



Questing the three key growth determinants: Energy consumption, foreign direct investment and financial development in South Asia



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ABSTRACT

The relationship between energy led growth, foreign direct investment (FDI) led growth and financial development led growth hypothesis has been widely debated inside the academic circles. There is a general consensus that these factors are a major cause of growth and vice versa. The objective of this study is to analyze the causal relationship among energy consumption, economic growth, relative price, financial development (FD) and foreign direct investment (FDI) in South Asia using a bivariate and multivariate framework. This study covers a sample from 1975 to 2011. The results of cointegration suggests that variables are cointegrated at their first order i.e., $I(1)$ variables and there has been long-run relationship exist between them. The study finds that both energy consumption and economic growth Granger causes each other in the short and long run. The study supported five growth hypotheses in the context of South Asia and these hypotheses have important policy implications in the South Asian region i.e., a) energy led growth hypothesis, b) energy led financial development, c) FDI led growth hypothesis, d) finance led growth hypothesis and e) FDI led relative prices are supported by the findings from this study. The finding of bidirectional Granger causality between energy consumption and economic growth implies that South Asia is an energy dependent country. Energy is a prominent resource for financial sector development in South Asia, further developed financial sector need more energy resources, and this result indicates that energy consumption Granger cause FD and FD Granger cause energy consumption in South Asian region. Moreover, there is a bidirectional link between FDI & economic growth; and between FDI & relative prices of energy in South Asia which explains that FDI increases energy prices in the host countries, whereas brighter growth prospects in the host countries attract an increased flow of FDI in this region. Finally, existing energy infrastructure fails to comply with speedy FDI and thus put strain on the energy channels which leads to higher energy prices. This quest supports the FDI led relative price hypothesis in South Asian region.

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1. Introduction

South Asia is a region of enormous prosperity, growth and economic development. It has a long cultural heritage of strong bonding. This region is endowed with huge natural resources in and around. To strengthen the bonding among the people of this region, South Asian Association for Regional Cooperation (SAARC)

was created in 1985 with its Secretariat in Kathmandu, Nepal. Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka are the proud Members of this Association [1]. The Asia Sustainable and Alternative Energy Program (ASTAE) were created in 1992 as a Global Partnership Program. Its mandate is to scale up the use of sustainable energy options in Asia to reduce energy poverty and protect the environment. Achieving this objective rests on promoting ASTAE's three pillars for sustainable development: renewable energy, energy efficiency, and access to energy [2]. South Asian region is enjoying unprecedented economic growth. The growth, however, is becoming constrained by significant shortages in energy supply, and unless corrective steps are

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urgently initiated and implemented, it may be difficult to sustain the achieved growth rates. The region's political leaders and its business community are increasingly recognizing the need to foster cross-border energy investments and promote regional energy trade in order to take full advantage of the energy resources available within the region [3].

South Asian countries have facing the problem of energy shortage and the gap between energy consumption and energy production is persistently increases over time. This growing gap between demand for and the supply of energy is expected to retard the economic growth in these countries [4]. Keeping in mind the vital and critical role of energy in the process of development, this study developed the link among energy consumption, economic growth, real prices, FDI and financial development for South Asia. With the growing demand of energy and constraints in the domestic resource availability, the South Asian countries face a number of challenges in terms of provision of energy services. The energy demand is going to grow rapidly. Inefficiency is a major strain on volume needs in most of Asia. One of the reasons for the low level of efficiency in energy production in this region is the high level of technical losses. The power sector, for instance, faces problems of high technical losses. These are due to poor quality transmission lines, pilferage, unmetered connections as well as low plant load factors due to aging generators and poor maintenance of equipment at existing plants (plus low-quality coal in many cases). Transmission and distribution (T&D) losses of electricity are very high in the region. The South Asian region has a great potential in renewable energy forms, which has not been explored to a substantial extent [5]. Table 1 shows the current statistics of energy use in South Asian countries.

Economic theory suggests that sound and efficient financial systems i.e., banks, equity markets, and bond markets - which channel capital to its most productive uses are beneficial for economic growth. Sound and efficient financial systems are especially important for sustaining growth in developing Asia because efficiency of investment will overshadow quantity of investment as the driver of growth in the region [7]. A well established and developed financial system increases the efficiency and effectiveness of financial institutions and boosts the innovations in the financial services delivery system. It also helps the advancement of technology, reduction of information cost and profitability of investment. Improvement in monetary transmission mechanism, as a result of financial liberalization, also encourages savings and investment and enhances economic growth [8].

Countries of the South Asian region have shown a sharp increase in their efforts to attract foreign direct investment (FDI) over the last few years. Moreover, there has been a general rise in the region's competitiveness vis-à-vis the service sector, particularly in

information technology enabled services. South Asia as a whole continues to enforce policies to create an investor-friendly climate. India's position with regard to FDI is considerably better when compared to other countries in the region. Investments not only flow into the country's service industry, but also its entertainment and consumer goods industries [9]. In contrast, other South Asian countries lag behind India when it comes to attracting FDI. There are, however, a few industries that have typically seen investment inflows in the past few years. For example, the textile industries in Bangladesh and Sri Lanka have been popular, with manufactured items finding placements in international markets. Similarly, the sports goods and leather industries in Pakistan continue to provide quality products, which remain attractive to foreign investors. However, the primary impediments to substantial investment inflows are the poor business climate as well as the socio-political instability [10]. Yet, there are some promising industries in South Asian economies that may attract greater FDI. In particular, the tourism industry in Sri Lanka and Nepal along with SMEs and cottage industries in Bangladesh are ripe for FDI, provided that the respective governments continue to support the private sector and keep business and permit regulations simple [11].

In varying degrees of success, South Asian economies have reformed their banking sector to intermediate more efficiently the large volumes of remittances inflows. Nonetheless, banks' lending portfolios are dominated by consumption and personal loans as opposed to lending to manufacturing and production. Energy constitutes a significant cost of manufacturing. Its price and availability are important elements of competitiveness of manufacturing. The energy policy bias in South Asia is for protecting the residential consumer at the expense of manufacturing enterprises. The average power tariff paid by residential consumers in India, Pakistan, Sri Lanka and Nepal is substantially lower than that paid by industrial consumers. Furthermore, electricity rationing is more severe for manufacturing than for residential units. A similar bias is seen in the pricing and availability of natural gas [12].

Economic growth in South Asia has been strong in recent years, but many areas are lagging due to a lack of infrastructure such as efficient transport corridors. Regional connectivity can improve access to goods and services, increase access to markets, provide greater income and job opportunities, and help businesses to develop competitive advantages [13]. Table 2 shows the comparative analysis of South Asia's GDP per capita with other regions.

Table 2 shows that the steady improvement for South Asia in terms of GDP per capita which increased almost two and half times between 1990 and 2010. Further, South Asia stands at almost fourth of the world's averages and nearly half of East Asia & Pacific region, which was actually behind it during the early 1980s. Despite its

Table 1
Energy use (kg of oil equivalent per capita).

South Asian Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Afghanistan	—	—	—	—	—	—	—	—	—	—	—	—
Bangladesh	14	15	15	15	16	17	17	18	19	19	19	20
	4	3	5	9	3	0	8	3	1	4	7	1
Bhutan	—	—	—	—	28	30	31	35	35	36	37	38
					0	9	3	4	9	4	2	1
India	43	43	43	44	46	47	49	51	52	54	56	57
	4	4	9	3	2	3	0	0	6	1	2	2
Maldives	—	—	—	—	85	76	96	98	99	10	11	11
					9	2	2	5	2	12	42	89
Nepal	33	33	33	33	33	33	32	32	33	34	36	38
	2	5	1	3	1	5	8	7	2	5	7	2
Pakistan	43	43	43	44	46	47	48	50	48	50	55	51
	9	7	4	6	8	6	8	6	7	1	2	2
Sri Lanka	43	42	43	45	45	45	45	46	44	46	48	47
	6	8	3	3	3	8	7	2	2	1	2	2

Source: World Bank [6].

Table 2

A comparative glance at the GDP per capita, PPP (current international \$).

Regions	1980–85	1985–90	1990–95	1995–00	2000–05	2005–10
East Asia & Pacific	479	777	1256	1986	2890	5425
High income OECD	11,198	15,316	19,839	24,167	29,595	38,412
South Asia	507	703	949	1255	1636	2599
Sub-Saharan Africa	934	1055	1170	1284	1480	2123
World	3199	4156	5138	6120	7497	1012

Source: World Bank [6].

rapid growth, South Asia still stands just above Sub-Saharan Africa region [14].

One of the remarkable features of globalization in the 1990s was the flow of private capital in the form of foreign direct investment. FDI is an important source of development financing, and contributes to productivity gains by providing new investment, better technology, management expertise and export markets. Given resource constraints and lack of investment in developing countries, there has been increasing reliance on the market forces and private sector as the engine of economic growth [15]. Overall, the FDI environment has undergone a sea change in South Asian countries during the 1990s, and more so in recent years. With their liberalized approach to FDI and constant changes in improving the FDI policy framework, it is certain that South Asia has become an important destination for investment [16].

The deterioration of the economic environment has caused considerable concern around the globe. Advanced economies are battling with legacy issues from the recent crisis as well as events that increase financial instability on a near daily basis. Emerging economies have been impacted as well, particularly in areas such as financial intermediation [17]. Financial liberalization in South Asia was late in coming. By the time the reforms took place in South Asia, many other countries in Asia had already undergone reform. With the exception of Malaysia, several of the smaller, more trade dependent Asian countries had already attained more or less open capital accounts by the 1990s (e.g. the Republic of Korea). In these countries debt and equity type inflows were liberalized as part of the reforms in the 1990s. Since government debt and deficits were generally low in East Asia, firms and banks were borrowing abroad. Table 3 shows the outcomes across different financial sectors in Asian countries.

