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**Abstract**


This paper investigates the causal relationship between energy consumption and economic growth and energy consumption and employment in Pakistan. By applying techniques of co-integration and Hsiao's version of Granger causality, the results infer that economic growth causes total energy consumption. Economic growth also leads to growth in petroleum consumption, while on the other hand, neither economic growth nor gas consumption affect each other. However, in the power sector it has been found that electricity consumption leads to economic growth without feedback. The implications of the study are that energy conservation policy regarding petroleum consumption would not lead to any side-effects on economic growth in Pakistan. However, an energy growth policy in the case of gas and electricity consumption should be adopted in such a way that it stimulates growth in the economy and thus expands employment opportunities.


In the present paper, an attempt is made to examine the causal relationship between the per capita consumption of coal, electricity, oil and total commercial energy and the per capita real gross domestic product (GDP), using a co-integration and vector error correction model. The increase in real GDP, among other things, indicates a higher demand for a large quantity of commercial energy such as coal, oil and electricity. This implies that low infrastructure development limits the usage of commercial energy, which may also hold back economic growth. Empirical findings reveal that there is a unidirectional causality running from coal, oil and commercial energy consumption to per capita real GDP, whereas a unidirectional causality running from per capita real GDP to per capita electricity consumption is found. It is suggested that the input of per capita energy consumption stimulates enhanced economic growth in Nepal.

In this paper, the energy-GDP relationship (in per capita terms) is analyzed for a sample of 16 countries, over the time period 1950-51 to 1984-85. Co-integration theory is first used to test whether a long-run equilibrium relation exists between the two variables. After co-integration has been established, causality measures are constructed to quantify various types of feedback between energy and GDP for each country. It is then examined whether the causality measures are longitudinally related to certain basic economic indicators of the countries in the sample.

Unlike previous studies on the casual relationship between energy consumption and economic growth, this paper illustrates how the finding of cointegration (i.e. long-term equilibrium relationship) between these variables, may be used in testing Granger causality. Based on the most recent Johansen's multiple cointegration tests preceded by various unit root or nonstationarity tests, we test for cointegration between total energy consumption, real income and price level of two Asian LDCs: Thailand and Sri Lanka. Nonrejection of cointegration between variables rules out Granger noncausality and implies at least one way of Granger-causality either unidirectional or bidirectional. Secondly, by using a dynamic vector error-correction model, we then analyse the direction of Granger-causation and hence the within-sample Grangerexogeneity or endogeneity of each of the variables. Thirdly, the relative strength of the causality is gauged (through the dynamic variance decomposition technique) by decomposing the total impact of an unanticipated shock to each of the variables beyond the sample period, into proportions attributable to shocks in the other variables including its own, in the multivariate system. Finally, these response paths of shocks to the system are traced out using impulse response graphs. Results based on these four tools of methodology, broadly indicate that all three variables are cointegrated and exhibit two common trends within each system. Energy consumption seems to be relatively exogenous as neither income nor prices seems to Granger cause this variable via any of the channels where potential casuality may occur. Though, energy consumption itself plays an important role in in¯uencing income and prices by varying degrees of signi®cance for each country. Overall, shocks to the system seemed to have had a more sustained if not pronounced e€ct in Thailand than in Sri Lanka.


Applying recently developed techniques of cointegration and Hsiao's version of Granger causality to three Latin countries (Brazil, Mexico, and Venezuela), this study finds no causal linkages between energy consumption and economic growth for both Mexico and Venezuela using the trivariate models. However, capital is found to negatively, though weakly, cause economic growth for both Mexico and Venezuela. Additionally, energy is found to cause economic growth for Brazil. In sum, we detect no consistent causal patterns between energy and economic growth based on the causality tests from the three Latin countries.

We investigate the causal relationship between GDP and different types of energy consumption for the five South Asian Countries; Pakistan, India, Sri Lanka, Bangladesh and Nepal by using Error Correction Model and Toda and Yamamoto(1995) approach. For Pakistan evidence shows that there is unidirectional Granger causality running from coal to GDP, and unidirectional Granger causality running from GDP to electricity consumption and total energy consumption. For India no causality in either direction between GDP and different energy consumption is detected. For Sri Lanka there is unidirectional Granger causality running from GDP to electricity consumption and total energy consumption. For Bangladesh unidirectional Granger causality is detected from GDP to electricity consumption and from gas consumption to GDP. For Nepal causal direction is from petroleum to GDP.

This paper presents a model to quantify the impact of electric power outages on GDP by using Cobb– Douglas production function to develop an economic relationship between the reliability of the electric power supply system and the cost of electric energy unserved. Our findings show that average costs for providing a stable power supply are much lower than disruption costs, which is supported by recurring to the data available of Shanghai. Estimated by using Shanghai's macroeconomic data of 1990–2006, this relationship indicates that the impact of electricity service disruption on Shanghai's GDP is about 48.18  $10^8$ CNY in 2006, matching an alternative ''back-of-envelope'' estimate of 50.91  $10^8$ CNY. The estimated costs per kWh unserved are 1.81–10.26 CNY in 1990–2006, mirroring the increasing importance of electricity in the period's economic development. These results demonstrate the usefulness of our approach for quantifying the reliability benefits of investments in electricity infrastructure.

This paper investigates the existence and direction of Granger causality between economic growth, energy consumption, and carbon emissions in China, applying a multivariate model of economic growth, energy use, carbon emissions, capital and urban population. Empirical results for China over the period 1960–2007 suggest a unidirectional Granger causality running from GDP to energy consumption, and a unidirectional Granger causality running from energy consumption to carbon emissions in the long run. Evidence shows that neither carbon emissions nor energy consumption leads economic growth. Therefore, the government of China can purse conservative energy policy and carbon emissions reduction policy in the long run without impeding economic growth.

This paper investigates the long run Granger causality relationship between economic growth, carbon dioxide emissions and energy consumption in Turkey, controlling for gross fixed capital formation and labor. The most interesting result is that carbon emissions seem to Granger cause energy consumption, but the reverse is not true. The lack of a long run causal link between income and emissions may be implying that to reduce carbon emissions, Turkey does not have to forgo economic growth.

This paper uses the panel data of energy consumption and GDP for 82 countries from 1972 to 2002. Based on the income levels defined by the World Bank, the data are divided into four categories: low income group, lower middle income group, upper middle income group, and high income group. We employ the GMM-SYS approach for the estimation of the panel VAR model in each of the four groups. Afterwards, the causal relationship between energy consumption and economic growth is tested and ascertained. We discover: (a) in the low income group, there exists no causal relationship between energy consumption and economic growth; (b) in the middle income groups (lower and upper middle income groups), economic growth leads energy consumption positively; (c) in the high income group countries, economic growth leads energy consumption negatively. After further in-depth analysis of energy related data, the results indicate that, in the high income group, there is a great environmental improvement as a result of more efficient energy use and reduction in the release of CO2. However, in the upper middle income group countries, after the energy crisis, the energy efficiency declines and the release of CO2 rises. Since there is no evidence indicating that energy consumption leads economic growth in any of the four income groups, a stronger energy conservation policy should be pursued in all countries.

In this paper, we analyse the long-run relationship between energy consumption and real GDP for 93 countries. We find mixed results on the impact of energy consumption on real GDP, with greater evidence at the country level supporting energy consumption having a negative causal effect on real GDP. For the G6 panel of countries, we find significant evidence that energy consumption negatively Granger causes real GDP. This means that for countries where energy consumption has a negative long- run causal effect on real GDP, energy conversation policies should not retard economic growth. We identify these countries and regional panels. We argue that these countries/regions should play a greater role in reducing carbon dioxide emissions.

This paper 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. Althought the positive role of energy on growth has become a stylized fact, there are some methodological reservations about the results from these empirical studies. A general observation from these studies is that the literature produced conflicting results and there is no consensus neither on the existence nor on the direction of causality between energy consumption (electricity consumption) and economic growth. As a policy implication, to avoid from conflicting and unreliable results, the authors may use the autoregressive distributed lags bounds test, two-regime threshold co-integration models, panel data approach and multivariate models including new variables (such as: real gross fixed capital formation, labor force, carbon dioxide emissions, population, exchange rates, interest rates, etc.) Thus, the authors should focus more on the new approaches and perspectives rather than by employing usual methods based on a set of common variables for different countries and different intervals of time.

This paper reexamines the causality between GNP and energy consumption by using updated US data for the period 1947-1979. As a secondary contribution, we investigate the causal relationship between energy consumption and employment. Applying Sims' technique, we ftnd no causal relationship between GNP and energy consumption. We find further that there is a slight unidirectional flow running from employment to energy consumption. Economic interpretations of the empirical results are also presented.

This study examines the relationship between electricity consumption and economic growth in Jamaica during 1970-86, a period of rapid increase in energy prices. The results show that the aggregate demand for electricity is slightly income elastic, electricity has a signtjicant impact on economic growth, the electricity intensity has increased over time, residential demand is fairly income elastic, commercial demand is price inelastic, and the rate of adjustment is slow. These results suggest that conservation policies could be ineflective. Therefore, indigenous sources of electricity are important for Jamaica to be less dependent on imported energy.

This paper examines the causal relationship between GDP and energy use for the period 1947-90 in the USA. The relationship between energy use and economic growth has been examined by both biophysical and neoclassical economists. In particular, several studies have tested for the presence of a causal relationship (in the Granger sense> between energy use andeconomic growth. However, these tests do not allow a direct test of the relative explanatory powers of the neoclassical and biophysica2 models. A multivariate adaptation of the test-vector autoregression ( VAR) does allow such a test. A VAR of GDP, energy use, capital stock and employment is estimated and Granger tests for causal relationships between the variables are carried out. Although there is no evidence that gross energy use Granger causes GDP, a measure ofjinal energy use adjustedfor changing fuel composition does Granger cause GDP.

Unlike previous studies on the causal relationship between energy consumption and economic growth, this paper illustrates how the finding of cointegration (i.e. long-term equilibrium relationship) between these variables, may be used in testing Granger causality. Based on the most recent Johansen's multivariate cointegration tests preceded by various unit root or non-stationarity tests, we test for cointegration between total energy consumption and real income of six Asian economies: India, Pakistan, Malaysia, Singapore, Indonesia and the Philippines. Non-rejection of cointegration between variables rules out Granger non-causality and imples at least one way of Granger-causality, either unidirectional or bidirectionial. Secondly, by using a dynamic vector error-correction model, we then analyse the direction of Granger-causation and hence the within-sample Granger-exogeneity or endogeneity of each of the variables. Thirdly, the relative strength of the causality is gauged (through the dynamic variance decomposition technique) by decomposing the total impact of an unanticipated shock to each of the variables beyond the sample period, into proportions attributable to shocks in the other variables including its own, in the bivariate system. Results based on these tools of methodology indicate that while all pair-wise relationships shared common univariate integrational properties, only relationships for three countries (India, Pakistan and Indonesia) were cointegrated. For these countries, temporal causality results were mixed with unidirectional causality from energy to income for India, exactly the reverse for Indonesia, and mutual causality for Pakistan. The VDCs were not inconsistent with these results and provided us with an additional insight as to the relatively more dominant direction of causation in Pakistan. Simple bivariate vector-autoregressive models for the three non-cointegrated systems did not indicate any direction of causality, significantly in either direction.

Applying Hsiao's version of the Granger causality method, this paper examines the causality between energy and GNP and energy and employment by applying recently developed techniques of co-integration and Hsiao's version of the Granger causality to Taiwanese data for the 1955-1993 period. The Phillips-Perron tests reveal that the series with the exception of GNP are not stationary and therefore differencing is performed to secure stationarity. The study finds causality running from GDP to energy consumption without feedback in Taiwan. It is also found that causality runs from GDP to energy but not vice versa.

This paper extends my previous analysis of the causal relationship of GDP and energy use in the USA in the post-war period. A majority of the relevant variables are integrated justifying a cointegration analysis. The results show that cointegration does occur and that energy input cannot be excluded from the cointegration space. The results are plausible in terms of macroeconomic dynamics. The results are similar to my previous Granger causality results and contradict claims in the literature based on bivariate models. that there is no cointegration between energy and output.

This paper estimates the causal relationships between energy consumption and income for India, Indonesia, the Philippines and Thailand, using cointegration and error-correction modelling techniques. 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. The study results do not support the view that energy and income are neutral with respect to each other, with the exception of Indonesia and India where neutrality is observed in the short-run.

This paper re-examines the causality between energy consumption and GDP by using updated Taiwan data for the period 1954]1997. As a secondary contribution, we investigate the causal relationship between GDP and the aggregate as well as several disaggregate categories of energy consumption, including coal, oil, natural gas, and electricity. Applying Granger's technique, we find bidirectional causality between total energy consumption and GDP. We find further that different directions of cause exist between GDP and various kinds of energy consumption.

This paper attempts to shed light into the empirical relationship between energy consumption and economic growth, for Greece Ž1960 1996. employing the vector error-correction model estimation. The vector specification includes energy consumption, real GDP and price developments, the latter taken to represent a measure of economic efficiency. The empirical evidence suggests that there is a long-run relationship between the three variables, supporting the endogeneity of energy consumption and real output. These findings have important policy implications, since the adoption of suitable structural policies aiming at improving economic efficiency can induce energy conservation without impeding economic growth.

