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Dynamic Relationships among Urbanization, Economic Growth and Energy Consumption in Bangladesh: An ARDL Bounds Test Approach

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ABSTRACT

From energy economics we know the nexus between economic growth and energy consumption and from urban economics we get the nexus between urbanization and economic growth. In this study we amalgamate this two theory and try to investigate the dynamic relationships among urbanization, economic growth and energy consumption in the context of Bangladesh. Times series data of Bangladesh are taken from World Development Indicator 2017 over the period of 1973-2014. Augmented Dickey Fuller test are used to check the unit root problem and ARDL bounds test approach has been employed for empirical analysis. Three different regressions are estimated separately to investigate the dynamic relationships among urbanization, economic growth and energy consumption and among them only one is free from serial correlation and heteroscedasticity problem, distributed normally, functional form is correct and cumulative sum and cumulative sum squares of the recursive residuals are within the bounds that means the long-run and short-run parameters are stable. This one is that when we use energy consumption as dependent variable. Empirical results confirm that urbanization, economic growth and energy consumption are cointegrated that means they have long-run equilibrium relationships. Empirical results reveal that one percent increase in economic growth will cause to increase energy consumption by 0.40 percent in the short run and 0.74 percent in the long-run, while one percent increase in urbanization process will cause to increase energy consumption by 0.072 percent in the short-run and 0.13 percent in the long-run. Moreover, the short-run deviations from the long-run equilibrium are corrected by at a speed of 54.03 percent towards the long-run equilibrium path each year. Finally results of Granger causality tests confirm that there is a unidirectional causality running from economic growth to energy consumption.

Keywords : : Economic growth, Urbanization, Energy consumption, Bangladesh, ARDL Bounds test

1 Introduction

Theoretically Lewis's, 1954 [16] work on "Economic development and unlimited supplies of labor" was the prior work involving rural-urban migration which tries to explain the development process as a structural change involving transformation from a stagnating economy based on traditional rural sector to a growing industrial one. Not only accumulation of capital but also the interaction between rural and urban sector accelerate economic growth according to his model. Lewis assumed two sector in an economy; agricultural sector and industry sector and there exist diminishing marginal productivity in both sectors. The central assumption of the Lewis model was the idea of surplus labor in the agricultural sector and the marginal productivity of that surplus workers is closed to zero. Therefore, a significant portion of agricultural labor can be shifted, without adversely affecting the agricultural output, into the industrial sector where wage rate is higher than the agricultural sector. This migration of labor from the low population density rural area to high population density urban area continues to occur until the surplus labor or disguised unemployment cannot be absorbed by the growing industrial modern sector. But Lewis model has some criticisms. This model ignores the role of foreign trade and the human capital theory [4]. Moreover does surplus labor really exist is a question of concern and this model is unable to explain the wage determination process in agricultural sector, the greater role of agriculture in development process, the way of absorption of industrial goods and the realistic nature of urban labor market etc.

Ranis and Fei, 1961 [24] also work with the dualistic development model by extending and formalizing the Lewis model by introducing the possibilities of technical progress in the agricultural sector and by assuming that capital investments are also possible in the agriculture sector. They come with the extension that the duration period of "take-off" stage for a developing country increases with the rate of demographic growth and decreases with the intensity of investment effort in both economic sectors. But in reality the urban sector is not as simple as in the model and heterogeneity of labor also exists in the urban labor market. There is a clear fragmentation of urban labor market; urban formal sector and urban informal sector. Large and persistent wage gap exists between this two sectors and wages in urban formal sector are much higher than the urban informal sector as well as the agricultural sector. The allocation of urban labor between the informal and formal urban sector is a key issue of the Harris-Todaro model [15]. Harris-Todaro assume that migration decision depends on expected real wage differential rather than actual, and expected urban real wage differential depends on not only the actual differential but also on the probability to find jobs in the urban sector. Therefore, the core assumption of Harris-Todaro model is that migration is positively related to the urban – rural real income differential and is an increasing function of the probability of finding an urban formal job. Later some extensions of Harris-Todaro model have been formulated. Fields, 1975 [12] extends the model by including the job search behavior in addition to an informal sector. Beladi and Marjit, 1996 [3] made extension of Harris-Todaro model by introducing non-traded goods into the model. They also examine the risk averse behavior of households into the migration decision.

