financial globalization and development	The benefits of financial globalization depend partly on domestic conditions and absorptive capacity.	Helps explain why the relationship between financial globalization and logistics performance may differ across countries.
Hausman, Lee and Subramanian (2013)	Logistics performance and trade	Better trade-related logistics performance is associated with stronger trade outcomes.	Establishes the broader economic relevance of logistics performance.
Martí, Puertas and García (2014)	Logistics performance and international trade	Improvements in logistics performance are associated with higher trade flows.	Confirms the relevance of logistics quality for international economic activity.
Gani (2017)	Logistics performance and international trade	Logistics performance is positively associated with exports and imports.	Highlights the broader economic importance of logistics efficiency.
Arvis et al. (2018)	Logistics Performance Index methodology	Provides the conceptual and measurement framework underlying the LPI.	Supports the use of the LPI as the measure of logistics performance.
Zaman and Shamsuddin (2017)	Logistics performance and macroeconomic conditions	Logistics performance is associated with broader development and macroeconomic conditions.	Indicates that logistics outcomes are related to countries' structural economic characteristics.

3. Methodology

3.1 Methodological Issues

The empirical analysis employs a sequence of panel econometric techniques designed to address three features that are particularly relevant to the present dataset: cross-sectional dependence, persistence and common stochastic components, and heterogeneity across countries. These characteristics are important in a Mediterranean panel because the economies under consideration are exposed to common regional and global shocks, while differing substantially in their financial structures, institutional environments, and levels of logistics development.

A first methodological issue concerns cross-sectional dependence. Countries in the Mediterranean region are interconnected through trade, financial flows, energy markets, and common exposure to international economic disturbances. Ignoring such interdependence may lead to misleading inference when conventional panel procedures based on cross-sectional independence are applied. We thus examine cross-sectional dependence using the Breusch–Pagan LM test (Breusch and Pagan, 1980), the Pesaran scaled LM test (Pesaran, 2004), the bias-corrected LM statistic (Pesaran et al., 2008), and the Pesaran CD test (Pesaran, 2004, 2021). Viewed together, these diagnostics provide evidence on whether common shocks and regional spillovers generate dependence across the cross-sectional units.

Given evidence of cross-sectional dependence, the stochastic properties of the variables are examined using second-generation panel unit-root procedures. Specifically, the Cross-Sectionally Augmented Dickey–Fuller (CADF) and Cross-Sectionally Augmented IPS (CIPS) tests proposed by Pesaran (2007) are employed. These procedures augment conventional unit-root regressions with cross-sectional averages of the variables and their lagged differences, thereby allowing for unobserved common factors. The CIPS statistic is constructed from the average of the individual CADF statistics and provides a panel-level assessment of persistence under cross-sectional dependence.

The CIPS and CADF tests are complemented by the Bai and Ng (2004) PANIC decomposition. PANIC decomposes an observed panel series into common and idiosyncratic components, allowing persistence associated with common stochastic factors to be distinguished from persistence originating in country-specific components. This distinction is particularly useful in the present application because Mediterranean economies may share persistent regional and global influences even when country-specific deviations from those common movements are mean-reverting.

The evidence from these procedures is evaluated jointly rather than imposing a strict classification based on any single unit-root statistic. This is particularly important because the unit-root evidence is not uniform across all variables and specifications. Accordingly, the empirical strategy focuses on the degree and source of persistence and on the presence of common stochastic movements rather than assuming *a priori* that every series can be unambiguously characterized as an $I(1)$ process.

A related methodological consideration concerns the periodic nature of the Logistics Performance Index. The LPI is survey based and is observed at discrete survey dates rather than annually. As explained in Section 4, interpolation between observed survey benchmarks is used to align the LPI with the annually observed financial variables and to approximate its medium- and long-run trajectory. Interpolation inevitably smooths the series and may strengthen measured persistence. For that reason, the unit-root and cointegration results are interpreted cautiously and are not treated as evidence that interpolation itself establishes an underlying stochastic trend. Rather, the analysis asks whether the observed persistence and common movements are sufficiently systematic across complementary procedures to support an investigation of persistent long-run relationships.

To examine such relationships, the study employs two complementary approaches to panel cointegration. First, the residual-based tests developed by Pedroni (1999, 2004) allow for heterogeneity in intercepts and, depending on the specification, slope and autoregressive parameters across panel members. Both within-dimension and between-dimension statistics are considered. Second, the error-correction-based tests of Westerlund (2007) examine whether deviations from a long-run relationship generate statistically significant error-correcting behaviour. The use of bootstrap-adjusted inference in the Westerlund framework is particularly relevant in the presence of cross-sectional dependence.

In the context of the present study, evidence of cointegration is interpreted as evidence of persistent long-run co-movement among logistics performance, financial development, and financial globalization rather than as proof of a deterministic equilibrium mechanism or structural causality. This interpretation is deliberately conservative given the persistence of the variables, the common stochastic components identified in the data, and the interpolated annual representation of the survey-based LPI.

Conditional on evidence supporting persistent long-run co-movement, long-run coefficients are estimated using Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS). FMOLS incorporates semi-parametric corrections for serial correlation and potential endogeneity in the cointegrating regression (Phillips and Hansen, 1990; Pedroni, 2000). DOLS addresses similar concerns by augmenting the long-run regression with leads and lags of first differences of the regressors (Stock and Watson, 1993). Using both estimators provides complementary evidence on the magnitude and direction of the estimated long-run relationships.

The analysis additionally employs the Pooled Mean Group (PMG) ARDL estimator developed by Pesaran et al. (1999). PMG allows short-run coefficients and adjustment dynamics to differ across countries while imposing homogeneity on the estimated long-run coefficients. This distinction is useful in the present setting because Mediterranean economies may respond differently to short-run disturbances while still exhibiting common long-run relationships. The associated error-correction term provides information on the speed at which deviations from the estimated long-run relationship are corrected.

The direction of temporal predictive relationships among the variables is subsequently examined using the Dumitrescu–Hurlin (2012) heterogeneous panel Granger-causality test. The procedure allows the underlying Granger-predictive relationships to differ across cross-sectional units and is therefore appropriate for a heterogeneous panel. Importantly, rejection of the non-Granger-causality null is interpreted as evidence of temporal predictive content rather than as identification of structural causality. This distinction is maintained throughout the interpretation of the empirical results.

Finally, potential heterogeneity across different levels of logistics performance is investigated using the Method of Moments Quantile Regression (MMQR) approach of Machado and Santos Silva (2019). Unlike mean-based estimators, MMQR allows the coefficients associated with financial development and financial globalization to vary across the conditional distribution of logistics performance while accommodating individual heterogeneity. This allows us to examine whether domestic and international financial conditions exhibit different relationships with logistics performance in relatively low-, intermediate-, and high-performing economies.

Viewed together, these methods provide complementary rather than interchangeable evidence. The empirical conclusions are thus based on the pattern of results across different procedures instead of on any single estimator. This multi-method approach is particularly important in the present application because the panel combines cross-sectional dependence, heterogeneous country characteristics, persistent variables, and a survey-based logistics indicator observed at discrete benchmark dates.

