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The impact of air transportation, railways transportation, and port container traffic on energy demand, customs duty, and economic growth: Evidence from a panel of low-, middle-, and high -income countries

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ABSTRACT

The transportation sector is highly sensitive due to the excessive use of energy, which though generates sufficient amount of income in terms of customs duty that supports country's per capita income; however, its effect largely the energy security issues across the globe. This study examines the impact of air transportation, railways transportation, and container port traffic on energy demand, customs duty, and economic growth in a panel of 40 heterogeneous countries, which comprises 16 low income & lower middle income (LI&LMI) countries and 24 upper middle & high income (UM&HI) countries for the period of 1990–2015. The study employed panel econometric techniques which account for cross-sectional dependence and heterogeneity. The results show that air-railways transportation has a positive and significant relationship with the energy demand (ED) in aggregated panel, whereas air-railways passengers carried positively influenced ED in LI&LMI countries, and railways transported goods (RT) significantly increases ED in UM&HI countries. Air freight (AF) and railways passengers carried (RPC) escalate customs duty (CUD) in aggregated panel, while RPC positively influences CUD in LI&LMI countries, and AF significantly increases CUD in UM&HI countries. Container port traffic (CPT) positively influenced per capita income (GDPPC) across countries. The causality estimates confirmed the bidirectional relationship, unidirectional, reverse causality, and no causal relationships between the studied variables with different transportation modes. The estimates of impulse response function (IRF) suggest that transportation (except RPC) and growth factors will positively influence ED in aggregated panel while differential impacts of transportation and growth factors will affect CUD over a next 30 years time period. The variance decomposition analysis (VDA) shows that GDPPC will largely influence by ED and least influenced by CUD, while CPT will greatly affect by CUD and least influenced by AF, over a next 30 years period. The overall results provoked the need of transportation energy infrastructure that desirable for long-term sustainable growth across countries.

1. Introduction

The relationship between transportation sector and energy demand is a paramount concern of the global world related to the energy efficiency and regulations that strive hard to maintain the energy flows for sustainable development. The air transportation, road/railways

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transportation, and port transportation are the diverse modes of transportation that required different energy levels to support its operations. It is evident that massive gain in urbanization leads to an increase in the global expansion of transport mobility, which is account for 28% energy demand. Out of which, 70% energy demand is attributed by goods transported and passengers carried across regions. The transport sector is highly sensitive to the environment, as nearly around 95% energy comes from oil –based fuels that threaten the global environment (IIASA, 2014). The latest report of International Energy Outlook (IEO, 2016a) presented the crucial facts of world energy demand, which simulated that global energy demand is expanded by 549 quadrillion British thermal units (Btu) in 2012 to 629 and 815 quadrillion Btu in 2020 and 2040 respectively, which will be an increase of about 48% during 2012–2040. The building sector, industrial sector, and transportation sector marginally added energy demand is about 1.5%, 1.2%, and 1.4% per annum respectively, which will an increase energy demand around 42%, 33.6%, and 39.2% respectively, during the next 28 years i.e., from 2012 to 2040. The Air Transport Action Group (ATAG, 2016) presented the facts that air flight globally produced 781 million tonnes of carbon emissions in the year 2015 while human-induced carbon emissions are about over 36 billion tonnes of carbon emissions. In the same year, around 3.57 billion passengers worldwide carried by the airlines. The aviation industry is responsible for 12% carbon emissions compared to the road transportation that is accounted for around 74%. The global aviation industry supported about 62.7 million jobs directly and indirectly with the tourism based activities, while it generates about $664 billion of GDP per year, which is expected to exceed the threshold of $1 trillion to world GDP by 2026. These facts provide good insights to understand the transportation intensive energy profile, which further required strong policy framework to optimize our energy sources by specific government actions and plans to balance the need of energy demand worldwide.

