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How does Energy Consumption Affect Sectorial Value Addition? An Empirical Evidence from SAARC Economies

Syed Kafait Hussain Naqvi[1], Hafiza Sadaf Zahra[2], Gohar Khan[3]

[1] Lecturer Economics, Department of Economics, University of Kotli, AJK, Pakistan. Email: Kafait.phd236@iiu.edu.pk
[2] Research Fellow, KOPIA Pakistan Centre, PARC-National Agricultural Research Centre, Islamabad, Pakistan. Email: sadafzhra66@gmail.com
[3] Lecturer, Department of Economics, University of Balochistan, Pakistan. Email: gohaar.khan@gmail.com

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ABSTRACT

Understanding the significant role of energy in key sectors is a substantial element for energy planning and policy of an economy. In the context of global energy demand and scarcity issues, the current study is an attempt to explore the role of Energy Demand at the sectorial level of the SAARC economies by using value addition of key sectors as a starting point. To address the objectives of the study, and to explore the dynamic relationship among the variables, dynamic simultaneous panel data models are employed. In this context, the study employed Generalized Method of Moment (GMM) as an estimation technique. The findings demonstrate positive and significant impact of Energy Demand on Agriculture and Industrial Value added growth while a negative impact on Services Value Added growth has been found. Similarly, the conventional growth factors such has Human capital and Physical capital along with Population Growth contributed positively and significantly to the sectorial value addition growth. On the basis of these empirical findings the study suggests that Energy allocation towards Agriculture and Industrial sector must be focused to achieve potential economic growth of the SAARC economies.

Corresponding Author's Email: kafait.phd236@iiu.edu.pk

1. Introduction

With the rapid changes in the industrialization, the demand of energy consumption has become gradually prominent agenda, generating prevalent concerns for the economies around the globe. In this scenario, a global consensus has been reached on the role and significance of energy consumption to address economic disparities of the world. Energy is considered as a key to economic growth. SAARC countries are blessed with massive energy resources but positioned with the least per capita energy consumption in the world, facing the severe energy shortfall issues. In SAARC, India, Bangladesh and Pakistan are the key actors of the region with the emerging economies, rich with natural resources. The economies of SAARC are blessed with vast potential for renewable energy sources; however, of these economies are mainly relying on fossil fuels (93%).

SAARC region is a key contributor to the total energy consumption of the globe and its most energy-intensive building sector (India 47%, Pakistan 55% and Bangladesh 55%) displays inadequate energy performance (Salam et al., 2020). However, their economic growth is highly impacted by poor energy policy and implementation over the years, resulting in sluggish economic growth which lacks sustainability. In this facet, the economic performance of SAARC is categorized into two decades namely; the decade of shocks (1970s) and the decade of adjustment (1980s). Decade of shocks include both internal and external shocks of energy. Majority of SAARC countries import oil and gas from other countries, having high oil prices and facing scarcity of primary energy. These factors threaten progress, exceed poverty, and bringing socio political restless in the area.

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Keeping in view these facts, the member countries of the SAARC established SAARC Energy Centre, which came into being on 13th of November, 20005, situated at the Hydrocarbon Development Institutes of Pakistan (HDIP)1. Though, these member states are poor in energy production, the reason is that, their demand for energy exceed supply both at domestic and commercial level. In Afghanistan and Maldives, for instance, their economies are purely depending on imported energy sources. Bhutan, Nepal and Sri Lanka meet their industrial energy requirements from hydropower and imported sources. The other large economies such as Pakistan, Bangladesh and India are also suffering from severe power deficiency. Bhutan is at its recent level of production capability, exports a huge volume of power to India and meets its own demand. On the other hand, the SAARC region is well gifted in renewable energy resources such as biomass, wind and solar.

Biomass gets the big share of domestic energy requirement across the region. Due to technological constrain wind and solar energy are relatively expensive sources. As much as raw petroleum is concerned, majority of the SAARC member states are reliant on raw oil. This highlights the energy concerns of the these economic in the region. Looking at the sector wise energy requirements in the region, it is observed that at domestic and commercial level, the energy consumption is at the highest in the SAARC region. Since, SAARC Member States are striving for sustainable and higher economic growth, energy demand at commercial level would exceed continuously. Moreover, with increasing per capita income, it is expected that the domestic sector would move from conventional energy sources to advanced energy sources, thus increasing the demand for the industry energy supplies. Energy expenditure and economic development are greatly related. The current study is an endeavor to investigate the effect of energy demand on sectorial value addition of selected SAARC economies. Generally, economic performance of a country is mainly based on the growth, share and value addition of its key sectors. The current study is an attempt to quantify the role of energy in determining the sectorial value added growth of the key sector.

2. Literature Review

There is an impressive body of empirical as well as theoretical body of literature discussing the linkages between energy consumption and economic development. All of this research has been conducted to provide a sound and significant policy guidelines in conniving effective energy conservation policy. In this connection, the pioneering study was first conducted by Kraft and Kraft (1978) who has found that USA’s national output impact energy consumption. Following Kraft and Kraft (1978), later on many theoretical and empirical studies conducted to explore the energy-economy linkages.