The above discussion confirms a strong linkage between energy consumption, economic growth, energy prices, FDI and financial development in the context of South Asia. In this study an analysis has been carried out to find a short- and long-run relationship

among energy consumption and its determinants in South Asia using aggregate data from 1975 to 2011. A number of studies have analyzed the energy–growth, FDI–growth, and finance–growth nexuses in many developed and developing countries; however, the energy–finance nexus is very limited in the aggregate data of South Asia. The more specific objectives are as follows:

1. To provide work for the principal component analysis to compute a more presentable financial development (FD) indicator by considering various proxies for FD.
2. To utilized both bivariate and multivariate frameworks to analyze the relationship between energy consumption and economic growth in South Asia.

The paper is organized as follows: after introduction which is provided in Section 1 above, literature review is carried out in Section 2. Data source and methodological framework are explained in Section 3. The estimation and interpretation of results are mentioned in Section 4. Section 5 concludes the paper.

2. Literature review

Given the high level of inertia of the energy sector, on both the supply and demand sides, projecting the ‘natural’ evolution of the energy system, is a major research task. Uncertainty is amplified for Asia for several reasons. First, these countries are characterized by very dynamic economies with high rates of growth. Second, the energy sector is also in a rather dynamic phase characterized by volatile energy prices, political instabilities in key exporting regions, and changes in technology and its applicability. Finally, policies for either national security, economic development or the protection of the environment are already being implemented in developing countries at a rather fast pace [19]. Brew-Hammond ([20], p. 35) opines that,

“The Millennium Development Goals (MDGs) include eradicating extreme poverty, improving the health of women and children, gender empowerment, environmental sustainability and global partnerships. There are no energy-related targets, such as access to energy, although there is increasing evidence of relationships between energy and the MDGs and development in general. The global community has to commit to eradicating energy poverty within the next few decades”.

Asafu-Adjaye [21] estimates the causal relationships between energy consumption and income for India, Indonesia, the Philippines and Thailand. The series for India and Indonesia cover

Table 3

South Asia's financial sector assessment as percentage of GDP.

Financial sector assets								
Deposit-taking financial institutions			Non-bank financial institutions		Stock market capitalization		Total bonds outstanding	
	2000	2009	2000	2009	2000	2009	2000	2009
Bangladesh	46.8	62.0	0.7	1.7	2.4	14.4	–	17.1
China	157.5	200.6	5.1	15.8	48.9	82.7	16.9	52.3
India	64.5	103.5	15.6	29	69.9	205.2	24.6	48.8
Indonesia	63.6	34.7	8.7	11.4	16.2	39.8	31.9	18.2
Republic of Korea	130.5	158.6	41.9	67.3	27.8	100.3	66.6	122.7
Malaysia	154.2	211.5	41.4	99.9	120.6	149.5	73.3	96.5
Pakistan	44.8	52.6	4.7	5.9	18.6	–	–	27.5
Philippines	99.2	83.1	23.9	20	33.3	53.6	27.6	39.2
Singapore	646.3	643.7	76.6	83.9	167.3	271.7	48	84.7
Thailand	132.3	146.6	10.7	41.1	23.8	67.1	25.3	67
Asia average	181.1	197.8	28	46.1	63.5	121.2	39.3	66.2

Source: Goyal [18].

the period 1973–1995, while those for Thailand and the Philippines cover the period 1971–1995. The results indicate that, in the short-run, unidirectional Granger causality runs from energy to income for India and Indonesia, while bidirectional Granger causality runs from energy to income for Thailand and the Philippines. In the case of Thailand and the Philippines, energy, income and prices are mutually causal. Mahadevan and Asafu-Adjaye [22] reinvestigates the energy consumption–GDP growth nexus in a panel error correction model using data on 20 net energy importers and exporters from 1971 to 2002. The results show that there was bidirectional causality between economic growth and energy consumption in the developed countries in both the short and long run, while in the developing countries energy consumption stimulates growth only in the short run. Payne [23] discusses the various hypotheses associated with the causal relationship between electricity consumption and economic growth along with a survey of the empirical literature. The results for the specific countries surveyed show that 31.15% supported the neutrality hypothesis; 27.87% the conservation hypothesis; 22.95% the growth hypothesis; and 18.03% the feedback hypothesis. Ozturk [24] also provides a survey of the recent progress in the literature of energy consumption–economic growth and electricity consumption–economic growth causality nexus. The survey highlights that most empirical studies focus on either testing the role of energy (electricity) in stimulating economic growth or examining the direction of causality between these two variables. Although the positive role of energy on growth has become a stylized fact, there are some methodological reservations about the results from these empirical studies. Koljonen and Lehtilä [25] examine sensitivity analysis to study the impact of higher rates of energy demand growths in the non-OECD Asia on global mitigation costs. The results indicate that the impacts of accelerated energy demand in the non-OECD Asia has a relatively small impact on the global marginal costs of greenhouse gas abatement. However, with the accelerated demand projections, the average per capita greenhouse gas emissions in the OECD were decreased while China, India, and South-East Asia increased their per capita greenhouse gas emissions.

Akkemik and Göksal [26] extend the Granger causality relationship between energy consumption and GDP by taking into account panel heterogeneity by using a large panel of 79 countries for the period 1980–2007. The results show that roughly seven-tenths of the countries exhibit bidirectional Granger causality, two-tenths exhibit no Granger causality, and one-tenths exhibit unidirectional Granger causality. Azam et al. [27] examines the potential effect of political risk and macroeconomic policy uncertainty on FDI in South Asia. The long run results show negative effect of political risk and macroeconomic policy uncertainty indices on FDI inflows. Trade openness shows positive effect on FDI inflows only in short run while in long run it has negative impact on due lack of creditability regarding consistent trade liberalization policy and high trade cost. Furthermore, the market size significantly affects the inflow of FDI both in long run and short run which shows that FDI inflows in South Asia are mainly depend on market size. Sahoo [28] examines the determinants of FDI for South Asian countries with emphasis on infrastructure development, trade openness and reforms. The results reveal that major determinants of FDI in South Asia are market size, labor force, infrastructure stock, trade openness and economic reforms. Further, the panel causality analysis shows that there is a strong relationship between infrastructure development and FDI inflows. Sahoo and Dash [29] examine the output elasticity of infrastructure for four South Asian countries viz., India, Pakistan, Bangladesh, and Sri Lanka using panel cointegration techniques for the period 1980–2005. The results reveal that gross domestic capital formation, labor force, export and expenditure on human capital exhibit a positive

contribution to output. More importantly, infrastructure development contributes significantly to output growth in South Asia. Further, the panel causality analysis shows that there is mutual feedback between total output and infrastructure development. Narula et al. [30] examine the role of Decentralized Distributed Generation (DDG) in achieving universal rural electrification in South Asia by 2030. The results find that the cost of delivering electricity by centralized generation and grid distribution is up to four times the cost of stand-alone and mini-grid DDG options in the case of 'minimum threshold' demand scenario.

Al-Mulali et al. [31] investigated the long run relationship between urbanization, energy consumption and carbon dioxide emission in seven regions, namely, East Asia and Pacific, East Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia, Sub-Saharan Africa, and Western Europe, taking the period 1980–2008. The results show that while 84% of the countries have a positive long run relationship between urbanization, energy consumption, and carbon dioxide emission, only 16% the countries have mixed results. Some countries have a negative long run relationship and others, especially low income countries have no relationship between urbanization, energy consumption, and carbon dioxide emission. Furthermore, a one way long run relationship between energy consumption and carbon dioxide emission and urbanization was found in a number of countries while a one way long run relationship between urbanization and energy consumption and carbon dioxide emission was found in other countries. Sadorsky [32] examines the impact of information communication technology (ICT) on electricity consumption in emerging economies. The empirical results show a positive and statistically significant relationship between ICT and electricity consumption when ICT is measured using internet connections, mobile phones or the number of PCs. Long-run ICT elasticities are smaller than income elasticities but because ICT growth rates are so much higher than income growth rates, the impact of ICT on electricity demand is greater than the impact of income on electricity demand. Noor and Siddiqi [33] examines causal link between energy use and economic growth for five South Asian countries over period 1971–2006. In short run, unidirectional causality from per capita GDP to per capita energy consumption is found, but not vice versa. In the long run, one percent increase in per capita energy consumption tends to decrease 0.13 percent per capita GDP, i.e., energy use discourage economic growth. Nasir and Hassan [34] empirically examine the role of economic freedom, market size and exchange rates in attracting foreign direct investment in south Asian countries for the period 1995–2008. Results indicate the presence of significant positive relationship between economic freedom and FDI inflows in South Asian countries during the period of study. The real effective exchange rate was having negative association with it indicating that depreciation in host country currency negatively influences the inflow of FDI to that country. Fisman and Love [35] analyze the relationship between financial development and inter-industry resource allocation in the short and long run. They suggest that in the long run, economies with high rates of financial development will devote relatively more resources to industries with a "natural" reliance on outside finance due to a comparative advantage in these industries. By contrast, in the short run the authors argue that financial development facilitates the reallocation of resources to industries with good growth opportunities, regardless of their reliance on outside finance.

Hossain [36] examines the dynamic causal relationship between economic growth, electricity consumption, export values and remittance for the panel of three SAARC countries using the time series data for the period 1976–2009. The results support that there is only bidirectional short-run causal relationship between

economic growth and export values but there is no evidence of long-run causal relationship. It is found that the long-run elasticity of economic growth with respect to electricity consumption and remittance are higher than short run elasticity. Lee [37] reinvestigates the co-movement and the causality relationship between energy consumption and GDP in 18 developing countries, using data for the period 1975–2001. The evidence shows that long-run and short-run causalities run from energy consumption to GDP, but not vice versa. Kirkpatrick et al. [38] provide an empirical examination of the relationship between the quality of the regulatory framework and foreign direct investment (FDI) in infrastructure in middle and lower income developing countries during the period 1990–2002. The results confirm that FDI in infrastructure responded positively to an effective domestic regulatory framework. Lee and Chang [39] reinvestigate co-movement and the causal relationship between energy consumption and real GDP within a multivariate framework for 16 Asian countries during the 1971–2002 periods. The empirical results fully support a positive long-run cointegrated relationship between real GDP and energy consumption when the heterogeneous country effect is taken into account. It is found that although economic growth and energy consumption lack short-run causality, there is long-run unidirectional causality running from energy consumption to economic growth. Barros et al. [40] investigate the attraction of foreign direct investment (FDI) by Asian countries, aiming to identify the attractions for the investment. A balanced panel data on FDI in 27 Asian countries over the period 2003–2011 is taken for consideration. The results are robust among the distinct regressions and the policy implication derived is that the FDI attraction of large countries is different from that of small countries. Hence, this distinction should be taken into account by Asian governments when defining an FDI attraction policy.