Results of this paper indicate that the real oil price is a major determinant of real national income and energy consumption. The combined effects of real money and real government expenditure on real income and energy consumption are also substantial. A lack of causality or the causality between energy and real income in prior studies is due to the omitted variables. Results also confirm that the two oil price shocks combined adversely affected real national income.

The causality relationship between energy consumption and income is a well-studied topic in energy economics. This paper studies the time series properties of energy consumption and GDP and reexamines the causality relationship between the two series in the top 10 emerging markets excluding China due to lack of data and G-7 countries. We discover bi-directional causality in Argentina, causality running from GDP to energy consumption in Italy and Korea, and from energy consumption to GDP in Turkey, France, Germany and Japan. Hence, energy conservation may harm economic growth in the last four countries.

The Granger-causality (GC) and error correction (ECM) techniques were applied on 1970–1999 data for Malawi to examine cointegration and causality between electricity consumption (kWh) and, respectively, overall GDP, agricultural-GDP (AGDP) and nonagricultural- GDP (NGDP). Cointegration was established between kWh and, respectively, GDP and NGDP, but not with AGDP. The GC results detect bi-directional causality between kWh and GDP suggesting that kWh and GDP are jointly determined, but one-way causality running from NGDP to kWh. The ECM results detect causality running one-way from GDP (also from NGDP) to kWh suggesting that a permanent rise in GDP may cause a permanent growth in electricity consumption.

Yang (Energy Econ. 22 (2000) 309) has found a bi-directional causal relationship between gross domestic product and electricity consumption in Taiwan, ROC. This study applies Yang's model to examine the impact of electricity supply on economic growth in Sri Lanka. Morimoto and Hope (An extended CBA model of hydro projects in Sri Lanka (2001)) have found that the expected increase in economic output due to increased electricity supply (parameter EO) plays a crucial role in their cost benefit analysis model. This study shows that the application of Yang's regression analysis is one possible approach to estimate a better range for the parameter EO. The estimated figure is that an extra output of Rs. 88 000– 137 000 ($US1120–1740) for every 1 MW h increase in electricity supply.

Using a neo-classical one-sector aggregate production technology where capital, labor and energy are treated as separate inputs, this paper develops a vector error-correction (VEC) model to test for the existence and direction of causality between output growth and energy use in Canada. Using the Johansen cointegration technique, the empirical findings indicate that the long-run movements of output, labor, capital and energy use in Canada are related by two cointegrating vectors. Then using a VEC specification, the short-run dynamics of the variables indicate that Granger-causality is running in both directions between output growth and energy use. Hence, an important policy implication of the analysis is that energy can be considered as a limiting factor to output growth in Canada.

This note examines the different direction of causal relation between energy consumption and economic growth in India. Applying Engle–Granger cointegration approach combined with the standard Granger causality test on Indian data for the period 1950–1996, we find that bi-directional causality exists between energy consumption and economic growth. Further, we apply Johansen multivariate cointegration technique on the different set of variables. The same direction of causality exists between energy consumption and economic growth. This is different from the results obtained in earlier studies.

Causal relationship between energy consumption and economic growth is investigated applying a multivariate model ofcapital, labor, energy and GDP. Usual BTU energy aggregate is substituted with a Divisia aggregate in an attempt to mitigate aggregation bias. To test for Granger causality in the presence ofcointegration among the variables, we employ a vector error correction model rather than a vector autoregressive model. Empirical results for Korea over the period 1970–1999 suggest a long run bidirectional causal relationship between energy and GDP, and short run unidirectional causality running from energy to GDP. The source ofcausation in the long run is found to be the error correction terms in both directions.

This paper investigates the causal relationship between various kinds of industrial energy consumption and GDPin Shanghai for the period 1952–1999 using a modified version of the Granger (1969) causality test proposed by Toda and Yamamoto (J. Econ. 66 (1995) 225). The empirical evidence from disaggregated energy series seems to suggest that there was a uni-directional Granger causality running from coal, coke, electricity and total energy consumption to real GDPbut no Granger causality running in any direction between oil consumption and real GDP.

This paper tries to investigate a series of unit root and causality tests to detect causality between the GDP and energy consumption in Turkey employing Hsiao's version of Granger causality method for the 1950–2000 period. The conventional unit root tests indicate the series are I(1), whereas the endogenous break unit root tests proposed by Zivot and Andrews [Zivot, E. and Andrews, D.W.K., 1992, Further evidence on the great crash, the oil price shock, and the unit root hypothesis, Journal of Business and Economics Statistics 10, 251–270.] and Perron [Perron, P., 1997, Further evidence on breaking trend functions in macroeconomic variables, Journal of Econometrics 80, 355–385.] reveal that the series are trend stationary with a structural break. Therefore, it is inappropriate to take the first difference of the data to achieve stationarity. The main conclusion of this study is that there is no evidence of causality between energy consumption and GDP in Turkey based on the detrended data.

This study investigates the causal relationship between electricity consumption and real GDP in Turkey during the period of 1950–2000. Both of the series were found to be a stationary process around a structural break by the Zivot and Andrews test. Thus, two different methodologies have been employed to test the Granger non-causality: the Dolado–Lu¨tkepohl test using the VARs in levels, and the standard Granger causality test using the detrended data. Both tests have yielded a strong evidence for unidirectional causality running from the electricity consumption to the income. This implies that the supply of electricity is vitally important to meet the growing electricity consumption, hence to sustain the economic growth in Turkey.

In this paper we re-investigate the co-movement and the causality relationship between energy consumption and GDP in 18 developing countries, using data for the period 1975 to 2001. Recently developed tests for the panel unit root, heterogeneous panel cointegration, and panel-based error correction models are employed. The empirical results provide clear support of a long-run cointegration relationship after allowing for the heterogeneous country effect. The long-run relationship is estimated using a full-modified OLS. The evidence shows that long-run and short-run causalities run from energy consumption to GDP, but not vice versa. This result indicates that energy conservation may harm economic growth in developing countries regardless of being transitory or permanent.

This paper studies the stability between energy consumption and GDP for Taiwan during 1954–2003. We use aggregate as well as various disaggregate data of energy consumption, including coal, oil, gas, and electricity, to employ the unit root tests and the cointegration tests allowing for structural breaks. Our main findings are: First, though gas consumption seems to have structural breaks in the 1960s, after considering the structural breaks, the series is a stationary variable when Taiwan adopted its expansionary export trade policy. Second, we find that different directions of causality exist between GDP and various kinds of energy consumption. The empirical result shows unanimously in the long run that energy acts as an engine of economic growth, and that energy conservation may harm economic growth. Third, the cointegration between energy consumption and GDP is unstable, and some economic events may affect the stability. Overall, we do find the structural breakpoints, and they look to match clearly with the corresponding critical economic incidents.

The paper presents the first empirical analysis of electricity consumption in Cyprus. Using annual data from 1960 to 2004, we have examined electricity use in the residential and the services sectors, which are the fastest-growing electricity consumers in the island, and its interaction with income, prices and the weather. The analysis was performed with the aid of time series analysis techniques such as unit root tests with and without a structural break in levels, cointegration tests, Vector Error Correction models, Granger causality tests and impulse response functions. Results show long-term elasticities of electricity use above unity for income, and of the order of −0.3 to −0.4 for prices. In the short-term electricity consumption is rather inelastic, mostly affected by weather fluctuations. Granger causality tests confirm exogeneity of electricity prices and bidirectional causality between residential electricity consumption and private income. The commercial sector is less elastic and reverts faster to equilibrium than the residential sector. Despite the relatively small sample size, results reported here are quite robust and can be used for forecasts and policy analyses.

This paper investigates the relationship between electricity consumption and economic growth for OPEC members. The bounds test yields evidence of a long-run relationship between electricity consumption and economic growth for all OPEC members. Causality results suggest that economic growth is dependent on electricity consumption in five countries, less dependent in three countries, and independent in three countries. Because these countries do not necessarily share similar political and economic traits, no single universal policy implication can be inferred from the results. The disparities across these causality results, therefore, stress the importance of formulating causality explanations while taking into account the particularities of individual countries rather than blindly applying the conventional interpretations.

Fiji is a small open island economy dependent on energy for its growth and development; hence, the relationship between energy consumption and economic growth is crucial for Fiji's development. In this paper, we investigate the nexus between electricity consumption and economic growth for Fiji within a multivariate framework through including the labour force variable. We use the bounds testing approach to cointegration and find that electricity consumption, GDP and labour force are only cointegrated when GDP is the endogenous variable. We use the Granger causality F-test and find that in the long-run causality runs from electricity consumption and labour force to GDP, implying that Fiji is an energy dependent country and thus energy conservation policies will have an adverse effect on Fiji's economic growth.

This paper applies the cointegration theory to examine the causal relationship between electricity consumption and real GDP (Gross Demostic Product) for China during 1978–2004. Our estimation results indicate that real GDP and electricity consumption for China are cointegrated and there is only unidirectional Granger causality running from electricity consumption to real GDP but not the vice versa. Then Hodrick–Prescott (HP) filter is applied to decompose the trend and fluctuation component of the GDP and electricity consumption series. The estimation results indicate that there is cointegration between not only the trend components, but also the cyclical components of the two series, which implies that, the Granger causality is probably related with the business cycle. The estimation results are of policy implication to the development of electric sector in China.

The causal relationship between overall GDP, industrial and agricultural value added and consumption of different kinds of energy are investigated using vector error correction model for the case of Iran within 1967–2003. A long-run unidirectional relationship from GDP to total energy and bidirectional relationship between GDP and gas as well as GDP and petroleum products consumption for the whole economy was discovered. Causality is running from value added to total energy, electricity, gas and petroleum products consumption and from gas consumption to value added in industrial sector. The long-run bidirectional relations hold between value added and total energy, electricity and petroleum products consumption in the agricultural sector. The short-run causality runs from GDP to total energy and petroleum products consumption, and also industrial value added to total energy and petroleum products consumption in this sector.

Energy consumption and GDP are expected to grow by 5.9% and 7% annually until 2025 in Turkey. This paper tries to unfold the linkage between energy consumption and GDP by undertaking a cointegration analysis for Turkey with annual data over the period 1970–2003. The analysis shows that energy consumption and GDP are co-integrated. This means that there is a (possibly bi-directional) causality relationship between the two. We establish that there is a unidirectional causality running from GDP to energy consumption indicating that energy saving would not harm economic growth in Turkey. In addition, we find that energy consumption keeps on growing as long as the economy grows in Turkey.

This paper applies a new panel data stationarity testing procedure, first developed byCarrion-i-Silvestre et al. [2005, Econometrics Journal 8, 159–175], with panel VARs that employ the generalized method of moment techniques in order to re-investigate the dynamic interactions between energy consumption per capita (LEC) and real GDP per capita (LRY) in 22 developed and 18 developing countries.When multiple breaks in the series are taken into account, there is convincing evidence of panel stationarity for LEC and LRY in both groups. The energy crises evidently had a substantive impact on both LEC and LRYin all sample countries. Furthermore, our panel VARs attest to bidirectional causality between LEC and LRY in developed countries, but there is unidirectional causality from LRY to LEC in developing countries. Finally, from the orthogonalized impulse response functions, all of the variables in the panel VARs have a positive effect on each other, but their impact is greater and more persistent in developing countries. Some important policy implications do emerge.

This paper examines two issues that are central to the understanding of the need to increase efficiency in the use, distribution, and production of energy in the Caribbean region. The empirical results of this Paper suggest the following: first, the three Caribbean countries provide evidence of short-run bi-directional Granger-causality from energy consumption to real gross domestic product per capita. Second, the forecasts with A BVAR model indicate that significant growth in energy demand could be expected in Haiti, Jamaica, and Trinidad and Tobago until at least 2010. Third, the increased growth in energy consumption suggests the need for long-term commitments from Caribbean countries to undertake a series of policy, economic, market, and research and development measures to advance the adoption and deployment of new energy technologies.

There is a rapidly growing literature on the interaction between energy use and economic development, with many analysts drawing policy conclusions on the basis of Granger causality tests that involve only an energy and an economic variable. This paper attempts to demonstrate empirically that such studies, although useful for certain applications, may be of limited use for policy purposes. After outlining theoretical and methodological issues associated with such approaches, I apply bivariate energy–economy causality tests for Canada, France, Germany, Italy, Japan, the United Kingdom and the United States, using aggregate and sectoral data and three differentmodern econometric methods. The results, which are often contradictory or economically implausible, illustrate explicitly that one should be cautious when drawing policy implications with the aid of bivariate causality tests on small samples. I therefore underline the importance of utilizing as large sample sizes as possible and using multivariate models,which are closer to economic theory, accommodate several mechanisms and causality channels and provide a better representation of real-world interactions between energy use and economic growth.