Actually the migration decision of an individual is not only financial but also psychological. Basically people wants to migrate as a response of incentives. If there is no incentive people do not migrate. Most of the time the migration decision depends on attraction of getting higher wages and to lead a better life with higher standard of living. Sometimes friends and family directly influence to migrate from rural to urban area and the migration decision comes typically from family. Sometimes people heavily rely on informal information channel such as knowledge of relatives or neighbors which create desire to migrate. Sometimes families cannot be employed all of their male members in agriculture sector, so they send them into the urban area for working by thinking that they will earn more money and send some of that to the family. Therefore migration also plays a great role in rural development as it increases family income of the migrant and at the same time productivity of the remaining workers in the agricultural sector also increases.

At the time of emergence as an independent country Bangladesh was basically an agriculture based economy. Almost 50 percent of the share of GDP was under the agriculture sector and 80 percent of workers directly involved there. According to World Bank data [32] 91.78 percent people of Bangladesh lived in rural areas and only rest of 8.22 percent lived in urban areas during 1972. But the scenario has been greatly changed in 45 years from independence. Now Bangladesh's economy is the second fastest growing major economy of 2016 according to International Monetary Fund and is the 46th largest economy in the world in nominal terms and 33rd largest by purchasing power parity. Now 34.23% of the country's population live in urban areas [32] and it is projected to cross 56 percent by the year 2050 [30]. Bangladesh is now experiencing rapid growth of urbanization and urban areas are now contributing 60 percent of GDP. As 40 percent workers are in agriculture sector but share of agriculture on GDP is only 15.1 percent, and 34 percent urban population contribute 60 percent of GDP so the productivity in urban sector is much greater than the productivity in agriculture sector. As a result internal migration from rural to urban in Bangladesh still continue at a good rate. Moreover the supply of labor in industrial sector is quite well which lower the wage rate and stimulate investment in industrial sector and enhance economic growth. Actually Ready-Made Garments (RMG) in Bangladesh plays a good role for rural urban migration in Bangladesh. About 4 million workers were employed at 5,700 factories in 2011-12 comparing with 0.04 million workers at 134 factories in 1983-84 in Bangladesh. So the process of rural urban migration of low skill workers especially female workers (as more than 80 percent workers in RMG sector are female) are highly correlated with the emergence of RMG sector in Bangladesh, which is the main source of export earnings. So it is expected that urbanization and economic growth is highly correlated in the context of Bangladesh.

Theoretically there is a direct association between energy consumption and economic growth. To support this inter linkage various studies have been conducted after the end of the 1970s energy crisis. All these studies found a positive impact of energy consumption on economic growth. To foster industrialization and robust growth the availability of energy is so important and actually it is something like that as an engine will stop without energy, the growth engine of a country will also stop too without its use. Therefore, from energy economics we know there exists a nexus between economic growth and energy consumption and from urban economics we know there exists a nexus between urbanization and economic growth.

In this study we amalgamate this two theory and try to investigate the dynamic relationships among urbanization, economic growth and energy consumption in the context of Bangladesh.

2. Literature Review

This section contains some relevant empirical literature of the nexus between energy consumption and economic growth, nexus between urbanization and economic growth and nexus between urbanization, energy consumption and economic growth. Erdal, Erdal, & Esengün, 2008 [11] applied the causality test to examine the causal relationship between primary energy consumption (EC) and real Gross National Product (GNP) for Turkey during 1970–2006. Their results indicate that EC and GNP are cointegrated and there is bidirectional causality running from EC to GNP and vice versa. Apergis & Payne, 2009 [2] examined 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 heterogeneous panel cointegration test and corresponding error correction model they found cointegration 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. Odhiambo, 2000 [20] examined the causal relationship between energy consumption and economic growth in Tanzania over the period of 1971–2006. They used 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 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.

