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Factors Associated with Labor Productivity in Central and Eastern Europe and the MENA Region

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Abstract: This study examines within-country associations between institutional quality, human capital, demographic structure, resource dependence, and labor productivity in 11 Central and Eastern European and MENA countries. The descriptive dataset covers 2010–2022, while the principal first-difference model uses observations for 2011–2021 because oil-rent data end in 2021. The analysis applies year fixed effects and country-clustered standard errors, supplemented by lagged first-difference, regional interaction, variable exclusion, and sensitivity specifications. Annual changes in the aggregate Worldwide Governance Indicators measure are not significantly associated with changes in labor productivity. None of the six governance dimensions remains significant after adjustment for multiple testing. The Human Capital Index is also insignificant in an auxiliary specification based on 44 observations from four non-consecutive years. The young dependency ratio is positively associated with productivity changes in the principal model, but its significance is specification-sensitive. Oil rents show only a marginal positive association in the principal model and no robust association across alternative specifications. The complete MENA association for the young dependency ratio is positive at the 5% level but highly sensitive to sample composition, while the complete oil-rent association is statistically insignificant. The findings are interpreted as conditional associations rather than causal effects. Economic resilience serves as an interpretative framework, not a directly estimated outcome.

Keywords: labor productivity; human capital; institutional quality; panel data; Central and Eastern Europe and MENA region .

JEL classification: O47; J24; O43; C23.

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1. INTRODUCTION

Labor productivity plays a central role in economic growth, international competitiveness, living standards, and the capacity of economies to withstand adverse shocks. Its importance has become increasingly evident amid recurrent financial disruptions, the COVID-19 pandemic, geopolitical instability, energy market volatility, inflationary pressures, and ongoing changes in employment and production structures. A recent global survey across 107 countries identifies economic concerns, including living standards, prices, and wages, as the most frequently reported national problems (Gallup, 2026). Examining the factors associated with labor-productivity dynamics is therefore relevant not only to long-term development but also to an economy's ability to absorb disruptions, adjust to changing conditions, and restore productive activity.

Economic resilience is used in this paper as an interpretative framework rather than as a directly measured outcome. Labor productivity represents one element of the productive capacity that can support an economy during periods of instability. However, resilience involves more than the contemporaneous movement of GDP per employed person. It also concerns the ability to absorb an initial shock, reorganize economic activity, adapt institutions and labor markets, and undertake longer-term structural transformation. This understanding is consistent with research that links productivity, productive capacity, regional adaptation, and recovery, while distinguishing resilience from a simple return to a pre-crisis state (Giannakis and Mamuneas, 2022; Tsvetkova, 2024; Capoani *et al.*, 2025). The empirical analysis, therefore, focuses directly on labor productivity, while resilience provides a broader framework for interpreting the structural relevance of the results.

Human capital and institutional quality are commonly viewed as important foundations of productive capacity. Education, health, workforce skills, government effectiveness, regulatory quality, political stability, the rule of law, and control of corruption may shape productivity through investment, innovation, technological adoption, labor market performance, and resource allocation. However, the empirical relationship between these factors and productivity depends strongly on the type of variation used in the analysis. Cross-country comparisons may largely reflect persistent historical and structural differences, whereas fixed-effects and first-difference models identify relationships by focusing on changes within countries over time. This distinction is particularly important for institutional and human-capital indicators, which often change slowly and may display little annual variation even when their long-term economic relevance is substantial (Abdelgany and Saleh, 2022; Aizenman and Saadaoui, 2026).

The contrast between Central and Eastern Europe and the Middle East and North Africa provides a useful setting for examining this issue. The selected CEE countries are post-socialist economies that have experienced market integration, technological catch-up, migration, demographic aging, and substantial changes in their sectoral structures. The selected MENA countries include both highly resource-dependent and more diversified economies, with varying levels of labor-market informality, demographic pressure, institutional capacity, and exposure to developments in global energy markets. These regions do not constitute a homogeneous economic space, nor is the comparison intended to imply that they follow a common development model. Rather, their differences provide a deliberately heterogeneous context for assessing whether similar productivity relationships can be observed under contrasting institutional, demographic, and resource conditions.

Both regional groups have nevertheless been exposed to common external shocks, including the global financial crisis, the European sovereign debt crisis, the COVID-19 pandemic, energy price fluctuations, and recent geopolitical instability. Their ability to adjust to these shocks has depended on productive structures, institutional capacity, economic diversification, labor-market conditions, and exposure to individual sectors (World Bank, 2024b). Comparing the selected CEE and MENA countries, therefore, makes it possible to investigate whether within-country productivity associations differ across regional contexts without assuming that the regions themselves are internally uniform.

Although the literature on labor productivity, human capital, institutions, demographic change, and resource dependence is extensive, several methodological and empirical issues remain unresolved. These factors are frequently analyzed in isolation or in broad cross-country samples, where persistent differences between countries may be difficult to distinguish from changes occurring within them. The limited annual variation in governance and human capital indicators can further complicate their interpretation in fixed-effects models. Regional interaction terms are also sometimes discussed as though they represented the complete effect within a particular group, even though the relevant effect is the sum of the main and interaction coefficients. An additional concern arises when an explanatory variable overlaps definitionally with the dependent variable. In the present case, GDP per capita and labor productivity (GDP per employed person) both contain GDP in the numerator, creating a partially mechanical relationship that may influence model fit and the estimated coefficients of the remaining variables.

The empirical analysis covers 11 countries and uses several variable-specific balanced subsamples to reflect differences in the temporal availability of the indicators. The compiled descriptive dataset covers 2010–2022. The starting year provides a common post-global-financial-crisis reference point for the selected countries, supports consistent coverage of the core indicators, and coincides with the earliest Human Capital Index observation used in the analysis. The period captures the aftermath of the global financial and European sovereign debt crises, the COVID-19 shock, the initial post-pandemic recovery, and the onset of the geopolitical and energy market disruptions of 2022.

The endpoint of the study was determined by the latest common availability of consistently defined observations in the World Bank data extracted on 2 February 2026. At that date, labor productivity, the aggregate Worldwide Governance Indicators measure, the young dependency ratio, and GDP per capita were available for all 11 countries through 2022. Oil-rent observations were available only through 2021, while the Human Capital Index was available only for 2010, 2017, 2018, and 2020. Consequently, 2022 represents the final year of the descriptive dataset rather than the end year of every econometric specification. The principal first-difference model covers 2011–2021 because it requires oil-rent observations, whereas the HCI analysis is conducted separately using the four available benchmark years. Extending the common estimation window to 2023–2025 would not have yielded a consistently defined and directly comparable panel for the full set of variables used in the study as of the data-extraction date.

The purpose of the paper is to examine the conditional within-country associations between institutional quality, demographic structure, resource dependence, and labor productivity in the selected CEE and MENA countries, while assessing human capital in an auxiliary specification. The analysis considers whether annual changes in institutional quality, the young dependency ratio, and oil rents are associated with annual changes in

labor productivity. It also evaluates whether the observed relationships remain similar in alternative first-difference specifications using one-year-lagged changes and a variable-exclusion sensitivity check. Regional heterogeneity in the associations involving demographic structure and resource dependence is examined by calculating the complete effects for the MENA group rather than interpreting interaction coefficients in isolation. Human capital is assessed separately in the auxiliary HCI specification.

The paper contributes to the literature by bringing institutional, demographic, resource-related, and human-capital factors into a common comparative framework while maintaining a clear distinction between short-run within-country dynamics and persistent structural differences across countries. The empirical design responds to the unit-root indication for log labor productivity by using a first-difference model as the principal specification. Alternative first-difference specifications using lagged annual changes and a variable-exclusion check are employed to assess the sensitivity of the results while avoiding long-run interpretations of variables expressed in levels. Residual cross-sectional dependence is examined explicitly in each specification. GDP per capita is excluded from the regression specifications used for substantive inference because of its definitional overlap with GDP per employed person. It is retained only in the descriptive, correlation, and preliminary multicollinearity analyses.

The treatment of regional heterogeneity also differs from approaches that rely only on the statistical significance of interaction coefficients. The effects for the MENA group are calculated as linear combinations of the relevant main and interaction terms and are evaluated using the corresponding standard errors and p-values. Separate regional estimates and leave-one-country-out checks are used to assess whether the findings depend excessively on the small number or identity of the countries in each group.

The analysis also clarifies the role of economic resilience in the paper. Labor productivity is the direct empirical outcome, whereas resilience is not estimated as a separate dependent variable. The concept is used to distinguish the short-run relationships examined econometrically from the longer-term structural channels through which institutions, human capital, demographic conditions, productive structures, and resource allocation may shape economies' capacity to adapt to shocks.

The empirical strategy is designed to assess the robustness of conditional associations rather than to establish causal effects. The first-difference model forms the principal specification, while lagged first-difference and variable-exclusion models provide complementary checks. The Human Capital Index is analyzed only in auxiliary specifications due to its sparse, non-consecutive temporal coverage. Lagged variables improve temporal ordering but do not eliminate potential feedback effects, measurement error, or omitted time-varying factors. The estimated coefficients are therefore interpreted as associative rather than causal.

The remainder of the paper is organized as follows. Section 2 reviews the literature on human capital, institutional quality, labor productivity, regional economic structures, and economic resilience. Section 3 describes the data, variables, econometric specifications, and estimation strategy. Section 4 presents the principal results and robustness checks, including the analysis of regional heterogeneity. Section 5 discusses the findings and their policy implications within the economic-resilience framework. Section 6 summarizes the study's contribution, its main limitations, and directions for future research.

2. LITERATURE REVIEW

Human capital, institutional quality, and productive capacity are closely interconnected in shaping labor-productivity dynamics and economies' responses to shocks. Education, health, workforce skills, and technological capabilities influence the efficiency with which labor and capital are used. At the same time, institutional conditions affect investment, innovation, resource allocation, and the implementation of economic policy (Abdelgany and Saleh, 2022). Labor productivity is also closely related to economic resilience because stronger productive capacity can support the absorption of shocks, structural adaptation, and subsequent recovery (Giannakis and Mamuneas, 2022). These relationships are particularly complex in the CEE and MENA regions, where demographic pressures, resource dependence, institutional capacity, technological upgrading, and macroeconomic instability combine in different ways (Haque and Tausif, 2025; Aizenman and Saadaoui, 2026).

2.1 Human capital and labor productivity

Human-capital theory and endogenous growth models treat education, health, skills, and learning capacity as forms of productive investment that can influence workers' efficiency and an economy's capacity to generate and absorb knowledge (Becker, 1964; Lucas, 1988). Recent research generally conceptualizes human capital as a multidimensional construct encompassing education, professional skills, health status, and learning capacity, which jointly shape long-term productive potential (Abdelgany and Saleh, 2022; Javed, 2025; Magida *et al.*, 2025).

Macroeconomic studies generally identify a positive association between human capital development and labor productivity, while emphasizing that the magnitude depends on the economic, institutional, and demographic context (Abdelgany and Saleh, 2022; Javed, 2025; Magida *et al.*, 2025). In particular, evidence from different country groups indicates that the effectiveness of human capital investment – particularly public expenditure on health – depends substantially on economic development and demographic conditions (Magida *et al.*, 2025).

Education occupies a prominent position in the empirical literature on human capital. Systematic reviews and cross-country panel studies associate educational development with higher labor productivity, knowledge accumulation, and positive externalities that may support sustainable growth in both advanced and developing economies (Kokkinopoulou *et al.*, 2026). This conclusion is consistent with Abdelgany and Saleh (2022), who find that the educational component of human capital generally has a stronger association with labor productivity than the health component.

Cross-country evidence also points to complementarities between human capital and other conditions of economic development. In particular, Javed (2025)'s findings suggest that the positive association between human capital and labor productivity strengthens with financial development and rising foreign direct investment, highlighting the complementarity between human capital and the financial and institutional conditions for economic growth.

Micro-level evidence is broadly consistent with the macroeconomic literature. Firm-level studies report positive associations between labor productivity, employee education,

investment in professional training, and the development of human resource management practices. Workforce age composition may also be associated with differences in productivity outcomes (Subramony *et al.*, 2022; Naz *et al.*, 2025).

A distinct strand of contemporary research emphasizes the interrelationship between human capital, digital transformation, and labor productivity. Evidence from the corporate sector suggests that digital development is associated with higher labor productivity both directly and indirectly through improvements in human capital, particularly digital competencies and organizational learning capacity (Song *et al.*, 2025).

Theoretical syntheses and regional empirical studies also emphasize the potentially endogenous relationship between human capital and labor productivity. Cross-country differences and catch-up development processes are associated with the pace of knowledge accumulation, investment in human capital, and qualitative aspects of learning capacity (Hamrouni, 2022; Pürhani *et al.*, 2022). More productive economies may have greater fiscal and institutional capacity to invest in education, health, and workforce development, while improvements in human capital may in turn support subsequent productivity growth. As shown by Bils and Klenow (2000), the observed relationship between schooling and economic growth may reflect both the contribution of education to productive performance and the effect of expected economic development on investment in education. This two-way relationship complicates causal interpretation in observational cross-country and panel studies.

A limited body of Ukrainian research provides context-specific evidence on human capital development amid digital transformation and wartime disruption. These studies emphasize changes in workforce skills, investment priorities, professional development, and the preservation of productive capabilities during a severe external shock. They are used here as illustrative evidence of human-capital adaptation under exceptional conditions rather than as a direct empirical foundation for the CEE–MENA sample (Bykova *et al.*, 2023; Fedorova and Momot, 2023; Kravchenko and Tkachuk, 2024).