AI-assisted tools were used for language editing and manuscript preparation. All empirical analyses were conducted by the authors, who reviewed and take full responsibility for the interpretations and final content.

3.2 Empirical Strategy

The empirical strategy proceeds sequentially and is designed to distinguish between preliminary stochastic properties, long-run relationships, temporal predictive patterns, and distributional heterogeneity.

First, cross-sectional dependence is examined to determine whether the Mediterranean economies are subject to common shocks and regional spillovers. Evidence of such dependence motivates the subsequent use of second-generation panel procedures and estimators capable of accounting for common factors.

Second, the persistence properties of logistics performance, financial development, and financial globalization are investigated using the CIPS and CADF tests together with the Bai–Ng PANIC decomposition. Because these procedures provide information on different dimensions of non-stationarity, their results are interpreted jointly. Particular attention is given to whether persistence reflects common stochastic components shared across countries or country-specific dynamics.

Third, Pedroni and Westerlund panel cointegration tests are employed to examine whether the variables display persistent long-run co-movement. The two approaches provide complementary evidence because the former is residual based whereas the latter focuses directly on error-correction behaviour. Given the characteristics of the LPI series, these tests are used to identify persistent long-run structural associations rather than to claim a uniquely identified equilibrium relationship.

Fourth, conditional on the cointegration evidence, long-run coefficients are estimated using FMOLS and DOLS and compared with those obtained from a PMG-ARDL specification. The comparison across estimators allows the stability of the direction and magnitude of the estimated long-run relationships to be assessed rather than relying on a single specification. The PMG framework additionally provides an estimate of the error-correction coefficient and hence of the adjustment toward the estimated long-run relationship.

Fifth, the Dumitrescu–Hurlin procedure is used to investigate whether past values of financial development and financial globalization contain predictive information for logistics performance and whether corresponding reverse relationships are present. These results are interpreted in the Granger-predictive sense and are not taken to establish structural causal effects.

Sixth, MMQR estimates are used to investigate distributional heterogeneity. The objective is to determine whether the relationships of domestic financial development and financial globalization with logistics performance vary across the conditional logistics-performance distribution. This stage is particularly relevant to the third research question and allows relationships that may be obscured by average-effect estimators to be identified.

Finally, the sensitivity of the baseline findings is evaluated using estimators that place different demands on the cross-sectional and slope structure of the panel. Driscoll–Kraay inference, Common Correlated Effects Mean Group (CCEMG/CCE-MG), Augmented Mean Group (AMG), and Cross-Sectionally Augmented ARDL (CS-ARDL) specifications are used to assess the extent to which the estimated finance–logistics relationships persist when cross-sectional dependence, unobserved common factors, and slope heterogeneity are accommodated more flexibly.

These sensitivity estimates are not treated merely as confirmatory exercises. Instead, differences between the baseline and alternative estimators form part of the substantive interpretation of the results. In particular, a coefficient that loses statistical significance once common factors or heterogeneous slopes are explicitly accommodated is interpreted as specification-sensitive rather than robustly established. Conversely, relationships that remain statistically supported across heterogeneous common-factor estimators receive comparatively stronger empirical support. This approach allows the analysis to distinguish between baseline long-run associations and relationships that are more stable across alternative econometric assumptions.

Overall, the empirical framework is intended to evaluate whether financial development and financial globalization display persistent and heterogeneous associations with logistics performance under alternative treatments of cross-sectional dependence, common factors, and country heterogeneity. Given the survey-based and interpolated nature of the annual LPI series, the analysis is deliberately oriented toward medium- and long-run structural patterns, and the resulting coefficients are not interpreted as estimates of short-run annual responses or as evidence of structural causal effects.

4. Data and Variables

The analysis uses a balanced annual panel of 19 Mediterranean economies covering the period 2007–2022, yielding a total of 304 country-year observations. The Mediterranean region offers a useful setting for the analysis because the countries in the sample differ substantially in income levels, financial-system development, international financial integration, and logistics capability. At the same time, they are exposed to several common regional and global influences, including the global financial crisis, the European sovereign debt crisis, geopolitical disturbances, the COVID-19 pandemic, and disruptions to international supply chains. These common exposures, combined with substantial cross-country heterogeneity, motivate the panel econometric framework adopted in the study.

Logistics performance is measured by the natural logarithm of the World Bank Logistics Performance Index (LLPI). The LPI is an internationally comparable, survey-based measure of countries' logistics capability and evaluates performance across six dimensions: customs efficiency, the quality of trade- and transport-related infrastructure, the ease of arranging competitively priced international shipments, the competence and quality of logistics services, tracking and tracing, and the timeliness of shipments (Arvis et al., 2018; World Bank, 2024). The composite nature of the index makes it particularly suitable for the present analysis because logistics capability encompasses a broader set of institutional, infrastructural, and operational characteristics than can be captured by individual indicators of transport infrastructure or trade costs.

An important data issue concerns the frequency of the LPI. Unlike the financial variables employed in the study, the LPI is not observed annually but is available only for periodic World Bank survey rounds. Because the LPI is observed only in periodic survey rounds rather than annually, values between observed survey benchmarks are linearly interpolated to construct an annual panel. Linear interpolation has been considered in the panel-data literature as a method for handling missing observations in nonstationary settings (Kang, 2011). In the present application, however, interpolation is used only to approximate the medium- and long-run trajectory between observed LPI benchmarks and is not treated as generating additional independently observed information. This alignment permits the logistics indicator to be combined with the annually observed financial variables within a balanced panel while preserving the information contained in the original survey benchmarks.

This treatment fits the study's focus on medium- and long-run structural movements rather than short-term annual fluctuations. Logistics capability reflects relatively slow-moving characteristics—including transport and trade infrastructure, customs procedures, logistics-service competence, and tracking systems—that generally evolve over longer horizons. Interpolation is thus used as a continuous approximation between observed benchmarks, not as a substitute for directly observed annual LPI data.

At the same time, this procedure has an important limitation. Interpolation necessarily smooths the trajectory between observed survey rounds and may mechanically increase the measured persistence of the resulting annual series. The interpolated LLPI should not, thus, be interpreted as equivalent to an independently observed annual logistics indicator. Nor should statistical persistence in the annual series be attributed exclusively to the underlying economic process without taking the construction of the variable into account. For that reason, the empirical analysis focuses on persistent medium- and long-run associations, and the evidence on stochastic properties and long-run relationships is evaluated jointly across alternative tests and estimators rather than inferred from a single specification. This limitation is also explicitly taken into account when interpreting the empirical findings.

Financial development is measured by the natural logarithm of the IMF Financial Development Index (LFD). Following Svirydzenka (2016), the index provides a broad measure of financial-system development by combining information on financial institutions and financial markets and capturing dimensions related to their depth, access, and efficiency. A composite indicator is preferable for the purposes of the present study to a single financial proxy, such as private credit or stock-market capitalization, because logistics investment may depend on several segments of the financial system. The measure therefore captures the broader domestic financial environment within which investment in transport, warehousing, digital infrastructure, and other logistics-related activities takes place.