Costantini & Martini, 2010 [9] analyzed 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. Their results show that alternative country samples hardly affect the causality relations, particularly in a multivariate multi-sector framework. Ozturk, Aslan, & Kalyoncu, 2010 [21] used the panel data of energy consumption (EC) and economic growth (GDP) for 51 countries from 1971 to 2005. They divided these countries into three groups: low income group, lower middle income group and upper middle income group countries. Their results found energy consumption and GDP are cointegrated for all three income group countries. The panel causality test results reveal that there is long-run Granger causality running from GDP to EC for low income countries and there is bidirectional causality between EC and GDP for middle income countries.

Payne, 2010 [22] investigated the various hypotheses associated with the causal relationship between electricity consumption and economic growth along with a survey of the empirical literature. The results for the specific countries surveyed show that 31.15% supported the neutrality hypothesis; 27.87% the conservation hypothesis; 22.95% the growth hypothesis; and 18.03% the feedback hypothesis. Tsani, 2010 [28] investigated the causal relationship between aggregated and disaggregated levels of energy consumption and economic growth for Greece over the period 1960–2006 by using Toda and Yamamoto (1995). At aggregated levels of energy consumption empirical findings suggest the presence of a unidirectional causal relationship running from total energy consumption to real GDP. At disaggregated levels empirical evidence suggests that there is a bi-directional causal relationship between industrial and residential energy consumption to real GDP but this is not the case for the transport energy consumption with causal relationship being identified in neither direction.

Belke, Dobnik, & Dreger, 2011 [4] examined the long-run relationship between energy consumption and real GDP, including energy prices, for 25 OECD countries from 1981 to 2007 a bi-directional causal relationship between energy consumption and economic growth. Fuinhas & Marques, 2012 [13] examined the nexus between primary energy consumption and growth in Portugal, Italy, Greece, Spain and Turkey (PIGST) over the period of 1965 to 2009. Their results suggest bidirectional causality between energy and growth in both the long-run and short-run, supporting the feedback hypothesis. Shahiduzzaman & Alam, 2012 [25] investigated the cointegration and causal relationships between energy consumption and economic output in Australia over a period of five decades. They used the single-sector aggregate production function framework for their study, which was the first comprehensive approach used in an Australian study of this type to include energy, capital and labor as separate inputs of production. The empirical evidence points to a cointegration relationship between energy and output and implies that energy is an important variable in the cointegration space, as are conventional inputs capital and labor. They also found some evidence of bidirectional causality between GDP and energy use. Although the evidence of causality from energy use to GDP was relatively weak when using the thermal aggregate of energy use, once energy consumption was adjusted for energy quality, they found strong evidence of Granger causality from energy use to GDP in Australia over the investigated period.

Ahmed & Azam, 2016 [1] tried to investigate the causal nexus between energy consumption and economic growth for 119 countries from all over the world having at-least 30 years of available data on candidate variables, including 30 high income OECD, 13 high income non-OECD, 65 middle income and 11 low income countries. Their study employed Granger-causality in the frequency domain context for empirical analysis, which allows one to examine the causal nexus over different frequencies and thus provides relatively a better picture of the causal nexus between the candidate variables. In particular, they examine the temporary (short-run) as well as at permanent (long-run) causal nexus between energy consumption and economic growth. Their empirical results suggest that 18 countries (including 5 high income OECD, 2 high income Non-OECD, 10 middle income and 1 low income) confirm the existence of feedback hypothesis, 25 countries (including 4 high income OECD, 3 high income non-OECD, 14 middle income and 4 low income) confirm growth hypothesis out of total 119 countries. Similarly, 40 countries (including 6 high income OECD, 6 high income non-OECD, 27 middle income and 1 low income) suggest conservation hypothesis, while, 36 countries (comprising of 15 high income OECD, 2 high income non-OECD, 14 middle income and 5 low income) hold neutrality hypothesis between energy consumption and economic growth out of 119 countries.