This article provides fresh empirical evidences for the income and price elasticies of the residential energy demand both in the short-run and long-run for Turkey over the period 1968–2005, using the bounds testing procedure to cointegration. The computed elasticities of income and price are consistent with the previous studies and, as expected, the long-run elasticities are greater than the short-run elasticities. An augmented form of Granger causality analysis is implemented among residential electricity, income, price and urbanization. In the long-run, causality runs interactively through the error-correction term from income, price and urbanization to residential energy but the short-run causality tests are inconclusive The parameter stability of the short-run as well as long-run coefficients in the residential energy demand function are tested. The results of these tests display a stable pattern.

Energy consumption growth ismuch higher than economic growth for Taiwan in recent years, worsening its energy efficiency. This paper provides a solid explanation by examining the equilibrium relationship between GDP and disaggregated energy consumption under a non-linear framework. The threshold co-integration test developed with asymmetric dynamic adjusting processes proposed by Hansen and Seo [Hansen, B.E., Seo, B., 2002. Testing for two-regime threshold cointegration in vector error-correctionmodels. Journal of Econometrics 110, 293–318.] is applied.Non-linear co- integrations betweenGDP and disaggregated energy consumptions are confirmed except for oil consumption. The two-regime vector error-correction models (VECM) show that the adjustment process of energy consumption toward equilibrium is highly persistent when an appropriately threshold is reached. There is mean-reverting behavior when the threshold is reached, making aggregate and disaggregated energy consumptions grow faster than GDP in Taiwan.

Using a neo-classical aggregate production model where capital, labor and energy are treated as separate inputs, this paper tests for the existence and direction of causality between output growth and energy use in China at both aggregated total energy and disaggregated levels as coal, oil and electricity consumption. Using the Johansen cointegration technique, the empirical findings indicate that there exists long-run cointegration among output, labor, capital and energy use in China at both aggregated and all three disaggregated levels. Then using a VEC specification, the short-run dynamics of the interested variables are tested, indicating that there exists Granger causality running from electricity and oil consumption to GDP, but does not exist Granger causality running from coal and total energy consumption to GDP. On the other hand, short-run Granger causality exists from GDP to total energy, coal and oil consumption, but does not exist from GDP to electricity consumption. We thus propose policy suggestions to solve the energy and sustainable development dilemma in China as: enhancing energy supply security and guaranteeing energy supply, especially in the short run to provide adequate electric power supply and set up national strategic oil reserve; enhancing energy efficiency to save energy; diversifying energy sources, energetically exploiting renewable energy and drawing out corresponding policies and measures; and finally in the long run, transforming development pattern and cut reliance on resource- and energy-dependent industries.

The relationship between energy consumption and economic growth is considered as an imperative issue in energy economics. Previous studies have ignored the nonlinear behavior which could be caused by structural breaks. In this study, both linear and nonlinear Granger causality tests are applied to examine the causal relationship between energy consumption and economic growth for a sample of Asian newly industrialized countries as well as the U.S. This study finds evidence supporting a neutrality hypothesis for the United States, Thailand, and South Korea. However, empirical evidence on Philippines and Singapore reveals a unidirectional causality running from economic growth to energy consumption while energy consumption may have affected economic growth for Taiwan, Hong Kong, Malaysia and Indonesia. Policy implications are also discussed.

The paper examines the causal relationship between energy consumption and economic growth for eleven countries in sub-Saharan Africa. Using the autoregressive distributed lag (ARDL) bounds test, the study finds that energy consumption is cointegrated with economic growth in Cameroon, Cote D'Ivoire, Gambia, Ghana, Senegal, Sudan and Zimbabwe. Moreover, this test suggests that energy consumption has a significant positive long run impact on economic growth in Ghana, Kenya, Senegal and Sudan. Granger causality test based on vector error correction model (VECM) shows bi-directional relationship between energy consumption and economic growth for Gambia, Ghana and Senegal. However, Granger causality test shows that economic growth Granger causes energy consumption in Sudan and Zimbabwe. The neutrality hypothesis is confirmed in respect of Cameroon and Cote D'Ivoire. The same result of no causality was found for Nigeria, Kenya and Togo. The result shows that each country should formulate appropriate energy conservation policies taking into cognizance of her peculiar condition.

This paper applies a recent advance in panel analysis to estimate the panel cointegration and panel vector error correction models for a set of 22 OECD countries using annual data covering the period 1960–2001. We investigate the relationship between energy consumption and income using an aggregate production function and controlling for the capital stock, as well as by exploring the dynamic directions of the causality among these three variables. We firstly obtain solid and convincing evidence of a fairly strong long-run equilibrium relationship among them. Secondly, it is found that the capital stock is much more productive than energy consumption. Third, it is observed that neglecting the impact of the capital stock on income tends to overestimate the effect of energy consumption. Finally, the panel causality test shows bi-directional causal linkages exist among energy consumption, the capital stock and economic growth. Overall, the findings reveal that the capital stock plays a critical role in realizing the dynamic relationship between energy and income.

This paper examines the relationship between capital formation, energy consumption and real GDP in a panel of G7 countries using panel unit root, panel cointegration, Granger causality and long-run structural estimation. We find that capital formation, energy consumption and real GDP are cointegrated and that capital formation and energy consumption Granger cause real GDP positively in the long run. We find that a 1% increase in energy consumption increases real GDP by 0.12–0.39%, while a 1% increase in capital formation increases real GDP by 0.1–0.28%.

In this paper we examine the causal relationship between electricity consumption and economic growth in South Africa.We incorporate the employment rate as an intermittent variable in the bivariate model between electricity consumption and economic growth—thereby creating a simple trivariate causality framework. Our empirical results show that there is a distinct bidirectional causality between electricity consumption and economic growth in South Africa. In addition, the results show that employment in South Africa Grangercauses economic growth. The results apply irrespective of whether the causality is estimated in the short-run or in the long-run formulation. The study, therefore, recommends that policies geared towards the expansion of the electricity infrastructure should be intensified in South Africa in order to cope with the increasing demand exerted by the country's strong economic growth and rapid industrialisation programme. This will certainly enable the country to avoid unprecedented power outages similar to those experienced in the country in mid-January 2008.

The aim of this paper is to re-examine the causal relationship between energy consumption and economic growth for seventeen African countries in a multivariate framework by including labor and capital as additional variables. We apply the variance decomposition analysis due to Pesaran and Shin [Pesaran M.H. and Shin, Y. Generalised impulse response analysis in linear multivariate models, Economics Letters, 1998; 58; 17–29.] to evaluate how important is the causal impact of energy consumption on economic growth relative to labor and capital. The results of our multivariate modified Granger causality analysis due to Toda and Yamamoto [Toda, H.Y. and Yamamoto, T. Statistical inference in vector autoregressions with possibly integrated process, Journal of Econometrics, 1995; 66; 225–250.] tend to reject the neutrality hypothesis for the energy–income relationship in fifteen out of the seventeen countries. In contrast, results of our variance decomposition analyses show that in eleven out of the seventeen countries, energy is no more than a contributing factor to output growth and not an important one when compared to capital and labor. Labor and capital are the most important factors in output growth in fifteen out of the seventeen countries. However, these results should be interpreted with care as they may not be sufficiently robust enough to support the inference that energy consumption plays a minor role in the economic growth of African countries.

This study examines the relationship between energy consumption and economic growth for six Central American countries over the period 1980–2004 within a multivariate framework. Given the relatively short span of the time series data, a panel cointegration and error correction model is employed to infer the causal relationship. Based on the heterogeneous panel cointegration test by Pedroni (Pedroni, P., 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics 61, 653–670; Pedroni, P., 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis: new results. Econometric Theory 20, 597–627), cointegration is present between real GDP, energy consumption, the labor force, and real gross fixed capital formation with the respective coefficients positive and statistically significant. The Grangercausality results indicate the presence of both short-run and long-run causality from energy consumption to economic growth which supports the growth hypothesis.

This study examines the relationship between energy consumption and economic growth for eleven countries of the Commonwealth of Independent States over the period 1991–2005 within a multivariate panel data framework. Based on Pedroni's (1999, 2004) heterogeneous panel cointegration test and corresponding error correction model, cointegration is present between real GDP, energy consumption, real gross fixed capital formation, and labor force with the respective coefficients positive and statistically significant. The results of the error correction model reveal the presence of unidirectional causality from energy consumption to economic growth in the short-run while bidirectional causality between energy consumption and economic growth in the long-run. Thus, the results lend support for the feedback hypothesis associated with the relationship between energy consumption and economic growth.

The increasing attention given to global energy issues and the international policies needed to reduce greenhouse gas emissions have given a renewed stimulus to research interest in the linkages between the energy sector and economic performance at country level. In this paper, we analyse the causal relationship between economy and energy by adopting a Vector Error Correction Model for non-stationary and cointegrated panel data with a large sample of developed and developing countries and four distinct energy sectors. The results show that alternative country samples hardly affect the causality relations, particularly in a multivariate multi-sector framework.

This study examines the relationship between energy consumption and economic growth for a panel of nine South American countries over the period 1980–2005 within a multivariate framework. Given the relatively short span of the time series data, a panel cointegration and error correction model is employed to infer the causal relationship. Pedroni's heterogeneous panel cointegration test reveals a long-run equilibrium relationship between real GDP, energy consumption, the labor force, and real gross fixed capital formation with the respective coefficients positive and statistically significant. The Granger-causality results indicate both short-run and long-run causality from energy consumption to economic growth which supports the growth hypothesis.

This study tests the relationship between energy consumption and economic growth in Sub-Saharan Africa, using a panel co-integration approach. Country-level time series data of energy consumption and economic growth are pooled and used to estimate the model. Sub-Saharan African countries in the sample are classified into low income and middle income countries. The findings support the neutrality hypothesis in the shortrun, except for middle income countries, and a strong causation running in both directions is found in the long-run. The different results for low and middle income countries provide evidence of the importance of income level in the causal relationship. This study helps to explain the interdependence of energy consumption and economic growth in Sub-Saharan Africa. Results are critical in formulating sustainable development policies that are geared to the efficient allocation of resources which are expected to increase access to energy services in the study region.

The debate about the precise role of energy in economic development remains contentious. Existing empirical studies have produced varying results: some have argued the complementarity between energy and other factors of production, and others have indicated that energy can be substituted for other factors of production. Commonly, these studies have focused primarily on the developed countries, one explanation being that supply constraints and price rigidities render any study on factor substitutions in developing countries meaningless. However, the functional relationship between energy consumption and income in developing countries is constantly investigated with the use of regression techniques. While such techniques are useful in empirical analysis, no mechanism exists for indicating causal directions between variables. This limits the scope for policy analysis and prescription. The need to identify causal direction between energy consumption and income growth in developing countries is overwhelming. Apart from providing further insights into the role of energy in economic development, it provides policy analysts with a clearer understanding of the likely impact of energy supply constraints on economic growth. This article examines the causal directions between energy consumption and economic growth (proxied by GDP and GNP) for Nigeria and Tanzania. The results show a simultaneous causal relationship between energy and economic growth for both countries, the implication being that, unless energy supply constraints are eased, economic growth and development will remain elusive to these countries. Given similar economic characteristics and profiling the same energy scenario for other developing countries, our finding supports the view that energy plays a key role in economic development.

A study of the relationship between electricity use and economic development in over one hundred countries, constituting over 99% of the global economy has been undertaken. Correlations between electricity consumption/capita and GDP/capita have been analysed and compared with those between total primary energy supply/capita and GDP/capita. A supporting analysis has correlated the proportion of energy used in the form electricity, the &e/E ratio', with GDP/capita. The general conclusions of this research are that wealthy countries have a stronger correlation between electricity use and wealth creation than do poor countries and that, for the global economy as a whole, there is a stronger correlation between electricity use and wealth creation than there is between total energy use and wealth. The study also shows that, in wealthy countries, the increase in wealth over time correlates with an increase in the e/E ratio. The results imply that the energy ratio ($/toe) should be replaced by the electricity ratio ($/kWh) as a development indicator and, more precisely, by the e/E ratio (kWh/toe).

This paper tries to examine the Granger causality between electricity consumption per capita and Gross Domestic Product (GDP) per capita for India using annual data covering the period 1950–51 to 1996–97. Phillips–Perron tests reveal that both the series, after logarithmic transformation, are non-stationary and individually integrated of order one. This study finds the absence of long-run equilibrium relationship among the variables but there exists unidirectional Granger causality running from economic growth to electricity consumption without any feedback effect. So, electricity conservation policies can be initiated without deteriorating economic side effects.

This paper applies the error-correction model to examine the causal relationship between electricity consumption and real GDP for China during 1971–2000. Our estimation results indicate that real GDP and electricity consumption for China are cointegrated and there is unidirectional Granger causality running from electricity consumption to real GDP but not vice versa. In order to overcome the constraints on electricity consumption, the Chinese government has to speed up the nation-wide interconnection of power networks, to upgrade urban and rural distribution grids, and to accelerate rural electrification.

This paper examines the relationship between electricity consumption, employment and real income in Australia within a cointegration and causality framework. We find that electricity consumption, employment and real income are cointegrated and that in the long-run employment and real income Granger cause electricity consumption, while in the short run there is weak unidirectional Granger causality running from income to electricity consumption and from income to employment.

This paper investigates the short- and long-run causality issues between electricity consumption and economic growth in Korea by using the co-integration and error-correction models. It employs annual data covering the period 1970–2002. The overall results show that there exists bi-directional causality between electricity consumption and economic growth. This means that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption.