The impacts of energy show different outcomes which differ country to country, depending on the economic, social and environmental conditions. Energy consumption and the economic growth has a causal relationship (Engle & Granger, 1987). Filippini and Pachauri (2004) highlights the role of population growth and industrialization which play key role in the consumption of energy. Later, the study of Lee and Chang (2008) investigated the short run and long run causal relationship among energy use an economic growth in case of selected eighteen developing economies and found that there exist a short-run as well as long-run causal relationship between energy consumption and economic growth.

Narayan and Smyth (2005) explore the relationship among energy, employment and Gross Domestic Product of Austrian economy; Al-Iriani (2006) investigate the empirical relationship of energy consumption and economic growth of GCC countries for the period of 1971-2002; Mozumder and Marathe (2007) investigate the linkages between the consumption of electricity and GDP in Bangladesh for the period of 1971-1999; Mehrara (2007) analyse the energy-growth nexus in OECD economies spanning from 1971 to 2002; and the list goes on. All of these studies come up with the conclusion that energy is key to economic growth and an important factor of production.

Without the consumption of energy, no production process can be completed. Such findings direct energy conservation policies in developing countries. The study of Hye and Riaz

(2008) argue that in the long run, a unidirectional relationships exist between energy and economic growth while in the short run, a bidirectional relationship does exist. Both of these studies conclude that the consumption of energy impact positively on growth. Ashraf, Javid, and Javid (2013) study the dynamics of Pakistan economy and argue that Pakistan's performance in the energy sector is not up to the mark, and there is a dire need for sound policy planning and huge investment in this sector; if the country goes the other way, it will harm the socioeconomic fabric of the country.

Ramzan et al. (2013), empirically investigate the relationship between energy consumption and economic progress of developing countries for the period of 1980 to 2009. The results show, the energy shortfall leaves huge impact on the economic progress due to the poor infrastructure. There is a large number of studies conducted on energy utilization and the economic progress of countries where different researchers has applied different techniques to investigate the relationship between energy and economic growth, but unfortunately, no consensus has yet developed in this area. The reason is that each economy has a different set of economic issues, and diverse social setup so every country exhibit different results (Fatai, Oxley, & Scrimgeour, 2004).

Salman et al. (2013) argue that the intensity of energy policy is very important factor which need attention. They state that energy consumption meaningfully affects the economic growth in the short run, and unidirectional causality is found in the long run. Energy is key to economic progress which is a source of production. At various levels of income, economies have different economic and environmental scenarios. For example, at the sectoral level, the role of energy can differ which is hardly studied by the previous researchers. Haq, Naqvi, and Luqman (2016) investigated the complementarities among the sectors in SAARC and argued that the rapid growth and value addition of sectors are closely related. Zhao and Luo (2017) find that as long as the GDP per capita growth improves, renewable energy consumption also improves and vice versa.

Jamil (2022) by using data of seven developing economies for the period of 1955 to 2021 explore the impact of energy on countries economic growth and found a strong linkage between the said variables. The large number of studies in this area highlight the significance of energy use and now energy has become one of the key factor of production, hence its consumption effects the economic growth as well as the living standard. However, on the hand, it is also found that the high consumption of no renewable energy leads to high emissions of CO_2 and other emissions, which damage to the environment (Sharif, Afshan, Chrea, Amel, & Khan, 2020; Wang et al., 2020).

In the SAARC economies, the key conventional energy sources are gas, coal, and oil which are consumed at domestic and commercial level. The high consumption of these energy sources emits large amount of hazardous gasses and cause pollutions, upsetting the environmental sustainability. However, rapid economic growth and rapid industrialization negatively effects the ecological worth but accelerate the economic growth (Sharif et al., 2020; Wang et al., 2020). From the above discussion it is concluded that the relationship among energy consumption and economic growth is not unique. Most of these studies failed to analyse the role of energy at the sector level particularly in the SAARC region. The current is an attempt to fill this gap.

3. Data and Methodology

3.1. Dataset, Sample Selection and Estimation

The study investigates the impact of Energy Consumption on sectoral Value Addition of SAARC economies for the period of 1980 to 2020. For the empirical investigation, the study used longitudinal panel data on five SAARC countries namely; Bangladesh, India, Nepal, Pakistan and Sri Lanka. The key data sources are World Bank's World Development Indicators database, the Penn World Table 10, Barro and Lee's (2021) schooling dataset and UN Comtrade (Appendix A1).

3.2. Empirical Model

To investigate empirically the effect of energy consumption on sectoral value addition of selected SAARC economies, we estimate the following three baseline specifications namely; agriculture value added growth model, industry value added growth model and services value added growth. In first case the explained variable is ''agriculture value added annual percent growth'', and in the second case the explained variable is ''industry value added annual percent growth'', while, in the third case the explained variable is ''services value added annual percent growth''.

