The Long-Run Causal Relationship between Economic Growth, Transport Energy Consumption and Environmental Quality in Asian Countries

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Overview

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Introduction

- Rapid economic growth, the process of industrialization, urbanization, population growth and the growing specialization have accelerated the demand for transport sector. The expansion in transport demand has put pressure on the country's reserves of oil and gas. More than 90% of transport energy consumption is dependent on oil and oil related products (IEA, 2017).
- Transport sector as the largest consumer of petroleum and other liquid fuels, is a major cause of increase in Greenhouse gases (GHG) and other pollutants in atmosphere.
- The International Energy Agency (IEA, 2017) estimates show that the transport sector accounts for about 25% global CO_2 (carbon dioxide) emissions and its contribution relative to other sectors is projected to increase substantially in the near future.

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- Asia is the region of diverse group of countries, with different levels of economic prosperity and energy resource endowment. Transport sector in Asia is rapidly growing and the energy consumption is expected to rise at the rate of 2.9% per annum till 2030.
- China is the largest consumer of transport energy (12.3 quadrillion Btu) followed by India (3.3 quadrillion Btu).
- Like India and China, the other economies of the region also show substantial increase in transport energy demand from 5.5 quadrillion Btu in 2008 to 8.6 quadrillion Btu in 2017.
- CO_2 emissions from transport sector are increasing very rapidly with a growth rate of 2.8% per year. This growth indicates that the total share of CO2 emission will rise from 12.5% in 2005 to 13.7% in 2030.

Significance of the Study

- Number of empirical studies are available on the nexus between energy consumption, economic growth and environmental quality (e.g., Ajmi et al., 2015; Heidari et al. 2015; Arvin et al., 2015; Nasreen et al., 2017; Saidi et al. 2018; Nasreen et al., 2018).
- There are only a few studies in the case of Asian countries (Timilsina and Shrestha 2009; Chandran and Tang, 2013; Mustapa and Bekhet, 2015) that examine a link between transport energy and environmental quality.
- Our study is an attempt to fill the gap in energy-environment literature by examining the causal link between transport energy consumption, environmental quality and income growth in the case of Asian countries.
- We use latest panel data methodology that efficiently address the issue of heterogeneity and cross-country correlation.

Methodology

- **Econometric Model**
- Following, Hossain, (2011) and Chandran and Tang, (2013) the econometric model is

$$\mathrm{EQ}_{it} = \gamma_0 + \varphi_1 \mathrm{EG}_{it} + \varphi_2 \mathrm{TE}_{it} + \varphi_3 \mathrm{EP}_{it} + \mu_i + \varpi_{it}$$

Variables	Description	Data Sources
EQ	Environmental quality proxied by per capita CO_2 emission in metric tons	World Development Indicators by World Bank
EG	Economic growth measured by per capita GDP in constant 2010 US $	World Development Indicators by World Bank
TE	Transport energy consumption measured by per capita transport energy consumption in kilo tons of oil equivalent	International Energy Agency
EP	Energy prices are measured by real oil prices (simple average of three spot prices, West Taxes Intermediate, Dated Brent and Dubai Fateh deflated by country's consumer price index) in US$ per barrel	British Petroleum's 2018 Statistical Review of World Energy

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Data

- Used from 1980 to 2017

Countries

- 18 Asian countries

Empirical Methodology

- *Cross-sectional Dependence Test*

Pesaran (2004) Cross-sectional Dependence Test

- *Panel Unit Root Test*

Bai and Carrion-i-Silvestre (2009) panel unit root test

- *Panel Cointegration Test*

Westerlund and Edgerton (2008) panel cointegration test

- *Long-run Estimators*

Common correlated effects mean group (CMG) estimators developed by Pesaran (2006) and Augmented Mean Group (AMG) estimators developed by Eberhardt and Teal (2010)

- *Panel Long-run Granger Causality*

Granger causality approach developed by Holtz et al., (1988) and applied by Liddle and Lung (2013)

Results and Discussions

Table-1: Cross-Sectional Dependence Test Results

Variables	Statistics	P-value	abs
EQ_{it}	38.81	0.004	0.597
EG_{it}	99.47	0.000	0.817
TE_{it}	86.97	0.000	0.740
EP_{it}	47.10	0.000	0.421

Notes: Average absolute values (abs) shows correlation coefficient

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Table-2: Panel Unit Root Test Results

Variables	EQ_{it}	EG_{it}	TE_{it}	EP_{it}
Constant and Trend (No break)				
Z	-1.064	-0.515	-0.253	-0.738
P_m	0.288	0.648	-1.120	0.543
P	21.51	25.96	14.76	20.61
Trend Shifts				
Z	0.843	0.338	0.046	0.649
P_m	-0.540	-0.772	-0.149	-0.352
P	16.75	21.56	18.44	16.98
Z^*	-2.843*	2.065**	-1.970**	-3.132*
P_m^*	3.054*	4.873*	2.643*	4.738*
P^*	40.36*	57.72*	46.09*	60.02*

Note: Critical values for the rejection of null hypothesis of unit root at *1%, **5% and ***10% are 2.326, 1.645 and 1.282 respectively for both Z and P_m while for P test, chi-squared critical values are 40.28, 33.92 and 30.81 respectively