Financial globalization (LFGLOB) is measured using the natural logarithm of the *de facto* financial globalization sub-index of the KOF Globalisation Index (Gygli et al., 2019). The *de facto* financial globalization measure captures actual cross-border financial activity and thus provides an indicator of how far national economies are effectively integrated into international financial markets. This measure is preferred to a purely *de jure* indicator because the objective is to capture realized international financial integration rather than formal regulatory openness alone. This distinction is relevant to the mechanisms considered in the study, since access to international capital, foreign investment, technology, and internationally connected production networks depends more directly on realized financial integration (Lane and Milesi-Ferretti, 2007; Kose et al., 2009).

All three variables enter the empirical models in natural logarithms. This transformation permits the estimated coefficients in the log–log specifications to be interpreted as elasticities and reduces the influence

of differences in scale and extreme observations. Descriptive statistics for LLPI, LFD, and LFGLOB are reported in Table 2. These statistics provide an initial indication of the extent of variation in logistics performance, domestic financial development, and international financial integration across the Mediterranean sample. The stochastic properties of the variables, including their persistence and the role of common components, are examined formally in Section 5 not assumed at the data-description stage.

Table 2: Descriptive statistics for LLPI, LFD and LFGLOB

Statistic	LLPI	LFD	LFGLOB
Mean	1.084	4.263	3.565
Median	1.090	4.252	3.721
Maximum	1.395	4.462	4.502
Minimum	0.641	3.954	2.186
Std. Dev.	0.161	0.128	0.629
Skewness	−0.124	−0.612	−0.460
Kurtosis	2.343	2.705	2.114

Table 2 reports the descriptive statistics for the variables used in empirical analysis. LLPI exhibits comparatively limited overall variation, which is consistent with the relatively slow-moving nature of logistics capability over the sample period. In contrast, the financial variables display greater dispersion, reflecting the substantial heterogeneity of Mediterranean economies in terms of domestic financial development and international financial integration. The observed variation across the three variables provides a useful basis for the subsequent panel analysis. However, descriptive statistics alone do not provide information about stationarity, common stochastic components, or long-run relationships; these properties are formally examined in the empirical analysis that follows.

5. Results

This section presents the empirical results following the sequence established in the methodological framework. We first examine cross-sectional dependence, since Mediterranean economies are likely to be jointly affected by regional and global shocks. We then assess the stochastic properties of the variables using second-generation panel unit-root tests and the Bai–Ng PANIC decomposition. On the basis of this evidence, Pedroni and Westerlund tests are used to investigate persistent long-run co-movement among logistics performance, financial development, and financial globalization. Long-run coefficients are subsequently estimated using PMG-ARDL, FMOLS, and DOLS, while Dumitrescu–Hurlin tests examine temporal predictive relationships. Distributional heterogeneity is explored using Method-of-Moments Quantile Regression (MMQR). Finally, the sensitivity of the baseline estimates is assessed using alternative estimators that explicitly accommodate cross-sectional dependence, unobserved common factors, and slope heterogeneity.

Importantly, the results are interpreted in light of the data characteristics discussed in Section 4. Because the annual LLPI series includes interpolated observations between the original survey benchmarks, particular caution is required when interpreting persistence and long-run dynamics. Accordingly, the empirical evidence is evaluated jointly across methods, and the results are interpreted as medium- and long-run structural associations rather than as short-run annual responses or structural causal effects.

5.1 Cross-sectional Dependence

The first step is to determine whether the variables exhibit cross-sectional dependence. This is particularly relevant for Mediterranean economies, which are exposed to common macroeconomic, financial, geopolitical, and trade-related shocks. Table 3 reports four complementary tests of cross-sectional independence.

Table 3: Cross-sectional dependence tests

Series	Breusch–Pagan LM (p-value)	Pesaran scaled LM (p-value)	Bias-corrected LM (p-value)	Pesaran CD (p-value)
LLPI	810.28 (<0.001)	34.57 (<0.001)	33.93 (<0.001)	12.41 (<0.001)
LFD	568.75 (<0.001)	21.51 (<0.001)	20.87 (<0.001)	−0.16 (0.869)
LFGLOB	855.11 (<0.001)	36.99 (<0.001)	36.36 (<0.001)	15.29 (<0.001)

Notes: p-values are reported in parentheses below the test statistics. The null hypothesis is cross-sectional independence.

For LLPI and LFGLOB, all four tests strongly reject the null hypothesis of cross-sectional independence. For LFD, the three LM-based statistics also reject the null at the 1% level, although the Pesaran CD statistic does not. Viewed together, the evidence indicates substantial cross-sectional dependence in the panel, although its strength differs across variables.

This pattern is economically plausible given the exposure of Mediterranean economies to common regional and global developments. More importantly, it has direct econometric implications: conventional panel procedures that impose cross-sectional independence may provide unreliable inference. The evidence thus supports the use of second-generation unit-root procedures and motivates the subsequent robustness analysis based on estimators that explicitly accommodate common factors and cross-sectional dependence.

5.2 Second-Generation Unit-Root Tests and PANIC Decomposition

Given the evidence of cross-sectional dependence, the stochastic properties of LLPI, LFD, and LFGLOB are first examined using Pesaran's (2007) CIPS and CADF procedures. The results are reported in Table 4.

Table 4: Second-generation panel unit-root tests (CIPS and CADF)

Panel A: CIPS unit-root test (null: unit root)					
Variable	CIPS statistic	p-value		Truncated CIPS	p-value
LLPI	−1.632	≥ 0.10		−2.608	< 0.01
LFD	−2.864	< 0.01		−2.713	< 0.01
LFGLOB	−2.174	≥ 0.10		−2.174	≥ 0.10
Panel B: CADF unit-root test (null: unit root)					
Variable	t-bar	cv_10%	cv_5%	cv_1%	p-value
LLPI	−2.632	−2.630	−2.730	−2.920	0.065
LFD	−2.040	−2.630	−2.730	−2.920	0.850
LFGLOB	−2.558	−2.630	−2.730	−2.920	0.115

The results do not provide a uniform classification of all three variables as either stationary or non-stationary in levels. For LLPI, the standard CIPS statistic does not reject the unit-root null, whereas the truncated CIPS statistic rejects it at the 1% level. The CADF statistic is also borderline, rejecting at approximately the 10% level but not at the 5% level. For LFGLOB, both versions of the CIPS statistic and the CADF statistic fail to reject the unit-root null at conventional significance levels, providing comparatively clearer evidence of persistence. For LFD, by contrast, the CIPS and truncated CIPS statistics reject the unit-root null, whereas the CADF statistic does not.

These results do not justify the conclusion that all variables are unambiguously $I(1)$. Rather, the evidence is mixed, particularly for LLPI and LFD. This distinction is important because imposing a common integration order on the basis of one test would overstate what the data support. The analysis thus

complements these tests with the Bai and Ng PANIC decomposition, which distinguishes between persistence generated by common factors and that arising from country-specific components. The actual CIPS/CADF results support precisely this more cautious interpretation.