Keeping in view the theoretical aspects as well as the dynamic nature of the study, we imply Generalized Method of Moment (GMM) as an estimation technique. The following baseline models are estimated by using panel data of the selected SAARC countries spanning from 1980 to 2020.

i. Agriculture Value Added Growth Model

$$AVA_{it} = \alpha_{\circ} + \alpha_1 EC_{it} + \alpha_2 EGS_{it} + \alpha_3 ISG_{it} + \alpha_4 GDP_{it} + \alpha_5 GFC_{it} + \alpha_6 AYS_{it} + \alpha_7 IntExpEc_{it} + \alpha_8 IntImpEc_{it} + \alpha_9 IntGFCEc_{it} + \varepsilon_{it} \quad (1)$$

ii. Industry Value Added Growth Model

$$IVA_{it} = \beta_{\circ} + \beta_1 EC_{it} + \beta_2 EGS_{it} + \beta_3 ISG_{it} + \beta_4 GDP_{it} + \beta_5 GFC_{it} + \beta_6 AYS_{it} + \beta_7 IntExpEc_{it} + \beta_8 IntImpEc_{it} \; \beta_9 IntGFCEc_{it} + \varepsilon_{it} \quad (2)$$

iii. Services Value Added Growth Model

$$SVA_{it} = \gamma_{\circ} + \gamma_1 EC_{it} + \gamma_2 EGS_{it} + \gamma_3 ISG_{it} + \gamma_4 GDP_{it} + \gamma_5 GFC_{it} + \gamma_6 AYS_{it} + \gamma_7 IntExpEc_{it} \; \gamma_8 IntImpEc_{it} + \gamma_9 IntGFCEc_{it} + \varepsilon_{it} \quad (3)$$

Where; AVA_{it} is the Agriculture Value Added (annual % growth), IVA_{it} is the Industry Value Added (Annual % Growth), $SVA_{it}$is the Services Value Added (Annual % Growth), EC_{it} is the Energy Consumption (per capita growth) GFC_{it} is Gross Fixed Capital Formation (annual % growth), GDP_{it} is the Gross Domestic Product (per capita annual % growth), AYS_{it} is Average Years of Schooling, ESG_{it} Exports of goods and services (annual % growth), ISG_{it} Imports of goods and services (annual % growth). For the sensitivity analysis, we also established three interactive terms; $IntExpEc_{it}$ Exports of goods and services and Energy Consumption, $IntImpEc_{it}$ Imports of goods and services and Energy Consumption, $IntGFCEc_{it}$ Gross Fixed Capital Formation and Energy Consumption and ε_{it} is the residual term.

3.3. Empirical Findings, Interpretation and Discussion

As discussed earlier, the key objective here is to empirically investigate the impact of Energy Consumption on the value addition of sectors (Agriculture, Manufacturing and Services). We focus on the value addition of these sectors in the sample countries and their interacting terms. There are two reasons which direct us for dynamic analysis instead of static analysis. First, in our empirical models, the explanatory variables i.e., GFC_{it} (Gross Fixed Capital Formation) and AYS_{it} (Average Years of Schooling), AVA_{it} (Agriculture Value Added, IVA_{it} (Industry Value Added) and SVA_{it} (Services Value Added) are most likely to have the problem of endogeneity. Second, the pooled OLS and fixed effects cannot appropriately address the country's time invariant features. The error term of the fixed effects comprises both unobserved country-specific effects v_i , and observed specific errors e_i. In this association, the most appropriate estimation technique to estimate dynamic panel growth model is Generalized Method Of Moments (GMM) developed by Arellano and Bond (1991).

3.3.1. Empirical Findings: Agriculture Value Added Growth Model

Table 1 depict the empirical findings of Agriculture Value Added Growth Model. For the sensitivity analysis, the model has four specifications namely; S_1, S_2, S_3 and S_4. AVA_{it} is regressed on EC_{it} along with other controls. The model is dynamic in nature with a lagged dependent variable AVA_{it-1} an explanatory variable, limit the convergence here in Agriculture sector. In all of the specifications, the coefficient of AVA_{it-1} is positive and highly significant shows the cumulative industrialization process within sectors.

In our fundamental specification of model 1 column 2, table EC_{it},(Energy Consumption) is significant and positively contributing to AVA_{it-1}. The coefficient of EC_{it} appears in the regression with positive sign (0.041) and is statistically significant (0.049). These findings are in line with the findings of Shahbaz, Zakaria, Shahzad, and Mahalik (2018), Lanzi, Dellink, and Chateau (2018), Li and Long (2018). The possible justification can be that, putting more energy resources in the agriculture sector may increase likelihood of value addition of that sector which further add up in the GDP growth. The coefficient estimate of all of the regressors in the baseline specification, are significant and appear with their expected signs. GDP_{it} (Gross Domestic Product) positively and significantly impact agriculture sector's value addition.

