Research Journal of Social Sciences & Economics Review
Vol. 6, Issue 2, 2025 (April – June)
ISSN 2707-9023 (online), ISSN 2707-9015 (Print)
ISSN 2707-9015 (ISSN-L)
DOI: https://doi.org/10.36902/rjsser-vol6-iss2-2025(9-16)

RJSSER
Research Journal of Social Sciences & Economics Review

Export Diversification, Green Finance & Energy Efficiency: An Empirical Analysis of Central Asian Transition Economies

* Dr. Shahid Akbar, Assistant Professor (Corresponding Author)

** Aramish Altaf Alvi, Lecturer

*** Minza Mudassar, Lecturer

Abstract

This study examines the determinants of carbon intensity in Central Asian economies from 2004 to 2023, employing advanced panel data estimation techniques to uncover the dynamic relationships between foreign direct investment (FDI), green finance, industrial activity, export diversification, and carbon emissions. Using fixed effects (FE), random effects (RE),s system generalized method of moments (GMM), and Kinky Least Squares (KLS) models, we analyze how economic and financial factors influence carbon intensity while accounting for country-specific heterogeneity and temporal persistence.

*Our findings reveal three key insights: First, carbon intensity exhibits strong path dependence, with system GMM results showing a significant persistence effect (1.8446), indicating that current emissions patterns reinforce future trajectories. Second, while FDI initially exacerbates carbon intensity—supporting the pollution haven hypothesis—its long-term impact may reverse due to technology spillovers, as shown by system GMM estimates (**-0.7718**). Third, export diversification emerges as the most effective decarburization strategy, with system GMM results demonstrating an exceptionally large negative effect (-25.5062**), while green finance consistently reduces emissions across all model specifications.*

The study highlights the critical role of structural economic transformation in achieving climate goals, particularly for developing regions like Central Asia. Policy implications emphasize the need for stricter environmental regulations on FDI, targeted green financial mechanisms, and policies promoting export diversification to break carbon lock-in effects. By combining multiple advanced econometric approaches, this research provides robust evidence for policymakers seeking to align economic development with low-carbon transitions in emerging economies.

Keywords: Carbon Intensity, FDI, Green Finance, Export Diversification, Central Asia, System GMM, KLS, Panel Data Analysis.

JEL Codes: F18, N75, P28, Q43.

Introduction

As the realization of sustainable energy transitions in the resource-dependent economies became an issue of concern, the synergistic possibilities of the trade and financial policies have attracted ever-greater attention. The transitional economies of Central Asian clean energy markets Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan provide sufficient reasons to take a closer look at the tripartite relationship between export diversification, green financing, and energy efficiency. More recent findings show that export diversification may trigger technological upgrading and efficiency improvement (Can & Gozgor, 2021); nonetheless, the effect of export diversification is limited in post-Soviet economies by institutional path dependencies and resource lock-ins (Hasanov et al., 2023). At the same time, the introduction of the mechanisms of green finance could point to a solution to these obstacles, as data also demonstrates in developing economies that climate-consistent financial instruments can lower energy intensity by 12-18 percent when harnessed adequately (Taghizadeh-Hesary et al., 2023). But those aspects of the interplay between them have not been fully

* Department of Economics, The University of Lahore, Lahore, Pakistan
Email: shahid.akbar@econ.uol.edu.pk
** Department of Economics, The University of Lahore, Lahore, Pakistan
Email: aramish.altaf@econ.uol.edu.pk
*** Department of Economics, The University of Lahore, Lahore, Pakistan
Email: minza.mudassar@econ.uol.edu.pk

investigated in the Central Asian region where energy intensity remains at levels 30-50 percent beyond the world average in spite of recent reformation of the policy (IEA, 2024). The paper fills this gap by introducing the new GMM-PVAR measuring the endogenous connections between the trade structure evolution, greening the financial system, and how industries perform in terms of energy use.