Table 5: Bai and Ng PANIC panel unit-root test

Variable	Deterministics	Selected factors	Common-factor statistic (p-value)	Common trends	Pooled idiosyncratic statistic (p-value)	Interpretation
LLPI	Constant and trend	7	-18.003 (0.999)	7	11.472 (<0.001)	Non-stationarity driven by common stochastic trends; idiosyncratic component stationary
LFD	Constant and trend	7	-19.188 (0.999)	7	-2.037 (0.042)	Non-stationarity mainly driven by common stochastic trends; weak evidence of idiosyncratic stationarity
LFGLOB	Constant and trend	6	-8.192 (0.999)	6	2.349 (0.018)	Non-stationarity mainly driven by common stochastic trends; idiosyncratic component stationary

Notes: p-values are reported in parentheses below the corresponding statistics. PANIC denotes Panel Analysis of Non-stationarity in Idiosyncratic and Common Components. Rejection in the pooled idiosyncratic test indicates stationary idiosyncratic components after extracting common factors.

The PANIC estimates provide useful additional information. For all three variables, the common-factor component displays strong evidence of non-stationarity, with a reported p-value of 0.999. The procedure identifies seven common trends for LLPI and LFD and six for LFGLOB. In contrast, the pooled idiosyncratic statistics reject the unit-root null for all three variables, although the evidence is weaker for LFD than for LLPI and LFGLOB.

Taken together, the CIPS/CADF and PANIC results indicate that persistence in the panel cannot be adequately understood solely in terms of country-specific unit-root processes. A substantial part appears to be associated with common stochastic components shared across Mediterranean economies. This finding is consistent with the cross-sectional-dependence results and reinforces the importance of accounting for common factors in the subsequent analysis.

At the same time, these results must be interpreted cautiously for LLPI. As discussed in Section 4, interpolation between observed LPI survey benchmarks can contribute mechanically to smoothness and persistence in the annual series. The PANIC results therefore do not eliminate the data-frequency limitation. Rather, they show that the observed panel dynamics contain a substantial common component and provide a basis for investigating whether the variables exhibit persistent long-run co-movement, while maintaining a deliberately cautious interpretation of such relationships.

5.3 Panel Cointegration Tests

We next investigate whether logistics performance, financial development, and financial globalization exhibit evidence of persistent long-run co-movement. Two complementary approaches are used: the residual-based Pedroni tests and the error-correction-based Westerlund tests.

Table 6: Pedroni residual-based panel cointegration tests

Specification	Statistic	Value (p-value)
Panel-specific AR parameter	Modified Phillips–Perron t	3.1649 (0.0008)
Panel-specific AR parameter	Phillips–Perron t	0.6000 (0.2742)
Panel-specific AR parameter	Augmented Dickey–Fuller t	2.3813 (0.0086)
Common AR parameter	Modified variance ratio	−2.1773 (0.0147)
Common AR parameter	Modified Phillips–Perron t	1.8778 (0.0302)
Common AR parameter	Phillips–Perron t	0.4843 (0.3141)
Common AR parameter	Augmented Dickey–Fuller t	2.2812 (0.0113)

Notes: p-values are reported in parentheses below the test statistics. The null hypothesis is no cointegration. Tests include panel means, Bartlett kernel, one Newey–West lag, one augmented lag, no time trend, and cross-sectional means removed.

The Pedroni results provide substantial, although not unanimous, evidence against the null hypothesis of no cointegration. Under the panel-specific AR specification, the modified Phillips–Perron and ADF statistics reject the null, whereas the Phillips–Perron statistic does not. Under the common AR specification, the modified variance ratio, modified Phillips–Perron, and ADF statistics reject the null, while the Phillips–Perron statistic again remains insignificant. Thus, five of the seven reported statistics support a persistent long-run relationship among the variables.

The Westerlund tests provide a complementary assessment based on error-correction behaviour.

Table 7: Westerlund error-correction panel cointegration tests

Statistic	Value (p-value)	Robust p-value
Gt	−19.38 (0.000)	0.000
Ga	−0.47 (1.000)	0.400
Pt	−8.40 (0.960)	0.033
Pa	−0.75 (1.000)	0.033

Notes: p-values are reported in parentheses below the test statistics. The null hypothesis is no cointegration. Robust p-values are based on resampling/bootstrap correction for cross-sectional dependence.

The bootstrap-adjusted Westerlund evidence is again supportive but not uniform. The robust p-value for Gt strongly rejects the null of no cointegration, while Pt and Pa reject at the 5% level. Ga, however, does not reject the null. Thus, three of the four bootstrap-adjusted statistics support the presence of error-correcting long-run dynamics.

Taken jointly, the Pedroni and Westerlund results provide evidence consistent with persistent long-run co-movement among LLPI, LFD, and LFGLOB. Nevertheless, given the mixed unit-root evidence, the presence of common stochastic components, and the interpolated construction of the annual LLPI series, these findings are interpreted as evidence of persistent long-run structural associations rather than as proof of a uniquely identified deterministic equilibrium relationship.

This distinction is important for the remainder of the analysis. The cointegration evidence provides a basis for estimating long-run coefficients, but the strength of the resulting relationships must ultimately be evaluated jointly with estimators that explicitly account for cross-sectional dependence and heterogeneous slopes.

5.4 PMG-ARDL and Long-Run Coefficient Estimates

Following the evidence of persistent long-run co-movement, we estimate a PMG-ARDL specification and compare its long-run coefficients with those obtained from FMOLS and DOLS. The PMG model is reported separately because it also provides information on short-run dynamics and the speed of adjustment.

Table 8: PMG-ARDL(1,0,1) estimates

Component	Coefficient (p-value)
Long-run LFD	0.515 (<0.001)
Long-run LFGLOB	0.967 (<0.001)
Constant	−4.312 (<0.001)
Error-correction term	−0.060 (0.019)
Δ LFGLOB	0.235 (0.319)
D_2013	−0.019 (0.021)
D_2019	−0.016 (0.033)

Notes: p-values are reported in parentheses below coefficients. The dependent variable is Δ LLPI in the short-run equation. The error-correction term measures the annual speed of adjustment toward the estimated long-run relationship.

The PMG-ARDL estimates indicate positive and statistically significant long-run coefficients for both financial development and financial globalization. The estimated long-run elasticity of LLPI with respect to LFD is 0.515, while that associated with LFGLOB is 0.967. These estimates suggest positive baseline long-run associations between both dimensions of finance and logistics performance.

The error-correction coefficient is negative and statistically significant (−0.060; $p = 0.019$), consistent with gradual adjustment following deviations from the estimated long-run relationship. Its magnitude implies an annual adjustment of approximately 6%. The relatively slow estimated adjustment is compatible with the structural nature of logistics capability, although its exact magnitude should not be overinterpreted given the interpolated annual representation of the LPI.

The short-run coefficient for Δ LFGLOB is positive but statistically insignificant. The negative coefficients on the 2013 and 2019 dummy variables are statistically significant, indicating downward shifts in LLPI in those years after controlling for the variables included in the specification. These coefficients should be viewed as controls for period-specific disturbances not as evidence identifying particular causal events.

Table 9 compares the estimated long-run coefficients across FMOLS, DOLS, and PMG-ARDL.

Table 9: Long-run coefficient comparison: FMOLS, DOLS and PMG-ARDL

Estimator	LFD (p-value)	LFGLOB (p-value)
FMOLS	0.0675 (<0.001)	0.1940 (<0.001)
DOLS	0.0637 (0.0026)	0.2002 (<0.001)
PMG-ARDL	0.515 (<0.001)	0.967 (<0.001)

Notes: p-values are reported in parentheses below coefficients. The dependent variable is LLPI. FMOLS and DOLS estimate long-run cointegrating elasticities, while PMG-ARDL reports the long-run coefficients implied by the dynamic ARDL specification.