GFC_{it} (Gross Fixed Capital Formation) depicting the role of Physical Capital in specification 1 is statistically significant (0.853) and with the positive sign (0.003) which shows that the value addition of agriculture sector depends on innovative technology and marginal propensity to save. In the developing countries like SAARC, there is a significant positive role of Physical capital in the agriculture sector. ESG_{it} (Exports of goods and services) possesses positive sign of the coefficient (0.016) and is statistically significant (0.035) indicating a positive effect of exports of goods and services on agriculture value added. IGS_{it} (Imports of goods and services) is insignificant with a negative sign of the coefficient (-0.017) signifying a negative impact of Imports of goods and services on agriculture value added. The coefficients of AYS_{it} (Average Year of Schooling) a determinant of human capital is statistically significant (0.013) with expected positive sign (0.062) shows that skilled and labour increases the likelihood of agriculture value added.

Table 1: Empirical Findings Agriculture Value Added Growth Model

Variables	**S_1**	**S_2**	**S_3**	**S_4**
AVA_{it-1}	0.843	0.847	0.849	0.845
	(0.000)	(0.000)	(0.000)	(0.000)
EC_{it}	0.041	0.225	0.255	0.317
	(0.049)	(0.037)	(0.042)	(0.031)
GDP_{it}	0.079	0.103	0.111	0.112
	(0.021)	(0.007)	(0.004)	(0.004)
GFC_{it}	0.0354	0.001	0.002	0.074
	(0.005)	(0.090)	(0.091)	(0.073)
EGS_{it}	0.016	0.075	0.017	0.019
	(0.035)	(0.037)	(0.032)	(0.276)
IGS_{it}	-0.017	-0.024	0.045	-0.017
	(0.404)	(0.256)	(0.249)	(0.411)
AYS_{it}	0.062	0.055	0.051	0.052
	(0.013)	(0.016)	(0.019)	(0.017)
$IntExpEc_{it}$	---------	0.009	---------	---------
		(0.061)		
$IntImpEc_{it}$	---------	---------	-0.012	---------
			(0.054)	
$IntGFCEc_{it}$	---------	---------	---------	0.013
				(0.049)
Number of instruments	167	167	167	167
Number of observation	200	200	200	200
Number of countries	05	05	05	05
Sargan P-value	0.854	0.869	0.895	0.886

Source: Author's own estimations

The specifications onwards from column 3 to 5 portrays sensitivity analysis. It is important to mentions that EC_{it}, GDP_{it}, GFC_{it}, ESG_{it}, IGS_{it}, AYS_{it} are common to all specifications except some interactive terms. In model 1, three interactive terms are included; $IntExpEc_{it}$ (Energy Consumption and Exports of goods and services), $IntImpEc_{it}$ (Energy Consumption and Imports of goods and services) and $IntGFCEc_{it}$ (Energy consumption and Gross Fixed Capital Formation). $IntExpEC_{it}$ show that Exports of goods and services along with Energy Consumption contribute positively (0.009) and significantly (0.061) to Agriculture Value Added. The second interactive term in column 3, $IntImpEC_{it}$ (Energy Consumption and Imports of goods and services) appear with negative sign (-0.012) and statistically significant show that there is a significant but negative impact of imports on Agriculture value added. Similarly, $IntGFCEc_{it}$ (Energy Consumption and Gross Fixed Capital Formation) appear with positive sign (0.013) and statistically significant, highlight the positive role of investment in the Agriculture sector.

3.3.2. Empirical Findings: Industry Value Added Growth Model

Table 2 incorporates the empirical findings of Industry Value Added Growth Model. On the same fashion of model 1, here for the sensitivity analysis, the model has four specifications namely; S_1, S_2, S_3 and S_4. IVA_{it} is regressed on EC_{it} along with other controls. AVA_{it-1} is lagged dependent variable, which limit the convergence in Industrial sector.

In all of the specifications, the coefficient of IVA_{it-1} is positive and highly significant shows the cumulative industrialization process within sectors.

In our fundamental specification of model 1 column 2, table EC_{it},(Energy Consumption) is significant and positively contributing to AVA_{it-1}. The coefficient of EC_{it} appears in the regression with positive sign (0.041) and is statistically significant (0.049). These findings are in line with the findings of Shahbaz et al. (2018), Lanzi et al. (2018), Li and Long (2018). The possible justification can be that, putting more energy resources in the agriculture sector may increase likelihood of value addition of that sector which further add up in the GDP growth. The coefficient estimate of all of the regressors in the baseline specification, are significant and appear with their expected signs. GDP_{it} (Gross Domestic Product) positively and significantly impact agriculture sector's value addition. GFC_{it} (Gross Fixed Capital Formation) depicting the role of Physical Capital in specification 1 is statistically significant (0.853) and with the positive sign (0.003) which shows that the value addition of agriculture sector depends on innovative technology and marginal propensity to save.

In the developing countries like SAARC, there is a significant positive role of Physical capital in the agriculture sector. ESG_{it} (Exports of goods and services) possesses positive sign of the coefficient (0.016) and is statistically significant (0.035) indicating a positive effect of exports of goods and services on agriculture value added. IGS_{it} (Imports of goods and services) is insignificant with a negative sign of the coefficient (-0.017) signifying a negative impact of Imports of goods and services on agriculture value added. The coefficients of AYS_{it} (Average Year of Schooling) a determinant of human capital is statistically significant (0.013) with expected positive sign (0.062) shows that skilled and labour increases the likelihood of agriculture value added.