The empirical literature employs a variety of human-capital measures, including educational attainment, mean years of schooling, enrollment and completion rates, health expenditure, life expectancy, professional training, and digital-skills indicators (Abdelgany and Saleh, 2022; Magida *et al.*, 2025; Naz *et al.*, 2025; Song *et al.*, 2025). These measures are not interchangeable: some capture accumulated educational stocks, others reflect current investment, health conditions, or firm-specific capabilities. Consequently, alternative proxies may produce different estimates from the Human Capital Index, particularly in short panels where HCI observations are sparse.

The literature therefore provides substantial evidence of an association between human capital and labor productivity, but also shows that its magnitude, timing, and direction depend on the selected measure, level of analysis, complementary financial and institutional conditions, and the possibility of reverse causality. These qualifications are particularly relevant to the present study because the Human Capital Index is available for only four non-consecutive years, provides limited within-country temporal variation, and is consequently examined only in an auxiliary specification.

2.2 Labor productivity and economic resilience

Economic resilience describes the capacity of an economy to withstand adverse shocks, limit the resulting losses in output and employment, adjust its structures and resource allocation, and, where necessary, develop a new growth trajectory. It is therefore broader than the restoration of pre-crisis indicators. The concept encompasses absorptive capacity, reflected in the ability to resist or contain the initial effects of a shock; adaptive capacity, which concerns the reallocation of labor, capital, and production in response to changed conditions; and transformative capacity, understood as the ability to renew institutions, technologies, and economic structures when a return to the previous development path is neither feasible nor desirable (Giannakis and Mamuneas, 2022; Capoani *et al.*, 2025; Sutton *et al.*, 2025).

Labor productivity is relevant to these dimensions but should not be equated with resilience itself. A higher level of output per employed person may provide firms, households, and governments with greater resources to maintain economic activity, finance adjustment, and support subsequent investment. The preservation or restoration of productivity indicates whether an economy has retained important productive capabilities after a shock. Resilience, nevertheless, depends on a broader set of conditions, including sectoral diversification, institutional capacity, labor-market flexibility, financial stability, infrastructure, trade relationships, and the distribution of productive resources. Labor productivity is therefore treated as one component of productive capacity rather than as a comprehensive measure of economic resilience.

Regional evidence shows that pre-existing economic structures strongly condition the capacity to maintain or restore productive activity. Research on European regions associates stronger productivity dynamics and denser intersectoral linkages with smaller crisis-related losses and more sustained recovery. Sectoral concentration, by contrast, may increase exposure to industry-specific disturbances and produce markedly different adjustment paths across territories (Giannakis and Mamuneas, 2022; Giannakis *et al.*, 2024). These findings support a place-sensitive understanding of resilience, as similar shocks can yield different outcomes depending on the productive structure and institutional environment of each region.

The relationship between productivity and resilience extends beyond the immediate recovery phase. Evidence covering European regions over several decades indicates that regions with higher pre-recession productivity generally experienced smaller employment losses and were more likely to return to their previous employment trajectories. However, the pattern was less pronounced during the COVID-19 crisis (Tsvetkova, 2024). Productivity in this context reflects not only short-term efficiency but also accumulated technological, organizational, and human capabilities that support adjustment over time.

Sutton *et al.* (2025) emphasize the path-dependent character of recovery. Their discussion of hysteresis and homeorhesis suggests that a major disturbance may leave persistent effects on employment, investment, productive capacity, and institutions, so the post-crisis economy need not return to its previous state. A post-crisis trajectory may instead involve movement toward a reconfigured path of development. In the period considered in this study, this concept refers to adjustment following several distinct yet partly overlapping disturbances: the aftermath of the global financial crisis, the European sovereign debt crisis, the COVID-19 pandemic, the subsequent energy price shock, and the geopolitical disruptions that intensified from 2022 onward.

Evidence covering multiple crisis episodes also confirms that sectoral composition affects both the depth of an initial downturn and the pattern of recovery. Sánchez and Cuadrado-Roura (2024) show that specialization can strengthen resilience when production is concentrated in sectors that remain stable during a particular disturbance. It may magnify vulnerability when the dominant sector is affected directly. The contribution of productivity to resilience is therefore contingent on the structure of the economy and the nature of the shock rather than uniform across countries and periods.

Cross-country research reaches a related conclusion. Bastanifar and Shirkhani (2025) associate productive capacity, trade integration, and financial development with stronger economic resilience, while geographical and trade-related barriers may constrain adjustment to external shocks. Productive potential consequently operates in combination with access to markets, financing, infrastructure, and institutional arrangements. Productivity gains concentrated narrowly in individual sectors may be insufficient to strengthen economy-wide resilience.

The theoretical literature accordingly treats resilience as a process of adjustment, reorganization, and renewal rather than as a single observed outcome. Capoani *et al.* (2025) emphasize that recovery from crises depends on interactions among economic structures, institutions, financial conditions, and productive resources. Labor productivity contributes to this capacity because it reflects the efficiency with which labor and capital are transformed into output. Its broader significance depends on whether investment, innovation, transferable skills, and effective institutional implementation accompany productivity gains.

Territorial evidence further demonstrates that resilience may vary considerably within the same national institutional framework. Sensier *et al.* (2024), examining subregions of the United Kingdom before, during, and after the 2008 financial crisis, identify persistent differences in the capacity to protect and restore employment and productivity. These disparities underline the role of local industrial composition, labor-market conditions, and accumulated productive capabilities and caution against treating national averages as complete representations of resilience.

A limited body of Ukrainian research is relevant because Ukraine represents an extreme case in which productive capacity, infrastructure, employment, migration, and institutional functioning have been affected directly by Russia's full-scale invasion. Its inclusion does not imply that economic resilience is primarily a Ukrainian phenomenon. Rather, the Ukrainian case provides context-specific evidence of adaptation under an unusually severe wartime shock and of the ability of particular sectors and organizations to maintain activity despite extensive physical and human losses. Kharchenko (2025) highlights the contribution of sector-specific productive capabilities to adaptation, while Kyzym *et al.* (2025) emphasize the need for dynamic approaches that account for recovery, restructuring, and the renewal of productive potential.

The effects of the war extend far beyond the directly affected economy. Disruptions to commodity markets, trade, financial flows, migration, regional supply chains, and investor confidence have transmitted the shock across Europe, the MENA region, and the wider global economy (Guénette *et al.*, 2022). These consequences have interacted with the uneven post-pandemic recovery, inflationary pressures, and energy market instability, thereby altering production costs and recovery conditions in countries not directly involved in the conflict.

Geopolitical tensions and armed conflicts in the Middle East have created additional uncertainty by potentially affecting energy supplies, transport routes, commodity prices, investment, and regional labor markets. The possibility of escalation represents a material risk to oil and gas prices, with potential spillovers to other commodity markets (World Bank, 2024a). Economic resilience after 2022 must therefore be considered in relation to interconnected geopolitical, energy, trade, financial, and humanitarian disturbances rather than through a single-country perspective.

This broader setting illustrates why resilience cannot be inferred from contemporaneous movements in productivity alone. A temporary increase in GDP per employed person may result from commodity-price changes, employment contraction, or shifts in sectoral composition rather than from an improvement in underlying productive capabilities. Conversely, investment in institutional reform, workforce skills, infrastructure, or diversification may initially impose adjustment costs while strengthening adaptive and transformative capacity over a longer horizon. The relationship between labor productivity and resilience is therefore dynamic, potentially nonlinear, and dependent on the measurement period.

The literature supports the view that labor productivity is an economically important but incomplete indicator of resilience. Productive capacity can help economies absorb shocks and finance adaptation. At the same time, structural diversification, institutional quality, labor market conditions, and intersectoral relationships determine whether productivity can be preserved and translated into a sustainable recovery. In the empirical analysis, labor productivity is the directly measured outcome. Economic resilience is used as a conceptual framework for interpreting the relevance of productivity dynamics, not as a variable whose causal determinants are estimated by the regression models.

2.3 Evidence from MENA and Central and Eastern Europe

Research on the Middle East and North Africa, and on Central and Eastern Europe, shows that different combinations of institutional capacity, demographic conditions, labor-market structures, technological development, sectoral specialization, and resource dependence shape labor-productivity dynamics. The contrast between the two regions is analytically useful because it brings together economies with markedly different historical and structural trajectories. At the same time, substantial heterogeneity within both groups requires caution when interpreting regional patterns.

In the MENA region, the relationship between natural-resource revenues and productive development depends largely on the institutional and sectoral environment in which these revenues are generated and allocated. Haque and Tausif (2025) associate weak institutional conditions with rent-seeking, constrained entrepreneurship, and insufficient economic diversification. Under such conditions, increases in resource revenues may support public expenditure or aggregate income without generating broader improvements in technological capability, private-sector productivity, or employment creation. Stronger administrative and regulatory institutions may improve the allocation of resource income toward infrastructure, investment, business development, and diversification, but these mechanisms are neither automatic nor uniform across the region.

Evidence from the COVID-19 crisis supports this conditional interpretation. MENA economies, characterized by concentrated production structures, limited fiscal space, and

institutional constraints, experienced greater difficulties in sustaining employment and economic activity. In contrast, more diversified economies and flexible labor markets were better positioned to adjust to the shock (OECD, 2022). The World Bank (2024b) similarly emphasizes that regional recovery depends on resource exposure, private-sector development, institutional implementation, and the capacity to reallocate labor and capital. Oil income alone, therefore, provides an incomplete representation of productive strength and resilience.

Institutional effects within MENA also vary according to national economic structures. Demir *et al.* (2025) show that the relationship between governance and development outcomes is conditioned by resource dependence and country-specific institutional arrangements. Improvements in formal governance indicators may not produce immediate productivity gains when administrative capacity remains weak, regulatory reforms are implemented unevenly, or fiscal systems continue to favor established resource-based sectors. The economic relevance of institutions depends not only on formal rules but also on their implementation and interaction with productive structures.

Labor-market conditions provide another source of regional heterogeneity. Informal employment, limited private-sector job creation, unequal labor-force participation, and persistent skill mismatches can weaken the transmission of education and economic growth into labor productivity. The International Labour Organization (2022) identifies formalization, social dialogue, employment protection, and active labor market policies as important elements of recovery. Demographic change may therefore influence productivity through labor-force participation, migration, employment composition, and access to formal work rather than through population structure alone.

Research on Central and Eastern Europe places greater emphasis on macroeconomic stability, technological convergence, institutional development, and integration into European financial and production systems. Aizenman and Saadaoui (2026) associate stronger institutional conditions, lower inflation, deeper financial markets, and more robust reserve positions with a greater capacity to withstand external monetary disturbances in Central, Eastern, and Southeastern Europe. The strength of these associations differs across countries because policy frameworks, financial exposure, productive capacity, and integration into international markets remain uneven.

Recovery patterns within CEE are likewise heterogeneous. Ifrim *et al.* (2022) and Zamfir (Avram) *et al.* (2022) relate differences in economic performance to macroeconomic conditions, education, institutional quality, and economic structure. Their findings support an interpretation of resilience as the outcome of the interaction among productive, institutional, and financial capacities rather than the consequence of a single determinant. Economies exposed to similar external disturbances may therefore experience different losses and recovery trajectories despite belonging to the same broad regional group.

Sectoral structure and technological upgrading are particularly important for productivity performance in CEE. Alcalá-Ordóñez *et al.* (2023) identify weak productivity dynamics in parts of the service sector as a constraint on longer-term economic performance. Bilenko (2022) reports that the contribution of total factor productivity to growth weakened in several CEE economies following crisis periods. A recovery in employment or aggregate output does not necessarily imply that technological and organizational capabilities have been restored sufficiently to sustain productivity growth.

Intersectoral relationships also affect the ability of regional economies to absorb and respond to shocks. Giannakis *et al.* (2024) associate stronger pre-crisis production linkages and more developed structural foundations with improved recovery capacity. Dense economic networks may facilitate the movement of resources and knowledge across sectors, although they can also transmit disruptions when several connected industries are affected simultaneously. The effect of economic interconnectedness, therefore, depends on the nature and location of the initial shock.

Constantinescu (2023) similarly treats adjustment in CEE as a systemic process involving monetary conditions, sectoral structures, financial channels, and institutional arrangements. Institutional quality, human capital, demographic structure, and technological development should not be regarded as independent influences. Their relationship with productivity depends on complementary investments, implementation capacity, labor-market institutions, and firms' ability to adopt and use new technologies.

The regional literature does not support a simple division in which productivity in MENA is determined primarily by oil rents. In contrast, productivity in CEE is driven exclusively by institutions or technological change. Resource dependence varies considerably among MENA countries, and the CEE group is itself heterogeneous in terms of energy structures, demographic pressures, institutional development, and sectoral specialization. Regional differences are better understood as differences in the relative importance and interaction of these mechanisms than as evidence of two internally homogeneous development models.

The interpretation of the empirical literature depends heavily on research design. Cross-sectional models primarily rely on differences across countries and may capture persistent variation in historical development, geography, income, human capital, and institutional capacity. Random-effects models combine within-country and between-country variation but require that the country-specific component be uncorrelated with the explanatory variables. Fixed-effects models control for time-invariant country characteristics and identify associations from within-country changes. This advantage is accompanied by an important limitation: institutional and human-capital indicators generally change slowly. They may contain insufficient within-country variation to produce precise estimates over relatively short periods.