The three baseline estimators yield a common qualitative result: the estimated long-run coefficients of both LFD and LFGLOB are positive and statistically significant. FMOLS and DOLS produce particularly similar estimates, with LFD coefficients of 0.0675 and 0.0637 and LFGLOB coefficients of 0.1940 and 0.2002, respectively. The PMG-ARDL estimates are substantially larger, reflecting the different dynamic structure and identifying assumptions of that estimator. The PMG coefficients should not, thus, be interpreted as directly interchangeable in magnitude with the FMOLS and DOLS estimates.

Within the baseline specifications, the estimates are consistent with H1 and H2 and indicate positive long-run associations between financial conditions and logistics performance. However, these results should be regarded as baseline evidence rather than definitive robustness evidence. Their stability under estimators that accommodate common factors and heterogeneous slopes is examined explicitly in Section 5.8 below.

5.5 Panel Granger-Predictive Relationships

Table 10 reports the Dumitrescu–Hurlin (2012) heterogeneous panel Granger tests. These tests examine whether past values of one variable contain statistically significant predictive information for another. They do not, by themselves, establish structural causality.

Table 10: Dumitrescu–Hurlin panel Granger-causality tests

Null hypothesis	W-stat	$\bar{Z}$ -stat	$\bar{Z}$ p-value	Conclusion
LFD does not cause LLPI	6.12	10.77	0.000	Reject $\rightarrow$ LFD $\Rightarrow$ LLPI
LLPI does not cause LFD	2.23	2.27	0.023	Reject $\rightarrow$ LLPI $\Rightarrow$ LFD
LFGLOB does not cause LLPI	4.40	7.01	0.000	Reject $\rightarrow$ LFGLOB $\Rightarrow$ LLPI
LLPI does not cause LFGLOB	1.92	1.59	0.113	Do not reject
LFGLOB does not cause LFD	2.23	2.27	0.023	Reject $\rightarrow$ LFGLOB $\Rightarrow$ LFD
LFD does not cause LFGLOB	1.65	0.98	0.325	Do not reject

The results indicate bidirectional Granger-predictive relationships between LFD and LLPI: the null that LFD does not Granger-predict LLPI is rejected, as is the reverse null that LLPI does not Granger-predict LFD. Thus, past domestic financial-development conditions contain predictive information for logistics performance, while past logistics performance also contains predictive information for domestic financial development.

For financial globalization, the pattern is asymmetric. The null that LFGLOB does not Granger-predict LLPI is rejected, whereas the reverse null is not. Similarly, LFGLOB Granger-predicts LFD, while LFD does not Granger-predict LFGLOB. The results therefore indicate temporal precedence running from financial globalization toward both logistics performance and domestic financial development within the information structure of the test.

These findings are compatible with the theoretical channels discussed earlier, according to which international financial integration may precede changes in investment opportunities, access to external finance, technology, and participation in international production networks. However, the Dumitrescu–Hurlin results should not be interpreted as establishing that financial globalization causes logistics development in a structural sense. They establish predictive directionality conditional on the panel specification.

5.6 Panel Quantile Regression Results

Average long-run estimates may conceal substantial heterogeneity across economies at different levels of logistics performance. To examine this possibility, MMQR estimates are obtained at the 20th, 40th, 60th, and 80th conditional quantiles of LLPI.

Table 11: Panel quantile regression estimates (dependent variable: LLPI)

Variable	q0.20 (p-value)	q0.40 (p-value)	q0.60 (p-value)	q0.80 (p-value)
LFD	0.1389 (0.000)	0.1087 (0.000)	0.0567 (0.021)	0.0036 (0.893)
LFGLOB	0.1405 (0.000)	0.1980 (0.000)	0.2974 (0.000)	0.3988 (0.000)
Constant	−0.0868 (0.491)	−0.1657 (0.193)	−0.3021 (0.043)	−0.4414 (0.015)

Notes: p-values are reported in parentheses below coefficients. Quantiles are reported horizontally. The estimates correspond to Method-of-Moments panel quantile regressions.

The quantile estimates reveal a clear contrast between domestic financial development and financial globalization. The coefficient of LFD is positive and statistically significant at q0.20, q0.40, and q0.60, but decreases monotonically from 0.1389 to 0.0567. At q0.80, the coefficient falls to 0.0036 and becomes statistically insignificant. Thus, the positive association between domestic financial development and logistics performance is concentrated primarily in the lower and intermediate parts of the conditional logistics-performance distribution.

One reading of this pattern is that domestic financial conditions may matter more where financing constraints are relatively binding. It does not, however, establish this mechanism directly; rather, financing constraints provide an economically plausible interpretation of the observed quantile pattern.

Financial globalization shows the opposite pattern. Its coefficient is positive and statistically significant at every reported quantile and increases monotonically from 0.1405 at q0.20 to 0.3988 at q0.80. Thus, the association between financial globalization and logistics performance strengthens progressively toward the upper part of the conditional LLPI distribution.

A plausible interpretation is that economies with more advanced logistics capabilities may be better positioned to translate international financial integration into logistics-related benefits through access to cross-border capital, foreign investment, technology, managerial expertise, and global production networks. Again, the quantile results identify heterogeneity in the empirical relationship rather than the specific structural mechanism generating it.

On balance, the MMQR estimates provide clear support for H3: the finance–logistics relationship is not homogeneous across the logistics-performance distribution. Moreover, the two financial dimensions display markedly different distributional profiles, with domestic financial development more strongly associated with lower and intermediate logistics-performance quantiles and financial globalization increasingly associated with higher quantiles.

5.7 Synthesis of Baseline Empirical Findings

The baseline analysis yields several results. First, the cross-sectional dependence tests point to a particular dependence structure which is significant from the point of view of the methods that incorporate regional/global common factors (a pervasive cross-sectional dependence). Second, unit-root tests are inconclusive, while the PANIC decomposition reveals that a large share of the persistence could be related to common stochastic factors.

Third, the Pedroni and Westerlund tests provide evidence of persistent long-run co-movement, although the evidence is not uniform across all statistics.

In this context, FMOLS, DOLS, and PMG-ARDL lead to positive and significant baseline long-run coefficients of financial development and of financial globalization, thus supporting hypotheses H1 and H2 in the baseline estimation.

Fourth, the Dumitrescu-Hurlin results find bidirectional predictive effects between domestic financial development and logistics performance and unidirectional predictive effects running from financial globalization toward LLPI and LFD. These results are about the temporal predictive content and should not be interpreted as structural causal effects. Lastly, the MMQR estimates detect evident distributional heterogeneity; the link between domestic financial development and logistics performance becomes less and less pronounced as the conditional quantile increases and is absent at $q_{0.80}$, while the link between financial globalization and logistics performance keeps steadily stronger as the conditional quantile increases. This pattern supports H3 and indicates that domestic and international finance are systematically associated with logistics performance in different ways.