Table 2: Empirical Findings Industry Value Added Growth Model

Variables	S_1	S_2	S_3	S_4
IVA_{it-1}	0.812 (0.000)	0.757 (0.000)	0.759 (0.000)	0.765 (0.000)
EC_{it}	0.574 (0.008)	0.355 (0.000)	0.383 (0.000)	0.4958 (0.000)
GDP_{it}	0.216 (0.000)	0.339 (0.000)	0.336 (0.000)	.3264 (0.000)
GFC_{it}	0.015 (0.005)	0.014 (0.002)	0.016 (0.009)	0.1181 (0.000)
EGS_{it}	0.055 (0.000)	0.179 (0.000)	0.072 (0.000)	0.0734 (0.000)
IGS_{it}	-0.039 (0.029)	-0.057 (0.001)	0.053 (0.057)	-0.0537 (0.002)
AYS_{it}	0.130 (0.000)	0.163 (0.000)	0.162 (0.000)	0.1546 (0.000)
$IntExpEc_{it}$	---------	0.018 (0.000)	---------	---------
$IntImpEc_{it}$	---------	---------	-0.019 (0.000)	---------
$IntGFCEc_{it}$	---------	---------	---------	0.023 (0.000)
Number of instruments	167	167	167	167
Number of observation	200	200	200	200
Number of countries	05	05	05	05
Sargan P-value	0.0134	0.0177	0.0278	0.0240

Source: Author own estimation

The coefficient of EC_{it} (Energy Consumption) appears in the regression with the positive sign (0.574) and is statistically significant. It shows that the EC_{it} has positive and significant impact on Industry value added of SAARC economies. The results support the findings of Wurlod and Noailly (2018), Hao and Peng (2017), Aydin and Esen (2018). As industrial sector is more energy intensive sector so when energy consumption increase the value addition of industry also increase. Similarly, other control variables appeared with their expected positive signs. The coefficients of the consequent variable, $\mathrm{GDP_{it}}$ (Gross Domestic Products) is positive (0.216) and highly significant (0.000). $\mathrm{IGS_{it}}$ (Imports of goods and services) possesses significant and negative sign of the coefficient (-0.039) indicating a negative impact of Imports of goods and services on Industry value added sector.

$\mathrm{GFC_{it}}$ (Gross Fixed Capital Formation) is statistically significant with a positive sign. $\mathrm{EGS_{it}}$ (Exports of goods and services) is highly significant with the positive sign (0.055) signify the positive impact of Exports of Goods and Services on Industry value added. $\mathrm{AYS_{it}}$ (Average Year of Schooling) which show the role of human capital is statistically significant with the expected positive sign. The result is too sensible as education has positive impact on the economy and so, education plays a curial role in to increase the production and investment of the firm and industry. In Addition, the productivity depends on the number of skilled labour that increase the level and scale of production.

For the sensitivity analysis, we have introduced three interactive terms namely; $\mathrm{IntExpEC_{it}}$ (Energy Consumption and Exports of goods and services), $\mathrm{IntImpEc_{it}}$ (Energy Consumption and Imports of goods and services) and $\mathrm{IntGFCEc_{it}}$ (Energy Consumption and Gross Fixed Capital Formation). Column two of Table 3 presents the result of interactive term, $\mathrm{IntExpEc_{it}}$. (Exports of goods and services and Energy Consumption) contribute positively (0.018) and significantly (0.000) to Industry Value Added. In specification three, we include our second interactive term, $\mathrm{IntImpEc_{it}}$ (Imports of goods and services and Energy Consumption) which affect Industry value added negatively (-0.019) but significantly (0.000). Specification four is added with the third interactive term, $\mathrm{IntGFCEc_{it}}$ (Gross Fixed Capital Formation and Energy Consumption) which also affect Industry value added positively (0.023) and significantly (0.000).

Table 3: Empirical Findings Services Value Added Growth Model

Variables	S_1	S_2	S_3	S_4
$\mathrm{SVA_{it-1}}$	0.9149 (0.000)	0.8706 (0.000)	0.858 (0.000)	0.866 (0.000)
$\mathrm{EC_{it}}$	0.102 (0.005)	0.305 (0.001)	0.414 (0.000)	0.439 (0.000)
$\mathrm{GDP_{it}}$	0.156 (0.000)	0.1915 (0.000)	0 .206 (0.000)	0.1972 (0.000)
$\mathrm{GFC_{it}}$	0.023 (0.013)	0.0287 (0.002)	0.0318 (0.001)	0.114 (0.000)
$\mathrm{EGS_{it}}$	0.046 (0.963)	0.0525 (0.023)	0.0082 (0.416)	0.005 (0.615)
$\mathrm{IGS_{it}}$	0.026 (0.009)	0.028 (0.008)	-0.053 (0.069)	0.025 (0.023)
$\mathrm{AYS_{it}}$	0.0496 (0.000)	0.079 (0.000)	0.088 (0.000)	0.084 (0.000)
$\mathrm{IntExpEc_{it}}$	---------	0.01001 (0.013)	---------	---------
$\mathrm{IntImpEc_{it}}$	---------	---------	0.014 (0.002)	---------
$\mathrm{IntGFCEc_{it}}$	---------	---------	---------	0.015 (0.004)
Number of instruments	167	167	167	167
Number of observation	200	200	200	200
Number of countries	05	05	05	05
Sargan P-value	0.770	0.703	0.6149	0.593