Chu and Chang [41] applied bootstrap panel Granger causality to test the relationship between energy consumption and economic growth using data from G-6 countries over the period of 1971–2010. The results reveal that nuclear consumption causes economic growth in Japan, the UK, and the US; while economic growth causes nuclear consumption in the US; nuclear consumption and economic growth show no causal relation in Canada, France and Germany. Çoban and Topcu [42] examine the relationship between financial development and energy consumption in the European Union over the period 1990–2011 by using system-GMM model. The results provide a strong evidence of the impact of the financial development on energy consumption in the old EU members. Using bank index the impact of financial development displays an inverted U-shaped pattern while no significant relationship is detected once it is measured using stock index. Khan et al. [43] empirically examine the relationship among energy consumption, economic growth, FDI, relative price and financial development in low income, middle income, high income non-OECD, high income OECD, South Africa, Middle East and North Africa (MENA) and the aggregate data of the World over a period of 1975–2011. The results indicate that GDP per capita has a positive impact on energy consumption in low income, middle income, South Africa, MENA and aggregate data of the World. FDI plays a pivotal role in increasing energy demand in middle income, high income OECD and non-OECD. Broad money supply exerts a positive impact on energy demand in low income, middle income, high income non-OECD and MENA regions. Finally, relative prices has either a positive impact i.e., middle income region and/or a negative impact on energy consumption i.e., low income, high income OECD and MENA region. Mumtaz et al. [44] examine the direction of the causality between energy consumption and six broad categories of growth factors i.e., trade factors, education indicators, growth measures, environmental indicators, health variables and population growth

in Pakistan over a period of 1975–2010. The results indicate that there is a unidirectional causality running towards energy consumption to trade factors but not vice versa. Similarly, energy consumption Granger cause education factors; growth factors; environmental factor; health factor and population measures in Pakistan.

Both energy led growth, FDI led growth and finance led growth has become a major debatable hypothesis in the recent literature on energy and economic development, hence there is a pressing need to evaluate and analyze these growth hypothesis and to find out the inter relationship. In the subsequent sections an effort has been made to empirically find out the casual relationship between energy and growth determinants in the context of South Asia.

3. Data source and methodological framework

The present study is based on annual time series data covering the time period from 1975 to 2011 for South Asia, aggregate data. The data set of energy consumption (i.e., kg of oil equivalent per capita); GDP per capita (current US\$); relative price of energy to non-energy goods (measured by the ratio of the price index to the GDP deflator, annual %) and foreign direct investment, net inflows (% of GDP) has been taken from *World Development Indicators* which is published by World Bank [6]. Following Tang and Tan [45] and Ang [46], we use the principal component analysis to construct the financial development (FD) indicator. The advantage to using this approach is that it allows us to composite different indicators of FD into one single index that contain most of the characteristic from the original dataset. This FD indicator is constructed from four alternative financial development indicators which is mostly used in literature i.e., Money and quasi money (M2); Liquid liabilities (M3); Domestic credit provided by banking sector and Domestic credit to private sector, as, these financial development (FD) indicators are highly correlated, but no consensus evidence of which variable is most appropriate for measuring FD. With the response to this, first, this study detecting the problem of multicollinearity between financial development indicators. The most logical way in order to detect multicollinearity problems through the correlation coefficient for those variables, as if the value of the correlation coefficient is large, then problems from multicollinearity emerged between the variables [47]. Table 4 shows the correlation and regression analysis for detecting collinearity between the variables.

The results of correlation matrix are of course symmetrical, while the diagonal elements are equal to 1 because they are correlation coefficients of the same series. We can see that M2 is highly positively correlated with PRI and BC and also that PRI and BC are nearly the same variables (the correlation coefficient is equal to 0.950, i.e., close to 1). The results of regression show that the effect of LL and PRI appear to be insignificant, this result is very strange considering the fact that both variables are highly correlated with M2 as we have seen in correlation matrix. From these results, we obviously suspect that there would be a very high possibility of the negative effects of multicollinearity. On the basis of such results, it is necessary to construct a single variable that represents the overall development in the financial sector by taking into consideration the aforementioned four original FD indicators [45]. Therefore, the present study constituted FD index from these four aforementioned financial development indicators in South Asia. Table 5 shows the results of principal component analysis for FD indicators.

The results reveal that the eigen values of the first principal component (PCA 1) explains about 80.2% of the standardized variance, the second principal component (PCA 2) explains another 17.7%, while the remaining 1.2% and 0.9% of the standardized variances are explained by the third and fourth principal components (PCA 3 and PCA 4). It is obvious that the PCA 1 is the best principal

Table 4

Descriptive statistics, correlation matrix and regression results.

	Mean	Min	Max	EC	GDPPC	RPRICES	FDI	M2	LL	PRI	BC
EC	366.62	270.20	525.23	1.000							
GDPPC	465.31	163.41	1371.04	0.924	1.000						
RPRICES	8.33	3.65	24.03	−0.415	−0.274	1.000					
FDI	0.64	0.004	3.31	0.868	0.845	−0.268	1.00				
Financial development (FD) indicators											
M2	46.05	22.07	72.35	0.975	0.923	−0.466	0.876	1.000	0.470	0.949	0.966
LL	40.37	4.96	50.25	0.487	0.419	−0.314	0.406	0.470	1.000	0.532	0.406
PRI	47.21	25.23	70.45	0.916	0.902	−0.440	0.780	0.949	0.532	1.000	0.950
BC	26.90	12.91	46.82	0.929	0.962	−0.385	0.884	0.966	0.406	0.950	1.000
Regression analysis – dependent variable: M2											
	Coefficient	Std. error	t-Statistics	Prob.	<i>R</i> -squared: 0.946						
Constant	−1.937	3.539	−0.547	0.587	Adjusted <i>R</i> -squared: 0.941						
LL	0.082	0.083	0.984	0.322	Durbin–Watson stat: 0.303						
PRI	0.322	0.199	1.616	0.115	<i>F</i> -statistics: 193.84						
BC	1.094	0.215	53.089	0.000	Prob. (<i>F</i> -statistic): 0.000						

component and we only extract one principal component. Finally, the individual contributions of M2, LL, PRI and BC are shown in panel 11, Table 5. The standardized variance of PCA 1 (i.e. 21.47, 13.66, 21.62 and 21.18%) is used as the weights to construct an index for FD. All these variables are expressed in natural logarithm and hence their first differences approximate their growth rates. The data trends are available for ready reference in Fig. 1.

3.1. Theoretical frame work

The role of energy in economic growth is underlined in a number of studies [see for example, Tugcu et al. [48]; Ozturk [24]; Belke et al. [49] and Hannesson [50]]. However, the model used by Tang and Tan [45] in energy led growth and financial led growth hypothesis in the context of Malaysia is distinct from other models as they uses the generic long run energy consumption model i.e.,

$$\ln(EC)_t = \alpha_0 + \alpha_1 \ln(GDPPC)_t + \alpha_2 \ln(RPRICES)_t + \alpha_3 \ln(FDI)_t + \alpha_4 \ln(FD)_t + \varepsilon_t \quad (1)$$

where $\ln(EC)$ is the natural logarithm of energy consumption; $\ln(GDPPC)$ is the natural log of per capita GDP; $\ln(RPRICES)$ is the natural log of relative prices, $\ln(FDI)$ is the natural log of foreign direct investment, inflows and $\ln(FD)$ is the natural log of financial development; and ε is the white noise error term.

Table 5

Principal component analysis for financial development indicators.

Panel 1	PCA 1	PCA 2	PCA 3	PCA 4
Eigen values	3.211	0.712	0.048	0.029
Percentage of variance	0.802	0.177	0.012	0.009
Cumulative percentage	0.802	0.980	0.992	1.000
Variables	Vector 1	Vector 2	Vector 3	Vector 4
MQ	0.973	−0.169	0.126	−0.099
LL	0.619	0.785	0.019	0.015
DCBS	0.98	−0.09	−0.175	−0.04
DCPS	0.96	−0.244	0.039	0.132
Sum	4.532	0.282	0.009	0.008
Panel 11: Standardized variance of individual FD variable				
FD variables	PCA 1	PCA 2	PCA 3	PCA 4
M2	21.47%	−0.59929	14.01%	−12.37%
LL	13.66%	2.783688	2.11%	1.87%
PRI	21.62%	−0.31915	−19.44%	−5.00%
BC	21.18%	−0.86525	4.33%	16.50%

Note: M2 – money and quasi money (orM2) as a percentage of GDP; LL – liquid liabilities (or M3) as a percentage of GDP; PRI – domestic credit claims on private sectors as a percentage of GDP and BC – domestic credit provided by banking sector as a percentage of GDP.

Similarly, the computational procedure for financial development indicator by using principal component analysis, long-run and short-run elasticities estimated by Johansen cointegration techniques & ARDL testing approach and Granger causality tests employed with Wald *F*-statistics is fairly simple and its mechanics are simple to understand, as compared to other econometric techniques. Therefore, the study follows the framework of Tang and Tan [45] for estimating the long-run relationship among the energy consumption, GDP per capita, relative energy prices, FDI and financial development variables in the context of overall South Asia. The present study hypothesizes the following results, which are given in Table 6.

