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Do Savings and Income affect energy consumption? An Evidence from G-7 countries.

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Abstract

The article investigates the relationship between the energy consumption, gross domestic savings and gross domestic income of G7 countries by using the time series data from 1970-2012. The study employs the recently developed ARDL- bounds testing approach. The article finds there is strong evidence that growth rate of income, gross domestic savings play a stronger role in determining the short run and long run behavior of energy consumption per capita in G7 countries. The empirical results suggested that in most of the countries the relationship of consumption per capita and gross domestic income is positive, that means when the income rises the consumption will also rise but not necessarily at the same rate, which is in accordance with theory of Keynes of marginal propensity to consume, confirming the absolute income hypothesis. On the other hand the gross domestic savings has a negative relationship with the energy consumption per capita which confirms the same relationship of consumption as the function of difference of income and savings in long run. The Parameters of error correction terms in USA and France are -0.4283 and -0.6190 represents the speed of adjustment is very high and it would return back to the equilibrium level very quickly. While countries like Canada, Germany, and Great Britain are having the parameters of the error correction term as -0.0794, -0.2205, and -0.0867 suggests speed of adjustments is fairly very small and would take time to return to its equilibrium position. While the error correction coefficient in case of Japan is equal to -1.0183, and also statistically significant showing that convergence is more elastic. The study suggests that although Japan, Italy, USA, France are more industrially advanced countries as production is mostly based on industries. The income generated on the basis of the energy consumption in their industries may be used as forced savings to further boost the economy that will definitely affects their growth performance positively in the long run. The reliability and validity of the estimations results are confirmed by the diagnostics tests.

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1. Introduction

The savings and income play a vital role in the development of any economy. The industrialized nations are predominantly depending on the income and savings. The economic theories have more emphasized the role of savings and investment in the economy that economic growth heavily depends on saving and investment. Harrod-Domar growth model emphasized the role of economic growth of a country mostly depends on incremental capital-output ratio, savings rates or and investment. The higher saving rates in any country implies positive economic growth and thus raising per capita income. The empirical evidences from the literature strongly support the rate of savings to achieve a higher level of per capita income. The industrialized nations mostly emphasized on saving and reinvestment which improves the per capita income and thus improving the standard of living. Most of the studies have been conducted in the past about the saving rates and economic growth. It is argued in the literature that the country's whose economy is developing, at the same time the rate of savings is also increased. Thus it was observed that savings and economic growth are strongly correlated. They further argued that the rapid economic developing countries have a positive impact on economic growth and thus contributing to the rise per capita income. But on the other hand the countries whose savings rate is very low results in steady development. The rest of the article is organized as follows. Section 2 highlights brief literature review. Section 3 elucidates the data and model specification. Section 4 explains econometric methodology. Section 5 outlines the empirical results. Finally section 6 concludes.

2. Brief Literature Review

Sheng et al. (2015) has argued in his study about the global imbalances from the perspective of savings and inequality. The causal study was conducted in order to find the impact of income inequality on the economic performance on one hand while on the other hand the causality relationship between savings imbalances and economic stability. It was observed that the savings and inequality was correlated positively. However at the same time the relationship becomes negative when the household who cannot save a part of their income borrows savers funds for consumption. The findings of the study were to reduce the income inequality to mitigate global imbalance. Another study was conducted in order to find the impact of households' savings in the Indian economy. The domestic savings promotes the capital accumulation which in turn helps in contributing to achieve a high economic growth. The estimated results revealed that the house hold savings in India is having statistically significant relationship with GDP, dependency ratios, interest rates, and inflation both in long-run and short-run(Samantaraya & Patra, 2014). The studies conducted by Hufner & Koske (2010) on G7 countries to empirically explain the household savings rates with implication for Germany. They analyzed whether the factors common to other industrial countries can better help to explain the behavior of savings for the German house hold. They argued that income development, real interest rate, inflation are influencing in most countries. Besides these factors they found the stocks prices were influencing the household savings rate positively after 1990. The results of the study suggested that the equilibrium saving rate has moved upward because of the decline in the stock prices. Edwards et al. (1996) conducted a study based on the savings of the Latin Americans that they were so low. The study was conducted by using the data from 36 different countries. A difference in public and private savings were made in such that the latter were determined endogenously by the economic and political variables. The most important element contributing to the public and private savings was the growth per capita income. The political instability was considered as the main reason of having low public savings in these countries. The savings of the Latin Americans are low because of the magnitude of their factors rather than the structural differences. AbuAl-Foul et al. (2010) empirically examined the relationship between real gross domestic savings and real gross domestic product in Tunisia and Morocco by using ARDL. The findings revealed that a long run relationship exists between the variables while no log run relationship was found in Tunisia. The bidirectional causality between economic growth and saving growth was found in Morocco, but a unidirectional causality was found from saving growth to economic growth. Sirisankanan et al.(2015) studied the consumption soothing mechanism of the Thai agricultural households.

