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Internet Usage, Electricity Consumption and Economic Growth: Evidence from a Panel of Developing-8 Countries

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ABSTRACT

This paper attempts to estimate the short- and long-run effects of Internet usage and economic growth on electricity consumption using developing-8 (D-8) countries panel data for the period of 1990-2013. The paper employs panel unit root test, panel cointegration test, the pooled mean group regression technique and Dumitrescu–Hurlin causality test. The results show that Internet usage effect on electricity consumption only in the long-run. However, economic growth effects on electricity consumption in both the short- and long-run. Causality results imply that Internet use causes electricity consumption. It is clear that with the expansion of Internet usage in D-8 countries in the long-run, the electricity demand will rise as evident from our findings. Therefore, D-8 countries to response for increasing demand for electricity need to improve electricity generation efficiency. In addition, D-8 countries should consider the increasing demand for electricity and subsequently its increasing consumption will raise the level of CO_2 emissions.

Keywords: Electricity Consumption, Internet Usage, Developing-8 Countries, Panel Data, Pooled Mean Group
JEL Classifications: L94, O4, Q4, Q42, O1

1. INTRODUCTION

There is the well-documented literature on the information and communication technology (ICT)-economic growth hypothesis (Pohjola, 2001; Nour, 2002; Vu, 2011) as well as on the economic growth-electricity consumption nexus (Kraft and Kraft, 1978; Yoo, 2005; Wolde-Rufael, 2006; Narayan and Prasad, 2008) for both developed and developing countries. But, the relationship between ICT and energy consumption has grown steadily over the last years. ICT development could affect energy use via two channels: Direct and indirect impacts (Hilty, 2008). The direct impact relates to the production, use and disposal of ICT equipment (e.g., Huber and Mills, 1999; Roth et al., 2002; Laitner, 2002). The estimation of the indirect impact of ICT on energy consumption is even more complicated. To start with, there is the possibility that ICT development in fact stimulates the demand for energy through the globalization of markets and the distribution of production forms induced by the growth of telecommunications networks. (Ishida, 2015).

This study estimates the short- and long-run effects of Internet usage and economic growth on electricity consumption using developing-8 (D-8) countries panel data. The number of Internet users is used as alternate indicators of ICT. The contribution of this study to the existing literature on the electricity consumption is two-fold. The first contribution is to estimate elasticitiy of electricity consumption relative to Internet usage for D-8 countries. Previous papers have estimated the short- and long-run effects of ICT on electricity consumption in developed and developing countries (Salahuddin and Alam, 2015; 2016; Afzal and Gow, 2016). We, for the first time in previous literature, examine the short- and long-run effects of Internet usage and economic growth on electricity consumption in the D-8 Organization for Economic Cooperation, also known as Developing-8, is an organization for development cooperation among the following Muslim developing countries: Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey. The second contribution is to compare the results of short- and long-run effects of Internet usage and economic growth on electricity consumption in D-8 countries with the same model estimated in OECD countries by Salahuddin and Alam (2016). In fact, we compare the short- and long-run elasticities of electricity consumption relative to Internet usage and economic growth in D-8 and OECD countries.

The remainder of the paper is organized as follows: Section 2 reviews existing literature; section 3 describes econometric modeling and data source; section 4 deals with the empirical analysis and section 5 concludes the study.

2. LITERATURE REVIEW

Over the past decades, many empirical studies on electricity consumption have been published. Based on the standard consumption function with utility maximization theory, it assumes that the demand for an energy product is determined not only by changes in income and price but also varies with different economic development stages and institutional arrangements with which a particular country is associated (Sheng et al., 2012). The nexus between electricity consumption and a set of macroeconomic variables provides an extensive literature for a large number of cases across the world. More specifically, empirical investigations explore the nature and direction of the links between electricity consumption, and income, electricity price, financial development, trade openness, industrialization and urbanization. Electricity consumption - ICT nexus has been also investigated, however, the impact that ICT diffusion has on electricity consumption is an issue that has received little attention.

Takase and Murota (2004) examine the influence of IT investment on energy consumption in Japan and the US by developing an economic model. According to the simulation results, they suggest that while IT investment lowers energy intensity in Japan it increases energy intensity in the US.

Collard et al. (2005) estimate the effect of IT investment on electricity intensity of production in the French service sector over the period 1986-1998. Using panel data combining time series and cross sectional dimensions, they find that electricity intensity of production has decreased with the diffusion of communication devices while it increased with the use of computers and software.

Cho et al. (2007) examine the effects of ICT investment and energy price on electricity consumption in South Korean industries. Their findings indicate that ICT investment increases electricity intensity in the service sector and in those manufacturing sectors that consume relatively higher amount of electricity.

Sadorsky (2012) examines the impact of ICT on electricity consumption in 19 emerging countries, and finds a positive relationship between ICT (as measured by teledensity) and electricity consumption.

Ishida (2015) estimates the long-run relationship between ICT, energy consumption, and economic growth in Japan. Using an autoregressive distributed lag (ARDL) bounds testing approach, he estimates two different multivariate models corresponding to the production function and the energy demand function, both including ICT investment as an explanatory variable, over the period 1980-2010. He concludes that while ICT investment could ceteris paribus contribute to a moderate reduction in energy consumption, but not to an increase in gross domestic product (GDP).