The causal relationship between institutions and economic performance remains contested. Acemoglu *et al.* (2001) use historical variation in European settler mortality as an instrument for institutional development and report substantial effects of institutions on contemporary income. Their study illustrates how external historical instruments can be used to address the endogeneity of institutional quality. The validity and interpretation of such instruments have nevertheless generated extensive debate.

Glaeser *et al.* (2004) question the assumption that the observed institution–growth relationship necessarily operates only from institutions to economic development. They argue that economic growth and human capital accumulation may themselves contribute to subsequent institutional improvement, and they raise concerns about the conceptual content of commonly used institutional indicators and the validity of some instrumental-variable strategies. Institutional quality may influence productivity through property rights, regulatory implementation, public-sector effectiveness, and investment conditions. In contrast, higher productivity may simultaneously increase fiscal capacity, administrative resources, and political demand for institutional reform.

Recent European evidence confirms that these identification problems remain relevant. Filip and Setzer (2025) examine institutional quality, economic growth, and resilience across approximately 200 European regions during 2010–2021. Their two-way fixed-effects estimates associate higher institutional quality with stronger medium-term growth and greater resilience to adverse shocks. The authors also apply an instrumental-variable approach to address the possibility that economic performance influences institutional quality. Their findings indicate that institutional relationships may be more visible over a multi-year horizon than in annual models, since improvements in governance require time to affect investment, innovation, and the provision of public goods.

A comparable problem arises in the relationship between human capital and productivity. Education, health, and professional skills can increase workers' productive capacity and support the adoption of technology. More productive and wealthier economies, however, are also better able to finance education, healthcare, professional training, and research. Bils and Klenow (2000) show that the observed cross-country relationship between schooling and growth cannot be interpreted automatically as a one-directional causal effect of education. Their analysis considers both the effect of schooling on growth and the possibility that expected economic growth increases investment in schooling.

Migration and demographic change introduce additional simultaneity. Productivity conditions can influence migration decisions, the demand for particular skills, and the participation of different population groups in employment. Migration, in turn, changes the size and composition of the labor force and may affect measured output per employed person. The estimated association between the young dependency ratio and labor productivity may therefore reflect labor-market selection, employment composition, fertility dynamics, and migration responses rather than a direct productivity effect of the population aged 0–14.

Resource dependence presents related identification difficulties. Oil rents may affect public investment, sectoral allocation, employment, and infrastructure, but their measured value also depends on international commodity prices and aggregate GDP. When labor productivity is measured as GDP per employed person, an increase in oil prices may raise both measured resource rents and the value of output without a proportional improvement in physical efficiency, technology, or workers' skills. The resulting coefficient may combine resource-allocation effects with price and compositional effects.

Fixed effects reduce bias from unobserved country characteristics that remain constant over time. However, they do not eliminate reverse causality, measurement error, or omitted variables that vary over the observation period. Lagged regressors improve temporal ordering, although they cannot ensure that the lagged variables are exogenous. Instrumental-variable and dynamic-panel estimators may strengthen causal identification when credible instruments are available and sample sizes are sufficiently large. However, their validity depends on restrictive assumptions and appropriate finite-sample properties.

The regional evidence should therefore be interpreted mainly as showing conditional relationships rather than uniformly identified causal effects. Institutional capacity, demographic and labor-market conditions, resource allocation, technological upgrading, and sectoral diversification are associated with productivity and resilience in both MENA and CEE. However, the magnitude and statistical visibility of these relationships depend on the time horizon, source of variation, measurement strategy, and econometric specification.

These methodological considerations provide the basis for the associative interpretation adopted in this study's empirical analysis.

3. DATA AND METHODOLOGY

The empirical framework combines a clearly defined comparative sample with several econometric specifications designed to examine the robustness of within-country associations. The following subsections describe the data and sample structure, define the variables and institutional-quality measure, present the econometric models, and explain the estimation and diagnostic procedures used in the analysis.

3.1 Data and sample

The empirical analysis covers 11 countries divided into two regional groups. The CEE group consists of Bulgaria, Czechia, Hungary, Poland, Romania, and the Slovak Republic. The MENA group comprises Jordan, Morocco, Saudi Arabia, Tunisia, and the United Arab Emirates. The country sample was formed using a common data-availability criterion. A country was included only when complete and consistently defined annual observations were available for labor productivity, the aggregate Worldwide Governance Indicators measure, the young dependency ratio, and oil rents over the common 2010–2021 estimation period. This criterion enabled the construction of a balanced core estimation sample without imputing, interpolating, or extrapolating missing values. The Human Capital Index was not used as a country-selection criterion because HCI data are reported only for four non-consecutive benchmark years and are analyzed separately in auxiliary specifications.

Countries not meeting this common-data requirement were not considered for inclusion in the final estimation sample. The resulting set of 11 countries should therefore be understood as a data-constrained comparative sample rather than as a statistically representative sample of all CEE and MENA economies. Within this constraint, the selected countries retain substantial variation in institutional conditions, demographic structures, labor-market characteristics, sectoral composition, and resource dependence, which is necessary for the study's comparative purpose.

The regional comparison does not imply that either group is internally homogeneous. The selected CEE countries differ in technological development, demographic trajectories, institutional evolution, and integration into European production systems. The MENA sample includes both highly resource-dependent economies and countries with more diversified productive structures. Regional estimates are therefore interpreted as sample-specific associations for the included countries and are not generalized automatically to all CEE or MENA economies.

The data were obtained from the World Bank's World Development Indicators, Worldwide Governance Indicators, and Human Capital Project databases, as well as the ILOSTAT database. Labor productivity was measured using the ILO modeled-estimates series "Output per worker (GDP constant 2021 international dollars at PPP)." The young dependency ratio, oil rents, and GDP per capita were drawn from the World Development Indicators. Institutional quality was constructed from the six dimensions of the Worldwide Governance Indicators, while human capital was measured using the Human Capital Index.

The definitions, transformations, and interpretation of the variables are presented in Section 3.2.

The compiled descriptive dataset covers 2010–2022. The starting year was selected as a common post-global-financial-crisis reference point for all countries and coincides with the earliest Human Capital Index observation used in the study. The analysis is not designed to estimate the immediate effects of the 2008–2009 crisis itself. Instead, the period captures the subsequent adjustment environment, including the aftermath of the global financial and European sovereign debt crises, the COVID-19 shock, the initial post-pandemic recovery, and the onset of the geopolitical and energy market disruptions of 2022.

The data were extracted from the World Bank's World Development Indicators, Worldwide Governance Indicators, and Human Capital Project databases, and from the ILOSTAT database, on 2 February 2026. They were subsequently harmonized for the 11 countries included in the study. The end point of the descriptive period was determined by the latest jointly available observations with consistent indicator definitions at the time of data extraction, rather than by assuming that developments after 2022 were economically irrelevant. At that date, labor productivity, the aggregate WGI measure, the young dependency ratio, and GDP per capita were available for all 11 countries through 2022. Oil-rent observations were available through 2021, while the Human Capital Index was available only for 2010, 2017, 2018, and 2020.

These differences in data availability resulted in several variable-specific balanced subsamples. Labor productivity, the aggregate WGI measure, the young dependency ratio, and GDP per capita form a balanced descriptive panel of 143 country-year observations covering 2010–2022. After annual differences are calculated, the principal first-difference model includes 121 observations across 11 countries, covering 2011–2021. The lagged first-difference specification contains 110 observations covering 2012–2021 because both the annual change and its one-year lag are required. The regional first-difference interaction model uses the same 121 observations as the principal specification. The HCI specifications are based on a separate balanced subsample of 44 observations from four non-consecutive years: 2010, 2017, 2018, and 2020. Because this structure provides limited within-country temporal variation and does not support a conventional annual first-difference model, the HCI estimates are treated as auxiliary evidence rather than as the principal basis for inference.

A complete and consistently defined set of observations for all variables entering the common empirical design was not available for 2023–2025 at the time of data extraction. Extending only those indicators for which more recent observations were available would have changed the temporal coverage and sample composition across specifications, thereby reducing their comparability. The study, therefore, retains variable-specific balanced subsamples and reports the exact period and number of observations for each model. No missing observations are imputed, interpolated, or extrapolated.

The limited number of countries and the restricted temporal coverage of some indicators constrain the statistical power of the analysis, particularly for regional comparisons and HCI-based estimates. These limitations motivate the use of country-clustered inference, cautious interpretation of coefficients close to conventional significance thresholds, and supplementary sensitivity checks. They also mean that the results should be interpreted as sample-specific conditional associations rather than as causal estimates or comprehensive regional averages.

3.2 Variables

The dependent variable is labor productivity, measured as gross domestic product per person employed in constant 2021 international dollars at purchasing power parity. This indicator reflects the average value of output produced per employed person and is widely used as a macroeconomic measure of labor-use efficiency. In the principal and robustness specifications, the dependent variable is the annual change in the logarithm of labor productivity, which can be interpreted approximately as its annual growth rate. Labor productivity in levels is retained only in the auxiliary HCI specification, which is based on four non-consecutive benchmark years and is not used for the principal substantive conclusions.

The principal explanatory variable is institutional quality, measured using an aggregate indicator based on the Worldwide Governance Indicators (WGI). The aggregate measure summarizes six dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. The construction and interpretation of this indicator are discussed in Section 3.3.

The set of structural explanatory variables includes the young dependency ratio and oil rents as a percentage of GDP. The young dependency ratio corresponds to the World Development Indicators series "Young dependency ratio (ADR) (% of working-age population)" (indicator code SP.POP.DPND.YG). It measures the number of persons aged 0–14 per 100 persons aged 15–64, and therefore captures the relative size of the young dependent population relative to the working-age population. The indicator excludes persons aged 65 and above and should not be interpreted as a measure of total age dependency. Oil rents measure the difference between the value of crude oil production at world prices and total production costs, expressed as a share of GDP, and are used as a proxy for resource dependence.

The Human Capital Index (HCI) is used as an auxiliary measure of human capital. It combines information on education and health outcomes. It reflects the expected productive potential of a child born in a given country relative to a benchmark of complete education and full health. However, HCI data are available only for 2010, 2017, 2018, and 2020. Consequently, specifications including HCI contain only 44 country-year observations and cannot support a comparable annual first-difference analysis. The HCI-based model is therefore treated as an auxiliary rather than a principal specification.

Alternative annual proxies of human capital, including educational attainment, enrollment, health, and workforce skills indicators, were considered conceptually but not mechanically substituted for the HCI. These indicators capture narrower, non-equivalent dimensions of human capital and were not available as a single, consistently defined measure across all countries and years in the common panel. Their use is therefore identified as a direction for future research rather than combined with the HCI in the present specifications.

GDP per capita at purchasing power parity was included as a control variable in the original model. However, labor productivity is defined as GDP per employed person, whereas GDP per capita is defined as GDP per total population. Because the two variables share GDP as a common numerator, their relationship is partially mechanical. Their high

pairwise correlation in the sample further indicates that including GDP per capita may absorb a substantial proportion of the variation in labor productivity and alter the estimated coefficients of the remaining variables.

For this reason, GDP per capita is excluded from the principal first-difference, lagged first-difference, variable-exclusion, regional-interaction, and auxiliary HCI specifications. It is retained only in the descriptive statistics, correlation matrix, and preliminary multicollinearity diagnostics.

In the principal and robustness specifications, annual changes in log labor productivity, WGI, the young dependency ratio, and oil rents are used. Labor productivity levels are used only in the auxiliary HCI specification and are not directly comparable to the annual first-difference models. HCI, WGI, ADR, and oil rents are not logarithmically transformed because they are indices, ratios, or percentage measures.

3.3 Measurement of institutional quality

Institutional quality is measured using the estimated series for the six dimensions of the World Bank's Worldwide Governance Indicators: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. The analysis uses the values retained in the authors' original working dataset, which was finalized in February 2026 and covers the period 2010–2022 for the 11 countries included in the study. No subsequent revisions of the historical WGI series were incorporated into the reported estimations.

For each country and year, the aggregate institutional-quality indicator is calculated as the unweighted arithmetic mean of the six component estimates:

$$WGI_{it} = \frac{1}{6}\sum_{k=1}^{6} G_{kit} \tag{1}$$

where WGI_{it} denotes the aggregate institutional-quality indicator for country i in year t; G_{kit} denotes the estimate for governance dimension k in country i and year t; and $k = 1, \dots, 6$ indexes the six WGI dimensions.

Equal weights are assigned to all six components. The composite indicator is used to capture the multidimensional nature of institutional quality while avoiding the simultaneous inclusion of several closely related governance variables within a relatively small panel.

The use of an aggregate measure also entails an interpretative limitation. Individual governance dimensions may influence labor productivity through different mechanisms and over different time horizons. Moreover, the WGI components are perception-based estimates and generally exhibit limited annual within-country variation. The estimated coefficient on the aggregate WGI measure should therefore be interpreted as a conditional association with short-run productivity dynamics rather than as a comprehensive estimate of the long-term effect of institutions.

3.4 Econometric specification

The empirical analysis distinguishes between a principal first-difference specification and several supplementary specifications that preserve the same short-run change-on-change structure. This design reflects the unit-root indication obtained for log labor productivity and avoids interpreting potentially non-stationary variables expressed in levels as a long-run equilibrium relationship.