3.2. Econometric framework

3.2.1. Econometric model

Comparable to all other techniques, that utilize time series data, it is essential to distinguish that unless the diagnostic tools used account for the dynamics of the link within a sequential 'causal' framework, the intricacy of the interrelationships involved may not be fully confined. For this rationale, there is a condition for utilizing the advances in time series version. The following sequential procedures are adopted as part of methodology used.

3.2.2. Univariate test

In order to confirm the degree, these series split univariate integration properties; we execute unit root stationarity tests. The Augmented Dickey Fuller (ADF) and Phillips Perron (PP) test is a suitable testing procedure that is based on the null hypothesis that a unit root exists in the autoregressive representation of the time series.

3.2.3. Setting the appropriate lag length of the model

The most common procedure in choosing the optimal lag length is to estimate a VAR model including all our variables in non-differenced data. This VAR model should be estimated for a large number of lags, then reducing down by re-estimating the model for one lag less until we reach zero lags. In each of these models, we inspect the values of AIC and the SBC criteria. The model that minimizes the AIC and the SBC is selected as the one with the optimal lag length.

3.2.4. Choosing the appropriate model regarding deterministic components in the multivariate system

In general, five distinct models can be considered. Although the first and the fifth model are not that realistic and they are also

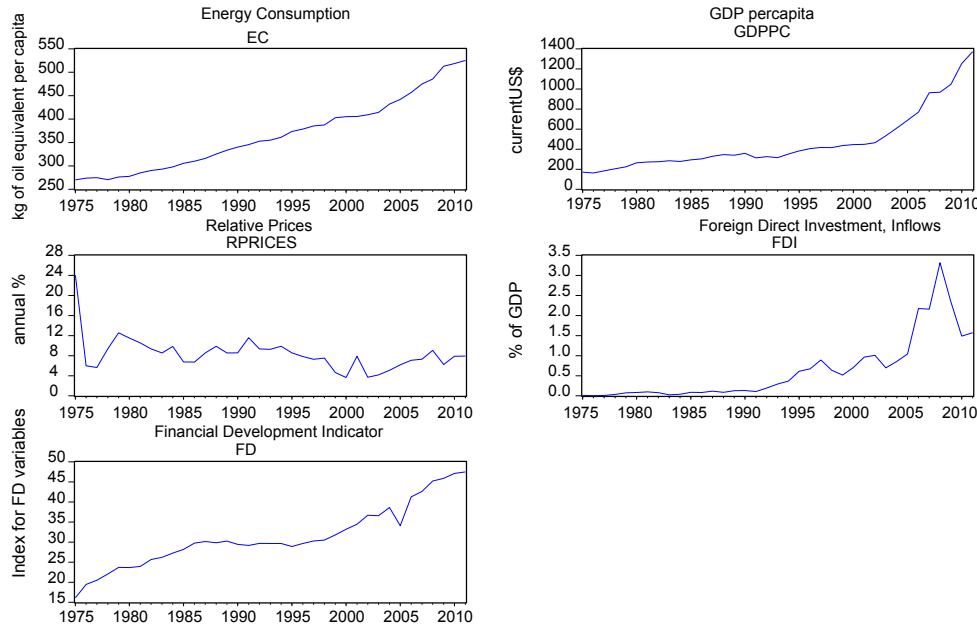


Fig. 1. Trend analysis of data.
Source: World Bank [6].

implausible in terms of economic theory, therefore, the problem reduces to a choice of one of the three remaining models (models 2, 3 and 4).

Model 1: No intercept or trend in CE or VAR.

Model 2: Intercept (no trend) in CE, no intercept or trend in VAR.

Model 3: Intercept in CE and VAR, no trends in CE and VAR.

Model 4: Intercept in CE and VAR, linear trend in CE, no trend in VAR.

Model 5: Intercept and quadratic trend in the CE intercept and linear trend in VAR.

3.2.5. Determining the ranks of Π or the number of cointegrating vectors

For the intention of investigating the long-run relationship among the variables, they must be cointegrated. In the multivariate case, if the $I(1)$ variables are linked by more than one cointegrating vector; the Engle–Granger procedure is not applicable. The test for co-integration used here is the likelihood ratio put forward by Johansen and Juselius [51], indicating that the maximum likelihood method is more appropriate in a multivariate system. Therefore, this method is used in this study to identify the number of cointegrated vectors in the model. The Johansen and Juselius method has been developed in part by the literature available in the field and reduced rank regression. The cointegrating vector ‘ r ’ is defined by Johansen as the maximum Eigen-value and trace test. There is ‘ r ’ or more cointegrating vectors. Johansen and Juselius [51] and Johansen [52] propose that the multivariate co-integration methodology can be defined as:

$$\ln(EC) = \ln(GDPPC, RPRICES, FDI, FD) \quad (2)$$

which is a vector of $P=4$ elements. Considering the following autoregressive representation:

$$Y_t = \pi_0 + \sum_{i=1}^K \pi_i Y_{t-i} + \mu_t$$

Johansen’s method involves the estimation of the above equation by the maximum likelihood technique, and the testing of the hypothesis $H_0: (\pi = \Psi\xi)$ of ‘ r ’ cointegrating relationships, where ‘ r ’ is the rank or the matrix $\pi(0 < r < P)$, Ψ is the matrix of weights with which the variable enters cointegrating relationships and ξ is the matrix of co-integrating vectors. The null hypothesis of non-cointegration among variables is rejected when the estimated likelihood test statistic $\phi_i = \{-n \sum_{t=r+1}^p \ln(1 - \hat{\lambda}_i)\}$ exceeds its critical value. Given estimates of the Eigen-value ($\hat{\lambda}_i$) the Eigen-vector (ξ_i) and the weights (ψ_i), we can find out whether or not the variables in the vector are cointegrated in one or more long-run relationships among the dependent variables.

If the time series are integrated at first difference, then one could run regressions in their first differences. However, by taking first differences, we drop the long-run correlation that is stored in the data. This means that one needs to use variables in levels as well. Error correction model (ECM) incorporates variables both in their levels and first differences. ECM depicts the short-run disequilibrium as well as the long-run equilibrium adjustments between variables. ECM term having negative sign and value between “0 and 1” specifies convergence of the model towards long-run equilibrium.

Table 6
List of variables.

Variables	Measurement	Expected sign	Data source
Energy consumption (EC)	kg of Oil equivalent per capita		World Bank [6]
Independent variables			
GDP per capita (GDPPC)	Current US\$	Positive	World Bank [6]
Relative price of energy to non-energy goods (RPRICES)	Measured by the ratio of the price index to the GDP deflator, annual %	Negative	World Bank [6]
Foreign direct investment, inflows (FDI)	As percentage of GDP	Positive	World Bank [6]
Financial development indicator (FD)	As percentage of GDP	Positive	World Bank [6]

3.2.6. Bounds testing approach

Following Pesaran et al. [53], we assemble the vector autoregression (VAR) of order p , denoted VAR (p), for the following growth function:

$$Z_t = \mu + \sum_{i=1}^p \beta_i Z_{t-i} + \varepsilon_t \quad (3)$$

where z is the vector of both x and y , where y is the dependent variable defined as energy consumption (EC), x_t is the vector matrix which represents a set of explanatory variables i.e., GDP per capita (GDPPC), relative prices (RPRICES), foreign direct investment inflows (FDI), financial development indicator (FD) t is a time or trend variable. According to Pesaran et al. [53], y_t must be $I(1)$ variable, but the regressor x_t can be either $I(0)$ or $I(1)$. We further developed a vector error correction model (VECM) as follows:

$$\Delta Z_t = \mu + \alpha t + \lambda Z_{t-1} + \sum_{i=1}^{p-1} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \quad (4)$$

where Δ is the first-difference operator. The long-run multiplier matrix λ as:

$$\lambda = \begin{bmatrix} \lambda_{YY} & \lambda_{YX} \\ \lambda_{XY} & \lambda_{XX} \end{bmatrix}$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either $I(0)$ or $I(1)$. If $\lambda_{YY} = 0$, then Y is $I(1)$. In contrast, if $\lambda_{YY} < 0$, then Y is $I(0)$.

The VECM procedures described above are imperative in the testing of at most one cointegrating vector between dependent variable y_t and a set of regressors x_t . To derive model, we followed the postulations made by Pesaran et al. [53] in Case III, that is, unrestricted intercepts and no trends. After imposing the restrictions $\lambda_{YY} = 0$, $\mu \neq 0$ and $\alpha = 0$, the hypothetical function can be stated as the following unrestricted error correction model (UECM):

$$\begin{aligned} \Delta \ln(EC)_t &= \beta_0 + \beta_1 \ln(EC)_{t-1} + \beta_2 \ln(GDPPC)_{t-1} \\ &+ \beta_3 \ln(RPRICES)_{t-1} + \beta_4 \ln(FDI)_{t-1} + \beta_5 \ln(FD)_{t-1} \\ &+ \sum_{i=1}^p \beta_6 \Delta \ln(EC)_{t-i} + \sum_{i=0}^q \beta_7 \Delta \ln(GDPPC)_{t-i} \\ &+ \sum_{i=0}^r \beta_8 \Delta \ln(RPRICES)_{t-i} + \sum_{i=0}^s \beta_9 \Delta \ln(FDI)_{t-i} \\ &+ \sum_{i=0}^t \beta_{10} \Delta \ln(FD)_{t-i} + u_t \end{aligned} \quad (5)$$

where Δ is the first-difference operator and u_t is a white-noise disturbance term. Eq. (5) also can be viewed as an ARDL of order (p, q, r, s, t) . Eq. (5) indicates that energy consumption tends to be influenced and explained by its past values. The structural lags are established by using minimum Akaike's information criteria (AIC), Pesaran et al. [53] suggested using the standard joint significance F test on the lagged levels variables. After regression of Eq. (5), the Wald test (F -statistic) was computed to differentiate the long-run relationship between the concerned variables. The Wald test can be carry out by imposing restrictions on the estimated long-run coefficients of GDPPC, RPRICES, FDI and FD. The null and alternative hypotheses are as follows:

$$\begin{aligned} H_0 : \beta_1 &= \beta_2 = \beta_3 = \beta_4 = \beta_5 \\ &= 0 \text{ (no long-run relationship)} \end{aligned}$$

Against the alternative hypothesis

$$H_0 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0 \text{ (a long-run relationship exists)}$$

The computed F -statistic value will be evaluated with the critical values tabulated in Table CI (iii) of Pesaran et al. [53]. According to these authors, the lower bound critical values assumed that the explanatory variables x_t are integrated of order zero, or $I(0)$, while the upper bound critical values assumed that x_t are integrated of order one, or $I(1)$. Therefore, if the computed F -statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between energy consumption and its determinants. Conversely, if the computed F -statistic is greater than the upper bound value, then variables among have a long-run level relationship. On the other hand, if the computed F -statistic falls between the lower and upper bound values, then the results are inconclusive.