These results set the empirical benchmark picture. But we cannot evaluate their robustness on the basis of the baseline estimators. This is especially relevant in light of the strong cross-section dependence revealed by Table 3 and the common stochastic components detected by PANIC. Hence, baseline relationships are tested using more demanding estimators in the next sub-section.

5.8 Robustness to Cross-Sectional Dependence and Slope Heterogeneity

The sensitivity analysis examines whether the positive baseline associations survive under alternative estimators designed to accommodate cross-sectional dependence, unobserved common factors, and heterogeneous slopes more flexibly. Table 12 reports results from Driscoll–Kraay, CCEMG/CCE-MG, AMG, and CS-ARDL specifications.

Table 12: Robustness estimates under cross-sectional dependence and heterogeneity

Estimator	LFD (p-value)	LFGLOB (p-value)
Driscoll–Kraay	0.008 (0.917)	0.059 (0.574)
CCEMG / CCE-MG	0.053 (0.472)	0.532 (0.004)
AMG	0.046 (0.544)	0.507 (0.001)
CS-ARDL	0.093 (0.825)	0.081 (0.819)

Notes: p-values are reported in parentheses below coefficients. Driscoll–Kraay estimates use two-way fixed effects with robust standard errors (Driscoll & Kraay, 1998). CCEMG/CCE-MG augments country-specific regressions with cross-sectional averages (Pesaran, 2006). AMG accounts for unobserved common dynamic processes (Eberhardt & Teal, 2010). CS-ARDL reports long-run coefficients from a cross-sectionally augmented ARDL specification (Chudik & Pesaran, 2015).

The sensitivity results materially qualify the baseline estimates. Under the Driscoll–Kraay specification, both LFD and LFGLOB retain positive coefficients, but neither is statistically significant. More importantly, the heterogeneous common-factor estimators reveal a clear distinction between the two financial variables. Under CCEMG, LFGLOB remains positive and statistically significant (0.532; $p = 0.004$), whereas LFD is insignificant (0.053; $p = 0.472$). The AMG results are very similar: LFGLOB remains positive and significant (0.507; $p = 0.001$), while LFD remains insignificant (0.046; $p = 0.544$).

The CS-ARDL specification provides a more demanding test in a dynamic heterogeneous framework. Both coefficients remain positive but are statistically insignificant: 0.093 ($p = 0.825$) for LFD and 0.081 ($p = 0.819$) for LFGLOB. Given the relatively short time dimension of the panel, the CS-ARDL estimates should be interpreted cautiously, since dynamic heterogeneous estimators with cross-sectional augmentation can be demanding in samples with limited T . Nevertheless, the loss of statistical significance is substantive evidence and should not be dismissed solely as a small-sample phenomenon.

Table 12 thus should not be read as showing that the robustness estimators uniformly confirm the baseline findings. Rather, they qualify them in an economically informative way. The positive relationship between domestic financial development and logistics performance is clearly specification-sensitive: LFD is statistically insignificant under all four alternative estimators. In this setting, H1 receives support from the baseline FMOLS, DOLS, PMG-ARDL, and lower/intermediate quantile estimates, but it does not receive robust support once common factors and heterogeneous slopes are accommodated more flexibly.

Financial globalization is supported more consistently. Although LFGLOB becomes insignificant under Driscoll–Kraay and CS-ARDL, it remains positive and highly significant under both CCEMG and AMG—the two specifications specifically designed to accommodate unobserved common factors together with heterogeneous country-specific slopes. H2 should thus be interpreted as receiving strong baseline but qualified robustness support, rather than universal support across specifications.

This distinction is important for interpreting the results. Domestic financial development appears to be better characterized as a conditional or enabling financial factor whose empirical association with logistics performance depends on the specification and the position in the logistics-performance distribution. By contrast, financial globalization displays a comparatively more persistent association, particularly when heterogeneous responses to common factors are explicitly allowed. Nevertheless, because it also loses significance in two of the four robustness specifications, its relationship with logistics performance should not be described as universally robust.

The sensitivity analysis thus strengthens the interpretation of the finance–logistics nexus as heterogeneous and estimator-sensitive rather than uniform. This conclusion is consistent with the MMQR evidence: domestic financial development matters primarily in the lower and intermediate parts of the logistics-performance distribution, while financial globalization shows a stronger association toward the upper part. Viewed together, the findings indicate that the two dimensions of finance should not be treated as interchangeable determinants of logistics performance.

Finally, these results reinforce the need for caution arising from the construction of the annual LPI series. Neither the baseline nor the robustness estimators can completely eliminate the limitations associated with interpolating a periodically observed survey indicator. The credibility of the evidence thus rests not on any single coefficient or specification, but on the broader pattern across complementary methods. Within that pattern, the most defensible conclusion is that financial globalization exhibits a comparatively stronger association with logistics performance, whereas the relationship with domestic financial development is substantially more conditional and specification-sensitive.

6. Discussion

The results contribute importantly to the literature on logistics performance in that they shift the emphasis away from the determinants and outcomes of logistics performance that have been traditionally studied to the financial circumstances linked to logistics development. Taken together, the results point to the relevance of finance to logistics performance in Mediterranean economies and imply that the relationship is far more complex than a positive finance-logistics link alone. In particular, the stability of the estimates and the pattern across the conditional distribution differ between domestic financial development and financial globalization.

The first major finding is on the estimated relationships of financial development and financial globalization with logistics performance. The long-run baseline estimates from FMOLS, DOLS, and the PMG-ARDL models reveal that there are positive and significant associations of financial development and financial globalization with logistics performance. These associations are consistent with the finance-growth literature, in which developed financial systems are expected to build up savings, allocate capital efficiently, alleviate financing constraints, and promote productive investments (Beck et al., 2000; Levine, 2005). These effects are particularly relevant to logistics investment, which is capital intensive that spends heavily on transport infrastructure, warehousing, tracking technology, digitalization, and supply-chain modernization.

Therefore, the baseline results argue in favor of the hypothesis that financial sector development domestically can promote logistics upgrading. However, the robustness analysis greatly moderates this argument. In all cases with more flexible error structures to account for cross-sectional dependence, unobserved common factors and heterogeneous country responses, the coefficient of domestic financial development does not turn out to be significantly different from zero.

Domestic financial development is statistically insignificant in Driscoll-Kraay, CCEMG, AMG and CS-ARDL models alike.

The fact that domestic financial development is insignificant across all robustness specifications suggests that it is premature to label it as an independent force behind logistics performance.

A more prudent view is that domestic financial development represents an enabling condition whose importance depends on the general economic or structural conditions (economic size, openness, cost of technology adoption, human capital, etc.). Stronger financial sectors will increase the availability of capital or relaxation of financial frictions, but these benefits do not necessarily translate into improvements in the country's logistics capabilities. Such effects are likely to be mediated by the financial capital allocation choices, the quality of investment climate, infrastructure investments and planning, and the ability of each country's firms to translate finance into logistics infrastructure investment. Such an explanation may help account for the difference between the baseline coefficients and specifications that more explicitly control for common factors and cross-country heterogeneity.

The MMQR results support this reasoning. The positive relationship between domestic financial development and logistics performance is stronger at the lowest quantiles, diminishing sequentially over the distribution and losing statistical significance in the 80th percentile. Taken together, the results do not indicate that this factor plays an equally important role across all Mediterranean economies.