This paper investigates the causal relationship between electricity consumption and economic growth among the Association of South East Asian Nations (ASEAN) 4 members, namely Indonesia, Malaysia, Singapore, and Thailand, using modern time-series techniques for the period 1971–2002. The results indicate that there is a bi-directional causality between electricity consumption and economic growth in Malaysia and Singapore. This means that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption in the two countries. However, uni-directional causality runs from economic growth to electricity consumption in Indonesia and Thailand without any feedback effect. Thus, electricity conservation policies can be initiated without deteriorating economic side effects in the two countries.

This paper explores whether energy conservation policies can be implemented in countries with the same level of development. That is, is restraining energy consumption without compromising economic growth feasible in all industrialized countries? A new Granger non-causality testing procedure developed by Toda and Yamamoto [1995, Journal of Econometrics 66, 225–250] is applied to re-investigate the relationship, if any, between energy consumption and income in 11 major industrialized countries. The results clearly do not support the view that energy consumption and income are neutral with respect to each other, except in the case of the United Kingdom, Germany and Sweden where a neutral relationship is found. Bi-directional causality in the United States and unidirectional running from energy consumption to GDP in Canada, Belgium, the Netherlands and Switzerland are found. This indicates that energy conservation may hinder economic growth in the latter five countries. Further, the causality relationship appears to be uni-directional but reversed for France, Italy and Japan which implies that, in these three countries, energy conservation may be viable without being detrimental to economic growth.

This work investigates the causality relationship between gross domestic product (GDP) and energy consumption in the six countries of the Gulf Cooperation Council (GCC). Recently developed panel cointegration and causality techniques are used to uncover the direction of energy–GDP causality in the GCC. Empirical results indicate a unidirectional causality running from GDP to energy consumption. Evidence shows no support for the hypothesis that energy consumption is the source of GDP growth in the GCC countries. Such results suggest that energy conservation policies may be adopted without much concern about their adverse effects on the growth of GCC economies.

This paper examines the dynamic causal relationships between pollutant emissions, energy consumption, and output for France using cointegration and vector error-correction modelling techniques. We argue that these variables are strongly inter-related and therefore their relationship must be examined using an integrated framework. The results provide evidence for the existence of a fairly robust longrun relationship between these variables for the period 1960–2000. The causality results support the argument that economic growth exerts a causal influence on growth of energy use and growth of pollution in the long run. The results also point to a uni-directional causality running from growth of energy use to output growth in the short run.

In this paper, we examine the causal relationship between the per capita electricity consumption and the per capita GDP for Bangladesh using cointegration and vector error correction model. Our results show that there is unidirectional causality from per capita GDP to per capita electricity consumption. However, the per capita electricity consumption does not cause per capita GDP in case of Bangladesh. The finding has significant implications from the point of view of energy conservation, emission reduction and economic development.

This article applies recently developed panel unit root and panel cointegration techniques to estimate the long-run and short-run income and price elasticities for residential demand for electricity in G7 countries. The panel results indicate that in the long-run residential demand for electricity is price elastic and income inelastic. The study concludes that from an environmental perspective there is potential to use pricing policies in the G7 countries to curtail residential electricity demand, and thus curb carbon emissions, in the long run.

This paper examines the causal relationship between the per capita energy consumption and the per capita GDP in a panel of 11 selected oil exporting countries by using panel unit-root tests and panel cointegration analysis. The results show a unidirectional strong causality from economic growth to energy consumption for the oil exporting countries. The findings have practical policy implications for decision makers in the area of macroeconomic planning. In most major oil exporting countries, government policies keep domestic prices bellow free market level, resulting in high levels of domestic energy consumption. The results imply that the energy conservation through reforming energy price policies has no damaging repercussions on economic growth for this group of countries.

This paper 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. Among the energy exporters, 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. The former result is also found for energy importers and the latter result exists only for the developed countries within this category. In addition, compared to the developing countries, the developed countries' elasticity response in terms of economic growth from an increase in energy consumption is larger although its income elasticity is lower and less than unitary. Lastly, the implications for energy policy calling for a more holistic approach are discussed.

This paper reexamines the inter-temporal link between energy consumption and income in six developing countries with diverse economic backgrounds and energy statistics, in a production function framework. We employ the generalized variance decompositions and generalized impulse response techniques to see if the growth of income and energy consumption contains considerable information to predict each other. In all countries, energy appears as an essential factor of production. Results indicate that energy may be a relatively more important input than labor and/or capital in some countries. Hence, neutrality of energy does not seem to hold.

This paper provides a detailed analysis of the energy consumption in Turkey during the last 40 years. It investigates the causal relationships between income and energy consumption in two ways: first, the relationship is studied at the aggregate level; then, we focus on the industrial sector. Previous findings suggest that, in the case of Turkey, there is a unidirectional causality running from energy consumption to growth. However, our findings suggest that in the long run, income and energy consumption appear to be neutral with respect to each other both at the aggregate and at the industrial level. We also find a strong evidence of instantaneous causality, which means that contemporaneous values of energy consumption and income are correlated. Furthermore, a descriptive analysis is conducted in order to reveal the differences in the use of energy resources. We conclude that energy conservation policies are necessary for environmental concerns and our empirical results imply that such policies would not impede economic growth in the long term.

The goal of this paper is to examine any causal effects between electricity consumption and real GDP for 30 OECD countries. We use a bootstrapped causality testing approach and unravel evidence in favour of electricity consumption causing real GDP in Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK. The implication is that electricity conservation policies will negatively impact real GDP in these countries. However, for the rest of the 22 countries our findings suggest that electricity conversation policies will not affect real GDP.

The purpose of this study is to re-investigate the relationship between electricity consumption and economic growth in Malaysia from 1972:1 to 2003:4. This study adopted the newly developed ECMbased F-test [Kanioura, A., Turner, P., 2005. Critical values for an F-test for cointegration in the multivariate model. Applied Economics 37(3), 265–270] for cointegration to examine the presence of long run equilibrium relationship through the autoregressive distributed lag (ARDL) model. The empirical evidence suggests that electricity consumption and economic growth are not cointegrated in Malaysia. However, the standard Granger's test and MWALD test suggest that electricity consumption and economic growth in Malaysia Granger causes each other. This finding provides policymakers with a better understanding of electricity consumption and allows them to formulate electricity consumption policy to support the economic development and to enhance the productivity of capital, labour and other factors of production for future economic growth in Malaysia.

We analyze the long-run relationship between energy consumption and real gross domestic product (GDP) in Turkey taking into account the size of unrecorded economy. Since in developing countries, mainly due to the unrecorded economic activities, the official GDP is not measured correctly, the investigation of the linkage between energy consumption and official GDP may not give reliable results. In this study, empirical results for the case of Turkey over the period 1970–2005 suggest that there is a long-run equilibrium relationship between the officially calculated GDP and energy consumption. Besides, using the error-correction modeling technique, we find out that unidirectional causality runs from official GDP to energy in both short and long runs. However, when we take into account unrecorded economy, we detect neither cointegration nor causality between energy consumption and true GDP. These empirical findings imply that: first, energy conservation policies can be implemented in order to reduce greenhouse gas emissions without any adverse effect on the recorded economic activities; second the production function in the unrecorded economy is not stable. Furthermore, economic policies to combat unrecorded economy may not serve as a complement to energy conservation policies.

This paper applies the causality test to examine the causal relationship between primary energy consumption (EC) and real Gross National Product (GNP) for Turkey during 1970–2006.We employ unit root tests, the augmented Dickey–Fuller (ADF) and the Philips–Perron (PP), Johansen cointegration test, and Pair-wise Granger causality test to examine relation between EC and GNP. Our empirical results indicate that the two series are found to be non-stationary. However, first differences of these series lead to stationarity. Further, the results indicate that EC and GNP are cointegrated and there is bidirectional causality running from EC to GNP and vice versa. This means that an increase in EC directly affects economic growth and that economic growth also stimulates further EC. This bidirectional causality relationship between EC and GNP determined for Turkey at 1970–2006 period is in accordance with the ones in literature reported for similar countries. Consequently, we conclude that energy is a limiting factor to economic growth in Turkey and, hence, shocks to energy supply will have a negative impact on economic growth.

This study attempts to empirically examine the dynamic causal relationships between carbon emissions, energy consumption, income, and foreign trade in the case of Turkey using the time-series data for the period 1960–2005. This research tests the inter relationship between the variables using the
bounds testing to cointegration procedure. The bounds test results indicate that there exist two forms of long-run relationships between the variables. In the case of first form of long-run relationship, carbon emissions are determined by energy consumption, income and foreign trade. In the case of second long-
run relationship, income is determined by carbon emissions, energy consumption and foreign trade. An augmented form of Granger causality analysis is conducted amongst the variables. The long-run relationship of $CO_2$ emissions, energy consumption, income and foreign trade equation is also checked for the parameter stability. The empirical results suggest that income is the most significant variable in explaining the carbon emissions in Turkey which is followed by energy consumption and foreign trade. Moreover, the re exists a stable carbon emissions function. The results also provide important policy recommendations.

This study extends the recent work of Ang (2007) [Ang,J.B.,2007. CO2 emissions, energy consumption, and output in France. Energy Policy35,4772–4778] in examining the causal relationship between
carbon-dioxide emissions, energy consumption,and output within a panel vector error correction model for six Central American countries over the period 1971–2004. In long-run equilibrium energy consumption has a positive and statistically significant impact on emissions while real output exhibits the inverted U-shape pattern associated with the Environmental Kuznets Curve(EKC) hypothesis. The short-run dynamics indicate unidirectional causality from energy consumption and real output,
respectively, to emissions along with bidirectional causality between energy consumption and real output. In the long-run there appears to be bidirectional causality between energy consumption and emissions.

This paper examines the causal relationship between electricity consumption, exports and gross domestic product (GDP) for a panel of Middle Eastern countries. We find that for the panel as a whole there are statistically significant feedback effects between these variables. A 1 percent increase in electricity consumption increases GDP by 0.04 percent, a 1 percent increase in exports increases GDP by 0.17 percent and a 1 percent increase in GDP generates a 0.95 percent increase in electricity consumption. The policy implications are that for the panel as a whole these countries should invest in electricity infrastructure and step up electricity conservation policies to avoid a reduction in electricity consumption adversely affecting economic growth. Further policy implications are that for the panel as a whole promoting exports, particularly non-oilexports, is a means to promote economic growth and  that expansion of exports can be realized without having adverse effects on energy conservation policies.

This study probes nexus between electricity supply, employment and real GDP for India within a multivariate framework using autoregressive distributed lag(ARDL) bounds testing approach of cointegration. Long-run equilibrium relationship has been established among these variables for the time span 1970–71 to 2005–06. The study further establishes long-and short-run Granger causality running from real GDP and electricity supply to employment without any feedback effect. Thus, growth in real GDP and electricity supply are responsible for the high level of employment in India. The absence of causality running from electricity supply to real GDP implies that electricity demand and supplyside measures can be adopted to reduce the wastage of electricity, which would not affect future economic growth of India.

In this paper, the Johansen cointegration technique is used to examine the causal relationship between per capita energy consumption(PCEC) and per capita gross domestic product (PCGDP) for Tunisia during the 1971–2004 period. In order to test for Granger causality in the presence of cointegration among the variables, a vector error correction model (VECM) is used instead of a vector autoregressive (VAR) model. Our stimation results indicate that the PCGDP and PCEC for Tunisia are related by one cointegrating vector and that there is a long-run bi-directional causal relationship between the two series and a short-
run unidirectional causality from energy to gross domestic product(GDP). The source of causation in the long-run is found to be the error-correction terms in both directions. Hence, an important policy implication resulting from this analysis is that energy can be considered as a limiting factor to GDP growth in Tunisia. Conclusions for Tunisia may also be relevant for a number of countries that have to go through a similar development path of increasing pressure on already scarce energy resources.

In this paper, we examine the inter temporal causal relationship between energy consumption and economic growth in Tanzania during the period of 1971–2006. Unlike the majority of the previous studies, we employ the newly developed autoregressive distributed lag(ARDL) - bounds testing approach by Pesaran et al. [2001. Bounds testing approaches to the analys is of level relationships. Journal of
Applied Econometrics 16, 289–326] to examine this linkage. We also use two proxies of energy consumption, namely total energy consumption per capita and electricity consumption per capita. The results of the bounds test show that there is a stable long-run relationship between each of the proxies of energy consumption and economic growth. The results of the causality test, on the other hand, show that there is a unidirectional causal flow from total energy consumption to economic growth and a prima- facie causal flow from electricity consumption to economic growth. Overall, the study finds that energy consumption spurs economic growth in Tanzania.


During the last three decades, following closely the developments in econometric theory, energy and environmental economists have empirically examined the energy-income nexus for different countries and time periods. However, today, in spite of the growing interest in this area, the state of knowledge is still controversial and unsettled. This viewpoint paper attempts to highlight some of the issues related to the existing literature on the long-run relationship and causality between energy consumption and economic growth. In particular, it discusses how it is difficult to make policy recommendations on the basis of inconsistent and conflicting results in the published literature on the subject. In order to do so,
the paper first illustrates the increasing trend in the number of studies published in this area providing also a brief comparison of the conventional methods used to estimate the energy-income nexus. It then deals with new directions and different view points on the same issue.