3.2.7. Granger causality analysis

The Granger causality test is then used to determine the direction of causality among the five variables in this study. However, if the variables are $I(1)$ and cointegrated, the Granger causality test within the first difference VAR model will be misleading [54]. In such circumstances, Granger causality should be tested using the ECM as follows:

$$\begin{aligned} \Delta \ln(EC)_t &= \alpha_1 + \sum_{i=1}^k k1i \Delta \ln(EC)_{t-i} + \sum_{i=0}^k \nu 1i \Delta \ln(GDPPC)_{t-i} \\ &+ \sum_{i=0}^k \delta 1i \Delta \ln(RPRICES)_{t-i} + \sum_{i=0}^k \theta 1i \Delta \ln(FDI)_{t-i} \\ &+ \sum_{i=0}^k \gamma 1i \Delta \ln(FD)_{t-i} + \vartheta 1 \varepsilon_{t-1} + \xi 1 t \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta \ln(GDPPC)_t &= \alpha_1 + \sum_{i=1}^k k1i \Delta \ln(GDPPC)_{t-i} + \sum_{i=0}^k \nu 1i \Delta \ln(EC)_{t-i} \\ &+ \sum_{i=0}^k \delta 1i \Delta \ln(RPRICES)_{t-i} + \sum_{i=0}^k \theta 1i \Delta \ln(FDI)_{t-i} \\ &+ \sum_{i=0}^k \gamma 1i \Delta \ln(FD)_{t-i} + \vartheta 2 \varepsilon_{t-1} + \xi 2 t \end{aligned} \quad (7)$$

$$\begin{aligned} \Delta \ln(RPRICES)_t &= \alpha_1 + \sum_{i=1}^k k1i \Delta \ln(RPRICES)_{t-i} + \sum_{i=0}^k \nu 1i \Delta \ln(EC)_{t-i} \\ &+ \sum_{i=0}^k \delta 1i \Delta \ln(GDPPC)_{t-i} + \sum_{i=0}^k \theta 1i \Delta \ln(FDI)_{t-i} \\ &+ \sum_{i=0}^k \gamma 1i \Delta \ln(FD)_{t-i} + \vartheta 3 \varepsilon_{t-1} + \xi 3 t \end{aligned} \quad (8)$$

$$\begin{aligned} \Delta \ln(FDI)_t &= \alpha_1 + \sum_{i=1}^k k1i \Delta \ln(FDI)_{t-i} + \sum_{i=0}^k \nu 1i \Delta \ln(EC)_{t-i} \\ &+ \sum_{i=0}^k \delta 1i \Delta \ln(GDPPC)_{t-i} + \sum_{i=0}^k \theta 1i \Delta \ln(RPRICES)_{t-i} \\ &+ \sum_{i=0}^k \gamma 1i \Delta \ln(FD)_{t-i} + \vartheta 4 \varepsilon_{t-1} + \xi 4 t \end{aligned} \quad (9)$$

$$\begin{aligned}\Delta \ln(\text{FD})_t = & \alpha_1 + \sum_{i=1}^k k1i\Delta \ln(\text{FD})_{t-i} + \sum_{i=0}^k \nu 1i\Delta \ln(\text{EC})_{t-i} \\ & + \sum_{i=0}^k \delta 1i\Delta \ln(\text{GDPPC})_{t-i} + \sum_{i=0}^k \theta 1i\Delta \ln(\text{RPRICES})_{t-i} \\ & + \sum_{i=0}^k \gamma 1i\Delta \ln(\text{FDI})_{t-i} + \vartheta 5\varepsilon_{t-1} + \xi 5t\end{aligned}\quad (10)$$

The equations above consist of short and long run elements. Δ and \ln are the notations for first difference and natural logarithm, respectively. The residuals ζ_{it} are assumed to be normally distributed and white noise. From the above equations, ε_{t-1} is the one period lagged error-correction term derived from the cointegrating equation. However, in the absence of cointegration, the ε_{t-1} term will be excluded from the above equation, thus it remains as the standard first difference VAR model. To examine the short run Granger causality, we apply the standard Wald test on the first difference lagged explanatory variables. However, to examine the long run Granger causality, we employ the standard Wald test on both the first difference lagged explanatory variables and the ε_{t-1} term.

4. Empirical analysis

The standard Augmented Dickey–Fuller (ADF) and Phillips Perron (PP) unit root test was exercised to check the order of integration of these variables. The results obtained are reported in Table 7. Based on the ADF and PP test statistic, it was concluded that given variables are non-stationary at their level. However, variables are stationary at their first difference i.e., $I(1)$ variables.

Fig. 2 shows the plots of EC, GDPPC, RPRICES, FDI and FD in their first difference forms, which sets the analytical framework as regarding the long-term relationship between the variables.

4.1. Johansen cointegration test

The relationship between dependent variable (i.e., energy consumption) and the independent variables (i.e., GDPPC, RPRICES, FDI and FD) is observed using the multivariate cointegration methodology proposed by Johansen [55] and Johansen and Juselius [51]. The Johansen's cointegration test designates at least one co-integrating vector. Thus, long-run relationship is maintained by the data generating method. Using Johansen and Juselius [51] multivariate cointegration tests, the study finds that a statistically significant relationship exists between independent variables on energy consumption in South Asia. The following cointegrating vector has been determined in Table 8.

Table 7
The unit root test results.

Variables	ADF	PP
EC_t	−0.563 (0)	−0.587 (2)
ΔEC_t	−5.911 (0)*	−5.911 (1)*
GDPPC_t	2.952 (0)	3.489 (3)
ΔGDPPC_t	−4.513 (0)*	−4.698 (3)*
RPRICES_t	−2.296 (0)	−2.202 (0)
$\Delta \text{RPRICES}_t$	−7.714 (1)*	−6.241 (1)*
FDI_t	−2.622 (0)	−2.572 (4)
ΔFDI_t	−7.507 (9)*	−6.877 (9)*
FD_t	−0.770 (1)	−1.807 (2)
ΔFD_t	−8.344 (0)*	−8.344 (1)*

Note: * denote significance at the 1% levels, respectively. The model with constant and trend was used to estimate the unit root tests. The optimal lag length for ADF is determined by Akaike's Information Criterion (AIC), while the bandwidth for the PP tests were determined using the Bartlett–Kernel procedure.

This starts with the null hypothesis of no co-integration ($r=0$) among the variables. It is found that the trace statistic of 82.70 exceeds the 95 percent critical value of the λ trace statistic. It is possible to reject the null hypothesis ($r=0$) of no co-integration vector in favor of the general alternative $r>0$. As evident in Table 8, the null hypothesis of $r \leq 1$, $r \leq 2$, $r \leq 3$ and $r \leq 4$ cannot be rejected at 5 percent level of confidence. Consequently, it is concluded that there are only one cointegration relationships, involving variables i.e., EC, GDPPC, RPRICES, FDI and FD. Similarly, λ max statistic rejects the null hypothesis of no co-integration vector as the calculated value $\lambda_{\max} = 43.47$ exceed the 95 percent critical value. Thus, based on λ_{\max} statistic, there is one co-integration vectors. The presence of the co-integration vectors shows that there exists a long-run relationship among the variables. This study further examined the existence of long-run relationship between the variables. We used a Hendry's general-to-specific modeling approach and selected the maximum lag order of three for the conditional ARDL-VECM. Maximum lag order of three years is sufficient to capture the system's dynamics' for the yearly data analysis. Table 8B reports the results of bounds test with F -statistics when each variable is considered as a dependent variable in ARDL-OLS regressions. Based on the Pesaran et al [53] and Narayan [56], only energy consumption model specification i.e., F_{EC} is significant at 1% level. Thus the null hypothesis of no cointegration is rejected in case of first model, implying long-run cointegration relationships between them, else remaining models i.e., F_{GDPPC} , F_{RPRICES} , F_{FDI} and F_{FD} accepted null hypothesis of no cointegration, therefore, the present study use first model where energy consumption is the dependent variable.

A number of diagnostic tests are conducted to ensure that the selected ARDL model is appropriate. Overall, the selected ARDL model is free from heteroskedasticity, serial correlation and general specification error. Moreover, both CUSUM and CUSUM of square tests reject the presence of structural break. Table 8, panel B, presents the calculated F -statistic for cointegration, the critical values provided by Narayan [56] and the diagnostic tests. We find that the calculated F -statistic is greater than the 1% upper bounds critical values. Hence, we reject the null hypothesis of no cointegration relationship among the variables. This is corroborated by the results of the Johansen–Juselius cointegration test. Since the suggestions of both cointegration tests are consistent, we confirm that the variables are cointegrated and that the cointegration results are robust.

4.2. Estimating the long-run and short-run relationship

In order to check the stability of the long-run and short-run relationship among EC, GDPPC, RPRICES, FDI and FD, we assess the error correction model in Table 9.