The principal model is estimated as follows:

$$\Delta \ln(LP_{it}) = \beta_1 \Delta WGI_{it} + \beta_2 \Delta ADR_{it} + \beta_3 \Delta OILRent_{it} + \lambda_t + \varepsilon_{it} \quad (2)$$

where LP_{it} denotes labor productivity in country i and year t; $\Delta\, ln\, LP_{it}$ is the annual change in the logarithm of labor productivity; ΔWGI_{it}, ΔADR_{it}, and $\Delta OILRent_{it}$ denote annual changes in institutional quality, the young dependency ratio, and oil rents, respectively; λ_t denotes year fixed effects; and ε_{it} is the error term.

First differencing removes observed and unobserved country characteristics that remain constant over time. Year fixed effects capture shocks affecting all countries in a given year, including global economic fluctuations, pandemic-related disruptions, and changes in international energy market conditions. The coefficients in Equation (2) therefore represent conditional associations between annual changes in the explanatory variables and annual changes in labor productivity.

To examine temporal ordering, the explanatory-variable changes are additionally lagged by one year:

$$\Delta \ln(LP_{it}) = \beta_1 \Delta WGI_{i,t-1} + \beta_2 \Delta ADR_{i,t-1} + \beta_3 \Delta OILRent_{i,t-1} + \lambda_t + \varepsilon_{it} \quad (3)$$

Equation (3) examines whether changes occurring in the previous year are associated with current changes in labor productivity. Lagging the changes improves temporal ordering but does not eliminate endogeneity arising from omitted time-varying factors, measurement error, or feedback effects. The specification is therefore interpreted as a robustness check rather than as a causal identification strategy.

The principal model is also re-estimated without the young dependency ratio because the unit-root classification of this variable is sensitive to the augmented ADF lag structure. This specification assesses whether the estimated associations between WGI and oil rents depend on the inclusion of the demographic variable.

Regional heterogeneity is examined within the first-difference framework:

$$\begin{aligned}\Delta \ln(LP_{it}) = {} & \beta_1 \Delta WGI_{it} + \beta_2 \Delta ADR_{it} + \beta_3 \Delta OILRent_{it} + \beta_4 (\Delta ADR_{it} \times MENA_i) \\ & + \beta_5 (\Delta OILRent_{it} \times MENA_i) + \lambda_t + \varepsilon_{it}\end{aligned} \quad (4)$$

In Equation (4), $MENA_i$ equals one for MENA countries and zero for CEE countries. The main ADR and oil-rent coefficients represent the estimated associations for the CEE group, while the interaction coefficients represent differences between the MENA and CEE slopes. The complete MENA associations are calculated as $\beta_2 + \beta_4$ for the young dependency ratio and $\beta_3 + \beta_5$ for oil rents. Their statistical significance is evaluated using linear-combination tests.

The Human Capital Index is included only in an auxiliary specification because comparable observations are available for four non-consecutive years: 2010, 2017, 2018,

and 2020. This specification cannot be expressed as a comparable annual first-difference model and is therefore treated exclusively as exploratory supplementary evidence.

GDP per capita is excluded from the principal and robustness specifications because both GDP per capita and labor productivity, measured as GDP per employed person, contain GDP in the numerator.

3.5 Estimation strategy

The empirical analysis proceeds in several stages. First, descriptive statistics and pairwise correlations are examined to identify the main characteristics of the data and potential overlap among the explanatory variables. Multicollinearity is additionally assessed using variance inflation factors. The diagnostic results are reported in the Appendix.

Second, panel unit-root diagnostics were extended to all variables entering the principal specification. The Im–Pesaran–Shin tests were estimated using the balanced 2010–2021 panel, with individual intercepts and alternative augmented ADF lag structures. The unit-root null was consistently not rejected for log labor productivity in levels and was rejected for its first difference. However, the classifications of the aggregate WGI measure, the young dependency ratio, and oil rents changed when an augmented ADF lag was introduced. Given the small number of countries and the short time dimension of the panel, these results do not provide a sufficiently reliable basis for assigning a common order of integration to all variables.

Panel cointegration tests were considered but were not applied because the revised empirical design does not estimate a long-run equilibrium relationship among variables expressed in levels. In addition, the explanatory variables do not exhibit clearly established and compatible integration properties, while the panel contains only 11 countries and a short annual time series. Under these conditions, the results of conventional panel cointegration tests would be difficult to interpret reliably.

The first-difference specification is therefore used as the principal basis for substantive inference. This choice does not assume that every explanatory variable has been conclusively established as integrated of order one. Rather, first differencing reduces the risk of spurious inference associated with trending variables expressed in levels and corresponds directly to the objective of examining annual within-country co-movements. The estimated coefficients are interpreted exclusively as short-run conditional associations. No long-run, equilibrium, or cointegrating relationship is inferred from the reported estimates.

Third, year fixed effects are included to account for shocks shared by all countries in a given year. Such shocks may include global business-cycle fluctuations, the COVID-19 pandemic, changes in international energy prices, and other common macroeconomic disturbances. Standard errors are clustered at the country level to allow for heteroskedasticity and serial correlation within countries. Because the sample contains only 11 country clusters, statistical inference is based on a t-distribution with 10 degrees of freedom rather than on a standard normal approximation. Results close to conventional significance thresholds are therefore interpreted cautiously.

Residual cross-sectional dependence is examined using the Pesaran CD test. The null hypothesis of residual cross-sectional independence is not rejected at the 5% level in the principal first-difference model ($p = 0.054$), the lagged first-difference model ($p = 0.110$),

or the regional interaction model ($p = 0.059$). In the specification excluding the young dependency ratio, however, the null is rejected ($p = 0.035$); this model is therefore treated only as an additional sensitivity check.

A dynamic specification that included a lagged dependent variable was also considered, but not estimated. Given the short annual time dimension of the panel, a conventional fixed-effects estimator with a lagged dependent variable would be subject to finite-sample dynamic-panel bias. Bias-corrected estimators and system-GMM were also considered; however, their finite-sample performance would be difficult to assess reliably in a sample containing only 11 countries. In particular, GMM estimates may be highly sensitive to instrument selection, while the number of instruments can become large relative to the number of countries. Specification tests such as the Hansen and Arellano–Bond tests would likewise have limited reliability. Applying a dynamic estimator in this setting could therefore create an appearance of improved identification without dependable finite-sample inference.

Because of its restricted and non-consecutive temporal coverage, the HCI does not support a comparable annual first-difference specification. The corresponding exploratory results are reported in the Appendix.

Regional heterogeneity in demographic structure and resource dependence is evaluated by examining interactions between annual changes in the young dependency ratio, oil rents, and the MENA indicator. Complete MENA associations are calculated as linear combinations of the main and interaction coefficients. Separate regional first-difference models and leave-one-country-out estimates are used as supplementary checks of sensitivity to the number and composition of countries.

Taken together, the estimation strategy is designed to evaluate the robustness of short-run within-country associations rather than to identify causal effects or long-run equilibrium relationships. Substantive conclusions are based on the principal, lagged, variable-exclusion, and regional specifications expressed in annual first differences.

4. ANALYSIS AND RESULTS

This section presents the empirical results of the study. It begins with descriptive statistics and pairwise correlations, followed by the principal first-difference estimates and robustness checks based on lagged first-difference and variable-exclusion specifications. The section then examines regional heterogeneity in the associations between labor productivity and the selected explanatory variables across the CEE and MENA groups.

4.1 Descriptive statistics

Table 1 presents descriptive statistics for labor productivity, institutional quality, human capital, demographic structure, resource dependence, and GDP per capita. The statistics are calculated from all available country-year observations without prior aggregation and include the mean, standard deviation, minimum, maximum, and number of observations.

Table no. 1 – Descriptive statistics (2010–2022)

Variable	Mean	Std. Dev.	Min	Max	N

Labor productivity (GDP per employed, PPP, const. 2021 USD)	73,462.50	32,536.63	22,868.60	159,509.91	143
Human Capital Index (HCI)	0.63	0.09	0.47	0.78	44
GDP per capita, PPP (const. 2021 USD)	32,881.05	19,419.96	7,210.64	75,671.06	143
Institutional quality (WGI aggregate)	0.26	0.44	−0.49	1.02	143
Oil rents (% of GDP)	4.88	10.72	0.00	49.16	132
Young dependency ratio (ADR)	29.49	10.89	19.68	59.45	143

Note: Labor productivity, GDP per capita, the aggregate WGI measure, and the young dependency ratio are observed for 2010–2022. Oil-rent data cover 2010–2021, while HCI observations are available for 2010, 2017, 2018, and 2020. Labor productivity and GDP per capita are measured in constant 2021 PPP international dollars. GDP per capita is reported for descriptive and diagnostic purposes but is excluded from the regression specifications. Data-extraction date: 2 February 2026. The final available year in the harmonized dataset was 2022 for labor productivity, the aggregate WGI measure, GDP per capita, and the young dependency ratio; 2021 for oil rents; and 2020 for the Human Capital Index, which was available only for 2010, 2017, 2018, and 2020.

Labor productivity, measured as gross domestic product per person employed in constant 2021 PPP prices, exhibits substantial cross-country variability within the sample over the period 2010–2022. The mean value amounts to approximately USD 73.5 thousand, while the minimum and maximum values differ considerably, indicating pronounced structural heterogeneity among the economies under study. A similar pattern of differentiation is observed in GDP per capita in PPP terms, reflecting significant disparities in economic development across the sample countries.

The pooled distribution of the Human Capital Index is relatively concentrated compared with the level-based economic indicators. However, the pooled standard deviation does not distinguish between within-country and between-country variation. More importantly, HCI observations are available for only four non-consecutive years, which substantially limits the temporal information available for within-country estimation. The aggregate WGI measure shows greater pooled dispersion than HCI, reflecting differences in governance conditions across the country-year observations included in the sample.

It is important to note that the estimates in the specification, including the Human Capital Index, are based on a substantially reduced subsample (N = 44) due to the irregular temporal availability of HCI data. This limitation reduces the statistical power of the tests and increases the sensitivity of the results to individual observations and model specification. For methodological reasons, HCI values were not interpolated, as artificial smoothing could generate pseudo-variation and distort within-country estimation. Accordingly, the specification including HCI is treated as an auxiliary exploratory analysis, whereas the main conclusions rely on annual first-difference models with broader temporal coverage.

The resource-dependence indicator, measured as oil rents as a percentage of GDP, exhibits high variability and a skewed distribution, reflecting substantial structural differences across the sample economies, particularly the presence of countries with considerable reliance on natural-resource extraction. The young dependency ratio also displays substantial cross-country variation, reflecting differences in the number of persons aged 0–14 relative to the working-age population. These differences may be associated with fertility patterns, migration, stages of the demographic transition, and labor market structures.

In addition, level-based economic indicators, particularly labor productivity and GDP per capita, exhibit substantially greater variability compared to index-based variables such

as the Human Capital Index and institutional quality measures. This pattern reflects differences in the speed at which various economic characteristics respond to structural change: while productivity and income levels are more sensitive to short- and medium-term economic fluctuations, institutional and educational characteristics evolve gradually and exhibit pronounced inertia.

The descriptive statistics reveal substantial cross-country and cross-regional heterogeneity in labor productivity, institutional quality, resource dependence, and demographic structure. This variation supports the subsequent econometric examination, although the descriptive patterns combine between-country differences and within-country changes and should not be interpreted as evidence of causal relationships.

4.2 Correlation analysis

To provide a preliminary assessment of the relationships among the key variables, Pearson correlation coefficients were calculated using pairwise complete observations (Table 2). The analysis identifies the direction and relative strength of the pooled linear associations among labor productivity, human capital, economic development, institutional quality, resource dependence, and demographic structure. It also provides an initial indication of potential overlap among the explanatory variables. Because the coefficients combine persistent differences between countries with changes occurring within countries over time, they are interpreted as descriptive associations rather than causal relationships.

Table no. 2 – Pearson correlation matrix

	LP	HCI	GDPpc	WGI	Oil	ADR
LP	1.000	0.367**	0.929***	0.257***	0.788***	−0.354***
HCI	0.367**	1.000	0.495***	0.921***	−0.167	−0.730***
GDPpc	0.929***	0.495***	1.000	0.429***	0.674***	−0.523***
WGI	0.257***	0.921***	0.429***	1.000	−0.264***	−0.724***
Oil	0.788***	−0.167	0.674***	−0.264***	1.000	0.044
ADR	−0.354***	−0.730***	−0.523***	−0.724***	0.044	1.000

*Note: LP denotes labor productivity measured as GDP per person employed in constant 2021 PPP international dollars; HCI denotes the Human Capital Index; GDPpc denotes GDP per capita in constant 2021 PPP international dollars; WGI denotes the aggregate Worldwide Governance Indicators measure; Oil denotes oil rents as a percentage of GDP; and ADR denotes the young dependency ratio, measured as the number of persons aged 0–14 per 100 persons aged 15–64. Pearson correlations are calculated using pairwise complete observations. Correlations involving HCI are based on 44 observations. Correlations involving oil rents but not HCI are based on 132 observations. All remaining correlations are based on 143 observations. Two-sided p-values are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The reported p-values are based on pooled pairwise observations and do not account for serial dependence within countries; they are therefore presented for descriptive purposes only.*

Most of the pairwise correlations are statistically significant at the 1% level. The association between labor productivity and HCI is statistically significant at the 5% level. The correlations between HCI and oil rents and between oil rents and the young dependency ratio are not statistically different from zero at conventional significance levels.