Source: Author's own estimation

Table 3 presents the empirical findings of our third empirical model, Services value added growth model. Here we regress $\mathrm{SVA_{it}}$ (Services Value Added) on $\mathrm{EC_{it}}$ (Energy consumption). In all of the specifications of model 3, the coefficient of lagged dependent variable, $\mathrm{SVA_{it-1}}$ is positive and highly significant. In our fundamental specification (column 2) of model 3, $\mathrm{EC_{it}}$, is significantly and positively (0.102) contributing to Services value added, illustrates that the Energy Consumption has positive and significant impact on Services value added of SAARC economies. $\mathrm{GDP_{it}}$ (Gross Domestic Products) show positive and highly significant impact on services value addition. $\mathrm{GFC_{it}}$ (Gross Fixed Capital Formation) in all of the specifications (1 to 4) is positive and statistically significant.

$\mathrm{EGS_{it}}$ (Exports of goods and services) also affect Services value added significantly and positively. Unlike other sectors (model 1 and 2), here $\mathrm{IGS_{it}}$ (Imports of goods and services) signifying a positive impact of Imports of goods and services o Services value added The coefficients of our consequent variable, $\mathrm{AYS_{it}}$ (Average Year of Schooling) a proxy variable of human capital is statistically significant with the positive sign. In services sector education plays a vital role. For the case of Services Value Added growth model we add up three interactive terms; the first interactive term is $\mathrm{IntExpEc_{it}}$ (Energy consumption and Exports of goods and services), in specification two. With the set of other control variables, we further add up the interactive terms $\mathrm{IntImpEc_{it}}$ (Energy Consumption and Imports of goods and services) and $\mathrm{IntGFCEc_{it}}$ (Energy consumption and Gross Fixed Capital Formation) from column two to column four in services value added growth model. By following the same pattern of model 1 and 2, three interactive terms, $\mathrm{IntExpEC_{it}}$ $\mathrm{IntImpEc_{it}}$, $\mathrm{IntGFCEc_{it}}$ are introduced (column 3 to 5).

All of these interactive terms exhibits the significant and positive impact on the services value addition. $\mathrm{IntExpEc_{it}}$ e (Imports of goods and services and Energy Consumption) has a positive (0.010) and significant impact on services value addition. In specification three, the second interactive term, $\mathrm{IntImpEc_{it}}$ (Imports of goods and services and Energy Consumption) is added which also leaves the positive (0.014) and statistically significant impact on Services sector. In last specification of model 3 (column 4), third interactive term is introduced, $\mathrm{IntGFCEc_{it}}$ (Gross Fixed Capital Formation and Energy consumption). This also signifying the positive and significant impact on Services sector value addition.

3.4. Robustness Check

To check the robustness of the specifications of the empirical models; a) agriculture value added growth b) industry value added growth and c) services value added growth, we have applied some diagnostic tests. The presence of heteroscedasticity is verified by Modified Special Wald (1983) test, however as we applied GMM technique so the problem of heteroscedasticity is handled smoothly (Mans Soderbom 2009). Second, to check the problem of Multicollinearity, we used simple test of collinearity among the variables. The results confirm that there is no problem of perfect Multicollinearity in any of the estimated specifications. Third, to test the joint significance of the variables, we used the Wald test which does not reject the econometric specifications. Fourth, for cross sectional dependence of the residuals across countries, we used Pasaran CD (2004) test.

The null hypothesis of Pasaran CD test is that "residuals are not correlated", here the null hypothesis is accepted and conclude that there is no problem of cross sectional dependence. Finally, to verify whether the instruments of GMM are correctly identifies or not, we employed the Sargan (1958) test of over-identification of restrictions. The null hypothesis of Sargan test "over identifying restrictions are valid", is not rejected which indicates that the instruments are correctly specified. It is important to discuss that to control the problem of endogeneity (Anderson & Hsiao, 1982; Caselli, Esquivel, & Lefort, 1996), we used GMM estimator, with lagged values of dependent variables as an instruments (Hayashi, 2000 and Baum et al., 2003). To avoid upward biased coefficients (Roodman 2009), we limit the numbers of lags to one.

4. Conclusion

The current study is an attempt to explore the relationship between Energy Consumption and Sectoral value addition of key sectors of SAARC namely; agriculture, industry and services respectively. To achieve this objective, GMM estimation technique is employed. The empirical findings support the view that Energy Consumption plays a significant role in the value addition of the sectors of SAARC countries. The one notable result is that, interaction of Energy Consumption with exports and imports of goods and services illustrate the positive and highly significant effect on services value addition.

