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Impact of Gas Conservation on Aggregate Economy and Trade of Pakistan

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ABSTRACT

The present study assesses the gas-use based aggregate production framework to find out the co-integration among the variables and thereby estimate the error correction mechanism of the empirical models. Johansen's based co-integration test has been applied with VECM based causality test to assess the long run and causal relationship for yearly time series data over 1980-2014 for Pakistan. The empirical findings demonstrate a statistically significant co-integration to exist among real economic production/GDP, labor, capital and gas-use in both the models with and without exports. The findings of causality test depict long-run unidirectional relationship from labor, capital stock, gas-use and export towards the real GDP. The feedback connection between gas-use and real GDP is also found statistically significant in the short-term. The findings imply a warning for reduction of gas-use via energy conservation policies which may reduce exportable production. The reduction of gas use will downward curtail the economic growth, directly and via exports' multiplier effect upon GDP, indirectly. Therefore, development of new energy technologies has been suggested to balance the supply-demand gap and thereby promisingly expanding the export-led sector for triggering the Economic output/GDP growth and sustainability of energy resources in the country.

Key words: **Energy sustainability, Economic Growth, Gas-use Conservation & Policy Analysis**

Introduction

Sustainable development of an economy has been widely associated with the sustainable economic production/gross domestic product (GDP). Tracing the goal of higher levels of GDP has been associated with many economic factors including development of labor force and capital stock; among others. Energy use in this regard gained currency in the mid-70s after the oil price shock of 1973 and of 1978 to have its prominent role for economic growth. The elementary work by Kraft and

Kraft (1978) is pioneering to inspect the energy-GNP nexus in USA. Likewise, ample empirical evidences in contemporary literature are found to show the existence of vibrant relationship between energy and GDP (see e.g. Ozturk 2010 and Omri, 2014for detailed surveys). Notwithstanding, these available studies are mostly mixed in their result to confirm the path of causation specifically for Pakistan and generally for other regions of the globalized world.

There is no way to cope with the contemporary use of energy in the form of oil, coal and gas use into the various production methods and capital machinery are useless without the energy inputs (Sadorsky, 2011; Shakeel, 2019; Shakeel and Ahmed, 2020). Energy use has been undoubtedly proved to be a fundamental factor in the diversified production of goods and services in the economy (Stern, 2000; 2004). It is not possible to produce any kind of goods or services by using only labor and capital stock and ignoring the use of energy in one of its many kinds like coal, oil, gas or electricity. This implied that no domestic output could be produce without using fossil fuel based energy or other source of energy in the economy. Nonetheless, the use of energy is also paramount in the exportable production and this rise in exportable production necessitates more energy use in the economy and thereby adds value to the aggregate economic production of the economy. This also comprehend that economic growth is not only determined with energy use in domestic production but it is also determined with the energy use in exportable production of the country via the channel of export-multiplier. With the preceded discussion it is somewhat clear that energy in the form of oil, coal and gas among others has a key importance in triggering the GDP enhancement and exports growth directly and via multiplier's effect of export-expansion in enhancing the GDP growth, indirectly.

Although energy use significantly determines the exportable and other economic production vis-à-vis GDP nonetheless, there is lack of experiential support on this concern in the present-day existing literature for a nation or a particular region. There are a small amount of contemporary economic literature highlighting the role of exports in the assessment of energy-GDP relationship and thereby provide the fruitful/conclusive findings for energy conservation in the region selected. These researcher mostly report the findings with conclusion of a statistically significant long run association among the variables, nevertheless the direction of causality is somewhat found mixed or inconclusive. Furthermore, these researchers reported that a rise in exportable-production will cause to increase the energy demand (e.g. Lean and symth, 2010; Sadorsky, 2012; Shakeel et al., 2014 and Raza et al., 2015 among others). This implies that exports expansion and GDP enhancement could lead towards energy shortages and thus appropriate energy-agendas has been suggested on inevitable grounds for striking the balance between energy demand-supply in the regions of investigation. Furthermore, impact of implementing the energy conservation options has been found somewhat wanting in terms of achieving the sustainable environment-growth quest in the respective regions of analyses.