Labor productivity is strongly positively correlated with GDP per capita ($r = 0.929$, $p < 0.01$). This result should not be interpreted as evidence of an independent effect of economic development on productivity because the two indicators share GDP as a common numerator.

The high correlation confirms the partially mechanical overlap discussed in Section 3.2 and supports the exclusion of GDP per capita from the principal regression specifications.

Labor productivity is also strongly positively correlated with oil rents in the pooled data ($r = 0.788$, $p < 0.01$). This association may reflect persistent differences between resource-dependent and less resource-dependent countries, as well as the influence of commodity prices on GDP. It does not demonstrate that an increase in oil rents directly improves workers' productive efficiency.

The correlation between labor productivity and HCI is positive and moderate ($r = 0.367$, $p < 0.05$). In contrast, the association between labor productivity and the aggregate WGI measure is positive but relatively weak ($r = 0.257$, $p < 0.01$). These pooled correlations capture both cross-country differences and temporal variation. They should therefore not be expected to correspond directly to the coefficients obtained from fixed-effects and first-difference models, which identify associations primarily from changes occurring within countries over time.

HCI and the aggregate WGI measure are strongly positively correlated ($r = 0.921$, $p < 0.01$). This relationship indicates substantial overlap between countries' human capital and institutional conditions and warrants caution when the two indicators are included in the same specification. The restricted, non-consecutive temporal coverage of HCI provides an additional reason to analyze it separately in auxiliary models.

The young dependency ratio is negatively correlated with labor productivity ($r = -0.354$, $p < 0.01$), HCI ($r = -0.730$, $p < 0.01$), GDP per capita ($r = -0.523$, $p < 0.01$), and WGI ($r = -0.724$, $p < 0.01$). These descriptive relationships should not be interpreted as evidence that a larger population aged 0–14 directly reduces productivity, human capital, income, or institutional quality. They may reflect differences among countries in fertility, stages of the demographic transition, migration, labor force participation, and economic development.

The correlation matrix consequently provides useful descriptive evidence but does not establish causal relationships. The reported significance levels should also be interpreted cautiously because the pooled Pearson tests treat country-year observations as independent and do not adjust for within-country dependence. It also combines between-country heterogeneity with within-country changes, whereas the principal econometric specifications focus on annual within-country dynamics. Differences between the signs, magnitudes, or statistical significance of the correlations and the panel-regression coefficients are therefore possible and do not necessarily indicate inconsistent results.

4.3 Econometric results

Before estimating the principal models, diagnostic tests were conducted using the balanced 2010–2021 sample of 132 country-year observations. The Wooldridge test rejected the null hypothesis of no first-order serial correlation ($F = 100.12$, $p < 0.001$), while the modified Wald test rejected the null hypothesis of homoskedastic country-specific error variances ($\chi^2 = 128.57$, $p < 0.001$). The expanded Im–Pesaran–Shin diagnostics did not reject the unit-root null for log labor productivity ($W_{t-bar} = 2.713$, $p = 0.997$), log GDP per capita ($W_{t-bar} = 2.284$, $p = 0.989$), the young dependency ratio ($W_{t-bar} = 4.620$, $p > 0.999$), or oil rents ($W_{t-bar} = 1.183$, $p = 0.882$) in levels. The unit-root null was rejected for the aggregate WGI measure in levels ($W_{t-bar} = -3.030$, $p = 0.001$).

In first differences, the unit-root null was rejected for log labor productivity, log GDP per capita, the aggregate WGI measure, and oil rents. Still, it was not rejected for the young dependency ratio. Because several conclusions changed when one augmented ADF lag was included, the unit-root results are not treated as definitive evidence that all variables share the same order of integration. The first-difference model is therefore used both to reduce the risk of spurious inference associated with labor productivity in levels and to estimate annual within-country co-movements through a consistent change-on-change specification. The Wooldridge and modified Wald results motivate the use of country-clustered standard errors. Full diagnostic results are reported in Appendix A. Because the tests do not establish compatibility of integration properties across all variables, the empirical analysis does not estimate or interpret a long-run equilibrium relationship. All substantive conclusions are based on specifications expressed in annual first differences.

Because data on oil rents are unavailable for 2022, the first-difference specification is estimated for the common period 2011–2021 and includes 121 country-year observations for 11 countries. The Human Capital Index is not included in this main specification because it is available only for 2010, 2017, 2018, and 2020, and therefore does not support a comparable annual first-difference model. The HCI-based estimates are retained as an auxiliary analysis in the Appendix.

Table no. 3 – First-difference estimates of annual changes in labor productivity

Dependent variable: Δ log(Labor productivity)

Variable	First-difference model
Δ WGI (aggregate)	−0.038 (0.026)
Δ Young dependency ratio (ADR)	0.021** (0.007)
Δ Oil rents (% of GDP)	0.002* (0.001)
Year fixed effects	Yes
Country-specific time-invariant effects	Removed by first differencing
Observations	121
Countries	11
Period	2011–2021
R-squared	0.542
Pesaran CD test, p-value	0.054

*Notes: Cluster-robust standard errors at the country level are reported in parentheses. The reported p-values are based on a t-distribution with 10 degrees of freedom, reflecting the 11 country clusters. First differencing removes time-invariant country-specific effects. Year fixed effects are included. *** p < 0.01, ** p < 0.05, * p < 0.10.*

The coefficient on the annual change in aggregate institutional quality is negative but statistically insignificant (β = −0.0379; p = 0.170). Thus, the first-difference estimates provide no evidence of a systematic short-run association between annual changes in the aggregate WGI measure and annual changes in labor productivity.

The annual change in the young dependency ratio has a positive coefficient and is statistically significant at the 5% level in the principal model ($\beta = 0.0208$; $p = 0.013$). The lagged first-difference specification produces a similar positive association between the preceding year's change in ADR and the current change in labor productivity ($\beta = 0.0166$; $p = 0.015$). The result should not be interpreted as evidence that an increase in the young dependent population directly causes higher productivity. It may reflect concurrent changes in fertility, migration, labor-force composition, employment selection, or the broader

demographic structure. The instability of the unit-root classification and the sensitivity of the regional results also require cautious interpretation.

The coefficient on the annual change in oil rents is positive but statistically significant only at the 10% level in the principal model ($\beta = 0.0021$; $p = 0.080$). In the lagged first-difference specification, the coefficient is smaller and statistically insignificant ($\beta = 0.0008$; $p = 0.136$). When ADR is excluded, the oil-rent coefficient remains positive and marginally significant ($\beta = 0.0025$; $p = 0.063$), but this specification exhibits residual cross-sectional dependence. The evidence, therefore, does not establish a stable short-run association between changes in oil rents and labor productivity.

The Pesaran CD test does not reject the null hypothesis of residual cross-sectional independence at the 5% level, although the result is close to the conventional threshold ($p = 0.054$). Residual cross-sectional dependence, therefore, cannot be ruled out confidently, and the estimated standard errors are interpreted cautiously.

Taken together, the principal model does not identify a stable short-run association between annual changes in WGI and annual changes in labor productivity. The positive ADR coefficient requires cautious interpretation, while the oil-rent result remains weak and specification-sensitive.

4.4 Robustness checks using alternative first-difference specifications

The robustness analysis examines whether the principal findings remain similar under alternative specifications that preserve the short-run first-difference structure of the empirical design. Level-based models are not used as a basis for substantive inference because the panel unit-root diagnostics do not establish compatible integration properties for all variables, and no long-run cointegrating relationship is estimated.

First, annual changes in the explanatory variables are lagged by one year to examine whether changes occurring in the previous period are associated with current changes in labor productivity. This specification improves temporal ordering but does not eliminate endogeneity and is therefore interpreted as a robustness check rather than as a causal identification strategy. Because the dependent variable is not lagged, this specification does not model persistence in labor productivity and should not be interpreted as a dynamic panel model.

Second, the principal model is re-estimated without the young dependency ratio because the unit-root classification of this variable is sensitive to the augmented ADF lag structure. This specification assesses whether the estimated associations involving institutional quality and oil rents depend on the inclusion of the demographic variable.

Table no. 4 – Robustness checks using alternative first-difference specifications

Dependent variable: Δlog(Labor productivity)

Variable	Principal first-difference model	Lagged first-difference model	First-difference model without ADR
Δ WGI	−0.038 (0.026)	–	−0.039 (0.026)
L.Δ WGI	–	−0.024 (0.038)	–
ΔYoung dependency ratio	0.021** (0.007)	–	–
L.Δ Young	–	0.017** (0.006)	–

dependency ratio			
Δ Oil rents	0.002* (0.001)	–	0.002* (0.001)
L.Δ Oil rents	–	0.001 (0.0005)	–
Year fixed effects	Yes	Yes	Yes
Observations	121	110	121
Countries	11	11	11
Period	2011–2021	2012–2021	2011–2021
R-squared	0.542	0.471	0.464
Pesaran CD test, p-value	0.054	0.110	0.035

Notes: Country-clustered standard errors are reported in parentheses. All specifications use annual first differences and include year fixed effects. The lagged model relates current changes in log labor productivity to one-year-lagged changes in the explanatory variables. The third model excludes the young dependency ratio because its unit-root classification is sensitive to the augmented ADF lag structure. The reported p-values are based on a t-distribution with 10 degrees of freedom. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

In the lagged first-difference model, the coefficient on the lagged change in aggregate WGI remains negative and statistically insignificant ($\beta = -0.0237;\ p = 0.544$). The lagged change in the young dependency ratio retains a positive and statistically significant association with the current change in labor productivity ($\beta = 0.0166;\ p = 0.015$). The lagged change in oil rents is positive but statistically insignificant ($\beta = 0.0008;\ p = 0.136$). The Pesaran CD test does not reject the null of residual cross-sectional independence ($p = 0.110$).

When the young dependency ratio is excluded, the WGI coefficient remains statistically insignificant ($\beta = -0.0391;\ p = 0.165$), while the oil-rent coefficient is positive and marginally significant ($\beta = 0.0025;\ p = 0.063$). The latter specification is treated only as a sensitivity check because its Pesaran CD test rejects residual cross-sectional independence at the 5% level ($p = 0.035$).

Taken together, the alternative first-difference specifications confirm the absence of a stable short-run association between annual changes in WGI and annual changes in labor productivity. The positive ADR association is retained in the principal and lagged models, whereas the oil-rent result remains weak and specification-sensitive.

4.5 Regional heterogeneity between CEE and MENA countries

Regional heterogeneity in the associations involving demographic structure and resource dependence is examined within the same first-difference framework as the principal model. Annual changes in the young dependency ratio and oil rents are interacted with a binary indicator for the MENA countries.

The main ADR and oil-rent coefficients represent the estimated short-run associations for the CEE group. The interaction coefficients represent differences between the MENA and CEE slopes. The complete MENA associations are calculated as the sums of the corresponding main and interaction coefficients and are evaluated using linear-combination tests.

The interaction coefficients are statistically insignificant for both the young dependency ratio ($\beta = -0.0162;\ p = 0.502$) and oil rents ($\beta = -0.0120;\ p = 0.731$). The

model, therefore, does not establish statistically significant differences between the CEE and MENA slopes.

Table no. 5 – First-difference estimates of regional heterogeneity

Dependent variable: $\Delta log(Labor\ productivity)$

Variable	Coefficient (standard error)
ΔWGI	−0.033 (0.027)
ΔADR: CEE effect	0.033 (0.022)
ΔOil rents: CEE effect	0.014 (0.035)
ΔADR × MENA	−0.016 (0.023)
ΔOil rents × MENA	−0.012 (0.034)
Complete MENA effect: Δ ADR	0.017** (0.008); p = 0.047
Complete MENA effect: Δ Oil rents	0.002 (0.001); p = 0.106
Year fixed effects	Yes
Observations	121
Countries	11
Period	2011–2021
R-squared	0.547
Pesaran CD test, p-value	0.059

Notes: Country-clustered standard errors are reported in parentheses. First differencing removes time-invariant country-specific characteristics. The main ADR and oil-rent coefficients represent the estimated associations for the CEE group. The interaction coefficients represent differences between the MENA and CEE slopes. Complete MENA effects are calculated using linear-combination tests. The reported p-values are based on a t-distribution with 10 degrees of freedom. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The complete MENA association for the annual change in the young dependency ratio equals 0.0173 and is statistically significant at the 5% level ($p = 0.047$). This finding should not be interpreted as evidence of a statistically significant regional difference, as the corresponding interaction coefficient is not significant. The complete MENA oil-rent association equals 0.0022 and is statistically insignificant ($p = 0.106$).

Separate regional first-difference models reported in the Appendix do not identify statistically significant coefficients on ADR, oil rent, or WGI in either regional subsample. Leave-one-country-out checks show that the complete MENA ADR association is highly sensitive to sample composition: its p-value ranges from 0.011 to 0.476. The regional findings are therefore considered exploratory and sensitive to sample composition.

5. DISCUSSION

The discussion focuses on why the estimated relationships differ across variables, specifications, and regional contexts and how these patterns compare with the existing literature.