This study applies the panel stationarity test developed by [Carrion-i-Silvestreetal2005. Breaking thepanels: An application to GDP per capita. Econometrics Journal 8,159–175] to examine the stationarity of energy consumption per capita for a panel of 13 Pacific Island countries over the period 1980–2005. This test has the advantage that it allows for multiple structural breaks at unknown dates that can differ across countries and can account for all forms of cross-sectional correlation between countries. The conclusion from the study is that energy consumption per capita inapproximately 60% of countries is stationary and that energy consumption per capita for the panel as a whole is stationary. The study offers several suggestions for modelling energy consumption and policy-making in the Pacific Islands.

Electricity has been the foundation of economic growth, and constitutes one of the vital infra-structural inputs in socio-economic development. The world faces a surge in demand for electricity that is driven by such powerful forces as population growth, extensive urbanization, industrialization, and the rise in the standard of living. This paper attempts to ascertain whether there is asystematic relationship between electricity consumption and economic growth. To this end, we usea large set of data that spans 88 countries during the period, 1975–2004. A statistically significant inverted-U-shaped relationship between per-capita consumption of electricity and per-capita income is detected. Nevertheless, by using
a purchasing power parity that is much higher than the per-capita income of all the countries in the world, the level of per-capita income is estimated at the peak point of per-capita electricity consumption to be $61,379 in 2000 constant international dollars. Moreover, we segment the sample into Organization for Economic Cooperation and Development (OECD) countries and non-OECD countries, and separately analyze the developed and developing countries. The separate estimation shows that even though the peak income is higher than the average per-capita income, a statistically
significant inverted-U-shaped relationship is found in OECD and developed countries but not in non-OECD and developing countries.

This study examines the relationship between renewable energy consumption and economic growth for a panel of twenty OECD countries over the period
1985–2005withinamultivariateframework.Given the relatively short span of the time-series data, a panel cointegration and error correction model is employed to infer the causal relationship. The heterogeneous panel cointegration test reveals a long-run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation, and the labor force with the respective coefficients positive and statistically significant. The Granger-causality results indicate bidirectional causality between renewable energy consumption and economic growth in both the short- and long-run.

This paper investigates the dynamic causal relationship between energy consumption and economic growth in Lebanon over the period 1980–2009. Within a bivariate framework, imposed on us due to data limitations, and in an effort to increase the robustness of our results, we employ a variety of causality tests, namely,Hsiao,Toda-Yamamoto, and vector error correction based Granger causality tests. We find strong evidence of a bidirectional relationship both in the short-run and in the long-run, indicating that energy is a limiting factor to economic growth in Lebanon. From a policy perspective, the confirmation of the feedback hypothesis warns against the use of policy instruments geared towards restricting energy consumption, as these may lead to adverse effects on economic growth. Consequently, there is a pressing need to revise the current national energy policy that calls for a 5% energy conservation target. Also, to shield the country from external supply shocks, given its substantial dependence on energy imports, policy makers should emphasize the development of domestic energy resources. Further, the most pertinent implication is that relaxing the present electric capacity shortages should be made a national priority, in view of its potential positive effect on the economy.

The aim of this paper is to study the nature of the relationship between energy consumption and economic growth in Cameroon through a three-step approach: (i) Study the stationarity of the chronic,
(ii) test of causality between variables and (iii) estimate the appropriate model. The study concludes in a non-stationarity of the series. Using the data in first difference, the Granger causality test yields a strong evidence for unidirectional causality running from OIL to GDP. Cointegration tests also show that these two series are co-integrated and the Error Correction Model (ECM) reveals that every percentage increase in Oil products consumption increases economic growth by around 1.1%. This result confirms the intuition that an economic policy aimed at improving energy supply will necessarily have a positive impact on economic growth. On the other side, a lack of energy is a major bottle neck for further economic development in Cameroon.

In this paper we empirically investigate the causal link between energy consumption and economic growth employing a Markov switching Granger causality analysis. We carry out our investigation using annual U.S. real GDP, total final energy consumption and total primary energy consumption data which cover the period between 1968 and 2010. We find that there are significant changes in the causal relation between energy consumption and economic growth over the sample period under investigation. Our results show that total final energy consumption and total primary energy consumption have significant predictive content for real economic activity in the U.S. economy. Furthermore, the causality running from energy consumption to output growth seems to be strongly apparent particularly during the periods of economic downturn and energy crisis. We also document that output growth has predictive power in explaining total energy consumption. Furthermore, the power of output growth in predicting total energy consumption is found to diminish after the mid of 1980s.

This paper examines the interrelationships between energy consumption, foreign direct investment and economic growth using dynamic panel data models in simultaneous-equations for a global panel consisting of 65 countries. The time component of our dataset is 1990–2011 inclusive. To make the panel data analysis more homogenous, we also investigate this interrelationship for a number of sub-panels which are constructed based on the income level of countries. In this way, we end up with three income panels; namely, high income, middle income, and low income panels. In the empirical part, we draw on the growth theory and augment the classical growth model, which consists of capital stock, laborforce and inflation, with foreign direct investment and energy. Generally, we show mixed results about the interrelationship between energy consumption, FDI and economic growth.

Public debates on electricity policy in Hong Kong focus on the regulation regime but seldom discuss the macroeconomic impact. In this paper, we use the novel dataset on electricity consumption and report the following findings: (1) there is a long run equilibrium relationship between real GDP and electricity consumption; (2) a one-way causal effect exists from electricity consumption to real GDP; (3) a significant adjustment process occurs when equilibrium is interrupted; (4) there exists possible structural change in the relationship between electricity consumption and economic activities in 1990s.

To cope with the increasing electricity demand and to overcome the supply shortage of electricity, it is imminent that investments be made on the electricity generation sector on a large scale in Indonesia. This paper attempts to investigate the causal relationship between electricity generation and economic growth in Indonesia, using time-series techniques for the period of 1971–2002. The results indicate that there is a uni-directional causality running from economic growth to electricity generation without any feedback effect. Thus, economic growth stimulates further electricity generation, and policies for reducing electricity generation can be initiated without deteriorating economic side effects in Indonesia.

This paper considers the possibility of both a linear effect and nonlinear effect of energy consumption on economic growth, using data for the period 1955–2003 in Taiwan. We find evidence of a level-dependent effect between the two variables. Allowing for a nonlinear effect of energy consumption growth sheds new light on the explanation of the characteristics of the energy-growth link. We also provide evidence that the relationship between energy consumption and economic growth in Taiwan is characterized by an inverse U-shape. Some previous studies support the view that energy consumption may promote economic growth. However, the conclusion drawn from the empirical findings suggests that such a relationship exists only where there is a low level of energy consumption in Taiwan. We show that a threshold regression provides a better empirical model than the standard linear model and that policy-makers should seek to capture economic structures associated with different stages of economic growth. It is also worth noting that the energy consumption threshold was reached in the case of Taiwan in the world energy crises periods of 1979 and 1982.

In this paper we investigate the co-movement and the causality relationship between energy consumption as well as electricity consumption and the HDI (human development index) using as a proxy of human well-being and by including energy prices as an additional variable, in fifteen developing countries for the period 1988 to 2008. Recently developed tests for the panel unit root, heterogeneous panel cointegration, and panel-based error correction models are employed.
The empirical results support the neutrality hypothesis in the short-term, regards total energy or electricity consumption, implying an absence of causality running in either direction. In the short term, energy as well as electricity consumption has a neutral effect on the HDI.
In the long-term the findings provide a clear support of a negative cointegration relationship between energy consumption and the HDI. While a positive cointegration relationship exists between electricity
consumption and HDI.
A 1% increase in per capita energy consumption reduces the HDI by 0.8% and, a 1% increase in per capita electricity consumption increases the HDI by 0.22%. Moreover, a 1% increase in energy price reduces the HDI by around 0.11%.
This study thus provides empirical evidence of long-run and causal relationships between energy consumption and the HDI for our sample of countries; supporting the assertion that lack or limited access to modern energy services could hamper economic and human development prospects of countries and underpins all the MDGs (millennium development goals).

The aim of this paper is to re-examine the causal relationship between energy consumption and economic growth for seventeen African countries in a multivariate framework by including labor and capital as additional variables. We apply the variance decomposition analysis due to Pesaran and Shin [Pesaran M.H. and Shin, Y. Generalised impulse response analysis in linear multivariate models, Economics Letters, 1998; 58; 17–29.] to evaluate how important is the causal impact of energy consumption on economic growth relative to labor and capital. The results of our multivariate modified Granger causality analysis due to Toda and Yamamoto [Toda, H.Y. and Yamamoto, T. Statistical inference in vector autoregressions with possibly integrated process, Journal of Econometrics, 1995; 66; 225–250.] tend to reject the neutrality hypothesis for the energy–income relationship in fifteen out of the seventeen countries. In contrast, results of our variance decomposition analyses show that in eleven out of the seventeen countries, energy is no more than a contributing factor to output growth and not an important one when compared to capital and labor. Labor and capital are the most important factors in output growth in fifteen out of the seventeen countries. However, these results should be interpreted with care as they may not be sufficiently robust enough to support the inference that energy consumption plays a minor role in the economic growth of African countries.


This paper examines the long-run relationship between energy consumption and real GDP, including energy prices, for 25 OECD countries from 1981 to 2007. The distinction between common factors and idiosyncratic components using principal component analysis allows to distinguish betweendevelopments on aninternational and a national level as drivers of the long-run relationship. Indeed, cointegration between the common components of the underlying variables indicates that international developments dominate the long-run relationship between energy consumption and real GDP. Furthermore, the results suggest that energy consumption is price-inelastic. Causality tests indicate the presence of a bi-directional causal relationship between energy consumption and economic growth.

Though there is a very large literature examining whether energy use Granger causes economic output or vice versa, it is fairly inconclusive. Almost all existing studies use relatively short time series, or panels with a relatively small time dimension. We apply Granger causality and cointegration techniques to a Swedish time series dataset spanning 150 years to test whether increases in energy use and energy quality have driven economic growth or vice versa.We show that these techniques are very sensitive to variable definition, choice of additional variables in the model, sample periods and size, and the introduction of structural breaks. The relationship between energy and growth may also have changed over time – energy causes output in the full sample while output causes energy use in recent smaller samples. Energy prices have a more robust causal impact on both energy use and output.

Access to modern energy is believed to be a prerequisite for sustainable development, poverty alleviation and the achievement of the Millennium Development Goals. However, theoretical models and empirical results offer conflicting evidence on the relationship between energy consumption and economic growth that we remain largely unsure of the cause-and-effect nature of this relationship, if indeed a relationship exists at all.

This paper tests, in a panel context, the long-run relationship between energy access, and economic growth for fifteen African countries from 1980 to 2008 by using recently developed panel cointegration techniques. We adopt a three-stage approach, consisting of panel unit root, panel cointegration and Granger causality tests to study the dynamic causal relationships between energy consumption, energy prices and growth as well as relationship between electricity consumption, prices and growth. Results show that GDP and energy consumption as well as GDP and electricity move together in the long-run.

By estimating these long-run relationships and testing for causality using panel-based error correction models, we found unidirectional long-run and short-run causality. The causality is running from GDP to energy consumption in the short-run, and from energy consumption to GDP in the long-run. There is also evidence of unidirectional causality running from electricity consumption to GDP in the long-run.

This study thus provides empirical evidence of long-run and causal relationships between energy consumption and economic growth for our sample of fifteen countries; suggesting that lack or limited access to modern energy services could hamper economic growth and compromise the development prospects of these countries.

This paper is a contribution to the on-going debate over whether there is a relationship between energy consumption and economic growth. Although the oil exporting countries are among the most energy-intensive economies in the world, little attention has been paid to the features of their energy consumption. Therefore, this study empirically investigates the two variables dynamic relationship in 12 oil exporting countries from 1990 to 2010. Using recently developed panel econometric techniques, the present paper accounts for crosssection dependence and structural breaks when analysing the energy-income nexus. The results of this study indicate that there exists a long-run equilibrium relationship between energy consumption and economic growth. Furthermore, the empirical evidence of a dynamic panel error-correction model reveals a short-run unidirectional causality from energy consumption to economic growth, whereas in the long-run, it is the economic process that determines the energy consumption trend.

The energy-growth literature contains a large number of discussions on the causal relationship between energy consumption and economic growth. The central debate focuses on whether energy consumption contributes or not to economic growth since it has direct implications for the formulation of strategic policies. Nevertheless, current studies cannot provide a conclusive suggestion due tomixed causality results. This inconclusive evidence is potentially attributed to model specifications and the stage of economic development of the countries under investigation. Hence, this study attempts to empirically re-investigate the validity of the energy-led growth hypothesis using a different model specification and different stages of economic development for 85 selected countries around the globe. Overall, although the causality results are mixed among countries, we do find a systematic pattern. In particular, Granger causality models with three and four variables are more likely to support the hypothesis compared to their counterparts that contain only two variables. In addition, both developed and developing countries are more likely to support the energy-led growth hypothesis compared to the less developed or lowincome countries. Therefore, causality results are very sensitive to the choice of themodel specification along with the stages of economic development. Finally, energy conservation policies should only focus on low income countries as these policies may not retard the process of economic growth.