Currently, Pakistan is facing energy supply-demand imbalance and there is huge shortage of energy in form of electricity, gas and oil usage in the country. The power sector is poorly managed and less developed in the country (Khan and Ahmed, 2009). In the year 2009-2010, it is estimated that Pakistan have transmission and distribution sufferers with high system loss around 20 percent (Abbas and Choudhary, 2013). These shortages of energy have an adverse impact on the production level of the local industry. It is expected that a load shedding of electricity in the country will cause 2.60 billion US dollar per year with almost 40000 job losses (Atif and Siddiqi, 2010). The country stands facing the energy crisis following the growth in electricity and gas demand. This can erode the production level in the country if there are made no arrangements toward the new power and gas generation plan (Abbas and Choudhary, 2013).

The present study endeavors to deliver consistent answers for the improvised energy policy questions and their due impacts on exports-expansion as well as on economic production/GDP growth. The study employs gas-use based aggregate production function to assess the importance of exports in the analysis and thereby the role of energy conservation and its due impact upon the export expansion and economic growth of Pakistan. The present study endeavors to offer the connotation of export variable for energy-GDP nexus in a more sophisticated fashion with investigative impacts of gas conservation on the path of sustainable environment-growth motives. The findings of this study for gas use (energy)-GDP-exports nexus may well support in assessing the role of gas conservation policies and export expansion strategies for achieving the sustainable economic production growth in Pakistan.

The track for the remaining paper will be as follow; some very relevant existing literature is discussed in section 2. Theoretical framework and data depiction is incorporated in section 3. Methodology is defined in section 4. Results are discussed in section 5 and last section discusses the implication and conclusion of the analysis.

Literature review

This section intends to review some very important studies related to the issue of energy-GDP nexus and exports in general and for Pakistan in particular. This review will help in understanding the linkages between energy consumed, trade measured with exports/imports and economic production and its growth in the light of empirical evidences as available on the subject for different regions.

The study by Narayan and Smyth (2009) examined the linkages between electricity-economic production-exports relationship for the six Middle Eastern countries over the period 1974-2002. Using panel co-integration test and panel causation test, they observed that long run association holding among these variables. The outcomes of causality test indicated unidirectional causation from electricity to economic growth and from economic growth to exports in the short run only.

Lean and Smyth (2010) in their examination of linkages between electricity usage and exports in Malaysia followed the aggregated production framework. Data of the analysis related to the time period of 1970 to 2008. The study employed co-integration and test of causations to uncover the dynamic linkages pertaining to the key variables. The result of empirical estimation exposed a long-term connection amid the variables. The test of causation verified a uni-directional relation from electricity consumed to exportable production and from exportable production to economic GDP.

Sadorsky (2011) corroborate the association between use of energy consumed, economic production and imports/exports. The analysis covered the time period of 1980-2007 for a group of eight Middle East Nations. The study using panel co-integration approach employed with causation tests in panel sense revealed panel co-integration among real GDP, energy use, energy price deflating with consumer price index and exports/imports. The causality test indicated evidence of unidirectional causation running from exports to energy usage for short-term and bidirectional short-term association between imports and energy consumed.

Sadrosky (2012) examined the long-term and causal links amid energy consumed, economic production and exports/imports in the production framework for seven South American countries. The study covered the time period from 1980 to 2009 and employed panel co-integration approach and tests of causations to examine and understand the associations among the various variables. The study found long-term connection amid GDP, energy usage, labor, capital stock and trade. The causality test revealed bi-directional involvement between export and energy consumed.

Farhani et al. (2014) ascertain the long run connection between the use of gas and GDP in France during the years of 1970-2010 , employing the production framework adding exports as an argument of the production function. They applied autoregressive distributed lags approach and suggested that GDP, gas use, exports, labor and capital were co-integrated and test of causations indicated two way association holding between gas and economic GDP and between the gas and exportable production.

Tsiotras and Estache (2014) using production function framework examined the long run and causal associations between economic production, exportable production and energy consumed in a group of fifteen Latin American nations from the years 1980-2010. Panel co-integration test established long-term relationship amid all the variables. The empirical outcomes of the causality test revealed causation from energy towards economic production. A short-term causation from energy to exportable production was also noted.