Annual changes in the aggregate WGI measure are statistically insignificant in the principal, lagged first-difference, and ADR-exclusion specifications. This finding differs from studies linking institutional quality to medium-term growth and economic resilience in European economies (Filip and Setzer, 2025; Aizenman and Saadaoui, 2026), but the difference may reflect the source and time horizon of variation. The present models identify relationships through annual within-country changes, whereas institutional reforms may

influence productivity gradually through regulatory implementation, investment confidence, competition, access to finance, and technological adoption.

The aggregate WGI measure may also conceal differences among governance dimensions. However, the supplementary dimension-level analysis provides no statistically significant result after adjustment for multiple testing. The available evidence, therefore, does not identify a stable short-run WGI association, without excluding the longer-term institutional mechanisms documented in the literature, including the role of governance in resource allocation and diversification in MENA economies (Demir *et al.*, 2025; Haque and Tausif, 2025).

The HCI coefficient is statistically insignificant, but the sparse and non-consecutive series provides limited within-country variation. The estimate is therefore inconclusive rather than evidence against the productivity relevance of human capital.

This result differs from cross-country and firm-level studies that associate education, health, workforce training, and human-resource development with higher productivity (Abdelgany and Saleh, 2022; Subramony *et al.*, 2022; Naz *et al.*, 2025). The difference is methodologically plausible: those studies capture accumulated human-capital differences or firm-level investments, whereas the HCI specification in the present study relies on limited temporal variation and does not directly measure annual changes in occupational skills, digital competencies, professional training, or the alignment of education with labor-market demand (Song *et al.*, 2025).

The young dependency ratio is the only explanatory variable that is statistically significant at the 5% level in both the principal and lagged first-difference models. This recurring positive coefficient provides evidence of a short-run association but does not establish that an increase in the population aged 0–14 directly raises labor productivity. Changes in ADR may occur simultaneously with fertility, migration, labor-force participation, employment selection, urbanization, and sectoral transformation. Migration may also change the working-age denominator and the composition of employment without directly affecting the young population. In MENA economies, these relationships may be further conditioned by labor-market informality, unequal labor-force participation, limited private-sector job creation, and the pace of structural transformation (International Labour Organization, 2022).

The regional results require additional caution. The complete MENA ADR association is positive and statistically significant at the 5% level in the full-sample pooled interaction model ($\beta = 0.0173$; $p = 0.047$), but the MENA–CEE interaction coefficient is statistically insignificant. Separate regional estimates are also insignificant, while the leave-one-country-out p-values range from 0.011 to 0.476. The results, therefore, do not establish a stable difference between the CEE and MENA slopes or a universal demographic mechanism. A more complete demographic analysis would require considering ADR alongside migration, working-age population growth, old-age and total dependency, labor force participation, and employment composition by age and sex.

The oil-rent results are weak and specification-sensitive. Annual changes in oil rents have a positive coefficient in the principal first-difference model, but the association is significant only at the 10% level. The coefficient becomes statistically insignificant when lagged annual changes are used and remains only marginally significant when ADR is excluded; the latter specification also exhibits residual cross-sectional dependence and is therefore retained only as an auxiliary sensitivity check. Because labor productivity is

measured as GDP per employed person, changes in international commodity prices may affect the value of measured GDP without proportional changes in physical production, technology, organizational capacity, or worker efficiency. The short-run oil-rent coefficient may therefore partly capture valuation and sectoral-composition effects rather than improvements in underlying productive capacity. This concern is particularly relevant during periods of substantial volatility in global energy markets (World Bank, 2024a).

The regional first-difference model does not identify a statistically significant oil-rent association for either regional group. The CEE coefficient and the MENA interaction coefficient are statistically insignificant, while the complete MENA association is also insignificant. Separate regional models likewise do not identify statistically significant oil-rent coefficients. The results, therefore, provide no evidence of a stable difference between the regional oil-rent slopes. This finding is consistent with research showing that resource revenues do not automatically translate into diversified productive capacity. Their economic contribution depends on institutional quality, the allocation of public investment, entrepreneurship, sectoral diversification, private-sector development, and the capacity to limit rent-seeking behavior (Demir *et al.*, 2025; Haque and Tausif, 2025). Evidence from the COVID-19 period similarly indicates that economies with concentrated production structures and institutional constraints were generally more vulnerable, whereas diversification and more flexible labor markets supported adjustment and recovery (OECD, 2022; World Bank, 2024b).

For the CEE countries, the absence of a statistically significant oil-rent association should not be interpreted as evidence that energy exposure and resource-related income are economically irrelevant. Rather, the selected CEE economies have relatively limited and heterogeneous oil-rent exposure, and annual changes in the indicator may reflect energy-price movements, sectoral reallocation, or country-specific changes in extraction. The regional literature identifies technological upgrading, service-sector efficiency, macroeconomic stability, institutional capacity, and structural transformation as more persistent foundations of productivity performance in CEE economies (Bilenko, 2022; Alcalá-Ordóñez *et al.*, 2023; Aizenman and Saadaoui, 2026). Temporary changes in resource income should therefore not be treated as a stable substitute for improvements in productive capacity.

5.1 Implications for Understanding Economic Resilience

Economic resilience can be understood as the capacity of an economy to absorb adverse shocks, adapt the allocation of labor, capital, and productive resources, and, where necessary, transform its economic structure. In this framework, labor productivity is not treated as a direct measure of resilience but as an element of the productive capacity that supports shock absorption, adjustment, and subsequent recovery. This interpretation is consistent with studies emphasizing the role of pre-existing productivity, sectoral structure, institutional arrangements, and intersectoral linkages in shaping regional resilience (Giannakis and Mamuneas, 2022; Giannakis *et al.*, 2024; Sánchez and Cuadrado-Roura, 2024; Capoani *et al.*, 2025).

The empirical results provide different implications for these dimensions of resilience. The absence of a stable short-run association between annual WGI changes and labor-productivity changes does not imply that institutions are irrelevant to resilience. Institutional

quality may influence adaptive and transformative capacity gradually through regulatory implementation, investment conditions, competition, public-sector effectiveness, and technological adoption. These mechanisms are unlikely to be fully reflected in contemporaneous annual movements in an aggregate governance indicator.

The statistically insignificant HCI coefficient is similarly inconclusive because the sparse, non-consecutive data provide limited information about within-country change. Human capital may contribute to adaptive and transformative resilience through workforce skills, health, occupational mobility, technological absorption, and the capacity to move workers toward more productive activities. These cumulative mechanisms are broader than the limited temporal variation captured by the available HCI series.

The positive association between changes in ADR and changes in labor productivity should not be interpreted as evidence that a larger young population directly strengthens resilience or productivity. Changes in the young dependency ratio may coincide with migration, fertility, labor-force participation, employment selection, and sectoral transformation. Its instability across regional and leave-one-country-out specifications indicates that the coefficient reflects a context-dependent demographic and labor-market configuration rather than a universal resilience mechanism.

The weak and specification-sensitive oil rent results show that changes in resource income alone do not provide a stable foundation for productive resilience. Resource revenues may temporarily support shock absorption through fiscal and external buffers. However, their contribution to adaptive and transformative capacity depends on whether they are converted into infrastructure, technological development, workforce skills, entrepreneurship, and sectoral diversification. This interpretation is consistent with research showing that resource dependence can either support or constrain resilience depending on institutional quality and the allocation of resource revenues (Demir *et al.*, 2025; Haque and Tausif, 2025).

Taken together, the findings indicate that economic resilience is structurally conditioned but also policy-sensitive. Existing productive capacity, sectoral composition, demographic conditions, institutional arrangements, and resource dependence shape an economy's initial exposure to shocks and its absorptive capacity. At the same time, investment, institutional implementation, labor-market reform, technological adoption, human-capital development, and diversification can gradually modify these structural conditions and strengthen adaptive and transformative capacity. Policy effects may first become visible through intermediate outcomes – including regulatory enforcement, firm creation, innovation, workforce participation, occupational skills, and public-investment quality – before affecting aggregate labor productivity and resilience.

Figure 1 summarizes the relationship between the short-run productivity associations examined empirically and the longer-term resilience mechanisms derived from the literature.

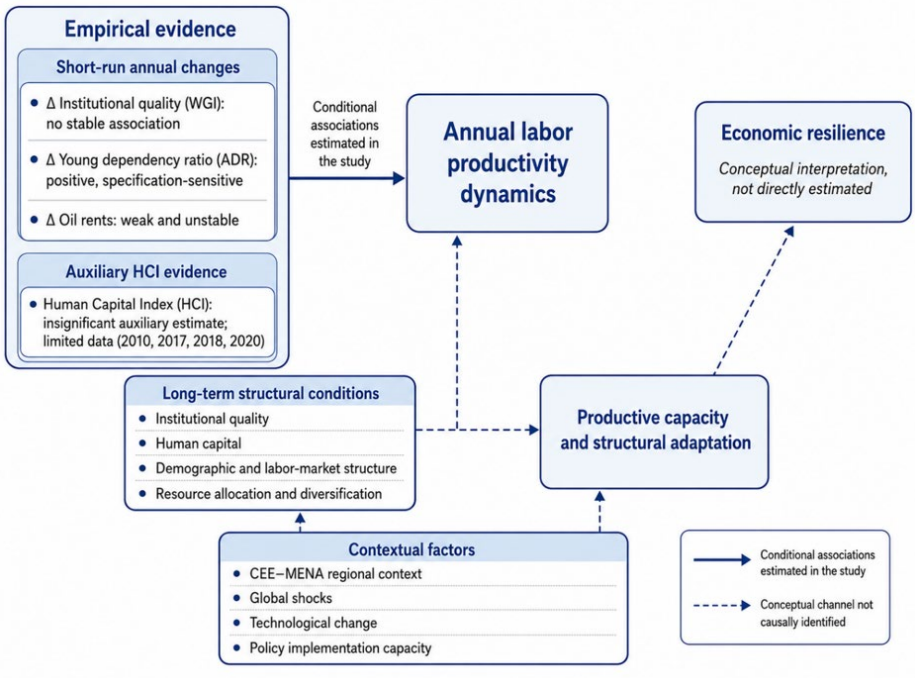


Figure no. 1 – Conceptual framework linking factors associated with labor productivity, time horizons, and economic resilience

Source: Authors' elaboration.

The solid arrows in Figure 1 represent the annual relationships examined in the empirical models. In contrast, the dashed arrows denote longer-term institutional, human-capital, demographic, technological, and diversification channels that are not estimated directly. The framework, therefore, separates short-run within-country productivity dynamics from the cumulative mechanisms through which structural conditions and policy interventions may shape economic resilience over longer horizons.

5.2 Policy implications

The recommendations below distinguish between implications supported by the empirical results and broader policy considerations derived from the regional literature.

For the CEE countries, the first-difference results do not identify a stable short-run association between changes in oil rents and labor productivity. Temporary resource-related income should therefore not be treated as a substitute for investment in innovation, infrastructure, workforce skills, technological upgrading, service-sector productivity, energy efficiency, and competitive productive sectors. Demographic policy should also consider labor-force participation, lifelong learning, migration management, and the retention and productive integration of skilled workers. These broader priorities are supported by the regional literature (Bilenko, 2022; Alcalá-Ordóñez *et al.*, 2023).

For the MENA countries, the statistically insignificant complete MENA oil-rent association and the economy-wide labor productivity measure mean that the present estimates do not support treating resource revenues alone as a reliable short-run source of higher economy-wide labor productivity. The recommendations concerning transparent public investment, infrastructure, technological adoption, private-sector competition, employment-intensive non-oil activities, female labor-force participation, and the alignment of education with labor-market demand are broader policy considerations grounded in the cited regional literature. Institutional reforms should be evaluated through concrete intermediate outcomes, including regulatory implementation, market access, business formation, competition, and the quality of public investment (International Labour Organization, 2022; World Bank, 2024b; Haque and Tausif, 2025).

For both regional groups, the insignificant short-run WGI and HCI coefficients indicate that the present models do not identify immediate associations between these aggregate indicators and GDP per employed person. This result should not be interpreted as evidence that institutional and human-capital policies are ineffective. Rather, the relevant transmission mechanisms are gradual and depend on complementary investment, implementation capacity, technological conditions, and labor-market structures. Short-term policy evaluation should therefore incorporate intermediate indicators of regulatory performance, innovation, workforce skills, labor force participation, firm creation, diversification, and public investment quality alongside aggregate productivity measures.

6. CONCLUSION

This study examined the conditional associations between institutional quality, human capital, demographic structure, resource dependence, and labor productivity in 11 Central and Eastern European and MENA countries. The descriptive dataset covers 2010–2022, while the econometric specifications use variable-specific balanced subsamples reflecting the availability of oil rent and Human Capital Index data. Economic resilience was used as an interpretative framework rather than as a directly estimated outcome. The empirical analysis, therefore, focused on labor productivity as one component of the productive capacity through which economies may absorb shocks, adapt their structures, and support subsequent recovery.

The principal first-difference model does not identify a statistically significant association between annual changes in the aggregate WGI measure and annual changes in labor productivity. The corresponding WGI coefficients also remain statistically insignificant in the lagged first-difference and ADR-exclusion specifications. The supplementary analysis of the six individual WGI dimensions leads to the same general conclusion. None of the dimensions is statistically significant at the 5% level. Government Effectiveness is marginally significant in the unadjusted test, but this result does not remain significant after correction for multiple testing. The findings therefore provide no robust evidence that short-run changes in either aggregate institutional quality or a specific governance dimension are systematically associated with annual within-country productivity changes.