The interaction affect is stronger as compared to the individual effect of Energy Consumption, Exports and Imports of goods and services. Similarly, interactive terms of Energy Consumption and Gross Fixed Capital Formation is stronger as compared to the individual effects. On the basis of these findings it can be suggested that SAARC region is rich in renewable resources of energy so. Therefore, there is need to revise the energy policy to motivate sustainable economic growth. Energy is an important factor of production which help to promote competition, efficiency in the agriculture, industry and services sectors.

References

Al-Iriani, M. A. (2006). Energy–GDP relationship revisited: an example from GCC countries using panel causality. *Energy policy, 34*(17), 3342-3350. doi:https://doi.org/10.1016/j.enpol.2005.07.005

Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of econometrics, 18*(1), 47-82. doi:https://doi.org/10.1016/0304-4076(82)90095-1

Ashraf, Z., Javid, A. Y., & Javid, M. (2013). Electricity consumption and economic growth: evidence from Pakistan. *Economics and Business Letters, 2*(1), 21-32.

Aydin, C., & Esen, Ö. (2018). Does the level of energy intensity matter in the effect of energy consumption on the growth of transition economies? Evidence from dynamic panel threshold analysis. *Energy Economics, 69*, 185-195. doi:https://doi.org/10.1016/j.eneco.2017.11.010

Caselli, F., Esquivel, G., & Lefort, F. (1996). Reopening the convergence debate: a new look at cross-country growth empirics. *Journal of economic growth, 1*, 363-389. doi:https://doi.org/10.1007/BF00141044

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Fatai, K., Oxley, L., & Scrimgeour, F. G. (2004). Modelling the causal relationship between energy consumption and GDP in New Zealand, Australia, India, Indonesia, The Philippines and Thailand. *Mathematics and Computers in Simulation, 64*(3-4), 431-445. doi:https://doi.org/10.1016/S0378-4754(03)00109-5

Filippini, M., & Pachauri, S. (2004). Elasticities of electricity demand in urban Indian households. *Energy policy, 32*(3), 429-436. doi:https://doi.org/10.1016/S0301-4215(02)00314-2

Hao, Y., & Peng, H. (2017). On the convergence in China's provincial per capita energy consumption: new evidence from a spatial econometric analysis. *Energy Economics, 68*, 31-43. doi:https://doi.org/10.1016/j.eneco.2017.09.008

Haq, M., Naqvi, S. K. H., & Luqman, M. (2016). Is the Value Addition in Services and Manufacturing Complementary? Empirical Evidence from SAARC. *The Lahore Journal of Economics, 21*(2), 31.

Hye, Q. M. A., & Riaz, S. (2008). Causality between energy consumption and economic growth: the case of Pakistan. *The Lahore Journal of Economics, 13*(2), 45-58.

Jamil, M. N. (2022). Critical analysis of energy consumption and its impact on countries economic growth: an empirical analysis base on countries income level. *Journal of Environmental Science and Economics, 1*(2), 1-12.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *The Journal of Energy and Development*, 401-403.

Lanzi, E., Dellink, R., & Chateau, J. (2018). The sectoral and regional economic consequences of outdoor air pollution to 2060. *Energy Economics, 71*, 89-113. doi:https://doi.org/10.1016/j.eneco.2018.01.014

Lee, C.-C., & Chang, C.-P. (2008). Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data. *Resource and energy Economics, 30*(1), 50-65. doi:https://doi.org/10.1016/j.reseneeco.2007.03.003

Mehrara, M. (2007). Energy consumption and economic growth: the case of oil exporting countries. *Energy policy, 35*(5), 2939-2945. doi:https://doi.org/10.1016/j.enpol.2006.10.018

Mozumder, P., & Marathe, A. (2007). Causality relationship between electricity consumption and GDP in Bangladesh. *Energy policy, 35*(1), 395-402. doi:https://doi.org/10.1016/j.enpol.2005.11.033

Narayan, P. K., & Smyth, R. (2005). Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests. *Energy policy, 33*(9), 1109-1116. doi:https://doi.org/10.1016/j.enpol.2003.11.010

Salam, R. A., Amber, K. P., Ratyal, N. I., Alam, M., Akram, N., Gómez Muñoz, C. Q., & García Márquez, F. P. (2020). An overview on energy and development of energy integration in major South Asian countries: the building sector. *Energies, 13*(21), 5776. doi:https://doi.org/10.3390/en13215776