This paper reassesses the causal relationship between per capita energy use and gross domestic product, while controlling for capital and labour (productivity) inputs in a panel of 30 OECD countries over the past 40 years. The paper uses panel unit root and cointegration testing and specifies an appropriate vector error correction model to analyse the nexus between income and energy use. In doing so we contribute to an old debate using modern tools that shed a new light. There is some evidence that over the very short-run bidirectional causality exists. Our results also show a strong unidirectional causality running from capital formation and GDP to energy usage. In the long run the reverse causality, found in recent work, is lost. We then show that we can reproduce these earlier results in our data if we reproduce a slightly misspecified model for the Engle–Granger two-step procedure used in these earlier papers. Our findings thus imply that results are very sensitive to model misspecification and careful testing of specifications is required. Our results have some strong policy implications. They suggest that policies aimed at reducing energy usage or promoting energy efficiency are not likely to have a detrimental effect on economic growth, except over the very short run.

This paper estimates the total effect of power outages on economic growth in Sub-Saharan Africa over the period 1995–2007. We pay close attention both to potential errors of measurement of African economic growth and to the endogeneity of outages. As suggested by Henderson et al. (American Economic Review 102(2): 994–1028, 2012), we combine Penn World Tables GDP data with satellite-based data on nightlights to arrive at a more accurate measure of economic growth. Following Andersen et al. (Review of Economics and Statistics 94(4): 903–924, 2012), we also employ lightning density as an instrument for power outages. Our results suggest a substantial growth drag of a weak power infrastructure in Sub-Saharan Africa.

This paper combines two aggregate production function models—one with urbanization as a shift factor and one that includes energy/electricity consumption and physical capital—to estimate the macro-level relationship among urbanization, energy/electricity consumption, and economic growth using a panel method that is robust to both cointegration and cross-sectional dependence. For four panels (comprising in turn high, upper middle, lower middle, and low income countries) GDP per capita, total final energy and electricity consumption per capita, gross fixed capital formation per capita, and urbanization were found to be 1(1), cross-sectionally dependent, and cointegrated. The long-run elasticity estimates suggest (i) that urbanization is important to and associated with economic growth, (ii) that urbanization's impact on economic growth ranges from substantially negative to nearly neutral to positive as countries develop—an "urbanization ladder" effect, and (iii) that less developed countries are over-urbanized (their elasticities being negative).

While the availability of electricity by itself is not a panacea for the economic and social problems facing Africa, the supply of electricity is nevertheless believed to be a necessary requirement for Africa's economic and social development. This paper tests the long-run and causal relationship between electricity consumption per capita and real gross domestic product (GDP) per capita for 17 African countries for the period 1971–2001 using a newly developed cointegration test proposed by Pesaran et al. (2001) and using a modified version of the Granger causality test due to Toda and Yamamoto (1995). The advantage of using these two approaches is that they both avoid the pre-testing bias associated with conventional unit root and cointegration tests. The empirical evidence shows that there was a long-run relationship between electricity consumption per capita and real GDP per capita for only 9 countries and Granger causality for only 12 countries. For 6 countries there was a positive uni-directional causality running from real GDP per capita to electricity consumption per capita; an opposite causality for 3 countries and bi-directional causality for the remaining 3 countries. The result should, however, be interpreted with care as electricity consumption accounts for less than 4% of total energy consumption in Africa and only grid-supplied electricity is taken into account.

The purpose of this study is to estimate the relationships between GDP and electricity consumption in 10 newly industrializing and developing Asian countries using both single data sets and panel data procedures. The empirical results from single data set indicate that the causality directions in the 10 Asian countries are mixed while there is a uni-directional short- run causality running from economic growth to electricity consumption and a bi-directional long-run causality between electricity consumption and economic growth if the panel data procedure is implemented. These empirical findings imply that electricity conservation policies through both rationalizing the electricity supply efficiency improvement to avoid the wastage of electricity and managing demand side to reduce the electricity consumption without affecting the end-user benefits could be initiated without adverse effect on economic growth. The findings on the long-run relationship indicate that a sufficiently large supply of electricity can ensure that a higher level of economic growth.

This paper attempts to investigate the causal relationship between electricity consumption and economic growth among seven South American countries, namely Argentina, Brazil, Chile, Columbia, Ecuador, Peru, and Venezuela using widely accepted time- series techniques for the period 1975–2006.

The results indicate that the causal nexus between electricity consumption and economic growth varies across countries. There is a unidirectional, short-run causality from electricity consumption to real GDP for Argentina, Brazil, Chile, Columbia, and Ecuador. This means that an increase in electricity consumption directly affects economic growth in those countries. In Venezuela, there is a bi-directional causality between electricity consumption and economic growth. This implies that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption in that country. However, no causal relationships exist in Peru. The documented evidence from seven South American countries can provide useful information for each government with regard to energy and growth policy.

The aim of this paper is to provide new empirical evidence on the relationship between energy consumption and economic growth for 21 African countries over the period from 1970 to 2006, using recently developed panel cointegration and causality tests. The countries are divided into two groups: net energy importers and net energy exporters. It is found that there exists a long-run equilibrium relationship between energy consumption, real GDP, prices, labor and capital for each group of countries as well as for the whole set of countries. This result is robust to possible cross-country dependence and still holds when allowing for multiple endogenous structural breaks, which can differ among countries. Furthermore, we find that decreasing energy consumption decreases growth and vice versa, and that increasing energy consumption increases growth, and vice versa, and that this applies for both energy exporters and importers. Finally, there is a marked difference in the cointegration relationship when country groups are considered.

This contribution investigates causal interdependence between energy consumption and economic growth in Liberia and proposes application of a bootstrap methodology. To better reflect causality, employment is incorporated as additional variable. The study demonstrates evidence of distinct bidirectional Granger causality between energy consumption and economic growth. Additionally, the results show that employment in Liberia Granger causes economic growth and apply irrespective of the short-run or long-run. Evidence from a Monte Carlo experiment reveals that the asymptotic Granger causality test suffers size distortion problem for Liberian data, suggesting that the bootstrap technique employed in this study is more appropriate. Given the empirical results, implications are that energy expansion policies like energy subsidy or low energy tariff for instance, would be necessary to cope with demand exerted as a result of economic growth in Liberia. Furthermore, Liberia might have the performance of its employment generation on the economy partly determined by adequate energy. Therefore, it seems fully justified that a quick shift towards energy production based on clean energy sources may significantly slow down economic growth in Liberia. Hence, the government's target to implement a long-term strategy to make Liberia a carbon neutral country, and eventually less carbon dependent by 2050 is understandable.

Unlike previous energy consumption-economic growth studies, this study examines the relationship among energy consumption, economic growth, employment and gross fixed capital formation for 17 highly developed OECD countries by employing both the Toda–Yamamoto procedure which based on asymptotic critical values and the bootstrap-corrected causality test, since non-normality of the error term harms the validity of the Toda–Yamamoto procedure. This study finds that there is very small bias due to the assumption of normality. Furthermore using different information criterions, importance of lag length is tested. Findings indicate that selection of lag length is important for Denmark, Ireland, Norway and Spain. It is concluded that while there exists uni-directional causality running from energy consumption to real GDP for Japan, bi-directional causality is found for Italy, New Zealand, Norway and Spain. On the other hand, uni-directional causality from GDP to energy is found for Australia, Canada and Ireland whereas no causal nexus is found for all of other nine countries. Our analyses covering the sample periods imply that Japan, Italy, New Zealand, Norway and Spain should not follow energy conservation policy at the aggregated level, since the reduction of energy damages the economic growth.

The causal relationship between GDP and energy consumption is a well- studied topic for various countries. This paper utilizes Johansen-Juselius Cointegration Methodology and Vector Error Correction Modeling to analyze this relationship for Turkey. The results indicate a unidirectional causality running from energy consumption to GDP. Thus, energy consumption positively affects GDP. This suggests that a possible energy conservation program may harm economic growth in the long run.

Energy plays a vital role in economic development. It performs a key for sustainable development. Hence, many studies have attempted to look for the direction of causality between energy consumption (EC), economic growth (GDP) and CO2 emissions. This paper, therefore, applies the panel unit root tests, panel cointegration methods and panel causality test to investigate the relationship between EC, GDP and CO2 emissions for 15 MENA countries covering the annual period 1973-2008. The finding of this study reveals that there is no causal link between GDP and EC; and between CO2 emissions and EC in the short run. However, in the long run, there is a unidirectional causality running from GDP and CO2 emissions to EC. In addition, to deal with the heterogeneity in countries and the endogeneity bias in regressors, this paper applies respectively the FMOLS and the DOLS approach to estimate the long-run relationship between these three factors.

This study is the first employing annual data for Turkey from 1970 to 2010 to examine the short and long-run causal relationship between economic growth, electricity generation, exports and prices in a multivariate model. According to the bounds test results, when electricity generation and economic growth are the dependent variable there are two cointegrating relationships. According to the results, long-run equilibrium relationship and long-term causality are found between economic growth, electricity generation, export and price. Hence, in the short-run, there are bi- directional causalities between economic growth- electricity generation, economic growth-export and electricity generation-export with feedback effect.

The paper investigates the role of infrastructure in promoting economic growth in China using ARDL and GMM techniques for the period 1975 to 2007. In this context, an attempt is made to understand growth accounting equations to investigate the impact of infrastructure development on output. Overall, the results reveal that infrastructure stock, labour force, public and private investment play an important role in economic growth in China. More importantly, the study finds that Infrastructure development in China has significant positive contribution to growth than both private and public investment. Further, there is unidirectional causality from infrastructure development to output growth justifying China's high spending on infrastructure development since the early nineties. The experience from China suggests that it is necessary to design an economic policy that improves the physical infrastructure as well as human capital formation for sustainable economic growth in developing countries.

Energy is the basic support of China's fast economic growth, industrialization and modernization, but China has suffered from an energy shortage. We examine the role of energy development in China, and then assess the effect that energy shortages have on economic development in the short-term. We suggest some policies for energy saving and development in the long-term.

The paper investigates the long run relationship between energy use per capita and per capita real gross domestic product (GDP) for 19 African countries for the period 1971–2001 using a newly developed cointegration test proposed by [Pesaran, M. H., Shin,Y,&Smith, R. (2001). Bounds testing approach to the analysis of level relationships. Jounal of Applied Econometrics, 16, 289–325], which is capable of testing for the existence of a long run relationship regardless of whether the underlying time series are individually I(0), I(1) or mutually cointegrated. The paper also uses the [Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated process. Jounal of Econometrics, 66, 225–250] version of the Granger causality test which is valid regardless of whether a series is I(0), I(1) or I(2), non-cointegrated or cointegrated of any arbitrary order. The empirical evidence shows that there was a long run relationship between the two series for only eight countries and causality for only 10 countries.

Several industrialized countries have signed the Kyoto Protocol, promising to reduce greenhouse gasses (GHG) emissions. To reduce or mitigate such emissions several policies including reducing energy consumption, increasing energy efficiency, decreasing energy intensity and forestation may be possible. The viability and effectiveness of each policy may differ due to country specific factors. This paper tries to assess the impact of a change in energy consumption on income and vice versa in G-7 countries.We employ multivariate cointegration, error correction models and generalized variance decompositions and uncover Granger causality relation between energy consumption and income in all countries. However, the direction of causality seems to differ across countries. This may suggest that although they are at the same level of economic development, different policy alternatives in support of the protocol may be available in each country.

Energy arguably plays a vital role in economic development. Hence many studies have attempted to test for causality between energy and economic growth; however, no consensus has emerged. This paper, therefore, tests for causality between energy and GDP using a consistent data set and methodology for over 100 countries. Causality from energy toGDPis found to be more prevalent in the developedOECDcountries compared to the developing non-OECD countries; implying that a policy to reduce energy consumption aimed at reducing emissions is likely to have greater impact on the GDP of the developed rather than the developing world.

The objective of this paper is to examine the long-run relationship between output, pollutant emissions, and energy consumption in Malaysia during the period 1971–1999. To supplement the findings of cointegrating analysis, we assess the causal relationships between the variables using the recent causality tests available in the literature. The results indicate that pollution and energy use are positively related to output in the long-run. We found a strong support for causality running from economic growth to energy consumption growth, both in the short-run and long-run.

This study utilizes U.S. annual data from 1949 to 2006 to examine the causal relationship between energy consumption and real GDP using aggregate and sectoral primary energy consumption measures within a multivariate framework. The Toda–Yamamoto long-run causality tests reveal that the relationship between energy consumption and real GDP is not uniform across sectors. Granger-causality is absent between total and transportation primary energy consumption and real GDP, respectively. Bidirectional Granger-causality is present between commercial and residential primary energy consumption and real GDP, respectively. Finally, the results indicate that industrial primary energy consumption Granger-causes real GDP. The results suggest that prudent energy and environmental policies should recognize the differences in the relationship between energy consumption and real GDP by sector.