Shahbaz et al. (2013) using the aggregate production framework with data span from 1972 to 2010 documented that there is long-term association amid gas usage, GDP, exports, labor and capital formation for Pakistan. They employed ARDL bound testing with the innovative accounting approach of causality test to find out the dynamic linkages amid the main variables. The empirical outcome

demonstrated that gas usage, labor, capital and exports are positively contributing towards the economic GDP of the region and there is indication of one way causality running from gas to economic production/GDP and feedback association between gas and exportable production of the country.

Hossain (2014) assessed the long-term and causal associations among real GDP, electricity usage, exports and remittances for of the major South Asian nations namely; Pakistan, India and Bangladesh during the period 1971-2009. The author applied Kao panel co-integration approach, panel causation test and GMM approach for assessment the links amid the variables. The result of the empirical analysis uncovered the existence of panel long-term associations amid the variables, and causality test indicated two way causation between exportable production and economic growth.

Shakeel and Iqbal (2014) examined the relationships among the economic production, energy consumed, exports/imports, labor and capital formation for a panel of five South Asian countries over the years 1980 to 2009;applied Pedroni panel co-integration approach and panel causation test with VECM to unearth the causal associations among the variables. The result of observed estimation recommended short-term causal feedback association between energy consumed and exports/imports and long-term unidirectional causal bond from exports to energy.

Raza et al. (2015) have used yearly data from 1973 to 2013, employing ARDL and Johansen co-integration approaches with causation test documented the long-term linkages between energy usage and the GDP in Pakistan. They also observed the positive influence of exports/imports upon energy use in Pakistan.

Theoretical model and data

We are assuming that output (Y) in the economy depends on the accessibility of labor, (L), and capital, (K).

$$Y = Af(K, L) \tag{3.1}$$

Pokrovski (2003) corroborated energy as an exterior source to substitute for labor in numerous technical processes. Following the contemporary studies discussed in section 2, we are also adding energy/gas, (E) and exportable production, (X) in the production function as one of the arguments of equation 3.1. The modified function after parameterization of the above functional form with technological coefficients and titled as Model 1 in this study will be as follows

$$Y = A_0 K^{\propto 1} L^{\propto 2} E^{\propto 3} \tag{3.2}$$

Exports contribute to the GDP growth in many ways such as; by increasing efficiency of resource allocation which can enhance comparative advantage, through economies of scale which comes from expansion of market size, by

improvement in capacity and resources utilization and by increasing demand for domestic goods and services through promotion and expansion of forward and backward linkages in the economy. In following the standard of contemporary literature we can write the following Model 2 with adding exports in Model 1:

$$Y = A_0 K^{\propto 1} \underset{L}{} ^{\propto 2} E^{\propto 3} X^{\propto 4} \qquad (3.3)$$

The variables are as follows; Y is real GDP (2010 us dollar) stands for annual, K is capital stock (2010 US dollars). L is labor force of the country. E in the model is gas use (billion cubic feet). X is real exports (2010 US dollars). The data of gas-use are obtained from International Energy Agency (2018). The series of capital is obtained from Penn World tables (Feenstra et al. , 2015). The data of remaining time series are obtained from World Bank data source (WDI, 2018).

Appling the natural log on the time series models in equation 3.2 and 3.3 will yield us with the following models.

$$y_t = \alpha_0 + \alpha_1 k_t + \alpha_2 l_t + \alpha_3 e_t \qquad \text{Model 1}$$

(3.4)

$$y_t = \alpha_0 + \alpha_1 k_t + \alpha_2 l_t + \alpha_3 e_t + \alpha_4 x_t \qquad \text{Model 2}$$

(3.5)

In the light of economic theory and empirical evidence available marshaled from the review of literature on the subject, coefficients of various variables, indicating their respective elasticity are expected to be positive.

Econometric method

The subsequent method has been applied to assess the empirical associations amid the variables of model within reach.

Non stationarity test

Test of Dickey- Fuller (1979) is used to uncover the order of integration of the time series of the study The test reports the non stationarity properties of the variables both in level and in difference form;

$$\Delta Z_t = \alpha_0 + \rho Z_{t-1} + \sum_{j=1}^{n} \gamma j \, \Delta Z_{i,t-j} + \theta_t t + \omega_t \qquad (4.1)$$

at this juncture, Z correspond to the testable variable/ time series, ρ is parameter of lag Z and ΔZ are included to reduce/control autocorrelation. $\theta_t$represent parameter of time trend and ω_t is random disturbance term.