Mutascu, 2016 [17] investigated the causality between energy consumption and economic growth in the countries which are members of the Group of Seven (G7), over the period 1970–2012, by following the bootstrap panel Granger causality approach. They found a bi-directional causality between energy consumption and GDP in Canada, Japan and United States. GDP causes energy consumption in France and Germany, while no causality is found for the rest of the sample (i.e. Italy and United Kingdom).

Tang, Tan, & Ozturk, 2016 [27] attempted to analyses the relationship between energy consumption and economic growth in Vietnam using the neoclassical Solow growth framework for the 1971–2011 period. Their results confirm the existence of cointegration among the variables. In particular, energy consumption, FDI and capital stock were found positively influence economic growth in Vietnam. The Granger causality test revealed unidirectional causality running from energy consumption to economic growth.

Coers & Sanders, 2013 [7] investigated the causal relationship between per capita energy use and gross domestic product, while controlling for capital and labor inputs in a panel of 30 OECD countries over the past 40years. Their results reveal a strong unidirectional causality running from capital formation and GDP to energy usage. Turok & McGranahan, 2013 [29] investigated the relationship between urbanization and development for Africa and Asia. Their paper reviews the arguments and evidence for whether rapid urban population growth can help to raise living standards. The main finding is that the development effects of urbanization and the magnitude of agglomeration economies are very variable. There is no simple linear relationship between urbanization and economic growth, or between city size and productivity. The potential of urbanization to promote growth is likely to depend on how conducive the infrastructure and institutional settings are. Removing barriers to rural–urban mobility may enable economic growth, but the benefits will be much larger with supportive policies, markets and infrastructure investments. Cities should use realistic population projections as the basis for investing in public infrastructure and implementing supportive land policies. Governments should seek out ways of enabling forms of urbanization that contribute to growth, poverty reduction and environmental sustainability, rather than encouraging (or discouraging) urbanization per se.

Chen, Zhang, Liu, & Zhang, 2014 [6] investigated the relationship between urbanization and economic growth. They identified the pattern of global change and the correlation of urbani zation and economic growth, using cross-sectional, panel estimation and geographic information systems (GIS) methods. The analysis has been carried out on a global geographical scale, while the timescale of the study spans the last 30 years. The data shows that urbanization levels have changed substantially during these three decades. Empirical findings from cross-sectional data and panel data support the general notion of close links between urbanization levels and GDP per capita. However, they also present significant evidence that there is no correlation between urbanization speed and economic growth rate at the global level. Hence, they conclude that a given country cannot obtain the expected economic benefits from accelerated urbanization, especially if it takes the form of government-led urbanization. In addition, only when all facets are taken into consideration can we fully assess the urbanization process. Zhao & Wang, 2015 [33] investigated the long-term equilibrium relationships, temporal dynamic relationships and causal relationships between urbanization, economic growth and energy consumption in China over the period 1980–2012. Cointegration tests indicate that the variables are cointegrated. Further, vector error-correction model (VECM) indicates that when the short-term fluctuations deviate from the long-term equilibrium, the current changes of energy consumption could eliminate 9.74% non-equilibrium error of the last period, putting back the situation to the equilibrium state through a reverse adjustment. Granger causality results reveal that there is a bi-directional Granger causal relationship between energy consumption and economic growth, and unidirectional causality running from urbanization to energy consumption and economic growth to urbanization. Solarin & Shahbaz, 2013 [26] investigated the causal relationship between economic growth, urbanization and electricity consumption in the case of Angola over the period of 1971–2009. Their results indicate the existence of long run relationships and bidirectional causality between electricity consumption and economic growth. The feedback hypothesis is also found between urbanization and economic growth. Urbanization and electricity consumption Granger cause each other.