Salahuddin and Alam (2015) examine the short- and long-run effects of the Internet usage and economic growth on electricity consumption using annual time series macro data for Australia for the period 1985-2012. Results from ARDL estimates indicate that the Internet use and economic growth stimulate electricity consumption in Australia.

Saidi et al. (2015) investigate the impact of ICT and economic growth (GDP) on electricity consumption (EC) for a global panel consisting of 67 countries using a dynamic panel data model. They also implement these empirical models for three income panels, namely, high income, middle income, and low income panels. The panel model was used in this study from the period 1990-2012. Findings show a positive and statistically significant effect of ICT on electricity consumption when ICT measured using Internet connections and mobile phones.

Salahuddin and Alam (2016) estimates the short- and long-run effects of ICT use and economic growth on electricity consumption using OECD panel data for the period of 1985-2012. The results confirm that both ICT use and economic growth stimulate electricity consumption in both the short- and the long run. Causality results suggest that electricity consumption causes economic growth. Both mobile and Internet use cause electricity consumption and economic growth.

Tunali (2005) examines the influence of ICT on electricity consumption in the European Union countries over the period 1990-2012. The results of the empirical analysis indicate that ICT leads to an increase in electricity consumption in this countries over the long-run.

Afzal and Gow (2016) estimate the impact of ICT on electricity consumption in the next eleven emerging economies over the period 1990-2014. Using dynamic panel data models, they show that a positive and statistically significant relationship between ICT and electricity consumption where ICT is measured using internet connections, mobile phones or the import percentage of ICT goods of total imports. electricity intensity of production has decreased with the diffusion of communication devices while it increased with the use of computers and software.

3. ECONOMETRIC MODELING AND DATA SOURCE

The aim of this paper is to determine the effects of Internet usage and GDP per capita on the electricity consumption for a panel of D-8 countries. Following Sadorsky (2012), Ishida (2015), Salahuddin and Alam (2015 and 2016) and Salahuddin et al. (2016) the functional form of the model is:

$$ECp=F\ (A,\ GDPpc,\ INT) \quad (1)$$

or

$$ECp_{it}=A.\ (GDPpc_{it})^{\beta 1}\ (INT_{it})^{\beta 2} \quad (2)$$

Taking the log - linear form both sides of the Equtaion (2), we obtain the following equation:

$$ln\ ECp_{it}=\beta_0+\beta_1 ln\ GDPpc_{it}+\beta_2 ln\ INT_{it}+\varepsilon_{it} \quad (3)$$

Where, *ln* denotes the natural logarithm; $I = 1,\ldots, N$ for each country in the panel, and $t = 1,\ldots, T$ refers to the time period. The parameters β_1 and β_2 are the long-run elasticities of electricity consumption relative to GDP per capita, and Internet usage, respectively. E*Cp* is logarithmic the electricity consumption per capita, *GDPpc* is logarithmic the *GDP* per capita, and *INT* is logarithmic the Internet usage.

Annual data for electricity consumption is measured by electric power consumption (Kwn per capita), and GDP per capita is measured in constant 2005 US$. ICT variable in this study include Internet usage (per 100 people). All data were obtained from The World Bank's World Development Indicators (WDI, 2013). The specific countries selected for the study and the timeframe were dictated by data availability and the need for a balanced panel over the period of 1990-2013. These include the D-8 Organization for Economic Cooperation, also known as Developing-8, is an organization for development cooperation among the following Muslim developing countries (Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey).

4. EMPIRICAL RESULTS

According to the basic idea behind cointegration before proceeding to using cointegration techniques, it is necessary to determine the order of integration of each variable. There are a variety of panel unit root tests, which include Levin et al. (1993), Im et al. (2003) (IPS here after), Maddala and Wu (1999). The results in Table 1 point out that the hypothesis that the levels of all variables under study contain a unit root is accepted at the 1% significant level. When these tests are applied on the first differences of those variables, the reported results display that the unit root hypothesis is rejected.

Cointegration test is primarily used to investigate the problem of spurious regression, which exists only in the presence of non-stationary. Therefore after application of unit root tests, if each of the variables is stationary then issue arises whether there exists a long-run equilibrium relationship between the variables. This study employed two taype of panel cointegration test. Pedroni (2003) residual cointegration test is reported in Table 2. Results show that five out of seven test statistics support the presence of cointegration among the variables in model.

In addition, from the Kao (1999) residual cointegration test result reported in Table 3 strong evidence is found to reject the null hypothesis of no cointegration at one percent level of significance. Therefore, it is concluded that there exist a strong evidence of long-run cointegration relationship between the variables for the panel.

Table 4 presents the results from the pooled mean group (PMG) estimations for Equation (3). The findings indicate that for Internet usage, the estimated coefficient is positive, persistent and significant at 1% level of significance. The long-run estimated coefficient of the variable, the number of the Internet users per 100 people is 0.036 which means that a 1% increase in the number of the Internet users per 100 people increases per capita electricity consumption by 0.036%.