Instead, they suggest that financial development appears more important for Mediterranean economies that are at the lowest or the intermediate parts of the conditional logistics performance distribution, where financing constraints could be an obstacle to logistics investment and where improvements in financial development would be more relevant.

Although the empirical analysis does not directly confirm this interpretation, the distribution pattern of the results suggests this.

The evidence for financial globalization is somewhat different. Financial globalization is positive and statistically significant in all three baseline long-run estimators and in all four quantiles. Additionally, in contrast to domestic financial development, the estimated relationship for financial globalization monotonically increases as we move up the quantiles in the distribution of logistics performance. This is consistent with some of the literature which argues that international financial integration not only provides access to international capital, but also to foreign investment, technology, managerial know-how, and global production (Bekaert et al., 2005; Lane and Milesi-Ferretti, 2007; Kose et al., 2009).

The robustness evidence, on the other hand, must be taken with the same level of precision. Financial globalization was positive and statistically significant in the common correlated effects mean group (CCEMG) and augmented mean group (AMG) estimation, though it becomes insignificant under Driscoll-Kraay and cross-sectional autoregressive distributed lag (CS-ARDL) techniques, therefore the across-the-board characterisation seems unwarranted. Given the relatively better support for financial globalization than for domestic financial development comes from the heterogeneous common-factor estimators (CCEMG and AMG), this difference does not seem trivial, since these models allow the relationship to differ across countries while controlling for unobserved common factors - characteristics arguably appropriate given the high cross-sectional dependence observed for the Mediterranean sample. But the insignificance of the estimations under the Driscoll-Kraay and CS-ARDL also indicates that the size and significance of the relationship may change with model specification.

Another perspective can be offered based on the increasing coefficient of financial globalization (LFGLOB) along the conditional logistics-performance distribution. Especially, countries with more developed logistics could have greater absorptive capacity to utilize the advantages of international financial integration. Existing infrastructure, technology, internationally integrated firms, and participation in global value chains could raise the productivity of foreign capital and knowledge in these economies.

However, the potential benefits of international financial integration may not be realized to the same extent if solely relying on access to international finance without complementary domestic capabilities.

It can be interpreted as consistent with the general idea proposed by Kose et al. (2009) that the gains of financial globalization may be contingent on domestic conditions.

A final and perhaps the most interesting result is the quite different quantile pattern displayed by the two variables of domestic financial development (LFD) and financial globalization (LFGLOB). While domestic financial development is more strongly related to logistics performance for the lower and intermediate quantiles, the opposite pattern applies to financial globalization for the upper part of the distribution. This is an important clue indicating that these two aspects of finance are not substitutes but complements. While domestic financial strength can be more critical where financial access is constrained, international financial integration can be more critical once the complementary capabilities needed to fully capitalize on the opportunities provided by international capital, information, and production networks are available.

The Dumitrescu-Hurlin tests add a time-lag component to this picture. Domestic financial development and logistics performance still Granger-predict each other in either direction - that is, past values of each variable contain information about future values of the other, on average. This pattern is consistent with a potentially mutually reinforcing process: the development of financial and logistics conditions may foreshadow logistics investment and trade growth, investment opportunities and the subsequent demand for financial products and services. However, this test is not specifically designed to detect these mechanisms and should not be used to establish structural causality.

By contrast, the case for financial globalization displays a different temporal ordering. Financial globalization (LFGLOB) Granger-predicts logistics performance (LLPI) and domestic financial development (LFD) and the reverse equations do not provide statistically significant evidence. This temporal asymmetry is consistent with the view that international financial integration is likely to change before domestic financial and logistics conditions change. However, the finding establishes "predictive precedence" rather than the causal relationship of financial globalization as an exogenous or structural determinant of logistics development (especially in a regional panel in which countries are exposed to a set of common global and regional shocks).

Another notable result is the presence of common factors. The cross-sectional dependence tests and the PANIC decomposition both indicate that the variables are substantially driven by common factors. From an economic point of view, this is quite reasonable for a set of Mediterranean countries which have experienced multiple systemic financial, trade, geopolitical, and supply-chain shocks simultaneously during the entire sample period.

It may also help explain the differences between the results under the use of either the conventional or the homogeneous estimators when they exclude common factors and heterogeneous responses in our entire framework.

In this respect, differences between the baseline and robustness estimates should not simply be perceived as conflicting results, since part of the finance-logistics nexus may be driven by common regional or global factors and countries react heterogeneously to those factors.

The results must also be interpreted taking into account the way in which the logistics variable was constructed. The World Bank's LPI is only available at the time of sample survey rounds, so that interpolation has been used to approximate annual movements between observed reference points. As elaborated in Sections 3 and 4, such an approach is consistent with the medium- and long-run nature of the relationships studied in this paper, yet it smooths both the series of LLPI and possibly the evidence of persistence. Thus, neither the unit-root test nor the cointegration analysis is completely detached from this feature of the data.

More importantly, the paper does not consider interpolated observations as additional independent data points of logistics performance, nor is the analysis based only on the persistence assumption to identify the finance-logistics link. Instead, the interpretation is based on the convergence of evidence from the cross-sectional dependence tests, the second-generation unit-root procedures, the PANIC decomposition, the two panel cointegration techniques, alternative estimators of the long run relation, the heterogeneous Granger-predictive tests, the quantile regressions, and the robustness estimators incorporating common factors and

the slope heterogeneity. The convergence of several of these approaches toward similar qualitative patterns substantiates the presence of persistent medium- and long-run relationships between the variables, while the differences across the estimators define the uncertainty around the interpretation of such relationships. To sum up, we find three main substantive findings: the evidence indicates that domestic financial development is not unambiguously a factor for logistics performance (the association is economically significant in baseline models and for lower-and-intermediate quantiles but loses significance for robust estimators, indicating that the result is specification-sensitive); financial globalization receives comparatively stronger empirical support; quantile estimation results suggest the importance of domestic vs international finance depends on logistics performance.

Unlike the existing research, however, these results contribute to the empirical literature by suggesting that the finance-logistics relationship is poorly captured by a homogeneous, single average effect. For Mediterranean economies it would therefore not be sufficient to ask 'does finance matter' for logistics performance, but more specifically 'which dimension of finance' is conducive to logistics strengths, 'at what level of logistics performance'. This refined focus is used to guide the policy implications which follow in the last section of the paper.

7. Conclusion, policy implications, limitations and future research

This paper assesses the relationships among logistics performance, domestic financial development, and financial globalization in 19 Mediterranean countries over 2007-2022. Using second-generation panel methods, long-run estimators, heterogeneous Granger-predictive tests, quantile regression, and alternative estimators assuming the existence of cross-sectional dependence and slope heterogeneity, the paper examines whether financial factors are systematically related to logistics performance and under which circumstances.

The results point to a heterogeneous finance-logistics nexus rather than a uniform one. The baseline FMOLS, DOLS and PMG-ARDL estimates show significant positive long-run relationships linking domestic financial development and financial globalization to logistics performance. The panel cointegration tests show evidence of a long-run co-movement among the variables, although the evidence is not uniform across all test statistics. These baseline results suggest a positive long-run association between financial conditions and logistics capability.