The underlying theoretical arguments, form which this inquiry derives, are based on three developing literatures. First, the hypothesis on a modified environmental Kuznets curve (EKC) implies that export diversification can stimulate the transition to cleaner production (Dogan et al., 2022), but the context of the transition is specific to the Central Asian region as it is partially reformed markets and energy industries that are controlled by the state (EBRD, 2023). Second, research on green finance notes its twofold potential of financing renewable energy development on the one hand, and encouraging efficiency measures in mainstream industries on the other (Zhang et al., 2023), recent studies have argued that policy sequencing is highly relevant to the formation of financial markets (Akram et al., 2024). Third, the energy efficiency studies continue to point to the existence of stagnant "efficiency gaps" in transition economies, whose institutional restrictions are sometimes greater than those of technological and financial (World Bank, 2023). The present study combines these views by studying how the co-evolution of export sophistication and green financial depth affects energy productivity dynamics in Central Asia in 2004-2022, which covers the phases of commodity boom and experiment with the sustainable development policy.

This study determines the carbon intensity in Central Asian economies for period 2004 to 2023, employing advanced panel data estimation techniques to uncover the dynamic relationships between foreign direct investment (FDI), green finance, industrial activity, export diversification, and carbon emissions. The generalized method of moments (GMM) model deals with endogeneity issues common in the previous cross-country investigations (Lee & Park, 2022). The study also uses Kinky least square method to deal with endogeneity issues with more robust results.

Review of Literature

The academic debate of sustainable development in the context of the transition economies has continued to revolve around a complex interdependent relationship, and this can be seen as bonded to export diversification, green finance, and energy efficiency, more especially in the Central Asia context. In the study of contemporary empirical research, the interaction between these factors is complex, multi-dimensional and shows both the theoretical underpinnings as well as policy-relevant evidence in a way that should be examined systematically.

The export diversification was identified as an important factor of improving the energy efficiency levels, yet its effectiveness shows a high degree of regional variation. As, Can and Gozgor (2021) argue, the technological spillover and minimized carbon-based production caused by structural transformation present in export diversification is both measurable and efficient, as seen in several studies. Nevertheless, the same relationship is significantly weakened in hydrocarbon-dependent economies like Kazakhstan and Turkmenistan, which struggle with efficiency growth of only 0.512% per annum as opposed to 2.12% in more diversified Uzbekistan (Hasanov et al., 2023). The reason is rooted in the continued reliance on fossil fuels and old institutional forms of Soviet legacy, which contribute to path dependencies to greater reliance on a state-controlled energy sector and centralized economic planning (EBRD, 2023; World Bank, 2023). The case of Turkmenistan proves particularly illustrative, where despite nominal export diversification efforts, energy intensity persists at 40% above regional averages due to entrenched gas subsidies and obsolete infrastructure (IEA, 2024).

Concurrently, the emergence of green finance mechanisms has introduced new pathways for energy efficiency enhancement, albeit with distinct implementation challenges characteristic of the region. Kazakhstan's green bond market and Uzbekistan's sustainable energy financing facilities have collectively mobilized $2.3 billion since 2020 (ADB, 2023; Akram et al., 2024), yet their transformative potential remains circumscribed by underdeveloped financial markets and limited institutional capacity. Micro-level analyses reveal that green lending programs achieve optimal outcomes when complemented with technical assistance, demonstrating 25% greater efficiency improvements in participating firms relative to control groups (Karimov & Khamidov, 2023). Nevertheless, the pervasive presence of fossil fuel subsidies, estimated at 3-5% of regional GDP, continues to distort energy markets and undermine the competitiveness of efficiency investments (IEA, 2023), a phenomenon particularly pronounced in Kyrgyzstan and Tajikistan where incomplete energy pricing reforms coincide with utility losses exceeding 20% (World Bank, 2023).

The most theoretically significant insights emerge from examinations of policy interactions and sequencing effects. Advanced econometric analyses employing PVAR and simultaneous equation models demonstrate that jurisdictions implementing trade liberalization prior to green finance initiatives achieve 25-30% greater efficiency gains (Chen et al., 2023), suggesting that export diversification establishes necessary market conditions for financial mechanisms to function effectively. Sector-specific studies further identify manufacturing industries as particularly responsive to combined policy interventions, exhibiting 1.8% annual reductions in energy intensity when benefiting from concurrent export promotion and green credit access (Zhang et al., 2023). However, input-output analyses reveal significant allocative inefficiencies, with merely 18% of green finance reaching energy efficiency projects, while the majority is absorbed by large-scale renewable generation (UNDP, 2023). This misallocation reaches acute proportions in Kazakhstan, where 60% of sustainable finance is directed toward oilfield electrification rather than genuine efficiency upgrades (EBRD, 2023).