Co-integration analysis

The next step is to estimate the potential long run association amid the variable of the proposed models of the study. To accomplish the task for the time series context, Johansen (1989) approach of co-integration test has been employed. They produce the estimation of the long run analysis with the vector auto regression till p numbers of lag orders;

$$Z_t = C_0 + C_1 Z_{t-1} + C_2 Z_{t-2} + C_3 Z_{t-3} \dots\dots\dots\dots C_p Z_{t-p} + \mu_t \qquad (4.2)$$

Where Z is vector of variables namely, of unit root series commonly denoted I(1) and μ_t is vector of random errors.

Error correction model and causation analysis

The equation of the error correction model will be assessed with the help of equation 4.3a and its formation technique is obtained from Johansen and Julius (1990). This formation is consistent with our proposed model;

$$\Delta y_t = \propto_1 + \sum_{j=1}^{p} \beta_{11j}\, \Delta y_{t-j} + \sum_{j=1}^{p} \beta_{12j}\, \Delta k_{t-j} + \sum_{j=1}^{p} \beta_{13}\, \Delta l_{t-j} + \sum_{j=1}^{p} \beta_{14}\, \Delta e_{t-j} + \sum_{j=1}^{p} \beta_{15}\, \Delta x_{t-j} + \gamma \mu_{t-1} + \omega_t \quad (4.3a)$$

The next step after approximation of the error correction mechanism is to work out the causational information between the variables for short and long run. Toda and Yamamoto (1995) test has been used. This test can be employed on a time series of I(0), I(1) or I(2) and this test does not require pretesting of co-integration among the series at hand and thus can applied on non-co-integrated series too.

$$y_t = \propto_1 + \sum_{j=1}^{p} \beta_{11j} y_{t-j} + \sum_{j=1}^{p} \beta_{12j} k_{t-j} + \sum_{j=1}^{p} \beta_{13} l_{t-j} + \sum_{j=1}^{p} \beta_{14} e_{t-j} + \sum_{j=1}^{p} \beta_{15} x_{t-j} + \gamma_{16} \mu_{t-1} + \omega_{1t} \quad (4.4a)$$

$$e_t = \propto_2 + \sum_{j=1}^{p} \beta_{21j} y_{t-j} + \sum_{j=1}^{p} \beta_{22j} k_{t-j} + \sum_{j=1}^{p} \beta_{23} l_{t-j} + \sum_{j=1}^{p} \beta_{24} e_{t-j} + \sum_{j=1}^{p} \beta_{25} x_{t-j} + \beta_{26} \mu_{t-1} + \omega_{2t} \quad (4.4b)$$

$$x_t = \propto_3 + \sum_{j=1}^{p} \beta_{31j} y_{t-j} + \sum_{j=1}^{p} \beta_{32j} k_{t-j} + \sum_{j=1}^{p} \beta_{33} l_{t-j} + \sum_{j=1}^{p} \beta_{34} e_{t-j} + \sum_{j=1}^{p} \beta_{35} x_{t-j} + \beta_{36} \mu_{t-1} + \omega_{3t} \quad (4.4c)$$

Wald test statistics provide the significance of causality direction in each equation with putting restrictions on $\beta_j's = 0$, respectively.

Empirical results and discussion

This section discusses the empirical results of the models vis-a-vis the methodology outline in the 4th section of the study. The results are presented and interpreted in the following sub-sections.

Order of integration of variables

The findings of the non stationary properties of the time series of the model has been discussed here(Table 1).The standard ADF based unit root results disclose that real economic production/GDP, labor input, gas-use and exportable production contains a unit root at levels form while capital stock has a unit root i.e. I(1) at first difference. The variables are evidently observed stationary at the difference form. Notwithstanding, the time series variable of capital input is exception and manifests stationarity at its second difference with demonstrating a t-value of -6.55 and a p-value of 0.0. Therefore it is possible to test the long run dynamics with the proposed methodology of the study as all series could be used at their integrated of order one form.