3. Estimation Method

In order to investigate the dynamic relationship among urbanization, energy consumption and economic growth in Bangladesh time series data of World Development Indicators 2017 for the period of 1973-2014 have been employed. Percentage of population living in urban areas to the total population has been captured as the process of urbanization, real GDP per capita has been used to represent economic growth and energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. For statistical simplicity and obtaining some desirable statistical properties logarithmic transformation of the variables have been performed. Variables and their descriptions are tabulated inTable-1:

Table 1: Variables and Description

Variables	Description
LNPRGDP	Natural log of real GDP per capita
LNUR	Natural log of urbanization process
LNEC	Natural log of energy consumption

3.1 Unit Root Test

At first, it is important to check whether the series are stationary or not because Nelson and Ploser, 1982 [18] mention that unit root problems exist in most of the time series which may produce spurious results. The series which is stationary at level form is called I(0) and which becomes stationary after first difference is called I(1). There exists several test to check for unit root but among them Augmented Dickey Fuller (ADF) test, which is developed by Dickey and Fuller, 1979 [10], has been employed to test each series in this study. If a series is nonstationary at level form then we take the first difference of that series to check the stationarity and a I(1) series becomes stationary after first difference is taken.

3.2 ARDL Bounds testing approach to Cointegration

Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration is developed by Pesaran, Shin, and Smith, 2001 [23] for empirical works. It has some econometric advantages in comparison to other traditional cointegration techniques. It can be applied if both series are I(0) or I(1) or admixture of both I(0) and I(1) and for small sample size it is superior to that of multivariate cointegration. In this study we actually run three regressions by assuming each of the variables as dependent variable respectively. In Model-1 we use economic growth as dependent variable, in Model-2 urbanization is the dependent variable and in Model-3 energy consumption is the dependent variable.

The error correction model integrates the short-run dynamics with the long-run equilibrium without loosing information about long-run. The error correction model represents one time period lagged error correction term which explains the speed of adjustment from short-run to long-run. The estimated F-Statistic in the bounds test will compare with upper bound value of Pesaran and Pesaran (1997) and Pesaran, Shin, and Smith, 2001 [23]. If the computed F-Statistic is greater than the upper bound value, we can reject the null hypothesis of no cointegration and conclude that there is cointegration among the variables.

3.3 Diagnostic test

After running three regressions we perform diagnostic tests. We use Lagrange multiplier test of residual serial correlation, Ramsey's RESET test using the square of the fitted values to check the correct functional form, Jarque-Bera test to check the normality assumption and ARCH test to check the heteroscedasticity problem. We also plot the cumulative sum and cumulative sum square of the recursive residuals to identify whether any structure break is exists or not and whether our short run and long run parameters are stable or not.

3.4 Pairwise Granger Causality tests

Pairwise Granger Causality tests are also performed in this study to find out the causal relationships among the variables.

4 Results and Discussion

4.1 Results of Unit root test

Find out the order of integration is important for ARDL bounds test approach because for bounds test neither of the variables would be I (2). Table-2 reports the results of ADF test. From Table-2 we observe that the series LNUR is stationary at its level form that means it is I(0) in nature, and the series LNPRGDP and LNEC are nonstationary at their level form, that means they contain unit root, but become stationary at their first difference form, so they are I (1) in nature. Therefore in this study we have admixture of I (0) and I (1) variables.

Table 2: Results of Unit Root Test

Variables	H_0 = Time series is non-stationary Exogenous: Constant and Linear trend			
	in level form		in first difference form	
	Test statistic	Prob*	Test Statistic	Prob*
LNPRGDP	0.495027	0.9989	-13.31354	0.0000
LNEC	-0.42432	0.9831	-8.875779	0.0000
LNUR	-8.00823	0.0000	No need	No need

4.2 Results of Diagnostic test

The diagnostic tests are performed to check the serial correlation, functional form, normality and Heteroscedasticity among the variables in the model.