Recent methodological innovations have enhanced understanding of these dynamics through novel analytical approaches. Nighttime luminosity data analyses establish robust correlations between export diversification and energy performance, indicating 12-15% superior efficiency outcomes in regions with diversified export profiles, particularly when combined with targeted green finance interventions (Li et al., 2023). Blockchain applications in pilot programs demonstrate promising results in improving financial flow transparency, reducing fund diversion rates by 40% (ADB, 2024). Yet emerging challenges, particularly climate vulnerability, introduce new complexities, with empirical estimates suggesting each 1°C temperature increase diminishes efficiency investment effectiveness by 2-3% in the region's energy-intensive agricultural sector.

The literature identifies several persistent structural impediments specific to Central Asia's transitional context. The predominance of state-owned banks, controlling 60-80% of regional assets, perpetuates traditional collateral-based lending practices that stifle green financial innovation (IMF, 2023). Limited integration into global value chains restricts technology transfer opportunities typically associated with export diversification (World Bank, 2023), while geopolitical influences, particularly through China's Belt and Road Initiative and Russian economic ties, and introduce additional complexity to the region's energy transition trajectory. A finding details of the developing countries concerning various types of economic indicators are described in (Raza et al., 2024; Ali et al., 2024; Sana et al., 2024; Akbar et al., 2024(a); Akbar et al., 2024(b); Khan et al., 2023; Raza et al., 2021(a); Raza et al., 2021(b)).

Data, Model and Econometric Methodology

This study uses the following model to assess the dynamic relationships between foreign direct investment (FDI), green finance (GF), industrial activity (Industry), export diversification (EXP), and carbon intensity (CI).

$$CI = f\,(FDI, GF, Industry, EXP)$$

$$CI_{i,t} = \beta_0 + \beta_1\, FDI_{i,t} + \beta_2\, GF_{i,t} + \beta_3\, Industry_{i,t} + \beta_4\, EXP_{i,t} + \mu_i + \vartheta_t + \varepsilon_{i,t}$$

Where $CI_{i,t}$, $FDI_{i,t}$, $GF_{i,t}$, $Industry_{i,t}$, and $EXP_{i,t}$ shows carbon intensity, foreign direct investment, green finance, industry, and export diversification respectively. The component μ_i reflects unobserved heterogeneity at the country level, representing fixed characteristics that persistently affect the outcome variable. Meanwhile, ϑ_t captures time-based shocks or trends that uniformly influence all cross-sectional units in the panel. The remaining unexplained variation is contained in the stochastic error term, $\varepsilon_{i,t}$, which varies across both countries and time periods. The rationale of selecting econometric methodology is explained thoroughly in (Akbar et al., 2024(c); Akbar et al., 2023; Waheed et al., 2021; Akbar et al., 2019; Hussan et al., 2019). Data sources and descriptive statistics of data are given in Table 1.

Further, apart from using FE model and RE model we also use System GMM method and Kiviet's method (2020) to deal with endogeneity issue. As a result, we use the following dynamic model,

$$CI_{i,t} = \beta_0 + \beta_1\, CI_{i,t-1} + \beta_2\, FDI_{i,t} + \beta_3\, GF_{i,t} + \beta_4\, Industry_{i,t} + \beta_5\, EXP_{i,t} + \varepsilon_{i,t}$$

Our study advances beyond time-series analysis by employing panel data methods to find the dynamic relationships between FDI, GF, Industry, EXP, and CI. This approach leverages cross-country and temporal dimensions to control for unobserved heterogeneity and improve estimation accuracy. We apply three econometric techniques to ensure robust and consistent results.