However, there are key qualifications added to the baseline results from the robustness analysis. Domestic financial development is not statistically significant in any of the four alternative specifications (Driscoll-Kraay, CCEMG, AMG and CS-ARDL) controlling for different forms of cross-sectional dependence, common factors and heterogeneous country-specific reactions. Financial globalization receives comparatively stronger support; the estimated coefficient of financial globalization is positively signed and significant at 1% level when controlling for common factors and heterogeneous countries' reactions (CCEMG and AMG), but it turns to insignificant when allowing for cross sectional dependence under alternative treatments of cross-sectional dependence (Driscoll-Kraay and CS-ARDL). The summary conclusion is that neither financial dimension is uniformly robust across all specifications, though evidence of financial globalization is relatively more robust and the result for domestic financial development is more sensitive to the regressions.

Quantile evidence further sharpens this picture. The MMQR estimates for domestic financial development imply a positive and significant association on logistics performance at the lower and median quantiles but show the magnitude gradually diminishing as the conditional quantile increases and becoming statistically insignificant at the upper end of the conditional distribution. Financial globalization, on the other hand, shows the opposite pattern, with its coefficient positive and significant throughout the entire conditional distribution and an increase in its magnitude as we move towards the upper quantiles.

The Dumitrescu-Hurlin tests further contribute to understanding of the temporal ordering. Domestic finance and logistics performance are found to have bidirectional Granger-predictive relationships, while financial globalization Granger-predicts logistics performance and domestic finance but has no statistically significant reverse relationships. The results are consistent with the presence of feedback channels between

domestic financial and logistics development and are suggestive of a role for international financial integration in time, but should not be read as evidence of a structural causal relationship.

Policy Implications

Several policy implications follow from these findings, although these should be interpreted in light of the heterogeneity and estimator sensitivity documented in the empirical analysis. First, strengthening domestic financial systems may contribute to an environment that facilitates logistics investment, particularly in economies located in the lower and intermediate parts of the logistics-performance distribution. Policies that improve access to finance, financial intermediation, and the allocation of capital toward productive investment may thus complement efforts to improve logistics capability.

At the same time, the robustness results indicate that domestic financial development alone should not be expected to generate automatic improvements in logistics performance. A deeper financial system may provide financing capacity, but its contribution to logistics upgrading is likely to depend on whether financial resources are effectively channelled toward productive infrastructure, warehousing, digitalization, transport services, and supply-chain modernization. Domestic financial development should thus be viewed primarily as an enabling condition that operates alongside broader institutional, infrastructural, and productive capabilities.

Second, the somewhat stronger evidence of financial globalization indicates that international financial integration may be one of several ways through which logistics upgrading can be supported. By enabling international capital flows, foreign direct investment may lead to increased investment in logistics infrastructure and technology, while at the same time enabling managerial transfer and deeper participation in international production networks. That LFGLOB is statistically insignificant under some of the robustness specifications warns against reading the finding of financial openness as a sufficient condition of improved logistics performance. Such a transition might depend on domestic absorptive capacity and other economic prerequisites.

Third, the strong quantile heterogeneity suggests that a common policy stance across Mediterranean economies might not be optimal. Weaker transportation and logistics performance may suggest the need for policies that relax domestic financing constraints and expand the availability of investment finance. More advanced logistics and transportation systems may enhance the ability of Mediterranean economies to make the most of international financial integration - getting access to foreign resources, technologies, managerial expertise and global value chains. The policy importance of domestic and international finance, then, seems to depend upon the prevailing logistics status.

Finally, the large cross-sectional dependence shows that the analysis of country-level logistics and financial indicators should account for regional and global developments, since common shocks, financial conditions, trade disruptions and internationally linked developments of the supply chain may affect more than one Mediterranean economy. This reinforces the argument for the use of domestic reforms along with regional cooperation in the fields of connectivity in transport and trade, investment environment and logistics and supply-chain resilience.

Limitations and Future Research

Several limitations should be acknowledged. The most important concerns the frequency of the Logistics Performance Index. The World Bank LPI is survey based and observed only in periodic survey rounds rather than annually. To construct an annual panel consistent with the study's medium- and long-run focus, values between observed survey benchmarks are interpolated. This procedure provides a continuous approximation of the trajectory between observed LPI values but does not create additional independently observed information.

Interpolation necessarily smooths the series and may contribute mechanically to measured persistence. Consequently, the unit-root, cointegration, and dynamic results should not be interpreted as evidence of short-run annual movements in logistics performance. The conclusions of this study refer instead to medium- and long-run structural associations. The use of multiple complementary procedures—including second-generation unit-root tests, PANIC decomposition, two panel cointegration approaches, alternative

long-run estimators, MMQR, and common-factor robustness estimators—helps assess whether the principal empirical patterns are sensitive to alternative econometric assumptions, but it does not eliminate the underlying data-frequency limitation.

A second limitation concerns the relatively short time dimension of the panel. Although the annualized dataset provides 16 observations per country, some of the more demanding heterogeneous dynamic estimators, particularly CS-ARDL, can be sensitive in panels with limited T. The corresponding estimates should therefore be interpreted together with, rather than independently of, the broader set of results.

Third, the composite financial-development and financial-globalization indices are appropriate for capturing broad financial conditions but do not identify the specific channels through which finance may be associated with logistics performance. Future research could distinguish among banking-sector development, capital-market development, access to credit, foreign direct investment, portfolio flows, and other dimensions of international financial integration. Such disaggregation could help identify which components of domestic and international finance are most closely associated with particular dimensions of logistics capability.

Future research could also examine the individual components of the LPI rather than the aggregate index. Customs efficiency, infrastructure quality, international shipments, logistics competence, tracking and tracing, and timeliness may respond differently to domestic and international financial conditions. This would allow a more detailed examination of the mechanisms underlying the aggregate relationships identified in this study.

Another extension would be to investigate explicitly the role of institutional and structural conditions. The present findings, particularly the sensitivity of domestic financial development and the stronger association of financial globalization at higher logistics quantiles, suggest that governance quality, regulatory effectiveness, economic complexity, technological capacity, or other dimensions of absorptive capacity may condition the finance–logistics relationship. Interaction models or threshold approaches could provide a useful framework for examining these mechanisms.

Finally, future studies could compare the Mediterranean experience with other regional groups and, where sufficiently long series of directly observed logistics indicators become available, reassess the relationships without the need to interpolate between survey rounds. Such extensions would help determine whether the heterogeneity documented here is specific to the Mediterranean setting or reflects a more general feature of the relationship between financial conditions and logistics development.

On balance, the study indicates that the relationship between finance and logistics performance in Mediterranean economies is persistent but heterogeneous and estimator-sensitive. Domestic financial development appears to function primarily as a conditional enabling factor, with its strongest association observed among lower- and intermediate-performing logistics systems. Financial globalization exhibits a comparatively stronger association, particularly among economies at higher levels of logistics performance, although this relationship is not invariant across specifications. These findings suggest that understanding logistics development requires attention not only to infrastructure, trade, and institutional conditions, but also to the different ways in which domestic and international financial environments interact with countries' existing logistics capabilities.

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