Table 3: Dignostic Tests Results for Model-1

Test Statistic	LM-Version	F-Version
A-Serial Correlation CHSQ(1)	8.8145 [0.003]	F(1, 36)= 9.5621 [0.004]
B-Functional Form CHSQ(1)	6.5471 [0.011]	F(1, 36)= 6.6481 [0.014]
C- Normality CHSQ(1)	36.2606 [0.000]	Not applicable
D-Heteroscedasticity CHSQ(1)	4.2544 [0.039]	F(1, 39)= 4.5086 [0.040]

Table 4: Dignostic Tests Results for Model-2

Test Statistic	LM-Version	F-Version
A- Serial Correlation CHSQ(1)	18.2679 [0.000]	F(1, 36)= 27.7112 [0.000]
B- Functional Form CHSQ(1)	25.0635 [0.000]	F(1, 36)= 53.2747 [0.000]
C- Normality CHSQ(1)	5.2823 [0.071]	Not applicable
D-Heteroscedasticity CHSQ(1)	18.3128 [0.000]	F(1, 39)= 30.9245 [0.000]

Table 5: Dignostic Tests Results for Model-3

Test Statistic	LM-Version	F-Version
A-Serial Correlation CHSQ(1)	1.2021 [0.273]	F(1, 36)= 1.0874 [0.304]
B- Functional Form CHSQ(1)	1.1825 [0.277]	F(1, 36)= 1.0691 [0.308]
C- Normality CHSQ(1)	0.35392 [0.838]	Not applicable
D-Heteroscedasticity CHSQ(1)	1.0900 [0.296]	F(1, 39)= 1.0652 [0.308]

The results of diagnostic tests are summarized in Table-3 for the estimated Model-1, in Table-4 for the estimated Model-2 and in Table-5 for the estimated Model-3. Lagrange multiplier test of residual is performed to test the serial correlation. The null hypothesis for serial correlation test is that there is no serial correlation and the alternative hypothesis is there is serial correlation. If the null hypothesis cannot be rejected at 5% level of significance then we can say that there is no serial correlation in this model. Ramsey's RESET test are used to check the functional form where the null hypothesis is that the variables in the model have correct functional form. If this null hypothesis cannot be rejected at 5% level of significance this confirms that the variables in the model have correct functional form. The normality test is conducted based on a test of Skewness and Kurtosis of residuals where the null hypothesis is that the data is normally distributed. If the null hypothesis of normality test cannot be rejected at 5% level then we can say that the time series data is normally distributed. Finally ARCH test is used to detect the heteroscedasticity problem in the data set where the null hypothesis is homoscedasticity. If the null hypothesis cannot be rejected at 5% level, then this means there is no heteroscedasticity problem in this model.

From Table 3, 4 and 5 we observe that our estimated Model-1 and Model-2 do not satisfy the conditions of diagnostic test. For this two model, there is serial correlation, functional form is not correct, data is not normally distributed and there is heteroscedasticity problem. Only our third model which is Model-3 is free from serial correlation, functional form is correct, data is normally distributed and there is no heteroscedasticity problem. For this reason we select Model-3 to investigate the relationship among energy consumption, real per capita GDP and urbanization.