The long run results are presented in Table 9A. With the exception of relative price, other explanatory variables positively affect energy consumption in the long run. Moreover, all variables are statistically significance at the 1 and 5% level respectively. The long run results show that if there is one percent increase in GDPPC, FDI and FD, on average the energy consumption in South Asia would increase by 0.290%, 0.041% and 0.170%, respectively. Nevertheless, a 1 percent increase in relative price, on average energy consumption in South Asia reduces by 0.065%. The result concludes that sound and developed financial system attract investors, boost the stock market and improve the efficiency of economic activities in the South Asia.

As the variables are cointegrated, the short run elasticities are evaluated using the ECM. Table 9B reveals the results of short run elasticities and also the diagnostic tests. The coefficient for error correction term is negative (i.e., −0.471) and statistically significant at the 5% level, implying the presence of a long run relationship

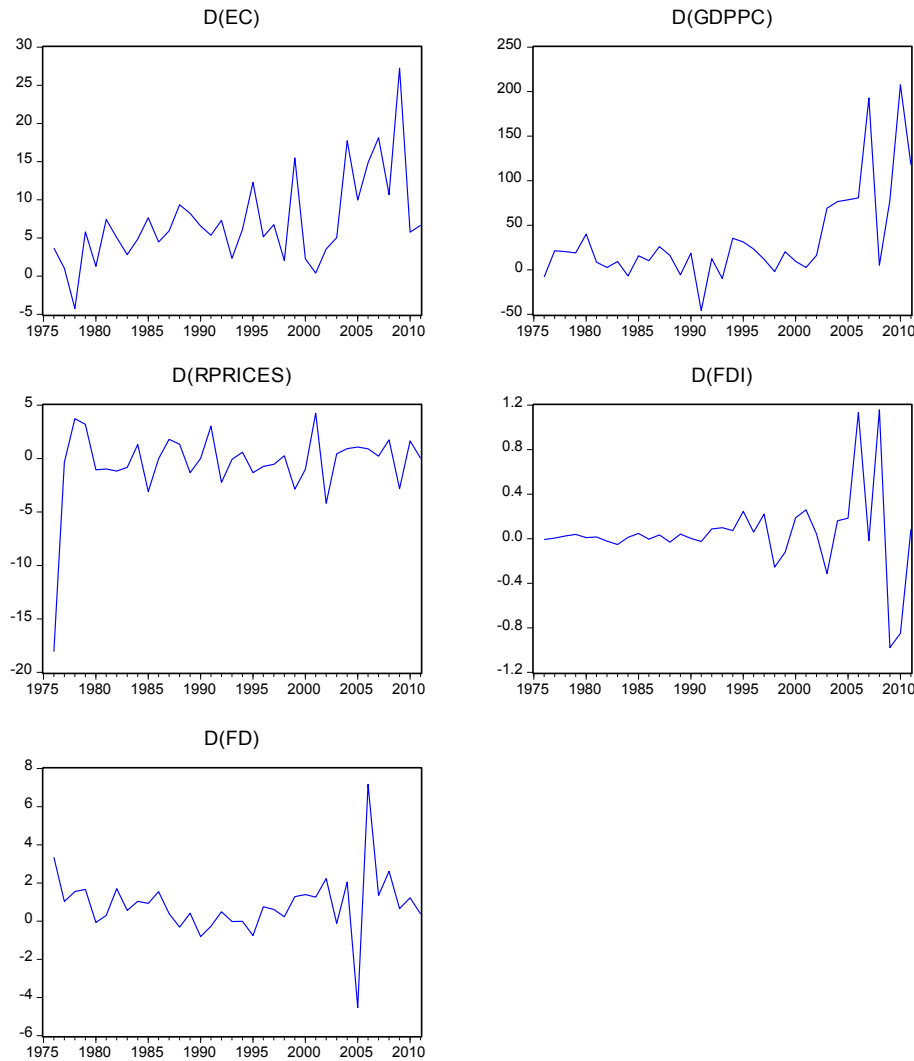


Fig. 2. Data trends at their first difference.
Source: World Bank [6].

among energy consumption, GDP, relative price, FDI and FD [45]. The result shows that about 47.1% of the variation in energy consumption in South Asia is due to disequilibrium. Moreover, if the system exposes to shock, energy consumption takes nearly a year to converge to its long run equilibrium. Regarding all other explanatory variables, we find that in the short run only relative prices is statistical significant at the 1% level. In the short run, a 10% increase in the relative prices, on average the growth rate of energy consumption will decrease by 2.0%. The value of R adjusted indicates that 54.1% variation in dependent variable has been explained by variations in independent variables. F -value is higher than its critical value suggesting a good overall significance of the estimated model. Therefore, fitness of the model is acceptable empirically. The Durbin Watson Test is almost equal to 2, therefore, there has no such problem of serial correlation in the model. The model seems to be robust to various departures from standard regression assumptions in terms of residual correlation, like Heteroscedasticity, Autoregressive Conditional Heteroscedasticity (ARCH), misspecification of functional form, or non-normality of residuals. This result tends to suggest that the impact of any structural change over the entire sample period does not appear to be significant at least in terms of model stability.

4.3. Results of Granger causality analysis

As the variables are cointegrated, we proceed to examine the short and the long run Granger causality in the ECM framework. Table 10 presents the results of Granger causality among energy consumption, economic growth, relative price, FDI and FD in South Asia. With regard to short run causality, we find a unidirectional causality running from FD to RPRICES; FD to FDI; EC to RPRICES; EC to FD; and GDPPC to RPRICES. Apart from that, there are also evidences of bidirectional causality: (a) between energy consumption and economic growth, (b) between energy consumption and FD, (c) between FD and economic growth, (d) between FDI and relative price, and e) between FDI and economic growth in South Asia. Turning to the long run causality, the results show that at the 5 and 10% significance level, there are five unidirectional causalities, however, there is no such bidirectional causality running between the variables in South Asia. The unidirectional causalities are running: (a) from energy consumption and economic growth, (b) from energy consumption and relative prices, (c) relative price and economic growth, (d) from economic growth to FD, and (e) from FDI and FD.

Table 8
Cointegration test results.

A: Multivariate Johansen–Juselius cointegration test			
Number of cointegrating equations (null hypotheses)	λ_{trace} Test statistics	λ_{max} Test statistics	
$r = 0$	82.70*	43.47*	
$r \leq 1$	39.22	24.71	
$r \leq 2$	14.50	10.05	
$r \leq 3$	4.45	2.94	
$r \leq 4$	1.50	1.50	
B: Bounds testing approach to cointegration			
Model		Wald F -statistics	
F_{EC} (EC GDPPC, RPRICES, FDI, FD)		7.993*	
F_{GDPPC} (GDPPC EC, RPRICES, FDI, FD)		0.867	
F_{RPRICES} (RPRICES GDPPC, EC, FDI, FD)		0.638	
F_{FDI} (FDI GDPPC, RPRICES, EC, FD)		1.522	
F_{FD} (FD GDPPC, RPRICES, FDI, EC)		1.549	
Narayan [56] critical value bounds of the F -statistic: intercept and no trend ($T = 35$)			
Significance level	Lower bounds, $I(0)$	Upper bounds, $I(1)$	
1%	4.590	6.368	
5%	3.276	4.630	
10%	2.696	3.895	
Diagnostic tests			
R^2	0.781		
Adjusted R^2	0.524		
F -statistics	2.415***		
JB (χ^2_{NORMAL})	1.497 (0.472)		
LM (χ^2_{SERIAL})	[1]: 0.171 (0.682)	[2]: 0.252 (0.779)	
ARCH (χ^2_{ARCH})	[1]: 0.376 (0.544)	[2]: 1.102 (0.109)	
Ramsey RESET (χ^2_{RESET})	[1]: 1.946 (0.175)	[2]: 2.216 (0.131)	
CUSUM	Stable at 5% level		
CUSUM of squares	Stable at 5% level		

Note * and ***** denote significance at the 1 and 10% levels, respectively.

The short and long-run causalities have some important policy implications in the context of South Asia. First, the finding of bidirectional Granger causality between energy consumption and economic growth implies that South Asia is an energy dependent country. Therefore, energy policy that aims to conserve energy consumption will slow down economic performance. Khan and Qayyum [57] suggest that the economies of South Asian region are energy dependent economies. Hence the policies of energy conservation are formulated in such a way that these policies would not any produce adverse effects on economic growth in the region. This result is consistent with earlier studies in South Asia or in selected South Asian countries i.e., Noor and Siddiqi [33], Hye and Mashkoor [58], Aqeel and Butt [59], Hossain [36]. Secondly, there is causal relationship between energy consumption and financial development in South Asia which implies that an increase in energy consumption lead to more economic and investment activities. This raises the demand for financial services that further leads to financial development [8]. Thirdly, there is a two way link between FDI & economic growth; and between FDI & relative prices of energy in South Asia which shows that FDI increases energy prices in the host countries, whereas brighter growth prospects in the host countries attract an increased flow of FDI [60]. Finally, there is bidirectional Granger causality between financial development and economic growth in South Asia which implies that financial depth stimulates growth and, simultaneously, growth propels financial development. The expansion of the real sector significantly influences development of the financial sector [61]. Hence, South Asian countries have more room for financial and economic improvement. On the basis of causality analysis, this study concludes that economic growth in South Asia depends not only on energy consumption; it is also depended on the level of FD and the influx of FDI. With these grounds, our results of this study support the energy-led growth, energy led financial development, FDI-led growth, FDI-led relative prices and FD-led growth hypotheses in South Asia.

5. Conclusion and policy recommendations

The objective of this study is to examine the relationship among energy consumption, economic growth, relative price, FDI and financial development in South Asia, using annual aggregate data from 1975 to 2011. Data are analyzed by cointegration theory and Granger causality test. The main findings from this study are as follows i.e., the Johansen–Juselius cointegration test and the bounds testing approach to cointegration consistently suggest that the variables under investigation are cointegrated. This implies that the variables stably move together in the long run, even though there might be deviations in the short run. The results of Granger causality test indicate that energy consumption, FDI and FD Granger causes economic growth in South Asia. These findings support the energy-led growth, FDI-led growth and finance-led growth hypotheses in South Asia. Moreover, FDI-led relative prices of energy also exist in South Asia. Considering the current paradigm shifts in the economic hubs and financial activities boots up the FDI inflows in South Asian market, but the tragedy remains unchangeable, the existing energy infrastructure fails to comply with speedy FDI and thus put strain on the energy channels which leads to higher energy prices. The results suggest that South Asia is an energy-intensive country. Moreover, there is evidence that energy consumption Granger causes FD, meaning that energy is an important input for the development of the financial sector in South Asia. Therefore, energy conservation policy would inversely affect the development of the financial sector, which in turn slows down the economic performance of the South Asian economy.