The study found that when there is an income shock, most of the households they heavily depend on savings for smoothing their consumption. They further argued that there was little or no evidence that the households depends on borrowing or for opting extra work to counteract income shock. The saving had a positive significant relationship with income, whereas the house holds never respond to the future income uncertainty by an extra work of borrowing. Ajmi & Nguyen (2013) confirmed the causal relationship between income and energy consumption in G7 countries. The Hiemstra- John test was applied to predict the causality direction. The results revealed that unidirectional causality was found running from energy consumption to GDP for United Kingdom, while bi directional causality was found in Japan, France, Canada, and United States. On other hand Kyrstou-Labys non-linear causality test revealed that a unidirectional causality was found in France and United Kingdom and the direction of causality for Germany was from energy consumption to GDP and from GDP to energy consumption. Soytas & Sari (2006) in their study stated that several industrialized develop countries have agreed to sign the Kyoto Protocol, which was aim to reduce the greenhouse gasses emission. To mitigate such emissions several policy were developed to support and help in reduction of greenhouse gasses emissions. They mainly include the reduction of energy consumption, reducing the intensity of energy; abundance forestation may sufficiently help in reducing the green houses gas emission. They argued the policy may differ on the basis country specific factors. The study analyzed the impact of energy consumption over income for G7 countries. They employed granger causality to predict the direction of income and energy consumption and a multi-variate cointegration generalized variance decomposition. The results were mixed for different countries and direction of causality was different in all G7 countries. The study however suggested that the G7 countries are at the same level of economic development still different policy protocol may be needed for each country. Ozturk, Aslan, & Kalyoncu (2010) conducted a study by utilizing Panel data for 51 countries for both energy consumption and economic growth (GDP). These countries were categorized into three groups on the basis of income distribution. Low income group, low middle income group and upper middle income group. They use Pedroni et al. (1999) for panel co-integration method to establish a relationship between the economic growth and the energy consumption, and found co-integration for all three income group countries. Secondly the causality test was applied to find the direction of causality between the economic growth and energy consumption. The panel causality test revealed that for low income countries long run causality was observed from GDP to energy consumption and for middle income countries there is bi directional causality between energy consumption and GDP. But no strong relationship was observed between economic growth and energy consumption. The finding suggested further prospect research in the area mentioned above. Ayalew et al.(2013) conducted a study on determinants of domestic savings. The ARDL model was used to determine both the long run and short run determinants of the savings. The estimated result showed that growth rate of income, budget deficit ratio and inflation rate, were statistically significant in both long-run and short run. But financial debt, interest rate, and current account deficit ratio were insignificant determinants of gross domestic savings in the long run. However in the short run both financial debt and interest rate were significant enough to explain the change in savings.

3. Methodology of the Study

3.1. Data

The bivariate frame work includes the Energy consumption in Kg of oil equivalent per capita, Gross domestic savings in current US dollars, and gross domestic income in constant local currency unit. Data set covers from 1970-2012 periods and was collected from the World Bank, 2015.As the data has been taken for 42 years for all the three variables to ensure that it is adequate enough for cointegration analysis.

3.2. Model Specification

Voluminous literature is available on the energy consumption. Majority of the studies have been conducted on the energy consumption and its relation with the economic growth by using different econometric approaches. However, to the extent of our knowledge no study has been conducted on energy consumption and its impact of

savings and income. The bivariate regression model includes the energy consumption per capita, gross domestic savings and gross domestic income. The G-7 country was selected on the basis of tremendous growth in their overall economies, including industrial growth and foreign trade. The industrial characteristic of G7 countries tends to contemplate, whether there is any effect of energy consumption over savings and income. The impressive economic growth of G-7 countries, over the past three decades, is majorly linked with its incredible industrial growth. As a result, it appears to be an interesting and valuable source of empirical study, spread in different parts of the world including Europe, Asia, and United States of America, to add some more valuable knowledge to the literature. From the above discussion the equation may be written in logarithms as

$$lnEN = \alpha_0 + \alpha_1 lnGDS + \alpha_2 lnGDI + \varepsilon_t \qquad (1)$$

Where EN represents the energy consumption per capita, GDS represents gross domestic savings and GDI represents Gross domestic income. The expected sign of α_1 may be negative, while the sign of α_2 must be positive. The ARDL bound approach of estimation was applied for cointegration as proposed by Pesaran et al. (2001).