Departing from previous studies on the causal relationship between energy consumption and economic growth, this paper illustrates how the finding of cointegration (i.e., longterm equilibrium relationship) between these variables, may be used in testing Granger causality. Based on the most recent Johansen's multiple cointegration tests preceded by various unit root or nonstationarity tests, we test for cointegration between total energy consumption, real income, and price level of two highly energy dependent East-Asian NICs: Korea and Taiwan. Nonrejection of cointegration between variables rules out Granger noncausality and implies at least one way of Granger causality, either unidirectional or bidirectional. Secondly, by using a dynamic vector error-correction model, we then analyze the direction of Granger causation and hence the within-sample Granger exogeneity or endogeneity of each of the variables. Thirdly, the relative strength of the causality is gauged (through the dynamic variance decomposition technique) by decomposing the total impact of an unanticipated shock to each of the variables beyond the sample period, into proportions attributable to shocks in the other variables, including its own, in the multivariate system. Finally, these response paths of shocks to the system are traced out using impulse response graphs. Results based on these four dynamic tools of analysis broadly indicate that all three variables are cointegrated and mutually causal. The Granger causal chain implied by our evidence tends to suggest that although all these variables are endogenous (i.e., they all share the brunt of adjustment to reestablish the long-term equilibrium), relatively in these two highly energy-dependent economies, in line with expectations, it is the rate of price change that leads to the change in energy consumption, which then leads on to the change in economic growth. Overall, shocks to the system seemed to have had a more sustained if not pronounced effect in Korea than in Taiwan.

This paper empirically examined the causality between electricity consumption and economic growth in two densely populated countries in South Asia, India and Pakistan. The causality analysis was estimated at aggregated and disaggregated level where the focus of the analysis was on the agricultural sector. The disaggregated causality analysis indicated a bi-directional causality between the agricultural electricity consumption and the agricultural GDP in India, while in Pakistan the causality was found to run from agricultural GDP to agricultural electricity consumption. At the aggregated level, India confirmed conservation hypothesis while Pakistan confirmed feedback hypothesis. From the public policy point of view, it can be inferred that, at the macro level, any electricity conservation measures in India will not have an affect on India's increasing economic growth prospects and hence a policy-favourite supply-enhancement strategy in the form of increasing electricity generation needs to be balanced with a demand-management strategy. In case of Pakistan any such policy recommendation is difficult given the bidirectional nature of causality.

Taking into accounts for the dual role of energy in the demand and supply, this paper develops a vector errorcorrection model (VECM) to test for the existence and direction of causality between energy consumption and economic development in Malaysia. Using the Johansen cointegration technique, the results indicate that the long-run movements of economic development, energy price, the structure of economy, capital, labour and energy use in Malaysia are related by two cointegrating vectors. Further, the results show that there is directional causality running from economic development to energy consumption. Hence, an important policy implication of this study is that energy saving would not harm economic development in Malaysia.

This paper offers an empirical evaluation of the output contribution of infrastructure. Drawing from a large data set on infrastructure stocks covering 88 countries and spanning the years 1960–2000, and using a panel time-series approach, the paper estimates a long-run aggregate production function relating GDP to human capital, physical capital, and a synthetic measure of infrastructure given by the first principal component of infrastructure endowments in transport, power, and telecommunications. Tests of the cointegration rank allowing it to vary across countries reveal a common rank with a single cointegrating vector, which is taken to represent the long-run production function. Estimation of its parameters is performed using the pooled mean group estimator, which allows for unrestricted short-run parameter heterogeneity across countries while imposing the (testable) restriction of long-run parameter homogeneity. The long-run elasticity of output with respect to the synthetic infrastructure index ranges between 0.07 and 0.10. The estimates are highly significant, both statistically and economically, and robust to alternative dynamic specifications and infrastructure measures. There is little evidence of longrun parameter heterogeneity across countries, whether heterogeneity is unconditional, or conditional on their level of development, population size, or infrastructure endowments.

As the world struggles to emerge from a global recession and financial crisis, countries are looking for solutions to improve domestic economic performance and put people back to work. Global energy demand and prices have been resilient during the recession, leading policy- makers in countries with the potential to produce energy to look to that sector as a potential engine for economic growth. The objective of this study is to undertake an empirical study on linkage samong energy consumption, economic growth, FDI, relative price and financial development (i.e.,broad money supply – M2) inlow income, middle income, high income non-OECD, high income OECD, South Africa, Middle East and North Africa (MENA) and the aggregated at a of the World over a period of 1975–2011. Data is analyzed by the Im–Pesaran–Shin (IPS) test of unit root to find out the order of integration. The long-run relationship is investigated through the Pedroni [37] test of panel cointegration. At last, the Seemingly Unrelated Regression (SUR) method is used for estimation of the impact of growth factors on energy consumption in these regions. The results reveal that each variable seem to have a unit root at level, so we could investigate cointegration of the series at level. On the basis of Pedroni test, we can bring to a close that series are cointegrated. The results of seemingly unrelated regression (SUR) suggests that GDP per capita has a positive impact on energy consumption in low income, middle income, South Africa, MENA and aggregated at a of the World. However, in high income OECD and non-OECD regions, there is no significant relationship been found in both regions. FDI plays a pivotal role in increasing energy demand in middle income, high income OECD and non-OECD region which implies that whatever other benefits may accrue from FDI, it should not be expected to generate sufficient energy in South Africa, MENA and the World directly. FDI enhancement policies should be supplemented to stimulate growth in those regions. Broad money supply exerts 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. The results conclude that low erenergy prices reduce input costs for nearly all goods and services in the regions, thus making them more affordable.

This paper examines the relationship between natural gas consumption, economic growth and capital by using G-7 countries data and a bootstrap-corrected causality test for the period 1970–2008. It was found eight significant Granger causality relationships. For Italy, the Granger causality is from natural gas consumption to growth and United Kingdom adverse. For pattern of France, Germany and United States there is two sided Granger causality between natural gas and growth.

This paper applies the most recently developed panel unit root, heterogeneous panel cointegration and panel-based error correction models to re-investigate co-movement and the causal relationship between energy consumption and real GDP within a multivariate framework that includes capital stock and labor input for 16 Asian countries during the 1971–2002 period. It employs the production side model (aggregate production function). 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. This means that reducing energy consumption does not adversely affect GDP in the short-run but would in the long-run; thus, these countries should adopt a more vigorous energy policy. Furthermore, we broaden the investigation by dividing the sample countries into two cross-regional groups, namely the APEC and ASEAN groups, and even more important results and implications emerge.

A recently developed methodology of the cointegration test is employed to determine whether energy consumption has a long-run equilibrium relationship with the level of income or employment. It is found that the long-run equilibrium relationship fails to exist in either case. The finding implies a long-run neutrality of energy consumption, which is consistent with the short-run neutrality found in the literature. The results are further confirmed by splitting the sample into two sub-periods.

This paper examines the causality issue between energy consumption and GDP for South Korea and Singapore, with the aid of cointegration and error-correction modeling. Results of the cointegration and error-correction models indicate bidirectional causality between GDP and energy consumption for both South Korea and Singapore. However, results of the standard Granger causality tests show no causal relationship between GDP and energy consumption for South Korea and unidirectional causal relationship from energy consumption to GDP for Singapore.

The Pacific Island countries are small island economies that are increasingly dependent on energy for growth and development, yet highly susceptible to climate change. Thus, the relationship between energy consumption and GDP is crucial for realizing their future development and growth objectives. This article tests for Granger causality and provides long-run structural estimates for the relationship between energy consumption, GDP and urbanization for a panel of Pacific Island countries. For the panel as a whole in the long-run there is bidirectional Granger causality between energy consumption and GDP and these variables exert a positive impact on each other. A 1% increase in energy consumption increases GDP by 0.11%, while a 1% increase in GDP increases energy consumption by 0.23%. The findings suggest that for the panel as a whole these countries should increase investment in energy infrastructure and regulatory reform of energy infrastructure to improve delivery efficiency, continue to promote alternative energy sources and put in place energy conservation policies to reduce unnecessary wastage. These strategies seek to realize the dual objectives of reducing the adverse effects of energy use on the environment, while avoiding the negative effect on economic growth of reducing energy consumption.

Energy arguably plays a vital role in economic development. Hence many studies have attempted to test for causality between energy and economic growth; however, no consensus has emerged. This paper, therefore, tests for causality between energy and GDP using a consistent data set and methodology for 30 OECD and 78 non-OECD countries. Causality from aggregate energy consumption to GDP and GDP to energy consumption is found to be more prevalent in the developed OECD countries compared to the developing non-OECD countries; implying that a policy to reduce energy consumption aimed at reducing emissions is likely to have greater impact on the GDP of the developed rather than the developing world.

This work adapts per capita income, energy demand (sub-group decomposed), inequality and poverty frameworks in a simultaneous equations setting to investigate the role of energy sources on per capita income, inequality and poverty in South Africa. It finds that energy sources (particularly electricity and diesel) are important in estimating production functions. Gasoline, kerosene and coal all exacerbate poverty, with the highest impacts on abject poverty. It is better to disaggregate energy sources in order to capture resource-specific details. Redistribution efforts that focus on reduction of between-group inequality can also moderate energy use since between-group inequality tends to increase the demand for most energy sources. Public efforts are yielding fruits in this direction and should be encouraged. Access to energy sources like electricity, diesel and gas are crucial for productivity enhancement, but for them to yield significant anti-poverty fruits, efforts must also target broadening capital access by the poor.

This study applies panel estimation techniques to investigate the long-run relationship between energy consumption and GDP for a panel of 18 African countries (COMESA). In the first step, we examine the degree of integration between GDP and energy consumption and find that the variables are integrated of order one. We also investigate the long-run relationship between energy consumption and GDP; our cointegration results provide strong evidence that GDP and energy consumption move together in the long-run. On a per-country basis, FMOLS results reveal that energy consumption has a positive long-run relationship with GDP. Finally, results from the panel error correction model show no evidence of a short-run transitory relationship between GDP and energy consumption; however, in the long-run, the error correction model captures a long-run bidirectional relationship between energy consumption and GDP.

We apply recent panel methodology to investigate the relationship between electricity consumption and real GDP for a set of 12 European Union countries using annual data for the period 1970-2004. Recently developed tests for panel unit roots, cointegration in heterogeneous panels and panel causality are employed. The results show a long-run relationship between the series. We estimate this relationship and test for causality. We ¯nd no short-run causality in any direction. These results might help to design appropriate electricity consumption policies in the sample countries, as well as investment policies in interconnections to build a single European market for electricity.

This study investigates the causal relationship between clean and non-clean energy consumption and economic growth in Brazil over the period of 1980–2009. Clean energy consumption at aggregated level of total renewable energy consumption and disaggregated levels of hydroelectric, new renewables, and nuclear energy consumption are tested within a production function framework. A cointegration test reveals a long-term equilibrium relationship between real output, capital, labor, and renewable and nonrenewable energy consumption at aggregated level, and a long-term equilibrium relationship between real output, capital, labor, and hydroelectric/new renewables/nuclear and fossil fuel energy consumption at disaggregated level. The capital, labor, and new renewables elasticities of real output are positive and statistically significant, other energy consumption item's elasticities are insignificant. The results from error correction model reveal the interdependencies between new renewables, nuclear, fossil fuel, andtion by dividing the sample countries into two cross-regional groups, namely the APEC and ASEAN groups, and even more important results and implications emerge. root at level, so we could investigate cointegration of the series at level. On the basis of Pedroni test, we can bring to a close that series are cointegrated. The results of seemingly unrelated regression (SUR) suggests that GDP per capita has a positive impact on energy consumption in low income, middle income, South Africa, MENA and aggregated at a of the World. However, in high inco

Understanding the impact of energy consumption on economic growth is an important consideration in the formulation of both energy and environmental policies. Motivated by this development, this paper empirically re-examines the direction of causality and the sign (in the panel sense) between energy consumption (EC) and the gross-domestic product (GDP) for seventeen selected Asian
countries. Results reveal long-run stable equilibriums in these countries, while the EC brings about a positive impact on GDP. Causality runs from EC to GDP in the short-run, while the long-run causal linkage exists from GDP to EC. This indicates that energy is a force for economic growth in the short-run, but in the long-run, the EC is fundamentally driven by economic growth. Efficient coordination and cooperation towards the implementation of energy conservation policies to support sustainable economic development should be in the regional agenda.