Energy consumption in South Asian countries seems to play an important role in determining economic growth. In order to achieve rapid economic growth, South Asian countries should adopt a policy of energy sector development [57]. The rapid growth in demand and increase in oil imports, steeply rising oil prices in the international oil markets, progress in new energy technologies and concerns about the long-term stability of oil supplies, all highlight a rapidly changing

Table 9
Long-run and short-run elasticities.

Variables	Coefficient	Std. error	t -Statistics
A: Long-run results			
Constant	4.769	0.281	16.965*
$\ln(\text{GDPPC})$	0.290	0.052	5.514*
$\ln(\text{RPRICES})$	−0.065	0.025	−2.561**
$\ln(\text{FDI})$	0.041	0.010	3.861*
$\ln(\text{FD})$	0.170	0.024	6.810*
B: Short-run results			
Dependent variable: $\Delta \ln(\text{EC})_t$			
Constant	0.017	0.005	3.409*
$\Delta \ln(\text{GDPPC})$	0.036	0.033	1.096
$\Delta \ln(\text{RPRICES})$	−0.020	0.006	−3.131*
$\Delta \ln(\text{FDI})$	0.001	0.005	0.251
$\Delta \ln(\text{FD})$	0.008	0.040	0.216
ε_{t-1}	−0.471	0.175	−2.680**
Diagnostic tests			
Adjusted R^2		0.541	
F -statistics		14.201*	
Durbin–Watson statistics		1.992	
JB (χ^2_{NORMAL})		1.186 (0.551)	
LM (χ^2_{SERIAL})		[1]: 0.297 (0.590)	[2]: 0.712 (0.500)
ARCH (χ^2_{ARCH})		[1]: 0.377 (0.543)	[2]: 0.623 (0.542)
Ramsey RESET (χ^2_{RESET})		[1]: 0.827 (0.371)	[2]: 0.489 (0.618)

Note: *, ** and *** denote statistical significance at the 1, 5 and 10% levels, respectively. Probability values are quoted in square brackets. LM (1) tests for the null of 1st order serial correlation amongst the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional Heteroscedasticity effects; RESET: Ramsey's Regression Specification Error-test with (m, n) degrees of freedom; and the Jarque–Bera $\chi^2_{(2)}$ LM test for normality of residuals.

Table 10
Short-run and long-run Granger causality test – VECM.

Null hypothesis	Source of causation	
	Short-run causality – Wald test statistics	Long-run causality
$\Delta \ln \text{GDPPC} \rightarrow \Delta \ln \text{EC}$	12.781*	2.098
$\Delta \ln \text{RPRICES} \rightarrow \Delta \ln \text{EC}$	0.814	1.825
$\Delta \ln \text{FDI} \rightarrow \Delta \ln \text{EC}$	1.664	1.801
$\Delta \ln \text{FD} \rightarrow \Delta \ln \text{EC}$	5.542*	1.649
$\Delta \ln \text{EC} \rightarrow \Delta \ln \text{GDPPC}$	35.341*	7.514**
$\Delta \ln \text{RPRICES} \rightarrow \Delta \ln \text{GDPPC}$	0.839	6.180**
$\Delta \ln \text{FDI} \rightarrow \Delta \ln \text{GDPPC}$	11.876*	1.498
$\Delta \ln \text{FD} \rightarrow \Delta \ln \text{GDPPC}$	5.759*	0.733
$\Delta \ln \text{EC} \rightarrow \Delta \ln \text{RPRICES}$	35.837*	8.523**
$\Delta \ln \text{GDPPC} \rightarrow \Delta \ln \text{RPRICES}$	13.113*	0.068
$\Delta \ln \text{FDI} \rightarrow \Delta \ln \text{RPRICES}$	4.760**	3.776
$\Delta \ln \text{FD} \rightarrow \Delta \ln \text{RPRICES}$	8.214*	0.746
$\Delta \ln \text{EC} \rightarrow \Delta \ln \text{FDI}$	34.641*	1.421
$\Delta \ln \text{GDPPC} \rightarrow \Delta \ln \text{FDI}$	12.726*	1.357
$\Delta \ln \text{RPRICES} \rightarrow \Delta \ln \text{FDI}$	3.301**	2.832
$\Delta \ln \text{FD} \rightarrow \Delta \ln \text{FDI}$	5.522*	0.540
$\Delta \ln \text{EC} \rightarrow \Delta \ln \text{FD}$	33.881*	2.963
$\Delta \ln \text{GDPPC} \rightarrow \Delta \ln \text{FD}$	12.230*	4.955***
$\Delta \ln \text{RPRICES} \rightarrow \Delta \ln \text{FD}$	2.189	2.060
$\Delta \ln \text{FDI} \rightarrow \Delta \ln \text{FD}$	1.372	5.241***

Note: *, ** and *** denote statistical significance at the 1, 5 and 10% levels, respectively. The optimal lag order is determined by AIC.

landscape of the energy markets with evolving energy needs, vulnerabilities and opportunities. Hence, the energy challenges that Asian countries face are more formidable than ever before and require policy measures to guard against them [62]. Asia's growth depends on securing adequate supplies of energy. The region is dependent on energy supplies from outside, and these are likely to increase as growth proceeds into the future [12]. The region already suffers from supply deficiencies, and governments have put in place a number of policy responses to address these problems. These include:

- Reforms in the energy sub-sectors, especially cost-reflective pricing and improved collection in the electricity sector.
- Development and exploration of new energy sources and supplies.
- Diversification of the energy mix and promotion of alternative fuel sources particularly renewable energy.
- Measures to improve energy efficiency and conservation.
- Technological developments especially for utilizing the existing hydrocarbon base (particularly for exploiting the rich coal base of the region) in an environmentally friendly manner.
- Enhancing emergency response coordination and preparedness in the event of energy supply disruptions.
- Promoting regional cooperation not only to better utilize the energy resources within the region but also to tackle competition and confrontation over energy resources, which are emerging between Asian countries especially between Japan, China and India [5].

Ting et al. [63] suggests that while expanding FDI scale, Asian countries should adopt unified energy-saving and emission-reducing requirements to FDI enterprises and domestic ones. Meanwhile, countries should increase the foreign investment proportion in the technology-intensive industries and encourage FDI enterprises to use and exchange advanced energy-saving technologies. Moreover, countries should adjust the distribution industry structure of FDI to optimize the industrial structure adjustment. Elliott et al. [64] suggested that inflows FDI could alleviate pressure on the energy consumption, via the technology spillover. Increasing income can help to enhance the energy

efficiency when economic development is mature enough. These are conjectures suggestive of the need to carry out a thorough analysis of the political economy of policy making in South Asia to understand better the factors that have contributed to shaping energy policy stance and what needs to be done to remove the disincentives faced by South Asian manufacturing firms. Experience in South Asia indicates that the main initiative for promotion of commercialization of renewable energy technologies has to come from governments. International and regional organizations should continue to enhance their catalytic role, particularly in terms of capacity building and promoting regional and sub-regional cooperation. However, some activities on renewable energy technologies have already been started in these countries [65]. South Asian countries should make concerted efforts in devising policies that improve level of economic freedom. In other words, they should provide more investment friendly climate, trade openness, efficient monetary and fiscal policies and freedom from corruption. This can help to attract more foreign direct investment in the South Asian countries [34]. To sustain economic growth over the medium term and make growth more inclusive, a diverse policy agenda will be required in different parts of Asia, ranging from economic rebalancing to strengthening the sources of private sector-led investment, to reforms in goods and labor markets, and meeting the opportunities and challenges from rapid demographic change. Collective action will also help particularly the maintaining and furthering of strong regional trade integration [66]. South Asian countries need to maintain their growth momentum, improve infrastructure facilities, frame policies for better use of abundant labor force and continue economic reforms with focus on trade policies to attract more FDI.

References

- [1] SEC (2013). SAARC Energy Centre, Islamabad, Pakistan. Online available at: <http://www.saarcenergy.org/AboutUs/Introduction.aspx> [accessed 15.02.13].
- [2] ASTAE. Asia sustainable and alternative energy program, FY 10 annual status report. Washington, DC: World Bank; 2010.
- [3] ESMAP. Potential and prospects for regional energy trade in the South Asia region. Washington, D.C.: Energy Sector Management Assistance Program, The World Bank Group; 2008.
- [4] UN. World economic situation and prospects 2012. New York, U.S.A.: United Nations Department of Economic and Social Affairs; 2012.
- [5] Jaswal P, Gupta MD. Energy demands and sustaining growth in South and East Asia. Asia: Institute of Development Studies and Overseas Development Institute; 2006. Online available at: <http://www.eldis.org/vfile/upload/1/document/0708/DOC21064.pdf> [accessed 17.01.13].
- [6] World Bank. World development indicators. Washington, DC, USA: The World Bank; 2012. Online available at: <http://data.worldbank.org/data-catalog/world-development-indicators/World-Bank-2011> [accessed 01.07.12].
- [7] ADB. Financial development and economic growth in developing Asia. ADB economics working paper series 233. Manila, Philippines: Asian Development Bank; 2010.
- [8] Shahbaz M, Lean HH. The dynamics of electricity consumption and economic growth: a revisit study of their causality in Pakistan. Online available at: <http://mp.ra.ub.uni-muenchen.de/33196/>; 2011 [accessed 11.02.13].
- [9] World Investment Report. Chapter 11, regional trends in FDI. Online available at: <http://www.unctad-docs.org/files/UNCTAD-WIR2012-Chapter-II-en.pdf>; 2012 [accessed 02.01.13].
- [10] ADB. Foreign direct investment in South Asia. Manila, Philippines: Asian Development Bank; 2008.
- [11] Majid H. Losing trading power. South Asia global affairs. Online available at: <http://www.saglobalaffairs.com/cover-stories/1287-losing-trading-power.html>; 2012 [accessed 15.02.13].
- [12] Nabi I. Economic growth and structural change in South Asia: miracle or mirage. Development policy research center monograph, South Asia Region. LUMS, Pakistan: World Bank; 2010.
- [13] AusAID. South Asia region infrastructure for growth initiative. Australia: South and West Asia Regional; 2011.
- [14] Kumar A. A review of human development trends in South Asia: 1990–2009. United Nations Development Programme; 2010. Human Development Research Paper 2010/44.
- [15] Sahoo P. Foreign direct investment in South Asia: policy, trends, impact and determinants. ADB Institute Discussion Paper No. 56; 2006. Online available at: http://www.adbi.org/files/dp56_fdi_in_south_asia.pdf [accessed 03.05.12].