4. Estimation Methodology

4.1. Unit Root

The selection of the most appropriate unit root test is very difficult when it comes in practice. To improve the robustness of the selected variables Energy consumption in Kg of oil equivalent per capita, Gross domestic savings in current US dollars, and gross domestic income in constant local currency unit, several unit root tests exists, like Philips Peron, Augmented Dickey Fuller test. Enders (1995) recommended the use of both unit root tests i.e. the augmented Dickey Fuller tests (1981) and the Philips–Perron (PP) test (1988). The use of two tests is to ensure the robustness of our estimations. In order to test the stationarity of the data the two tests i.e., Augmented Dickey Fuller test and Philips Perron are widely used.

4.2. Bound Test of Cointegration

The methodology used in this article is based on ARDL-bounds testing approach, developed by Pesaran *et al.* (2001). The ARDL bonds test can be performed by using the F- statistics or Wald test to check the significance of the lagged levels of variables. According to Pesaran et al. (2001) the ARDL model best works in small sample size in time series data. To perform the ARDL bound test can be performed in three steps. The long run cointegration is estimated among the variables in the first step. F-test can be used to check the long run cointegration among the estimated variables in the model. A joint significance test can be done by using wald test in which the lagged coefficients are equal to zero. (Tang, 2003). The Wald test or the joint test of significance is used in the case when we are having more the one lagged coefficients. The F test or Wald test is utilized to determine the long relationship by comparing with the critical values given in the Pesaran et al.(2001).

$$\Delta lnEN_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1i}\, \Delta lnEN_{t-i} + \sum_{i=1}^{n2} \beta_{2i}\, \Delta lnGDS_{t-i} + \sum_{i=1}^{n3} \beta_{3i}\, \Delta lnGDI_{t-i} + \lambda_1\, lnEN_{t-1} + \lambda_2\, lnGDS_{t-1} + \lambda_3\, lnGDI_{t-1} + vt \qquad (2)$$

Where v is an error term and Δ shows the first difference. EN is the energy consumption per capita GDS is the gross domestic savings; GDI is the gross domestic income.

The Wald test of joint significance is performed and the calculated F-statistics value is compared with both the upper bound and lower bound critical values by Pesaran et al. (2001) at (1%, 5%, 10%) significance level. The tabulated Pesaran et al. (2001) presents values whether the model contains intercept and/or a trend or restricted intercept. The tabulated critical value consists of both upper and lower bound values consisting of all the possible categorizations of the variables into *I* (0), *I* (1) or mutually cointegrated. If the value of the estimated F-statistics is higher than both the

upper and lower bound critical values, then it rejects the null hypothesis of no cointegration, implying that there is cointegration among the estimated variables in the model. If the estimated F-statistics value lies in the middle of lower and upper bound of the critical values, then the decision is inconclusiveness. If the F-statistics values falls below the lower bound value, which implies that the variables in the estimated model are not cointegrated.
Proceeding to the second step depends on the first step after finding a long run relationship among the variables. Then the long run elasticity and their coefficients is determined in the next step. The ARDL approach allows us to estimate simultaneously the short run and the long run effects of one variable over the other.

$$ln(EN)_t = \propto_1 + \sum_{i=1}^{p} \emptyset 1_i \, ln(EN)_{t-i} + \sum_{i=1}^{p} \beta 1_i \, ln(GDS)_{t-i} + \sum_{i=1}^{p} \gamma 1_i \, ln(GDI)_{t-i} + \mu_t \qquad (3)$$

From equation 4, the short run elasticity's are estimated. The difference coefficients of variables represents the short run elasticity. The confirmation of the long run relationship among the estimated variable implies, that an error correction representation exists. The signs of the Error correction coefficients must be negative and significant and the coefficient value should be between zero and one shows to convergence of the dynamics to the long run equilibrium after a short run shock.

$$\Delta lnEN_t = \gamma_0 + \sum_{i=1}^{p1} \gamma_{1i} \, \Delta lnEN_{t-i} + \sum_{i=1}^{p2} \gamma_{2i} \Delta lnGDS_{t-i} + \sum_{i=1}^{p3} \gamma_{3i} \Delta lnGDI_{t-i} + \varphi EC_{t-1} + \vartheta t, \quad (4)$$

Where EC_{t-1} is the error correction term defined as Where ϑ is an error term, and φ represents the speed of adjustment. When there is more than one coefficient of the short run elasticity of a particular variable, then Wald test is used to check their joint significance. To determine the best fit of the ARDL model, various diagnostics and model stability tests are performed. The diagnostics tests examine serial correlation, heteroscedasticity tests, Jarque-Bera Normality test, and correlogram of residuals to find the presence of autocorrelation at lags. The structural stability of the model is evaluated by performing the Ramsey Reset test.