The Human Capital Index coefficient is also statistically insignificant in the auxiliary two-way fixed-effects specification. This result should not be interpreted as evidence that human capital is unimportant for productivity. The HCI analysis is based on only 44 observations from four non-consecutive years and contains limited within-country temporal variation. The result indicates more narrowly that the available non-consecutive HCI observations do not provide sufficient evidence of a stable within-country association with labor productivity. Human capital may operate through gradual changes in education quality, health, occupational skills, technological capabilities, labor-force participation, and the matching of workers to productive employment – channels that are not adequately captured by a small number of aggregate HCI observations.

The young dependency ratio is the only explanatory variable that is statistically significant at the 5% level in both the principal and lagged first-difference models. The recurring positive coefficient indicates a short-run conditional association but does not establish that a larger population aged 0–14 directly increases labor productivity. The relationship may reflect concurrent changes in fertility, migration, labor-force composition, employment selection, urbanization, and sectoral transformation. Its regional significance is also sensitive to sample composition.

The oil-rent estimates are also dependent on model design. The coefficient is positive and marginally significant in the principal first-difference model, statistically insignificant in the lagged first-difference model, and marginally significant in the specification excluding ADR. These results do not provide robust evidence that annual changes in resource rents improve underlying productive capacity.

The regional first-difference analysis yields a positive complete MENA ADR association at the 5% level. However, the corresponding interaction coefficient is not statistically significant, and the result is highly sensitive to sample composition. The complete MENA oil-rent association is statistically insignificant. The estimates, therefore,

do not establish stable differences between the CEE and MENA slopes or distinct regional causal mechanisms.

These findings both converge with and qualify the conclusions of previous studies. The absence of a statistically significant short-run WGI association differs from research linking institutional quality to economic growth and resilience in European economies (Filip and Setzer, 2025; Aizenman and Saadaoui, 2026). This difference does not necessarily indicate a contradiction in the underlying economic mechanisms. The cited studies examine broader regional variation, medium-term outcomes, or identification strategies to capture more persistent institutional effects, whereas the present analysis focuses on annual within-country changes. The results suggest that the longer-term contribution of institutional quality documented in the literature may not be observable through contemporaneous annual movements in an aggregate governance indicator.

The insignificant HCI coefficient also contrasts with cross-country and firm-level evidence linking education, health, workforce training, and human resource development to higher productivity (Abdelgany and Saleh, 2022; Subramony *et al.*, 2022; Naz *et al.*, 2025). However, the comparison is limited because the present HCI model contains only four non-consecutive observations per country and does not capture the gradual accumulation of occupational skills, technological capabilities, or workforce competencies. By contrast, the weak and unstable oil-rent results are consistent with studies showing that resource revenues do not automatically generate diversified productive capacity and that their effects depend on institutional quality, productive investment, entrepreneurship, and economic diversification (Demir *et al.*, 2025; Haque and Tausif, 2025). The positive ADR association is not directly comparable with the cited demographic literature, which emphasizes labor-force participation, migration, informality, and stages of demographic transition rather than a direct productivity effect of the young dependency ratio (International Labour Organization, 2022). It should therefore be treated as a sample-specific short-run association rather than as confirmation of a general demographic mechanism.

Against the background of the existing literature, the study's main contribution is to demonstrate that relationships identified in broad cross-country or medium-term analyses do not necessarily remain observable when empirical identification is restricted to annual within-country changes. The use of first differences reduces the risk of spurious inference associated with the unit-root indication for log labor productivity. At the same time, the lagged and variable-exclusion first-difference specifications assess whether the findings depend on temporal ordering or the inclusion of the demographic variable. The exclusion of GDP per capita from the principal specifications avoids treating the partially mechanical overlap between GDP per capita and GDP per employed person as an independent productivity mechanism. The calculation of complete regional associations, separate regional estimations, leave-one-country-out checks, and disaggregated WGI models further shows that apparently significant individual coefficients may not represent stable relationships once model structure, multiple testing, and sample composition are considered.

Within the economic-resilience framework, the findings do not imply that resilience is determined exclusively by either fixed structural conditions or short-term policy action. This interpretation is consistent with research that conceptualizes economic resilience as a context-dependent capacity shaped by pre-existing productivity, sectoral structure, institutional arrangements, and intersectoral linkages rather than by the immediate movement of any single aggregate indicator (Giannakis and Mamuneas, 2022; Giannakis *et*

al., 2024; Capoani *et al.*, 2025). Institutional quality, human capital, demographic conditions, productive structures, and resource allocation may shape resilience over different time horizons. The absence of significant annual WGI and HCI coefficients suggests that improvements in institutions and human capital are unlikely to produce immediate changes in aggregate GDP per employed person. Their contribution may emerge gradually through regulatory implementation, innovation, workforce skills, investment quality, business development, technological adoption, sectoral diversification, and labor-market adjustment. Economic resilience should therefore be understood as structurally conditioned yet policy-sensitive, shaped by cumulative and complementary changes rather than by immediate movements in aggregate indicators.

The policy implications differ across the two regional contexts. For the CEE countries, productivity and resilience strategies should emphasize technological upgrading, service-sector efficiency, energy efficiency, workforce adaptation, lifelong learning, and the productive integration of migrant and domestic workers. Temporary resource-related income should not substitute for investment in innovation, infrastructure, skills, and competitive productive sectors. For the MENA countries, the statistically insignificant association between oil rents and the economy as a whole highlights the need to transform resource revenues into diversified productive capacity through transparent public investment, infrastructure, technological adoption, private-sector competition, employment-intensive non-oil activities, and stronger links between education and labor-market demand. In both regional groups, the short-run performance of institutional and human-capital reforms should be evaluated using intermediate indicators – such as regulatory implementation, business formation, innovation, workforce participation, skill development, diversification, and public-investment quality – rather than only contemporaneous changes in aggregate labor productivity. These recommendations combine the empirical patterns identified in the study with mechanisms documented in the regional literature.

These conclusions are subject to several methodological and data limitations. The empirical design does not estimate a long-run equilibrium or cointegrating relationship; therefore, the substantive findings are confined to annual first-difference associations. The sample contains only 11 countries and a relatively short time span, while HCI has sparse, non-consecutive coverage. The aggregate and individual WGI measures remain perception-based proxies, and commodity price movements may affect labor productivity, measured as GDP per employed person. Country-clustered inference is based on a limited number of clusters, while endogeneity, reverse causality, measurement error, and omitted time-varying factors cannot be eliminated. Future research should use broader samples, longer time series, richer annual measures of education, health, workforce skills, institutional implementation, migration, labor force participation, and demographic structure, as well as sectoral or physical output productivity indicators. Larger panels could support dynamic specifications, carefully controlled GMM estimation, panel cointegration analysis, instrumental-variable strategies, natural experiments, or other quasi-experimental approaches that can distinguish short-run adjustment from long-run causal mechanisms.

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APPENDIX

A.1. Model diagnostics and residual-dependence checks

A series of diagnostic tests was conducted to assess multicollinearity, within-country serial correlation, groupwise heteroskedasticity, unit-root properties, and residual cross-sectional dependence. The VIF, Wooldridge, modified Wald, and level IPS tests were conducted on the balanced 2010–2021 subsample, which contained 132 observations across 11 countries. The first-difference IPS tests use annual changes for 2011–2021 and contain 121 observations. The Human Capital Index was not included in the diagnostic sample because it is available for only four non-consecutive years. Residual cross-sectional dependence was examined for the principal first-difference model, the lagged first-

difference model, the first-difference model without ADR, and the regional interaction first-difference model.

Table A.1 – Diagnostic tests and residual-dependence checks

Test or specification	Statistic or VIF	p-value	Interpretation
Multicollinearity diagnostics			
log(GDP per capita)	8.29	–	Relatively high; consistent with definitional overlap with labor productivity
Young dependency ratio (ADR)	3.48	–	No critical multicollinearity
Oil rents (% of GDP)	4.80	–	No critical multicollinearity
Aggregate WGI measure	4.12	–	No critical multicollinearity
Within-country error structure			
Wooldridge test for first-order serial correlation	F = 100.12	<0.001	Serial correlation detected
Modified Wald test for groupwise heteroskedasticity	$\chi^2 = 128.57$	<0.001	Groupwise heteroskedasticity detected
Panel unit-root diagnostics			
IPS test: log labor productivity, level	2.713	0.997	Unit-root null is not rejected
IPS test: log labor productivity, first difference	−6.859	<0.001	Unit-root null is rejected
IPS test: log GDP per capita, level	2.284	0.989	Unit-root null is not rejected
IPS test: log GDP per capita, first difference	−6.863	<0.001	Unit-root null is rejected
IPS test: aggregate WGI measure, level	−3.030	0.001	Unit-root null is rejected
IPS test: aggregate WGI measure, first difference	−8.271	<0.001	Unit-root null is rejected
IPS test: young dependency ratio, level	4.620	>0.999	Unit-root null is not rejected
IPS test: young dependency ratio, first difference	1.229	0.891	Unit-root null is not rejected
IPS test: oil rents, level	1.183	0.882	Unit-root null is not rejected
IPS test: oil rents, first difference	−3.916	<0.001	Unit-root null is rejected
Residual cross-sectional dependence			
Pesaran CD test: first-difference model	–	0.054	Cross-sectional independence is not rejected at the 5% level; the result is close to the threshold
Pesaran CD test: lagged first-difference model	–	0.110	Cross-sectional independence is not rejected
Pesaran CD test: first-difference model without ADR	–	0.035	Cross-sectional independence is rejected at the 5% level; residual dependence remains
Pesaran CD test: regional interaction first-difference model	–	0.059	Cross-sectional independence is not rejected at the 5% level; the result is close to the threshold

Notes: VIF, Wooldridge, modified Wald, and IPS diagnostics in levels are based on the balanced 2010–2021 subsample comprising 132 country-year observations for 11 countries. The first-difference IPS tests use annual changes for 2011–2021 and comprise 121 observations. The baseline IPS tests include individual intercepts and no augmented ADF lags. $W_{\bar{t}}$denotes the standardized IPS statistic, and the reported p-values are one-sided. The null

hypothesis is that all panels contain a unit root, whereas the alternative hypothesis is that at least some panels are stationary.

One-lag sensitivity checks produced the same inference for log labor productivity and log GDP per capita but changed some conclusions for the aggregate WGI measure, the young dependency ratio, and oil rents. Specifically, with one augmented ADF lag, the unit-root null was not rejected for the aggregate WGI measure in levels ($p = 0.245$), was rejected for the first difference of the young dependency ratio ($p = 0.023$), and was not rejected at the 5% level for the first difference of oil rents ($p = 0.080$). Given the small number of countries and the short time dimension, the unit-root results are interpreted cautiously. They are not treated as evidence that all variables share a common order of integration.

The VIF results are calculated for the preliminary set of explanatory variables that includes log GDP per capita. GDP per capita is excluded from the principal and first-difference robustness specifications due to its largely mechanical relationship with labor productivity. The Pesaran CD results refer to the residuals of the principal first-difference model, the lagged first-difference model, the first-difference model without ADR, and the regional interaction first-difference model.

Variance inflation factors were used to assess linear dependence among the explanatory variables. The highest VIF is observed for log GDP per capita (8.29). This value is consistent with the close definitional relationship between GDP per capita and labor productivity, since both indicators contain GDP in the numerator. GDP per capita is therefore excluded from the regression specifications used for substantive inference. The VIF values for the young dependency ratio, oil rents, and the aggregate WGI measure remain below 5. These results do not indicate critical multicollinearity among the explanatory variables retained in the principal models.

The Wooldridge test rejects the null hypothesis of no first-order serial correlation ($F = 100.12$; $p < 0.001$). The modified Wald test also rejects the null hypothesis of homoskedastic country-specific error variances ($\chi^2 = 128.57$; $p < 0.001$). These findings indicate the presence of both within-country serial correlation and groupwise heteroskedasticity. Standard errors are consequently clustered at the country level in the principal and supplementary regression specifications. Because the sample contains only 11 country clusters, statistical inference is based on a t-distribution with 10 degrees of freedom, and results close to conventional significance thresholds are interpreted cautiously.

The IPS diagnostics provide mixed and lag-sensitive evidence regarding the time-series properties of the explanatory variables. The results are comparatively stable for log labor productivity but change across lag structures for the aggregate WGI measure, the young dependency ratio, and oil rents. Given the short time dimension and the limited power of panel unit-root tests in small samples, the diagnostics do not establish a common order of integration for the full set of variables.

Consequently, the analysis does not estimate a long-run relationship in levels and does not require a cointegrating interpretation. The principal and robustness models are expressed in annual first differences and are used exclusively to examine short-run within-country co-movements.

Residual cross-sectional dependence was examined using the Pesaran CD test for each first-difference specification. In the principal first-difference model, the null hypothesis of residual cross-sectional independence is not rejected at the 5% level ($p = 0.054$), although the result is close to the conventional significance threshold. Cross-sectional independence is also not rejected in the lagged first-difference model ($p = 0.110$) or in the regional interaction first-difference model ($p = 0.059$), with the latter result likewise remaining relatively close to the 5% threshold.