The aim of this paper is to study the nature of the relationship between energy consumption and economic growth in Cameroon through a three-step approach: (i) Study the stationarity of the chronic, (ii) test of causality between variables and (iii) estimate the appropriate model. The study concludes in a non-stationarity of the series. Using the data in first difference, the Granger causality test yields a strong evidence for unidirectional causality running from OIL to GDP. Cointegration tests also show that these two series are co-integrated and the Error Correction Model (ECM) reveals that every percentage increase in Oil products consumption increases economic growth by around 1.1%. This result confirms the intuition that an economic policy aimed at improving energy supply will necessarily have a positive impact on economic growth. On the other side, a lack of energy is a major bottleneck for further economic development in Cameroon.

| Testing for stationarity and cointegration | Testing for direction of causality | Inclusion of energy price variable | Inclusion of capital variable | Inclusion of labor force variable | Inclusion of all 3 variables | File Name |
|---|---|---|---|---|---|---|
| Y | Y | N | N | Y | N | AP dev J 2001 energy growth Pakistan |
| Y | Y | N | N | N | N | AP dev J 2008 Energy growth Nepal |
| Y | Y | N | N | N | N | App eco 1988 energy GDP co-integration |

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|---|---|---|---|---|---|---|
| Y | Y | Y | N | N | N | App Eco 1998 multivate cointegrated model Asian LDCs |
| Y | Y | N | Y | N | N | App eco let 1997 energy growth brazil mexico venezuela |
| Y | Y | N | N | N | N | Appl Econ International Dev 2008 energy-GDP in South Asia |

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|---|---|---|---|---|---|---|
| N | N | N | Y | Y | N | Applied Energy 2009 Power reliability in Shanghai |
| Y | Y | N | Y | Y | N | Eco Econ 2009 energy consumption growth carbon |
| Y | Y | N | Y | Y | N | Eco Econ 2009 EU energy consumption growth carbon |
| N | N | N | Y | Y | N | Ecol eco 2008 energy GDP panel |

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|---|---|---|---|---|---|---|
| Y | Y | N | N | N | N | Economic modeling 2012 Energy and real GDP in 93 countries |
| N | N | N | N | N | N | En Pol 2010 literature review |
| N | Y | N | N | Y | N | Ene eco 1984 energy GNP |
| N | N | Y | N | N | N | Ene eco 1990 electricity growth Jamaica |

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|---|---|---|---|---|---|---|
| N | Y | N | Y | Y | N | Ene eco 1993 energy growth USA |
| Y | Y | N | N | N | N | Ene eco 1996 energy income error-correction |
| Y | Y | N | N | Y | N | Ene eco 1997 co-integration energy economy Taiwan |

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|---|---|---|---|---|---|---|
| Y | Y | N | Y | Y | N | Ene eco 2000 energy macro US |
| Y | Y | Y | N | N | N | Ene eco 2000 energy price growth Asia |
| Y | Y | N | N | N | N | Ene eco 2000 GDP energy Taiwan |
| Y | Y | Y | N | N | N | Ene eco 2002 energy growth Greece |
| Y | Y | Y | N | N | N | Ene eco 2002 energy income Korea |
| Y | Y | N | N | N | N | Ene eco 2003 energy GDP G-7 |

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|---|---|---|---|---|---|---|
| Y | Y | N | N | N | N | Ene eco 2004 electricity growth Malawi |
| Y | Y | N | N | N | N | Ene eco 2004 Electricity supply growth Sri Lanka |
| Y | Y | N | Y | Y | N | Ene eco 2004 energy growth Canada |
| Y | Y | N | N | N | N | Ene eco 2004 energy growth India |
| Y | Y | N | Y | Y | N | Ene eco 2004 GDP energy Korea(1970-1999) |

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| Y | Y | N | N | N | N | Ene eco 2004 industrial energy GDP Shanghai(1952-1999) |
| Y | Y | N | N | N | N | Ene eco 2004 Structural break, energy GDP Turkey |
| Y | Y | N | N | N | N | Ene eco 2005 electricity econ growth Turkey |
| Y | Y | Y | Y | N | N | Ene eco 2005 Energy GDP developing countries |

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| Y | Y | N | N | N | N | Ene eco 2005 Energy growth structural break Taiwan |
| Y | Y | Y | N | N | N | Ene eco 2007 electricity consumption Cyprus |
| N | Y | N | N | N | N | Ene eco 2007 electricity consumption OPEC |

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| Y | Y | N | N | Y | N | Ene eco 2007 electricity GDP Fiji islands |
| Y | Y | N | N | N | N | Ene eco 2007 electricity growth China |
| Y | Y | N | Y | N | N | Ene eco 2007 energy econ activities Iran |
| Y | Y | N | N | N | N | Ene eco 2007 Energy GDP Turkey co-integration |

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| Y | Y | N | N | N | N | Ene eco 2007 Energy GDP Turkey panel |
| Y | Y | N | N | N | N | Ene eco 2007 Energy growth Caribbean countries |
| Y | Y | N | N | N | N | Ene eco 2007 energy growth G-7 countries |

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| N | Y | Y | N | N | N | Ene eco 2007 Residential electricity demand Turkey |
| Y | Y | N | N | N | N | Ene eco 2008 energy GDP Taiwan |
| Y | Y | N | Y | Y | N | Ene eco 2008 energy growth China aggregated and disaggregated |

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| Y | Y | N | N | N | N | Ene eco 2008 energy growth Granger causality |
| N | Y | Y | N | N | N | Ene eco 2008 energy growth Sub-Saraha Africa |
| Y | Y | N | Y | Y | N | Ene eco 2008 energy income OCED capital stock |
| Y | Y | N | Y | N | N | Ene eco 2008 energy real GDP G7 panel |

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| Y | Y | N | N | Y | N | Ene eco 2009 electricity growth South Africa |
| Y | Y | N | Y | Y | N | Ene eco 2009 Energy growth Africa |
| Y | Y | N | Y | Y | N | Ene eco 2009 Energy growth Central America |

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| Y | Y | N | Y | Y | N | Ene eco 2009 Energy growth Commonwealth of Independent States |
| Y | Y | Y | N | N | N | Ene Eco 2010 energy growth multi-sectoral analysis |
| Y | Y | N | Y | Y | N | Ene Eco 2010 energy growth South America |
| Y | Y | Y | N | N | N | Ene Eco 2012 Income energy GDP Sub-Saharan Africa |

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| N | Y | N | N | N | N | Ene Pol 1996 Energy Growth Tanzania Nigeria |
| N | N | N | N | N | N | Ene Pol 2000 Electricity development |
| Y | Y | N | N | N | N | Ene Pol 2002 electricity growth India |

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| Y | Y | N | N | N | N | Ene Pol 2004 Electricity growth in China |
| Y | Y | N | N | Y | N | Ene Pol 2005 Electricity employment income Austrailia |
| Y | Y | N | N | N | N | Ene Pol 2005 Electricity growth Korea |
| Y | Y | N | N | N | N | Ene Pol 2006 electricity growth ASEAN |

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| Y | Y | N | N | N | N | Ene Pol 2006 Energy GDP G-11 |
| Y | Y | N | N | N | N | Ene Pol 2006 Energy GDP Gulf Cooperation Council panel |
| Y | Y | N | N | N | N | Ene Pol 2007 carbon energy output France |
| Y | Y | N | N | N | N | Ene Pol 2007 Electricity GDP Bangladesh |
| Y | Y | Y | N | N | N | Ene Pol 2007 electricity residential demand elasticity G7 |

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| Y | Y | N | N | N | N | Ene Pol 2007 energy growth oil exporting countries |
| Y | Y | Y | N | N | N | Ene Pol 2007 energy growth price VECM |
| Y | Y | N | Y | Y | N | Ene Pol 2007 income energy six developing countries |
| Y | Y | N | N | N | N | Ene Pol 2007 sectoral energy growth Turkey |

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| Y | Y | N | N | N | N | Ene pol 2008 Electricity GDP OECD |
| Y | Y | N | N | N | N | Ene Pol 2008 electricity growth Malaysia |
| Y | Y | N | N | N | N | Ene Pol 2008 Energy growth informal economy |

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| Y | Y | N | N | N | N | Ene Pol 2008 energy growth Turkey |
| Y | Y | N | N | N | N | Ene Pol 2009 carbon energy income Turkey |
| Y | Y | N | N | N | N | Ene Pol 2009 CO2 energy output Central America |

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| Y | Y | N | N | N | N | Ene pol 2009 electricity exports GDP Middle east |
| Y | Y | N | N | Y | N | Ene Pol 2009 energy employment GDP India |
| Y | Y | N | N | N | N | Ene Pol 2009 Energy GDP Tunisia |

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| Y | Y | N | N | N | N | Ene Pol 2009 Energy growth Tanzania |
| N | N | N | N | N | N | Ene Pol 2009 energy income tranditional economicetrics |
| Y | Y | N | N | N | N | Ene Pol 2009 fluctuation energy Pacific island |

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| N | N | N | N | N | N | Ene Pol 2010 Electricity growth |
| Y | Y | N | Y | Y | N | Ene Pol 2010 Renewable energy growth OECD countries |
| Y | Y | N | N | N | N | Ene Pol 2012 dynamic caulsality Lebanon |

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| Y | Y | N | N | N | N | Ene Pol 2013 granger ECM Cameroon |
| Y | Y | Y | N | N | N | Ene Pol 2013 Markov Granger caulsaity US |
| Y | Y | N | Y | Y | N | Ene Pol 2014 fdi dynamic simulaneous model |
| Y | Y | N | N | N | N | Ene Pol Electricity GDP Hong Kong |

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| Y | Y | N | N | N | N | Energy 2006 electricity generation growth Indonesia |
| N | Y | N | Y | Y | N | Energy 2007 energy growth Taiwan |
| Y | Y | N | N | N | N | Energy 2013 energy consumption and HDI |

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| N | Y | N | Y | Y | N | Energy Economics 2009 electricity consumption and growth in AFR revisited |
| Y | Y | Y | N | N | N | Energy Economics 2011 Energy and growth in OECD |
| Y | Y | Y | Y | Y | Y | Energy Economics 2013 Causality between energy and output in Sweden |

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| Y | Y | N | N | N | N | Energy Economics 2013 ECOWAS |
| Y | Y | Y | N | N | n | Energy Economics 2013 energy as driver of growth in oil exporters |

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| Y | Y | N | N | Y | N | Energy Economics 2013 energy-led growth hypothesis testing |
| Y | Y | N | Y | Y | N | Energy Economics 2013 OECD energy-GDP nexus |
| N | N | N | N | N | N | Energy Economics 2013 Power outages and growth in Africa |

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| Y | Y | N | Y | Y | N | Energy Journal 2013 Energy, economic growth and urbanization in 79 countries |
| Y | Y | N | N | N | N | Energy Policy 2006 Electricity and economic growth in 17 AFR countries |
| Y | Y | N | N | N | N | Energy Policy 2007 Electricity and GDP in Asia |

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| N | N | N | N | N | N | Energy Policy 2010 Electricity and economic growth in LAC |
| Y | Y | Y | Y | Y | Y | Energy Policy 2011 AFR energy consumption and growth revisited |
| Y | Y | N | N | Y | N | Energy Policy 2012 Liberia Energy consumption and growth |

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| Y | Y | N | Y | Y | N | Energy Policy 2013 Energy and growth 17 developed countries |
| Y | Y | N | N | N | N | Global bus&tech asso. 2001 energy GDP Turkey |
| Y | Y | N | N | N | N | International J of Energy Economics and Policy 2012 Energy GDP $CO_2$ in MNA |
| Y | Y | Y | N | N | N | Intl J Energy Econ and Policy 2013 energy growth in Turkey |

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| Y | Y | N | Y | Y | N | J Econ Dev 2012 Infrastructure and growth in China |
| N | N | N | N | N | N | J Economic Policy Reform 2007 Energy and economic growth in China |
| N | Y | N | N | N | N | J Pol Model 2005 Energy growth Africa |
| Y | Y | N | Y | Y | N | J Pol Model 2006 Energy income G7 |

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| Y | Y | N | N | N | N | J Pol Model 2008 energy growth 100 countries |
| Y | Y | N | N | N | N | J Pol Model 2008 Growth Pollutant energy Malaysia |
| Y | Y | N | Y | Y | N | J Pol Model 2009 Energy output disaggregated US |

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| Y | Y | Y | N | N | N | J Pol Model 21996<br>Energy Income Price Asia |
| Y | Y | N | N | N | N | J Policy Modeling 2013<br>India and Pakistan<br>electricity and agriculture |

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| Y | Y | Y | Y | Y | Y | Procedia soc beh sci 2012 multivariate cointegration analysis |
| Y | Y | N | Y | Y | N | PRWP 2011 infrastructure and growth dynamic approach |

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| Y | Y | Y | Y | N | N | Re sus ene review 2014 FDI price finance |
| Y | Y | N | Y | N | N | Renewable and Sustainable Energy Reviews 2012 natural gas and economic growth G7 |

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|---|---|---|---|---|---|---|
| Y | Y | N | Y | Y | N | Resource and Energy Economics 2008 Energy and growth in Asia |
| Y | Y | N | N | Y | N | Resource Ene Eco 1992 Energy income employment |
| Y | Y | N | N | N | N | Resource Ene Eco 1997 GDP energy Korea Singapore |
| Y | Y | N | N | N | N | Resource Ene Eco 2009 Energy GDP Pacific Island |

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| Y | Y | N | N | N | N | SEED 2006 Energy GDP OECD Non-OECD |
| N | Y | Y | Y | Y | Y | South Africa 2011 |
| Y | Y | N | N | N | N | Southwestern Economic Review 2012 Energy and growth in COMESA |

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| Y | Y | N | N | N | N | Working paper 2008 energy growth 12 EU countries panel |
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