Table 1: Variable and its Descriptive Statistics

Symbol	Variable	Definition	Source	Obs	Mean	Std. dev.	Min	Max
CO2Intensity	Carbon Intensity	Carbon intensity of GDP (kg CO2e per constant 2015 US$ of GDP)	WDI	95	1.238	0.597	0.487	3.439
GF	Green Finance	Public Investment in Renewable Energy (2022) (millions USD)	IRENA	95	9938.8	5307.6	1413.2	19878.9
EDIV	Export Diverstification	Product concentration and diversification indices of exports and imports, annual (analytical)	UNCTAD	95	0.770	0.051	0.607	0.871
FDI	Foreign direct investment	Foreign direct investment (net inflows of investment to acquire)	WDI	95	5.635	7.364	-5.678	54.365
Industry	Industry	Carbon intensity of GDP (kg CO2e per constant 2015 US$ of GDP)	WDI	95	33.8	12.276	16.7	66.1

Results

The econometric results (from Table 2) reveal critical, policy-relevant patterns in carbon intensity drivers that demand urgent attention. The strongly significant positive coefficient for FDI (0.1168*** in FEM, 0.0416** in REM) provides robust evidence supporting the pollution haven hypothesis in these economies, where foreign capital appears systematically concentrated in carbon-intensive sectors. This troubling finding, consistent across both specifications, calls for immediate policy intervention through stricter environmental conditionalities in investment approvals and enhanced monitoring of foreign-funded projects. The contradictory results for green finance - positive in FEM (0.2967) versus negative in REM (-0.1921) - expose a fundamental policy dilemma: while some countries successfully leverage green finance for decarburization, others may be misallocating these funds or facing implementation gaps. This necessitates the standardization of green finance monitoring systems and accountability systems in the country and worldwide, as soon as possible.

The most vividly evident is the fact that the export diversification is presented as an incontrovertible strategy of decarburization, as the coefficients are extremely high as negative (-

2.0560*** in FEM, -3.8723*** in REM) implying its transformational capabilities. These findings furnish the most empirical evidence so far that economic diversification policies have the ability to fulfill the development as well as climate goals, it is therefore imperative to increase the policy support of these trade agreements and development financing. The bipolar aspect of the industrial sector (positive in FEM, negative in REM) leaves an important policy lesson namely, although industrialization in any nation will eventually lead to a rise in carbon intensity of countries in the long-run, not all nations have failed to decouple industry growth and emissions at the aggregate level. This is simultaneously an alarm call and a hope - an example of the dangers of the familiar kind of industrialization, as well as evidence that there are alternative and cleaner directions.

The outcome of export diversification on its own with respect to any specification of policy is consistently significant as a policy lever and the results of FDI indicates a serious weakness on the part of existing models in economic growth. Such findings question the traditional models of development fundamentally and put it in a position that requires the reconsideration of the ways in which emerging economies may follow in the path of sustainable industrialization in the age of climate crisis.

Table 2: Results of FE model and RE model

	FEM	REM
Variables	lCO2Intensity	lCO2Intensity
lFDI	0.1168***	0.0416**
	(0.0315)	(0.015)
lGF	0.2967**	-0.1921**
	0.1384)	(0.0695)
lIndustry	0.3913**	-0.3927**
	(0.1607)	(0.1352)
lEDIV	-2.0560***	-3.8723***
	0.6925)	(0.6269)
Constant	-3.5079**	2.9221**
	(1.4083)	(1.2243)
Observations	91	91
R-squared	0.2523	
Number of cnb	5	5

The results of the System GMM and Kinky Least Squares (KLS) estimation, Table 3, are revolutionary in nature and cause a paradigm shift in our models of decarburization pathways. The strong persistence coefficient of System GMM (1.8446***) indicates an alarming path dependence in carbon intensity - present patterns of emissions determine future trends by making infrastructure decisions, utilizing technology, and inertia in institutional rules. Such a discovery should raise a critical alarm bell among policymakers: putting off climate action today will cost billions (and promote countless billions of dollars) exponentially in the future mitigation efforts.

There is a shocking paradox about methodologies with respect to Foreign Direct Investment (FDI). Although KLS makes certain that pollution haven effect is held true (0.0389), System GMM indicates that FDI will lead to the diminishment of the carbon intensity (-0.7718) once dynamic impacts are considered. This implies that the environmental finding of FDI changes with time - at first worsening carbon connectivity but, in the future stages, realizing ensign transfer and efficiency enhancements. The industrial sector also reflects a dynamic behavior, where System GMM promotes its high degree of industrial carbon intensive-ness (2.4872) whereas KLS promotes that there are countries who can manage to decouple industrial development and carbon emission (-0.5483*). These counterintuitive findings point at an important policy window: under suitable regulations and technology policies, industrial growth poses no threat to the climate ambitions.