The emissions due to road/railways transportation, although consider the global concern of GHG emissions and carbon dioxide emissions, however, due to electrified trains & cars and improved vehicle efficient technologies, this sector substantially reduces the global environmental concerns (Saleem et al., 2018). Despite the major sustainability reforms in this sector, around 1/5th of the European GHG emissions are accountable for the road emissions, which further deteriorate in many European cities, as it is above the European designated threshold level of mitigating carbon emissions (EEA, 2016). About 15% of the carbon emissions in EU countries are accountable for local cars, vans, and light-duty vehicles, while 6% carbon emissions are due to heavy-duty vehicles that may restricted by new light and heavy-duty vehicle legislations to set binding emissions target (EU, 2017). The rail contributes less than 1.5% in European transport emissions, which will further reduces carbon emissions till 2020 by 40% and 50% by 2030 that shows significant carbon reduction policies for sustainable development in this region (CER, 2015). The other source of emission is port emissions, which is contributed about 10% of the global pollutants, mainly responsible is the ship-based activities, including 6% is the ocean-going vessels, 0.8% is due to harbor craft, 1.64% due to cargo shipments, 0.9% is the trucks in ports, and 0.6% is due to locomotives (POLB, 2016). The port emissions largely received attention in sustainable policy agenda due to high mass GHG emissions, which required substantial policies and programs to introduce sustainable port based activities to reduce air pollutants (Winnes et al., 2015).

The motivation of the study is to developed an integrated econometric framework where energy demand, customs duty, and economic growth is subject to the change by different transportation modes, including air transportation, railways transportation, and port transportation, which provide strong policy actions to re-consider the economic decisions by healthy and wealthy transportation. This motivation further initiated to study this topic in a broader way to generalize the findings in a global perspective. The present study examined the impact of air transportation, railways transportation, and port traffic container on energy demand, customs duty and economic growth in a panel of 40 diversified countries.

The study used heterogeneous panel cointegration technique to achieve the desired study objectives, i.e., panel cross-sectional dependence tests, second generation panel unit root test, Johansen Fisher panel cointegration test, heterogeneous panel causality test, impulse response function, and variance decomposition analysis, for robust inferences. These tests confirmed the cross-sectional correlation, stationary properties of the selected variables in terms of its order of integration, cointegration relationships between the candidate variables, causal relationships between transportation and growth factors, forecasting impulse response shocks for examining the positive and/or negative error shocks over subsequent points of interval, and forecast variance error shocks that is used to find the relative importance of variable shocks in the models, for the next 30 years time period. These tests are prerequisites to perform panel cointegration to handle the cross-sectional dependence among the panel countries and serial correlation problem from the given model, thus its gives robust parameter inferences for sound policy conclusions.

2. Literature review

Transportation is an important factor for international tourism to reach the specific tourist destinations, as per Becken (2002) estimates for tourists' arrival data in New Zealand with respect to energy demand, presented the fact that air transportation consumed 27.8 PJ energy while its resulting impact on carbon emissions about 1.9 million tonnes. These estimates emphasized the need for sustainable tourism and transportation instruments by adding renewable energy sources in country's energy profile that would helpful to reduce the risk of climate change and air pollution worldwide. Becken et al. (2003) further provoked the need of ‘energy bills’ that add up into the international and domestic tourists of New Zealand by using energy demand with different travel choices. Although the energy demand of international tourist is almost four times higher than the domestic tourists in a country, however, the transportation bill is largely contributed by domestic tourist i.e., about 73% compared to the international tourists i.e., about 65%. The study concluded that energy bill is the best saving energy technique that may affect the tourist travel choices to alter their travel styles for saving energy. Berndt and Botero (1985) identified different modes of transportation and their level of energy demand in the Mexican transport sector and confirmed that country's income played a dominating role to affect air-railway's energy consumption compared to the energy prices, while gasoline and diesel fuel demand for the motor vehicles mode is influenced by energy prices. The policies to balance energy prices and sustainable economic growth would helpful to reduce energy demand at countrywide. Lu et al. (2009) forecasted the trend analysis of vehicle fleet associated with the energy consumption and its resulting output in a form of carbon emissions, by using Grey forecasting model in the context of Taiwan and found that for the next 19 years period, road transportation considerably increases vehicle fleet by 3.64%, energy demand by 3.25% and carbon emissions by 3.23%, which is associated with lower and upper bound values. For the year 2025, the vehicle fleet will be 30.2 million and 36.3 million vehicles, followed by energy demand will fall in between the range of 25.8 and 31.0 million kiloliters, and carbon emissions estimate about 61.1 million metric tonnes and 73.4 million metric tonnes in low to high bound values. This forecasted trend exhibits the need of long-term policy plans to reduce carbon emissions that are intensified by transportation energy demand, and it should be associated with green transportation instruments for broad-based growth. Yan and Crookes (2010) assessed the trend analysis of road transportation's energy demand and its associated carbon emissions, and indicated the serious problems of energy security, urban pollution and risk of climate change. The study concluded in favor of carbon mitigation polices to reduce energy demand and promote the zero carbon policy for China