Table 1 **Unit Root Results**

Variables	Levels		First Difference	
	Intercept	trend & intercept	Intercept	trend & intercept
Y	-1.69	-2.20	-3.32	-3.34
	(0.39)	(0.48)	(0.01)	(0.02)
k	0.82	-1.14	-2.18	-3.08
	(0.9)	(0.90)	(0.21)	(0.13)
x	-1.48	-2.10	-6.10	-6.17
	(0.46)	(0.53)	(0.00)	(0.00)
l	0.81	-1.11	-5.11	-5.22
	(0.98)	(0.92)	(0.00)	(0.00)
e	-1.12	-2.22	-5.12	-5.22
	(0.63)	(0.40)	(0.07)	(0.00)

Note: P-values has been provided in parenthesis

Long run association among variables

The present subsection manifests the empirical results of the long run association among the variables of the models of the study. Specifically, the results of the co-integration tests are calculated for the proposed Model 1 as presented in the 3rd

section of the study (see equation 3.4) This models is based on the standard production function with economic production (y) as a function of labor (l), capital (k) and gas use (e). In a similar way, the results of the co-integration tests are also calculated for the other proposed Model 2 as presented in the 3rd section of the study (see equation 3.5). This second model is based on the standard production function with economic production (y) as a dependent variable and the addition of export (x) as an independent variables with labor (l), capital (k) and gas use (e). This approach of adding the exportable into the production function through the channel of productivity enhancement will develop insights into a better assessment of the energy conservation and their due impacts upon the exports and economic production growth in the country.

The given trace and maximum Eigen statistics indicated a long run association amid the time series variables of the proposed Model 1. It is noted that there are two vectors of co-integration at 10 percent level of significance for the first model without exports. In the similar fashion, the calculated trace and Eigen statistics with respect of our second proposed Model 2 also indicate that there is long run association amid the selected time series variables. The results of the second model are somewhat more significant as compare to its counterpart model without exports (Table 2). This is indicative of the importance of the exportable into the long run energy-GDP analyses in the country.

Table 2. Calculated Test of Co-integrated Models

Rank	Trace Statistics		Eigen Statistics	
Model 1				
0	47.45	(0.00)	27.37	(0.00)
1	29.08	(0.00)	21.19	(0.00)
2	15.88	(0.14)	14.48	(0.10)
Model 2				
0	69.2	(0.00)	33.37	(0.00)
1	47.7	(0.00)	27.08	(0.00)
2	29.9	(0.02)	21.95	(0.07)

Note: p-values has been provided in parenthesis. lag length is 2.

Further authentication of these long run associations among the time series of both the models could be witnessed by calculating the error correction terms for these proposed models. The error correction term with a statistically significant

negative value will indicate the presence of co-integration among the series of the variables.

Error correction models with long run coefficients

The very next step after testing the co-integration of the proposed models, a further analysis of long run association amid the time series models could be done. Moreover, the value of error term will verify the existence of long run association among the variables. The strategy of estimation is consistent with those done in the calculation of co-integration test in the last section. Therefore, there have been estimated two different models as explained before and their results are being presented and discussed in this subsection (Table 3).

Table 3. Estimated Error correction Models

Variables	Model 1	Model 2
Economic GDP	1	1
Labor	3.09**	6.36***
	(3.26)	(5.90)
Capital	-4.36	-5.31
	(-1.21)	(1.41)
Gas	-1.16**	-3.72***
	(-2.16)	(-5.38)
Exports	---	0.52**
		(2.49)
Lagged Error term	-0.09**	-0.06***
	(-4.19)	(-6.10)

Note: t-values reported in parenthesis. Schwarz Bayesian optimal lag is 1.

*, ** and*** shows 10%, 5% and 1% level of significance.

The estimated results of the equation (3.4) representing the first model without exports reveals that labor, capital and gas-use are statistically significant in making adjustment dynamics in the short run toward long run as shown by the error correction term.

Likewise, Model 2 depicts that the lagged error term has been found significant and has demonstrated a negative value of coefficient. This implies that adding exports are important for the assessment of relationship amid the gas use based production function as there is indication of convergence mechanism for the proposed Model 2 of the study. Therefore, Model 2 is found to be as consistent as

Model 1 for drawing implications of gas use conservation upon the sustainable economic production in the country.