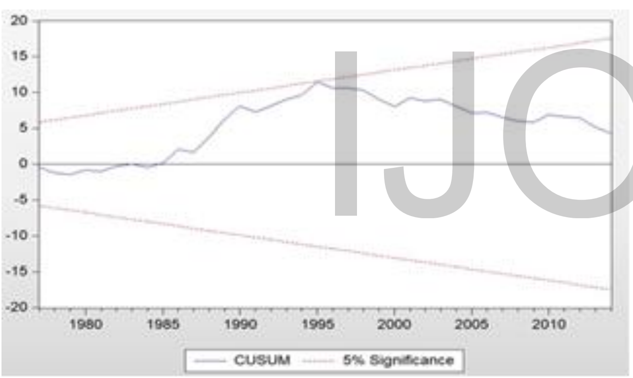

Fig. 1. Plot of CUSUM

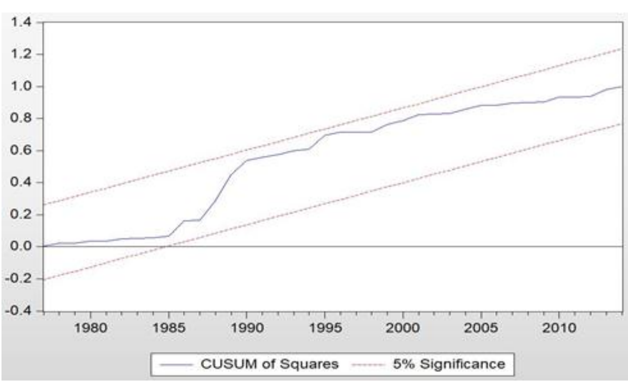

Fig. 2. Plot of CUSUM Square

To test the stability of the short-run and long-run parameters cumulative sum (CUSUM) of recursive residuals and cumulative sum of squares (CUSUMSQ) of the recursive residuals have been used. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) of the recursive residuals for the estimated Model-3 are presented in Figure-1 and Figure-2, respectively. From figure 1 and 2 we observe that the plot of CUSUM and CUSUMSQ are within the bounds and significant at 5% level. This ensures the stability of the long-run and short-run coefficients and there is no structural break.

2.2 Results of Bounds test

There are two steps in ARDL bounds test. In the first step we run unrestricted VAR model and get the maximum lag length which is selected by Schwarz Criterion (SC) in this study. From VAR lag order selection criteria we get the maximum lag which is 1. Then using Schwarz Bayesian Criterion (SBC) we get our desired ARDL model which we found ARDL (1, 0, 0, 0). Then we go for check the long-run association among the variables by bounds test. The results of bounds test are represented by Table-6. Here the calculated F-statistic is 14.79433 which is greater than the upper bound 3.99 of 1% level of significance. Therefore the null hypothesis of no cointegration is rejected at 1% level and alternative hypothesis of cointegration is accepted, that means our variables under consideration, energy consumption, real GDP per capita and urbanization, are cointegrated, that means in the long run they will go together.

Table 6: Results of ARDL Bounds Test

Critical Value	F-Statistic 14.79433	
	Lower Bound	Upper Bound
90%	1.99	2.94
95%	2.27	3.28
97.5%	2.55	3.61
99%	2.88	3.99

2.2 Long-run and Short-run results

As energy consumption, real GDP per capita and urbanization are cointegrated, now the long-run relationship among them can be estimated. Here LNEC is the dependent variable and others are the explanatory variables.

Table 7: Long-run Results

ARDL(1, 0, 0) selected based on Schwarz Bayesian Criterion Dependent Variable LNEC 41 observations used for estimation from 1974 to 2014			
Regressor	Coefficient	Standard Error	T-Ratio (prob)
LNPRGDP	0.74123	0.04961	14.9428 (0.000)
LNUR	0.1334	0.042899	3.1095 (0.004)
CONSTANT	-0.06899	0.20162	-0.34219 (0.734)

The long-run results of the model is presented in Table-7. In the long-run one percent increase in real per capita GDP, on average, will cause to increase energy consumption by 0.74123 percent and one percent increase in urbanization will cause to increase energy consumption by 0.1334 percent on average. This implies that in the long energy consumption will increase with the incraese in real per capita GDP and urbanization process.

Now the results of short-run dynamics are reported in Table-8. The estimated results for the short-run reveal that one percent increase in real per capita GDP, on average, will cause to increase energy consumption by 0.40 percent in the short run and one percent increase in urbanization process will cause to increase energy consumption by 0.0721 percent on average. The negative and statistically significant value of ECM_{t-1}, -0.54034, leads to support a long-run relationship among the series in case of Bangladesh. The coefficient is statistically significant at 1% level and the significant value of ECM shows the speed of adjustment from short-run to long-run equlibrium. In this model the short-run deviations from the long-run equilibrium are corrected by 54.034% toward long-run equilibrium path each year.