- [16] Bano S, Tabbada J. Foreign direct investment from developing countries: evidence, trends and determinants. Online available at: http://www.nzae.org.nz/wp-content/uploads/2012/07/Bano_NZAE-Conf-FDI-Paper-14-june-2012.pdf; 2011 [accessed 25.08.12].
- [17] Weforum. The financial development report 2011. New York, USA: World Economic Forum USA Inc; 2011.
- [18] Goyal A. The future of financial liberalization in South Asia. *Asia-Pacific Dev J* 2012;19(1):63–96.
- [19] Blanford GJ, Rose SK, Tavoni M. Baseline projections of energy and emissions in Asia. *Energy Econ* 2012;34(3):S284–92.
- [20] Brew-Hammond A. Energy: the missing millennium development goal. *Energy for development. Environ Policy* 2012;54:35–43.
- [21] Asafu-Adjaye J. The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy Econ* 2010;22:615–25.
- [22] Mahadevan R, Asafu-Adjaye J. Energy consumption, economic growth and prices: a reassessment using panel VECM for developed and developing countries. *Energy Policy* 2007;35(4):2481–90.
- [23] Payne JE. A survey of the electricity consumption-growth literature. *Appl Energy* 2010;87(3):723–31.
- [24] Ozturk I. A literature survey on energy-growth nexus. *Energy Policy* 2010;38(1):340–9.
- [25] Koljonen T, Lehtilä A. The impact of residential, commercial, and transport energy demand uncertainties in Asia on climate change mitigation. *Energy Econ* 2012;34(3):S410–20.
- [26] Akkemika KA, Göksalib K. Energy consumption-GDP nexus: heterogeneous panel causality analysis. *Energy Econ* 2012;34(4):865–73.
- [27] Azam M, Khan MA, Iqbal N. Impact of political risk and uncertainty on FDI in South Asia. *Transition Stud Rev* 2012;19(1):59–77.
- [28] Sahoo P. Determinants of FDI in South Asia: role of infrastructure, trade openness and reforms. *J World Invest Trade* 2012;13(2):256–78.
- [29] Sahoo P, Dash RK. Economic growth in South Asia: role of infrastructure. *J Int Trade Econ Dev Int Comp Rev* 2012;21(2):217–52.
- [30] Narula K, Nagaib Y, Pachauri S. The role of decentralized distributed generation in achieving universal rural electrification in South Asia by 2030. *Energy Policy* 2012;47:345–57.
- [31] Al-mulali U, Sabb SNBC, Fereidouni HG. Exploring the bi-directional long run relationship between urbanization, energy consumption, and carbon dioxide emission. *Energy* 2012;46(1):156–67.
- [32] Sadosky P. Information communication technology and electricity consumption in emerging economies. *Energy Policy* 2012;48:130–6.
- [33] Noor S, Siddiqi MW. Energy consumption and economic growth in South Asian Countries: a co-integrated panel analysis. *Int J Hum Soc Sci* 2010;5(14):921–6.
- [34] Nasir ZM, Hassan A. Economic freedom, exchange rates stability and FDI in South Asia. In: Paper presented at 27th annual general meeting and conference of The PSDE, 13th–15th December, 2011. Islamabad: Pakistan Institute of Development Economics (PIDE); 2011.
- [35] Fisman R, Love I. Financial development and growth in the short and long run. World Bank Policy Research Working Paper 3319; May 2004.
- [36] Hossain MS. Multivariate Granger causality between economic growth, electricity consumption, exports and remittance for the panel of three SAARC Countries. *Eur Sci J* 2012;8(1):347–76.
- [37] Lee C. Energy consumption and GDP in developing countries: a cointegrated panel analysis. *Energy Econ* 2005;27(3):415–27.
- [38] Kirkpatrick C, Parker D, Zhang Y. Foreign direct investment in infrastructure in developing countries: does regulation make a difference? *Transnat Corp* 2006;15(1):143–71.
- [39] Lee C, Chang C. Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data. *Resour Energy Econ* 2008;30(1):50–65.
- [40] Barros CP, Chen Z, Damásio B. Attracting foreign direct investment: an analysis of Asian countries. CESA; 2013. Working paper series 116/2013. Online available at: http://pascal.iseg.utl.pt/~cesa/files/Doc_trabalho/WP116-1.pdf [accessed 03.02.13].
- [41] Chu H, Chang T. Nuclear energy consumption, oil consumption and economic growth in G-6 countries: bootstrap panel causality test. *Energy Policy* 2012;48:762–9.
- [42] Çoban S, Topcu M. The nexus between financial development and energy consumption in the EU: a dynamic panel data analysis. *Energy Econ* 2013;39: 81–8.
- [43] Khan MA, Khan MZ, Zaman K, Arif M. Global estimates of energy-growth nexus: application of seemingly unrelated regressions. *Renew Sust Energy Rev* 2014;29:63–71.
- [44] Mumtaz R, Zaman K, Sajjad F, Lodhi MS, Irfan M, Khan M, et al. Modeling the causal relationship between energy and growth factors: journey towards sustainable development. *Renew Energy* 2014;63:353–65.
- [45] Tang CF, Tan BW. The linkages among energy consumption, economic growth, relative price, foreign direct investment, and financial development in Malaysia. *Qual Quant*. Online available at: <http://link.springer.com/article/10.1007%2Fs11135-012-9802-4>; 2012 [accessed 17.01.13].
- [46] Ang JB. Financial development and the FDI-growth nexus: the Malaysian experience. *Appl Econ* 2009;41:1595–601.
- [47] Asteriou D, Hall SG. Applied econometrics: a modern approach using EVIEWS and Microfit (revised edition). New York: Palgrave Macmillan; 2012.
- [48] Tugcu CT, Ozturk I, Aslan A. Renewable and non-renewable energy consumption and economic growth relationship revisited: evidence from G7 countries. *Energy Econ* 2012;34(6):1942–50.
- [49] Belke A, Dobnik F, Dreger C. Energy consumption and economic growth: new insights into the cointegration relationship. *Energy Econ* 2011;33(5): 782–9.
- [50] Hannesson R. Energy and GDP growth. *Int J Energy Sect Manage* 2009;3(2): 157–70.
- [51] Johansen S, Juselius K. Maximum likelihood estimation and inference on cointegration: with application to the demand for money. *Oxford Bull Econ Stat* 1990;52:169–210.
- [52] Johansen S. Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica* 1991;55:1551–80.
- [53] Pesaran MH, Shin Y, Smith R. Bounds testing approaches to the analysis of level relationships. *J Appl Econ* 2001;16(3):289–326.
- [54] Engle RF, Granger CWJ. Co-integration and error correction: representation, estimation, and testing. *Econometrica* 1987;55:251–76.
- [55] Johansen S. Statistical analysis of cointegration vectors. *J Econ Dyn Control* 1988;12:231–4.
- [56] Narayan PK. Estimating income and price elasticities of imports for Fiji in a cointegration framework. *Economic Modelling* 2005;22:423–38.
- [57] Khan MA, Qayyum A. Dynamic modeling of energy and growth in South Asia. *Pakistan Dev Rev* 2007;46(4 part II):481–98.
- [58] Hye QMA, Mashkoor M. Growth and energy nexus: an empirical analysis of Bangladesh economy. *Eur J Soc Sci* 2010;15(2):217–21.
- [59] Aqeel A, Butt MS. The relationship between energy consumption and economic growth in Pakistan. *Asia-Pacific Dev J* 2001;8(2):101–10.
- [60] Basu P, Chakraborty C, Reagle D. Liberalization, FDI, and growth in developing countries: a panel cointegration approach. *Econ Inquiry* 2007;41(3):510–6.
- [61] Calderón C, Liu L. The direction of causality between financial development and economic growth. *J Dev Econ* 2003;72(1):321–34.
- [62] Liu H. The trends of energy consumption & economic growth in Asia and the Pacific. In: Asia Pacific consultations – Gleneagles dialogue 18–19 July 2007, Seoul, Republic of Korea. Environment and Sustainable Development Division. United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP); 2007.
- [63] Ting Y, Yin LR, Ying ZY. Analysis of the FDI effect on energy consumption intensity in Jiangsu Province. *Energy Proc* 2011;5:100–4.
- [64] Elliott RJR, Sun P, Chen S. Growth, FDI and energy intensity: evidence from Chinese cities. Online available at: <http://www.nottingham.ac.uk/gep/documents/conferences/2011/china-conf-november/puyang-sun.pdf>; 2012 [accessed 24.01.13].
- [65] UNIDO. South–South Cooperation, economic and industrial development of developing countries: dynamics, opportunities and challenges. Vienna: United Nations Industrial Development Organization, Research and Statistics Branch Working Paper 02/2009; 2009.
- [66] IMF. Asia and Pacific regional economic outlook—October 2012 update. Washington, D.C.: International Monetary Fund; 2012.