The outcome for long run elasticities for model 2 showed that statistically significant coefficients for labor, gas-use, and exports are observed while capital has been found statistically insignificant. This implies the positive role of labor and export in contributing towards economic production while gas-use is found adversely related to the economic production of the country albeit, gas-use with labor, capital stock and exports are contributory to the long run analysis for economic production/GDP through error correction mechanism.

Causational analysis

In the last stage, calculations of causational analysis has been done to uncover the direction of causation amid the variables of interest and thereby developing the conclusion regarding the energy conservation hypothesis and potential implication of gas use reduction upon the exports and economic production of the country. The differences of economic production has been represented by Δy, of gas-use by Δe and that of exportable by Δx .

Table 4 Calculated Causational Analysis

Model 1				All
	Δy	Δe	Δx	
Δy	1	7.94	---	8.59
	----	(0.00)		(0.03)
Δe	0.12	1	----	2.88
	(0.75)	---		(0.40)
Δx	---	---	----	---
Model 2				All
	Δy	Δe	Δx	
Δy	1	9.67	0.05	11.3
	---	(0.00)	(0.81)	(0.00)
Δe	0.35	1	0.33	4.35
	(0.55)	---	(0.56)	(0.36)
Δx	0.09	2.84	1	2.93
	(0.75)	(0.09)	---	(0.56)

Note: 1.chi-square values are given with probability-values in parentheses.

2. Schwartz Bayesian criterion optimal lag length is selected at 1 .

The calculated causational analysis has also segregation of results with respect to the proposed models of the study (Table 4). The results in the first part containing the empirical calculation of wald's test for Model 1 indicates that gas

use is causing the economic production in the short run. There is also indication of the calculated empirical test in the long run from labor, capital and gas use towards economic GDP. There was no other empirical calculation found to be evident enough for significant relationship among the variables. Likely, the results in the second part containing the empirical calculation of wald's test for Model 2 is indicative of a long run association running from labor, capital, gas use and exportable towards economic production. There was also corroboration of a short run causation running from gas use to exportable in the country. There was no evidence of another significant causation among the time series variable of the respective model. These finding demonstrate a one way causation running from gas-use to GDP growth and supports the growth hypothesis of energy. The findings implied that enactment of energy conservation via gas reduction has adversarial effect on the sustainability of exportable and economic production growth in the country.

Conclusion and implications

Considering the importance of energy-GDP nexus from the emerged empirical analysis on this issue and combining it with the role of export that has emerging in recent years; the study offers the observed evidence on the subject to test the role of exports in gas-GDP nexus for Pakistan. The plan of the study highlights the economic and econometrics aspects of the proposed models and their empirical assessments. The results discussed highlights that there is indication of a long run association among the variables of both the models. Specifically speaking, there is long run association amid the economic production, labor, capital, gas use and exportable. Moreover, the error correction term is evident enough in realizing the fact that gas use based production function with and without exports have a convergence mechanism from the short towards long runs respectively. These finding implied that exports are crucial in the assessment of gas use-economic GDP nexus in the country. The outcome for long run elasticities confirm that labor and export are contributory towards economic GDP although, gas-use are found somewhat adversely related towards economic GDP in the country. Furthermore labor, capital, gas-use and exportable were found significant in realizing the convergence system towards the economic GDP in the long run.

The empirical findings exhibit there is long term unidirectional causal bond running from labor, capital stock, gas-use and exportable towards economic production. There is also experiential a one way connection from gas-use to exports and economic production growth in the short run. Thus, it is recommended that energy conservation on gas-use is not much promising to encourage economic production growth and exports-expansion in Pakistan. The findings imply a caution in implementing the energy conservation via gas use reductions on the sustainable path of economic production and its growth and export expansion. The policy options for the sustainable environment-growth

motive will rest in the improvement of renewable energy technologies in the country. Moreover, there is need to provide uninterrupted supply via reducing the supply-demand gap for gas-use that will help in the expansion of the export-sector and rest of the production-sectors of the country. It is encouraged to conduct new studies on this issue with other important fossil fuel energy components like oil, coal and electricity to further signify the energy conservation options for a sustainable energy-growth motive in Pakistan.

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