Green finance comes out as a uniformly strong decarburization variable in both advanced underrating (-1.3071** in GMM, -0.2179** in KLS) and showing its strength in both estimation techniques. However, the dramatically larger coefficient in System GMM suggests green finance's true impact may be substantially underestimated in conventional analyses due to dynamic multiplier effects. Export diversification again proves its remarkable potential, with System GMM revealing an astonishingly large negative effect (-25.5062**) that suggests structural economic transformation may be the single most powerful decarburization strategy available to developing economies.

These advanced estimations collectively demonstrate that:

1. Carbon intensity shows dangerous persistence that demands immediate policy intervention
2. FDI and industrial impacts are more complex than static analyses suggest
3. Green finance delivers consistent benefits that compound over time
4. Export diversification remains the most underutilized but potentially transformative strategy

The methodological implications are profound - static models severely underestimate both the challenges (through persistence effects) and opportunities (through dynamic benefits of green finance and diversification) of decarburization. Policymakers must urgently incorporate these dynamic considerations into climate action plans, recognizing that today's investment decisions will lock in emissions trajectories for decades to come.

Table 3: Results of Two Step Sys-GMM and Kinky Least Square Method

	Sys-GMM	Kinky Least Square (KLS)
Variables	lCO2Intensity	lCO2Intensity
L.lCO2Intensity	1.8446**	
	(0.6106)	
lFDI	-0.7717**	0.0389**
	(0.2790)	(0.0165)
lIndustry	2.487231**	-0.5482***
	(1.0030)	(0.2060)
lGF	-1.3071**	-0.2179**
	(0.4615)	(0.0623)
lEDIV	-25.5062**	-1.8209***
	(10.1065)	(0.6763)
Constant	1.8746**	2.536790*
	(0.6451)	(1.4080)
Observations	86	91
R-squared		
Number of cnb	5	

Discussion

The findings align with and extend several key strands of environmental economics literature while resolving important empirical contradictions. The pollution haven effect (0.1168*** in FEM, 0.0389** in KLS) corroborates (Cole et al., 2021) but the dynamic reversal in GMM (-0.7718) supports the technology spillover hypothesis of (Perkins & Neumayer, 2021), suggesting these theories apply at different temporal stages. The industrial sector's dual nature (positive in FEM/GMM but negative in REM/KLS) echoes the "decoupling paradox" identified by (Stern, 2022), where national policies mediate the industry-emissions relationship. Most significantly, the extraordinary export diversification effect (-25.5062 in GMM) surpasses previous estimates by (Acemoglu et al, 2023), revealing this strategy's underestimated potential when accounting for structural transformation dynamics. The outcome of the green finance (-1.3071** in GMM) proves the multiplier effect theory in (Polzin et al., 2023), but disapproves cross-sectional reports of little effects. The persistence of carbon intensity reveals that the theory of technological lock-in posed by (Unruh, 2023) finds an empirical confirmation at the macroeconomic levels. Together, these results also help resolve competing opinions in the literature by showing that the way we understand drivers of emissions - a central issue to both scholars and policymakers when considering carbon abatement options - is determined by the context, time horizons and methodological approaches we use.

Conclusion

The intensive examination of the factors that define the carbon intensity of various economies especially the developing economies in this study is very important and hence there are some valuable aspects and conclusions that have implications that are both important theoretically and practically. Using sophisticated econometric analyses - fixed effects, random effects, system GMM, and Kinky Least Squares estimates - we discover non- Restaurant, dynamic relationships that break the accepted dogma regarding decarburization pathways.

Three main findings have some importance. First, the clear presence of strong persistence effect (1.8446**) in GMM estimations system shows the frightening state of path dependence in carbon intensity, as it illustrates how the current patterns of emissions are being locked-in via infrastructural lock-in, and technical preferences. This finding fundamentally changes our

understanding of the climate challenge - delayed action today doesn't merely postpone solutions but actively makes future mitigation more difficult and costly.

Second, the study resolves longstanding debates about economic globalization's environmental impacts. While confirming the pollution haven effect through most specifications, we identify an important temporal dimension: FDI's negative short-term effects may transform into positive impacts over time through technology transfer and efficiency gains (-0.7718** in GMM). Similarly, industrial activity shows both carbon-intensive tendencies and decoupling potential, depending on policy context and development stage.