By contrast, the null hypothesis is rejected in the first-difference specification excluding the young dependency ratio ($p = 0.035$), indicating that residual cross-country dependence remains in this model. The specification without ADR is therefore retained only as an auxiliary sensitivity check and is not used as the principal basis for substantive inference. Taken together, the diagnostics do not indicate residual cross-sectional dependence at the 5% level in most specifications, but they reveal a remaining concern in the model without ADR and borderline results in the principal and regional interaction models. Estimates from models with Pesaran CD p-values close to the 5% threshold are therefore interpreted with caution.

Taken together, the diagnostic results identify several features that must be considered in estimation and interpretation: definitional overlap involving GDP per capita, serial correlation, groupwise heteroskedasticity, mixed evidence on unit roots for the variables expressed in levels, and possible residual cross-country dependence. The empirical strategy addresses these concerns by excluding GDP per capita from the regression specifications, using first differences as the principal design, including year fixed effects, clustering standard errors at the country level, and comparing the results across the principal, lagged first-difference, ADR-exclusion, and regional-interaction specifications. These procedures reduce specific sources of misspecification but do not eliminate reverse causality, measurement error, omitted time-varying factors, or limitations associated with the small number of countries. These remaining constraints are discussed in Sections 3.5 and 6.

A.2. Auxiliary Human Capital Index specification

The Human Capital Index is analyzed in a separate two-way fixed-effects specification because comparable HCI observations are available only for 2010, 2017, 2018, and 2020. The model includes country and year fixed effects and country-clustered standard errors. Because the resulting sample contains only 44 country-year observations and provides limited within-country temporal variation, the estimates are treated as exploratory. Because HCI observations are available for only four non-consecutive benchmark years, this auxiliary model cannot be interpreted as either an annual short-run specification or a long-run cointegrating relationship. It is retained only as exploratory supplementary evidence and is not used as a basis for the principal substantive conclusions.

Table A.2 – Auxiliary two-way fixed-effects specification with HCI

Dependent variable: log(Labor productivity)

Variable	Coefficient (standard error)	p-value
Human Capital Index (HCI)	0.1619 (0.9102)	0.862
Young dependency ratio (ADR)	0.0187 (0.0157)	0.262
Oil rents (% of GDP)	0.0101* (0.0051)	0.074
Country fixed effects	Yes	–
Year fixed effects	Yes	–
Observations	44	–
Countries	11	–
Period	2010, 2017, 2018, and 2020	–
Within R-squared	0.625	–
Pesaran CD test, p-value	0.273	–

*Notes: Country-clustered standard errors are reported in parentheses. The reported p-values are based on a t-distribution with 10 degrees of freedom, reflecting the 11 country clusters. HCI denotes the Human Capital Index, and ADR denotes the young dependency ratio. Country and year fixed effects are included. The model is estimated using four non-consecutive years. *** p < 0.01, ** p < 0.05, * p < 0.10.*

The HCI coefficient is positive but statistically insignificant (β = 0.1619; p = 0.862). The estimate, therefore, provides no evidence of a systematic within-country association between HCI and labor productivity in the available four-year subsample. This result should not be interpreted as evidence that human capital is economically irrelevant, because the HCI series provides very limited temporal variation and the model is based on only 44 observations.

The young dependency ratio is also statistically insignificant in this specification. The coefficient on oil rents is positive and statistically significant only at the 10% level (β = 0.0101; p = 0.074). Given the small, non-consecutive sample, this marginal association is not considered a robust result. The Pesaran CD test does not reject the null of residual cross-sectional independence at the 5% level (p = 0.273), although the short four-period structure limits the reliability of this diagnostic.

A.3. Separate regional first-difference estimates

To supplement the pooled regional interaction analysis reported in Table 5, the principal first-difference specification was estimated separately for the CEE and MENA subsamples. The separate models allow the year effects and coefficient estimates to vary independently across the two regional groups. Each model relates annual changes in log labor productivity to annual changes in the aggregate WGI measure, the young dependency ratio, and oil rents.

The separate regional models are reported only as supplementary sensitivity checks. They do not constitute formal tests of whether the coefficients differ statistically between the CEE and MENA groups. Cross-regional differences are evaluated using the pooled interaction specification reported in Table 5.

Table A.3 – Separate regional first-difference estimates for the CEE and MENA subsamples

Dependent variable: annual change in log(Labor productivity)

Variable	CEE coefficient (SE)	p-value	MENA coefficient (SE)	p-value
Δ WGI	0.0020 (0.0362)	0.957	−0.0705 (0.0333)	0.102
Δ Young dependency ratio (ADR)	−0.0122 (0.0229)	0.617	0.0167 (0.0094)	0.151
Δ Oil rents (% of GDP)	0.0385 (0.0238)	0.166	0.0018 (0.0019)	0.413
Year fixed effects	Yes	–	Yes	–
Observations	66	–	55	–
Countries	6	–	5	–
Period	2011–2021	–	2011–2021	–
R-squared	0.634	–	0.517	–
Pesaran CD test, p-value	0.033	–	0.030	–

Notes: Country-clustered standard errors are reported in parentheses. Both specifications are estimated in annual first differences and include year fixed effects. The CEE model contains six country clusters, and its reported coefficient p-values are based on a t-distribution with five degrees of freedom. The MENA model contains five country clusters, and its reported coefficient p-values are based on a t-distribution with four degrees of

freedom. The separate regional models do not provide formal tests of the differences between the CEE and MENA coefficients. Such differences are evaluated using the pooled interaction model reported in Table 5. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

None of the explanatory variables is statistically significant at the 5% level in either regional subsample. In the CEE model, the coefficients on annual changes in WGI and oil rents are positive, whereas the coefficient on the young dependency ratio is negative; however, none of these associations is statistically significant. In the MENA model, the coefficient on the young dependency ratio is positive, while the WGI coefficient is negative and close to, but above, the 10% significance threshold. The oil-rent coefficient is positive but not statistically significant.

The separate estimates should be interpreted with caution because they are based on only six CEE countries and five MENA countries. Moreover, the Pesaran CD tests reject the null hypothesis of residual cross-sectional independence in both the CEE model ($p = 0.033$) and the MENA model ($p = 0.030$). The separate regional estimates are therefore retained only as supplementary sensitivity checks and are not used as the principal basis for regional inference. The pooled first-difference interaction model in Table 5 remains the appropriate basis for assessing differences between the CEE and MENA slopes.

A.4. Leave-one-country-out sensitivity analysis

A leave-one-country-out analysis was conducted to assess whether any single country disproportionately influences the regional first-difference results. The pooled first-difference interaction model was re-estimated 11 times, with one country excluded in each iteration. The complete MENA associations were calculated as the sums of the corresponding CEE coefficients and MENA interaction coefficients.

The analysis focuses on the full set of MENA associations with annual changes in the young dependency ratio and oil rents. HCI is not included because its auxiliary specification is based on only four non-consecutive years and is not comparable with the annual first-difference regional model.

Table A.4 – Leave-one-country-out sensitivity of the complete MENA associations

Excluded country	Complete MENA ADR effect: coefficient (p-value)	Complete MENA oil-rent effect: coefficient (p-value)	Pesaran CD test, p-value
Full sample	0.0173 (0.047)	0.0022 (0.106)	0.059
Bulgaria	0.0158 (0.065)	0.0023 (0.112)	0.052
Czechia	0.0171 (0.076)	0.0020 (0.157)	0.077
Hungary	0.0185 (0.046)	0.0022 (0.101)	0.053
Jordan	0.0197 (0.174)	0.0028 (0.016)	0.025
Morocco	0.0211 (0.011)	0.0019 (0.181)	0.070
Poland	0.0168 (0.060)	0.0022 (0.128)	0.042
Romania	0.0159 (0.075)	0.0023 (0.097)	0.050
Saudi Arabia	0.0066 (0.476)	−0.0005 (0.668)	0.062
Slovak Republic	0.0175 (0.049)	0.0018 (0.188)	0.065
Tunisia	0.0194 (0.037)	0.0021 (0.134)	0.065
United Arab Emirates	0.0177 (0.030)	0.0030 (0.003)	0.080

Notes: The full-sample row reproduces the complete MENA associations from the pooled first-difference interaction model reported in Table 5. Each subsequent row reports results obtained after excluding the indicated country. All models use annual first differences, include year fixed effects, and employ country-clustered standard errors. The complete MENA effects and their p-values are calculated using linear-combination tests that account for the variances and covariance of the corresponding main and interaction coefficients. The full-sample estimates contain 11 country clusters, whereas each leave-one-country-out model contains 10 clusters. Because the model is estimated on the pooled sample, excluding either a CEE or a MENA country may affect the estimated complete MENA associations. The final column reports the p-value from the Pesaran CD test for residual cross-sectional dependence.

The complete MENA association for the annual change in the young dependency ratio is sensitive to sample composition. Its coefficient remains positive in all leave-one-country-out specifications, but its p-value ranges from 0.011 after excluding Morocco to 0.476 after excluding Saudi Arabia. The association is statistically significant at the 5% level after excluding Hungary, Morocco, the Slovak Republic, Tunisia, or the United Arab Emirates, but is insignificant in several other specifications.

The complete MENA oil-rent association is also sensitive to sample composition. It becomes statistically significant after excluding Jordan ($\beta = 0.0028$; $p = 0.016$) or the United Arab Emirates ($\beta = 0.0030$; $p = 0.003$). After Saudi Arabia is excluded, the coefficient becomes slightly negative and remains statistically insignificant.

The Pesaran CD results provide an additional reason for caution. Residual cross-sectional independence is rejected at the 5% level after excluding Jordan ($p = 0.025$) or Poland ($p = 0.042$), while the result for Romania is located at the conventional threshold ($p = 0.050$). In the remaining specifications, the null is not rejected at the 5% level, although several p-values remain close to the threshold.

Taken together, the leave-one-country-out results demonstrate that the magnitude and statistical significance of the complete MENA associations are sensitive to sample composition.

A.5. Disaggregated WGI dimension analysis

To examine whether the aggregate WGI measure conceals differences among individual dimensions of institutional quality, the principal first-difference specification was re-estimated separately for each of the six Worldwide Governance Indicators dimensions. In each model, the aggregate WGI measure was replaced with a single dimension, while changes in the young dependency ratio and oil rents were retained as control variables. The six dimensions were not included simultaneously because they capture closely related aspects of governance and may exhibit substantial conceptual and statistical overlap.

None of the six individual WGI dimensions is statistically significant at the 5% level. The coefficient on the change in Government Effectiveness is negative and marginally significant at the 10% level in the unadjusted test ($\beta = -0.0230$; $p = 0.059$). However, this association is no longer statistically significant after adjustment for the six simultaneous dimension-level tests, with a Holm-adjusted p-value of 0.353.

The coefficients on Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, and Control of Corruption are negative but statistically insignificant. The coefficient on Rule of Law is positive but not statistically significant. The variation in signs across the dimensions and the absence of statistical significance after adjustment for multiple testing provide no robust evidence that annual

changes in any specific WGI dimension are systematically associated with short-run changes in labor productivity.

The coefficient on the change in the young dependency ratio remains positive and statistically significant at the 5% level in all six specifications. Its magnitude ranges only from 0.0205 to 0.0210, which is close to the estimate obtained in the principal model using the aggregate WGI measure. The oil-rent coefficient also remains positive and marginally significant at the 10% level in all six models, ranging from 0.0021 to 0.0023.

Table A.5 – First-difference specifications with individual WGI dimensions

Dependent variable: annual change in log(Labor productivity)

Variable	VA	PV	GE	RQ	RL	CC
Change in the respective WGI dimension	−0.0098 (0.0088)	−0.0187 (0.0118)	−0.0230* (0.0108)	−0.0079 (0.0207)	0.0158 (0.0245)	−0.0097 (0.0242)
Unadjusted p-value for the WGI dimension	0.294	0.146	0.059	0.713	0.535	0.696
Holm-adjusted p-value for the WGI dimension	1.000	0.728	0.353	1.000	1.000	1.000
Change in young dependency ratio (ADR)	0.0210** (0.0070)	0.0207** (0.0069)	0.0205** (0.0069)	0.0207** (0.0067)	0.0207** (0.0070)	0.0210** (0.0070)
Change in oil rents (% of GDP)	0.0022* (0.0011)	0.0023* (0.0011)	0.0022* (0.0012)	0.0021* (0.0011)	0.0023* (0.0011)	0.0022* (0.0011)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	121	121	121	121	121	121
Countries	11	11	11	11	11	11
Period	2011–2021	2011–2021	2011–2021	2011–2021	2011–2021	2011–2021
R-squared	0.539	0.543	0.542	0.538	0.539	0.538

*Notes: Each column reports a separate first-difference model. VA denotes Voice and Accountability; PV denotes Political Stability and Absence of Violence/Terrorism; GE denotes Government Effectiveness; RQ denotes Regulatory Quality; RL denotes Rule of Law; and CC denotes Control of Corruption. Country-clustered standard errors are reported in parentheses. The reported unadjusted p-values and significance stars are based on two-sided tests using a t-distribution with 10 degrees of freedom, reflecting the 11 country clusters. Holm-adjusted p-values are reported for the six individual WGI-dimension coefficients to account for multiple testing. All specifications include year fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

The disaggregated results, therefore, reinforce the principal finding obtained using the aggregate institutional-quality measure. The analysis does not identify a robust short-run within-country association between annual changes in institutional quality and labor productivity. The marginal unadjusted result for Government Effectiveness is treated as exploratory rather than as evidence of a dimension-specific effect, particularly given the small number of country clusters and the multiple comparisons involved.