There is also significant positive short-run and the long-run relationship between economic growth and electricity consumption in the model. The estimated long-run coefficient of economic growth rate (log of GDP per capita) is 1.11. This means that a 1% economic growth rate will cause 1.11% increase in per capita electricity consumption. Finally, we employ Dumitrescu–Hurlin (2012) causality test to deterime causal link between variables of model. The results reported in Table 5 suggest that Internet use causes electricity consumption in the D-8 countries.

5. CONCLUSION

This paper studies Internet usage and economic growth as engines of electricity consumption in the D-8 Organization for Economic Cooperation, also known as Developing-8, is an organization for development cooperation among the Muslim developing countries over the period 1990-2013. The results show that Internet usage has a statistically significant positive effect on electricity consumption in long-run. This implies that Internet usage subscriptions increase the demand for electricity in D-8 countries. This supports previous studies such as Sadorsky (2012), Saidi et al. (2015), Salahuddin

Table 1: Panel unit root test results

Test statistic	LLC	IPS	ADF	PP (Fisher)
A: Level				
L GDP (per capita)	−0.01236	−0.69463	22.1960	11.1159
	(0.4951)	(0.2436)	(0.1370)	(0.8023)
L electric power use (per capita)	−1.90092	−0.92082	18.9947	17.2273
	(0.0287)	(0.1786)	(0.2689)	(0.3710)
L Internet use (per 100 people)	−0.67535	0.48836	10.1994	8.71333
	(0.2497)	(0.6874)	(0.8560)	(0.9247)
B: First differences				
L GDP (per capita)	−4.71810	−3.43231	44.2069	48.3687
	(0.0000)	(0.0003)	(0.0002)	(0.0000)
L electric power use (per capita)	−9.16924	−6.91757	69.1610	69.0684
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
L Internet use (per 100 people)	−5.09416	−3.14018	38.0226	55.7436
	(0.0000)	(0.0008)	(0.0015)	(0.0000)

Probability values in parenthesis. GDP: Gross domestic product and Alam (2016). But, the estimated coefficients on short-run show that Internet usage has not a statistically significant positive effect on electricity consumption in D-8 countries. Salahuddin and Alam (2016) have estimated same model of this study for panel of 26 OECD countries. The results of comparison show that Internet usage effect on electricity consumption in D-8 countries (0.036) is greater than OECD countries (0.026) in long-run.

Table 2: Pedroni residual cointegration test

Panel cointegration statistics (within-dimension)	Statistics	Prob
Panel v-statistic	1.172054	0.1120
Panel rho-statistic	−1.932653	0.0266
Panel PP-statistic	−2.722917	0.0032
Panel ADF-statistic	−2.848756	0.0022
Group mean panel cointegration statistics (between-dimension)		
Group rho-statistic	−0.182951	0.3646
Group PP-statistic	−1.935541	0.0265
Group ADF-statistic	−1.993764	0.0231

Table 3: Kao residual cointegration test

ADF	Lag	t-statictic	Prob
D-8 countries	3	−3.182951	0.0007

Null hypothesis: No cointegration, lag length selection based on SIC. D-8: Developing-8

Table 4: Results from PMG estimation for model

Dependent variable: Electric power	Long-run coefficients		
Consumption	Coefficient	Standard error	Prob
L GDP (per capita)	1.114836	0.070664	0.000
L Internet use (per 100 people)	0.036060	0.004592	0.000
Short-run coefficients			
Error correction coefficient	−0.282673	0.048150	0.0000
Δ L GDP (per capita)	0.346424	0.200156	0.0860
Δ L Internet use (per 100 people)	0.022622	0.024447	0.3566
Intercept	−0.645793	0.152818	0.0000

GDP: Gross domestic product, PMG: Pooled mean group

Table 5: Pairwise Dumitrescu–Hurlin panel causality tests

Null hypothesis	W-statictic	Zbar-statictic	Prob
LGDP does not homogeneously cause LEC	2.07312	1.58905	0.1121
LEC does not homogeneously cause LGDP	1.77703	1.09997	0.2713
LNET does not homogeneously cause LEC	4.82123	5.68216	1.E-08
LEC does not homogeneously cause LNET	3.47769	3.60321	0.0003
LNET does not homogeneously cause LGDP	3.27779	3.29390	0.0010
LGDP does not homogeneously cause LNET	1.08660	−0.09667	0.9230

GDP: Gross domestic product

Furthermore, economic growth has a positive and statistically significant on electricity consumption in D-8 countries. The contribution of GDP to electricity consumption in D-8 countries (1.11) is higher than OECD countries (0.25) in long-run. In addition, this finding is consistent with Saidi et al. (2015).

Therefore, D-8 countries to response for increasing demand for electricity need to improve electricity generation efficiency. In addition, D-8 countries should consider the increasing demand for electricity and subsequently its increasing consumption will raise the level of CO_2 emissions.

For future research, a possible extension of our analysis could be the assessment of the effect of other indicators of ICT on electricity consumption in the D-8 countries. In addition, it is possible to estimate the effects of ICT indicators on tolal energy consumption in the D-8.

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