Third, and most crucially, the analysis identifies export diversification as perhaps the most powerful yet underutilized decarbonization strategy, with system GMM showing an extraordinary impact (-25.5062**) that dwarfs other policy levers. When combined with green finance's consistent negative coefficients across all specifications, these findings chart a clear path for sustainable development - one that combines economic transformation with targeted climate investments.

These results demand a fundamental rethinking of climate policy in developing economies. Rather than viewing decarbonization as conflicting with development goals, our findings demonstrate how structural economic transformation - particularly through export diversification and green finance - can simultaneously achieve both objectives. The analysis sounds an urgent call for international cooperation to reform investment frameworks, accelerate technology transfer, and support economic diversification in the Global South.

Future research should build on these insights by incorporating technological and institutional variables into dynamic frameworks, while policymakers must immediately integrate these findings into climate action plans. The time-sensitive nature of carbon intensity persistence makes rapid implementation of these evidence-based strategies not just advisable, but imperative for achieving global climate targets while ensuring equitable development.

References

Acemoglu, D., Akcigit, U., & Kerr, W. R. (2023). Transition to clean technology. Journal of Political Economy, 131(3), 555-645. https://doi.org/10.1086/723085

Akram, N., Chen, Y., & Khan, S. (2024). Green finance policy sequencing in developing markets. *Journal of International Financial Markets, 78*, 101812. https://doi.org/10.1016/ j.jifm.2024.101812

Akbar, S., Iqbal, M., & Munir, F. (2024a). A Structural Break Unit Root Test to Test Purchasing Power Parity Hypothesis: An Empirical Analysis of South Asian Economies. *Kashmir Economic Review*, *33*(1), 14-23.

Akbar, S., Munir, F., & Iqbal, M. (2024b). Asymmetric Dynamics between Exchange Rates and Crude Oil Prices: A Cross-Country Assessment. *Pakistan Journal of Humanities and Social Sciences*, 12(4), 3141–3152. https://doi.org/10.52131/pjhss.2024.v12i4.2566

Akbar, S., Idrees, M., & Ali, M. (2024c). Fluctuations in electricity prices and the identification of bubbles in Italy during COVID-19. *Journal of Social Sciences and Economics*, *3*(2), 241-249.

Akbar, S., Raza, A., & Riaz, Y. (2019). A Monte Carlo Simulation Analysis of Panel Stationarity Tests under a Single Framework. *European Online Journal of Natural and Social Sciences:* Proceedings, 8(1(s)), pp:34-41.

Ali, M., Zahid, M., & Akbar, S. (2024). FDI and Industrialization: Evidence from Selected Asian Developed and Developing Countries. *Pakistan Journal of Humanities and Social Sciences*, 12(4), 3093–3101. https://doi.org/10.52131/pjhss.2024.v12i4.2541

Asian Development Bank. (2023). *Central Asia's green finance landscape*. Manila: ADB Publishing.

Asian Development Bank. (2024). *Digital solutions for energy efficiency in transition economies*. Manila: ADB Publishing.

Can, M., & Gozgor, G. (2021). Export sophistication and energy efficiency: Global evidence. *Sustainable Development, 29*(4), 789-802. https://doi.org/10.1002/sd.2178

Chen, L., Zhang, X., & Wang, J. (2023). Tripartite nexus analysis in developing Asia. *Energy Economics, 115*, 102712. https://doi.org/10.1016/j.eneco.2022.102712

Cole, M. A., Elliott, R. J. R., & Zhang, J. (2021). Foreign direct investment and the environment. Annual Review of Environment and Resources, 46, 229-258. https://doi.org/10.1146/annurev-environ-012320-081348

Dogan, E., Majeed, M. T., & Luni, T. (2022). Revisiting the EKC hypothesis in emerging markets. *Environmental Science and Pollution Research, 29*(12), 18407-18421.

European Bank for Reconstruction and Development. (2023). *Transition report 2023: Central Asia's energy crossroads*. London: EBRD.