Table 8: Short-run Results

ARDL(1, 0, 0) based on Schwarz Bayesian Criterion Dependent Variable dLNEC 41 observations used for estimation from 1974 to 2014			
Regressor	Coefficient	Standard Error	T-Ratio (prob)
dLNPRGDP	0.40052	0.10830	3.6982(0.001)
dLNUR	0.0721	0.03066	2.3512(0.024)
dCONS	-0.03728	0.10566	-0.35282(0.726)
ECM(-1)	-0.54034	0.15162	-3.5639 (0.001)
R-Squared 0.32501 R-Bar-Squared 0.27028 S.E. of Regression 0.02203 F-stat. F(3, 37) 5.7882 (0.002) Mean of Dependent Variable 0.021381 S.D. of Dependent Variable 0.02524 Residual Sum of Square 0.017958 Equation Log-likelihood 100.3564 Akaika Info. Criterion 96.3564 Schwarz Bayesian Criterion 92.3634 DW-statistic 2.1787			

2.2 Results of Pairwise Granger Causality test

The results of pairwise Granger Causality test are represented in table 9. From pairwise Granger causality test results we find that there is a unidirectional causality running from real per capita GDP to energy consumption. This means although economic growth Granger causes energy consumption but energy consumption does not Granger causes economic growth in the context of Bangladesh. One probabale reason behind this may be that althogh recently Bangladesh experiences a rapid economic growth but energy consumption is still much lower than necessary. Access to energy, more specifically accesss to electrity is not available for all. Moreover, number of hours lost in production due to lack of energy or loadshadding is considerable. For this reason energy consumption does not causes economic growth in Bangladesh and also for similar reasoning there is no causal relationship between urbanization and energy consumption. If all people are covered access to electricity and there is no loadshadding and if more energy is produce then may be energy consumption can be able to accelarate economic growth in Bangladesh.

Table 9: Reseults of Granger Causality Test

Null Hypothesis:	Obs	F-statistic	Prob.
D(LNPRGDP) does not Granger causes D(LNEC)	40	0.42350	0.0194
D(LNEC) does not Granger causes D(LNPRGDP)		0.61319	0.5473
D(LNUR) does not Granger causes D(LNEC)	40	1.05683	0.3584
D(LNEC) does not Granger causes D(LNUR)		0.22192	0.8021
D(LNUR) does not Granger causes D(LNPRGDP)	40	0.94777	0.3973
D(LNPRGDP) does not Granger causes D(LNUR)		1.42745	0.2535

Moreover we also find that there is no causal relationship between urbanization and economic growth in Bangladesh. This implies that urbaniation is not the necessary condition of economic growth and this findings is relevant with some other empirical works conducted based on the data of Latin American countries where urbanization process is very high but economic growth is not sufficient.

4 Conclusion and Recommendation

The results of Granger causality tests provide us different results than our theory, which suggest that there exists no naxus between urbanization and economic growth, and energy consumption and economic growth in the context of Bangladesh. Sometimes we get unsatisfactory results from Granger Causality test due to the unavibility of good data. But it's also true that without urbanization, economic growth can acccelerate or sometimes high rate of urbanization process doesnot accelerate economic growth. So, it ultimately depends on whether the urbanization process is planned and whether positive externalities of urbanization are sustainable or not. If the urbanization process is unplanned and the negative externalities of urbanizations are much strong then it's become very hard for a country to accelerate economic growth by increasing the rate of urbanization process. At the same time energy use can enhance economic growth if energy is used mainly to establish a robust manufacturing sector by providing nonstop required energy. But if energy is used highly in the unproductive sector, then high energy use does not foster economic growth. So policy makers must have to be concerned of this type of findings. Moreover, why urbanization and energy consumption do not Granger causes economic growth would be the topics of further study. From this study we come in the end by concluding that probably the process of urbanization is not in the exact track of planned urbanization and may be good share of energy are used in Bangladesh in the unproductive sector and industrial sector does not get their required energy, that's why urbanization and economic growth do not Granger causes economic growth in the context of Bangladesh.

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