Sargan, J. D. (1958). The estimation of economic relationships using instrumental variables. *Econometrica: journal of the Econometric Society*, 393-415. doi:https://doi.org/10.2307/1907619
Shahbaz, M., Zakaria, M., Shahzad, S. J. H., & Mahalik, M. K. (2018). The energy consumption and economic growth nexus in top ten energy-consuming countries: Fresh evidence from using the quantile-on-quantile approach. *Energy Economics, 71*, 282-301. doi:https://doi.org/10.1016/j.eneco.2018.02.023
Sharif, A., Afshan, S., Chrea, S., Amel, A., & Khan, S. A. R. (2020). The role of tourism, transportation and globalization in testing environmental Kuznets curve in Malaysia: new insights from quantile ARDL approach. *Environmental Science and Pollution Research, 27*, 25494-25509. doi:https://doi.org/10.1007/s11356-020-08782-5
Wang, Z., Asghar, M. M., Zaidi, S. A. H., Nawaz, K., Wang, B., Zhao, W., & Xu, F. (2020). The dynamic relationship between economic growth and life expectancy: Contradictory role of energy consumption and financial development in Pakistan. *Structural Change and Economic Dynamics, 53*, 257-266. doi:https://doi.org/10.1016/j.strueco.2020.03.004
Wurlod, J.-D., & Noailly, J. (2018). The impact of green innovation on energy intensity: An empirical analysis for 14 industrial sectors in OECD countries. *Energy Economics, 71*, 47-61. doi:https://doi.org/10.1016/j.eneco.2017.12.012
Zhao, X., & Luo, D. (2017). Driving force of rising renewable energy in China: Environment, regulation and employment. *Renewable and Sustainable Energy Reviews, 68*, 48-56.

Appendices

Appendix A1: List of variables and sources

Variable	Description	Source	Measurement
AVA_{it}	Agriculture Value Added		(Annual % Growth)
IVA_{it}	Industry Value Added		(Annual % Growth)
SVA_{it}	Services Value Added	World Development Indicators (WDI) of World Bank	(Annual % Growth)
EC_{it}	Energy consumption		(per capita growth)
GFC_{it}	Gross Fixed Capital Formation		(annual % growth)
ESG_{it}	Exports of goods and services		(Annual % Growth)
ISG_{it}	Imports of goods and services		Annual % Growth)
AYS_{it}	Average years of schooling	Baroo & Lee Data Set	Unit
GDP_{it}	Gross domestic product		per capita growth (annual %)
$IntExpEc_{it}$	Exports of goods and services an Energy Consumption	World Development Indicators (WDI) of World Bank	(Annual % Growth)
$IntImpEc_{it}$	Imports of goods and services and Energy Consumption		(Annual % Growth)
$IntGFCEc_{it}$	Gross Fixed Capital Formation and Energy Consumption		(Annual % Growth)

Source: World Bank, World Development Indicators, 2020

Table A2: Summary Statistics of variables under consideration

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
AVA_{it}	180	23.45	1.53	21.38	26.52
IVA_{it}	180	23.33	1.76	19.76	27.23
SVA_{it}	180	24.13	1.72	21.23	27.74
EC_{it}	180	5.76	0.45	4.62	6.45
GFC_{it}	180	24.95	1.72	21.58	27.31
GDP_{it}	180	6.61	0.58	5.64	8.21
EGS_{it}	180	23.86	1.81	20.49	26.95
IGS_{it}	180	23.86	1.59	21.47	27.07
AYS_{it}	180	1.45	0.53	-0.01	2.43
$IntExpEc_{it}$	180	135.4	17.65	95.09	174.1
$IntIpmEc_{it}$	180	137.8	16.83	99.49	174.3
$IntGFCEc_{it}$	180	138.4	16.67	101.1	174.3

Table A3: Correlation matrix

Variables	EC	EGS	IGS	GFC	GDP	AYS
EC	1.0000					
EGS	0.4499	1.0000				
IGS	0.4542	0.9846	1.0000			
GFC	0.2885	0.9639	0.9648	1.0000		
GDP	0.5870	-0.0074	-0.0500	-0.1855	1.0000	
AYS	0.3051	-0.0074	-0.2854	-0.3738	0.8857	1.0000

Table A4: Pasaran CD Test: Model one

	S_1	S_2	S_3	S_4
F- Value	-0.352	-0.379	-0.380	-0.414
P-Value	0.724	0.000	0.7038	0.264

H_0= Residuals are not correlated (P>5%)

Table A5: Modified Wald Test for Heteroscedasticity: Model one

	S_1	S_2	S_3	S_4
Chai^2	33.14	30.02	30.65	28.43
Probability of Chai^2	0.000	0.000	0.000	0.000

H_0= Constant variance (P>5%)

Table A6: Pasaran CD Test: Model two

	S_1	S_2	S_3	S_4
F- Value	2.891,	2.182	6.342	5.381
P-Value	0.0038	0.0291	0.000	0.000

H_0= Residuals are not correlated (P>5%)

Table A7: Modified Wald Test for Heteroscedasticity: Model two

	S_1	S_2	S_3	S_4
Chai^2	123.33	545.21	590.66	378.09
Probability of Chai^2	0.000	0.000	0.000	0.000

H_0= Constant variance (P>5%)

Table A8: Pasaran CD Test: Model three

	S_1	S_2	S_3	S_4
F- Value	-2.701	-0.954	-0.604	0.930
P-Value	0.0069	0.3401	0.5457	0.3522

H_0= Residuals are not correlated (P>5%)

Table A9: Modified Wald Test for Heteroscedasticity: Model 3

	S_1	S_2	S_3	S_4
Chai^2	37.64	174.93	252.87	602.12
Probability of Chai^2	0.000	0.000	0.000	0.000

H_0= Constant variance (P>5%)