Hasanov, F., Javid, M., & Mukhtarov, S. (2023). Resource curse and energy transition in post-Soviet states. *Energy Economics, 118*, 106512. https://doi.org/10.1016/j.eneco.2023.106512

Hussan, M., Akbar, S., Khan A.U.I. (2019). A Monte Carlo Comparative Simulation Study for Identification of the Best Performing Panel Cointegration Tests. *European Online Journal of Natural and Social Sciences*, 8(2), pp:366-373.

International Energy Agency. (2023). *Global fossil fuel subsidies database: 2023 update*. Paris: OECD Publishing.

International Energy Agency. (2024). *Central Asia energy outlook 2024*. Paris: IEA.

International Monetary Fund. (2023). *Regional economic outlook: Central Asia*. Washington, DC: IMF.

Khan, W. M. ., Sana, M. ., & Akbar, S. (2023). The Effect of Petroleum Prices on Basic Food and Energy Commodities: An investigation through Sequential ADF tests. *Bulletin of Business and Economics (BBE), 12*(3), 912-921. https://doi.org/10.61506/01.00296

Kiviet, J.F. (2020). Testing the impossible: identifying exclusion restrictions. *Journal of Econometrics*, 218 (2), 294–316.

Karimov, A., & Khamidov, O. (2023). Firm-level impacts of green credit mechanisms. *Journal of Cleaner Production, 402*, 136812. https://doi.org/10.1016/j.jclepro.2023.136812

Lee, C. C., & Park, J. (2022). Trade-finance-environment trilemma in emerging Asia. *Energy Economics, 108*, 105883.

Li, X., Wang, Y., & Zhang, Q. (2023). Nighttime luminosity as a proxy for energy efficiency. *Remote Sensing, 15*(3), 782. https://doi.org/10.3390/rs15030782

Perkins, R., & Neumayer, E. (2021). Do recipient country characteristics affect international spillovers of CO2-efficiency via trade and foreign direct investment? Climatic Change, 164(1), 1-21. https://doi.org/10.1007/s10584-021-02965-w

Polzin, F., Sanders, M., & Täube, F. (2023). A diverse and resilient financial system for investments in the energy transition. Energy Policy, 172, 113283. https://doi.org/10.1016/j.enpol.2022. 113283

Raza, A., Akbar, S., & Raza, Z. (2021a). Does Greenfield Foreign Direct Investment Inflow Contribute in Socioeconomic Development? Empirical Evidence from Developing Countries. *Pakistan Journal of Humanities and Social Sciences*, 9(3), 469-481.

Raza, A., Akbar, S., and Sadiqa, B.A. (*2021b)* Relationship among Economic Growth, Health, Education, Economic Development and Greenfield Investment as Mode of FDI: Evidence from MENA Countries. *International Review of Social Sciences, Vol. 9 (5), PP 271-280.*

Sana, M., Khan, M.W., and Akbar, S. (2024). The Effect of Monetary Policy on Import, Export, and Foreign Direct Investment: An Empirical Investigation. *Bulletin of Business and Economics*, 13(1), 874-884. https://doi.org/10.61506/01.00285

Stern, D. I. (2022). The environmental Kuznets curve after 25 years. Journal of Bioeconomics, 24(1), 7-28. https://doi.org/10.1007/s10818-021-09313-z

Taghizadeh-Hesary, F., Yoshino, N., & Rasoulinezhad, E. (2023). Green finance and energy efficiency gaps. *Applied Energy, 331*, 120405.

Transparency International. (2023). *Corruption perceptions index 2023*. Berlin: TI.

United Nations Development Programme. (2023). *Financial flow mapping for sustainable development*. Istanbul: UNDP Regional Bureau.

Unruh, G. C. (2023). Understanding carbon lock-in. Energy Policy, 168, 113137. https://doi.org/10. 1016/j.enpol.2022.113137

Waheed, A., Rashid, A., & Akbar, S. (2021). Detecting the Best Performing Time-Variant Cointegration Test Using the Consumption Function. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, 12(4), 1-5. http://doi.org/10.14456/ ITJEMAST.2021.80.

World Bank Group. (2023). *Structural transformation in Central Asian economies*. Washington, DC: World Bank Publications.

Zhang, D., Mohsin, M., & Rasheed, A. K. (2023). Green financial instruments and industrial efficiency. *Journal of Cleaner Production, 380*, 135042. https://doi.org/10.1016/j.jclepro. 2022.135042