Table-3: Westerlund and Edgerton Cointegration Test Results

Model	**No shift**	**Mean shift**	**Regime shift**
Model	No shift	Mean shift	Regime shift
τ_N	-3.432	-4.540	-5.919
P-value	0.045	0.001	0.000
ϕ_N	-1.647	-2.782	-2.802
P-value	0.089	0.023	0.019

Table 4: Long-run Heterogeneous Estimates

(Dependent Variable: EQ)

Country	Variables	CMG			AMG		
		TE_{it}	EG_{it}	EP_{it}	TE_{it}	EG_{it}	EP_{it}
Pakistan	Coefficient	0.776	0.013	-0.345	1.903	0.256	-0.321
	Probability	0.005	0.058	0.065	0.000	0.032	0.098
India	Coefficient	0.541	0.444	-0.547	1.071	0.954	-0.430
	Probability	0.001	0.019	0.005	0.004	0.050	0.650
Bangladesh	Coefficient	0.706	0.230	-0.214	0.084	0.054	-0.123
	Probability	0.070	0.020	0.087	0.963	0.091	0.439
Indonesia	Coefficient	0.463	0.014	-0.830	1.536	1.086	-0.765
	Probability	0.401	0.069	0.076	0.000	0.021	0.054
Iran	Coefficient	0.247	-0.265	-0.650	1.575	1.320	-0.992
	Probability	0.097	0.397	0.004	0.068	0.091	0.231
Japan	Coefficient	0.320	1.053	-0.478	1.314	1.001	-0.864
	Probability	0.201	0.003	0.007	0.010	0.003	0.044
Jordan	Coefficient	0.597	0.748	-0.659	1.677	0.529	-0.213
	Probability	0.012	0.000	0.054	0.012	0.067	0.091

Table 5:conti…….

Country	Variables	CMG			AMG		
		TE_{it}	EG_{it}	EP_{it}	TE_{it}	EG_{it}	EP_{it}
Malaysia	Coefficient	0.516	-0.101	-0.490	0.059	0.114	-0.231
	Probability	0.000	0.082	0.098	0.910	0.870	0.438
Nepal	Coefficient	0.124	0.450	-0.129	0.754	1.094	-0.745
	Probability	0.029	0.469	0.959	0.000	0.004	0.009
Philippines	Coefficient	0.659	0.510	-0.553	0.755	0.455	-0.057
	Probability	0.260	0.012	0.080	0.525	0.097	0.665
Sri Lanka	Coefficient	0.562	0.107	-0.531	0.849	0.669	-0.032
	Probability	0.054	0.432	0.000	0.680	0.765	0.229
Thailand	Coefficient	0.385	0.328	-0.233	1.744	0.654	-0.869
	Probability	0.026	0.076	0.000	0.172	0.046	0.320
Vietnam	Coefficient	0.690	0.920	-0.578	0.412	0.878	-0.992
	Probability	0.005	0.054	0.005	0.022	0.084	0.567
Singapore	Coefficient	0.967	0.345	-0.443	0.785	0.540	-0.969
	Probability	0.010	0.003	0.067	0.007	0.060	0.084
Syria	Coefficient	0.779	0.508	-0.689	1.065	0.753	-0.561
	Probability	0.008	0.040	0.091	0.010	0.062	0.099
Korea Dem.	Coefficient	1.097	0.135	-0.589	1.413	1.490	-0.689
	Probability	0.000	0.075	0.010	0.000	0.004	0.020

Table 5:conti…….

Country	Variables	CMG			AMG		
		TE_{it}	EG_{it}	EP_{it}	TE_{it}	EG_{it}	EP_{it}
Israel	Coefficient	0.801	0.769	-0.833	0.944	0.652	-0.543
	Probability	0.093	0.540	0.349	0.667	0.840	0.999
China	Coefficient	0.721	0.376	-0.491	1.798	0.785	-0.633
	Probability	0.002	0.001	0.024	0.016	0.005	0.090
Panel statistics	Coefficient	0.576	0.464	-0.226	0.630	0.442	-0.382
	Probability	0.001	0.000	0.010	0.006	0.005	0.009

Table 6: Panel Causality Results

Dependent Variables	**Independent Variables**				
	Short-run causality				Long-run causality
	ΔEQ_{it}	ΔEG_{it}	ΔTE_{it}	ΔEP_{it}	ECT_{t-1}
ΔEQ_{it}	-	3.731 (0.023)	4.982 (0.000)	3.879 (0.014)	-0.307** [2.360]
ΔEG_{it}	1.253 (0.846)	-	1.672 (0.324)	4.995 (0.000)	-0.356* [3.051]
ΔTE_{it}	0.965 (0.648)	4.390 (0.006)	-	3.659 (0.036)	-0.262* [2.104]
ΔEP_{it}	1.659 (0.237)	2.991 (0.071)	0.950 (0.533)	-	0.182** [2.531]

Policy Implications

- There should be global coordination to promote clean and sustainable transportation system by encouraging the smart safe driving techniques that may be considered as a significant fuel saving technique.
- The energy efficient technology can play a critical role in both achieving transport energy security, and meeting environmental protection and economic objectives.
- Globalization can play a significant role in generating and transferring resource saving and cleaner production technology from developed to developing countries.
- At national level, Asian countries need to reform their domestic policies that have negative environmental impacts. They further need to correct their existing market failure through economic instruments rather than depend on economic integration and trade liberalization.

Thank you!