5. Empirical Results and Analysis

5.1. Unit Root test for Stationarity

The unit root tests were conducted for the estimated variables both at level and first difference by using the Schwarz information criterion to select the optimum as recommended by (Pesaran and Shin, 1997). Table 1shows the summary of ADF unit root test in which all the variables are non-stationary at 5% level of significance. However, they all become stationary by taking the first difference. The same results were confirmed by PP test. A summary of PP test is given in table 2. So therefore it can be concluded that all the variables in the estimated model are non-stationary at level, but they become stationary by taking the first difference. None of the variable is *I* (2).

Table 1. Augmented Dickey Fuller unit root test results for Stationarity of variables

Country (sample period)	ADF-test level		ADF- test First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Canada (1970-2012)				
LEN	-3.2458**	-2.9667	-5.0669***	-5.3652***
LGDS	-1.5321	-3.0267	-5.8875***	-5.9096***
LGDI	-1.5626	-2.7276	-5.2319***	-5.3335***
France (1970-2012)				
LEN	-2.1762	-1.3496	-6.9087***	-7.4377***
LGDS	-2.3093	-3.2533*	-4.6822***	-4.8926***
LGDI	-2.1409	-1.7197	-4.1867***	-4.7347***
Germany (1970-2012)				
Len	-1.7895	-2.7175	-4.0894***	-4.3365***

LGDS	-1.7148	-2.0341	-4.1804***	-4.8814***
LGDI	-2.2719	-0.8616	-4.6375***	-4.9520***
Great Britain(1970-2012)				
LEN	-0.3946	-0.8767	-3.8041***	-7.3124***
LGDS	-5.0532***	-2.9589	-3.8029***	-6.2567***
LGDI	-0.6480	-2.8300	-4.3539***	-4.3187***
Italy (1970-2012)				
LEN	-1.6587	-0.3141	-6.3527***	-6.9811***
LGDS	-2.4426	-2.2325	-4.4496***	-4.8621***
LGDI	-3.4580**	0.9736	-3.8874***	-5.9136***
Japan (1970-2012)				
LEN	-2.1781*	-0.5886	-6.0139***	-6.5628***
LGDS	-3.4712**	-1.2090	-4.3903***	-5.3281***
LGDI	-2.9052*	-0.1706	-3.7063***	-5.0459****
USA (1970-2012)				
LEN	-1.7292	-2.3199	-4.6570***	-4.8102***
LGDS	-2.7203*	-1.8495	-6.3376***	-7.0640***
LGDI	-1.2107	-1.9349	-4.5868***	-4.7089***

Note: (i) The E-Veiws 9 has been used for performing the unit root tests. (ii) The Augmented Dickey Fuller unit root test was performed both at level and first differenced (intercept, and both the trend and intercept) (iii) The automatic lag selection has set 9 maximum lags by using the Schwarz info criteria (SIC). (iv)*, **, *** represents significant at 10%, 5%, and 1%.

Table 2. Philips Perron (PP) unit root test results for Stationarity of variables

Country (sample period)	PP-test level		PP- test First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Canada (1970-2012)				
LEN	-2.739*	-1.9151	-3.8934***	-4.2615***
LGDS	-1.7560	-2.9299	-6.0225***	-6.0527***
LGDI	-1.4945	-2.7276	-5.2007***	-5.2878***
France (1970-2012)				
LEN	-2.2951	-1.2326	-7.1036***	-8.3219***
LGDS	-2.1922	-2.4590	-4.6078***	-4.1892***
LGDI	-3.2341	-1.8936	-4.0836***	-4.5585***
Germany (1970-2012)				
Len	-1.7679	-2.6477	-6.9541***	-7.8598***
LGDS	-1.0670	-2.0341	-4.6654***	-4.6921***
LGDI	-2.2459	-1.0416	-4.5075***	-4.7764***
Great Britain(1970-2012)				
LEN	-0.3842	-0.8428	-7.0524***	-7.3033***
LGDS	-2.3096	-1.9530	-4.4584***	-4.6395***
LGDI	-0.7810	-1.9149	-4.1095***	-4.0645***
Italy (1970-2012)				
LEN	-1.6593	-0.0705	-6.4126***	-6.9464***
LGDS	-2.9095	-1.4119	-4.2287***	-5.6057***
LGDI	-3.7419***	1.2527	-4.0911***	-5.9144***
Japan (1970-2012)				
LEN	-2.1906	-0.4744	-6.0028***	-6.5628***
LGDS	3.2688**	-1.2434	-4.3903***	-5.2603***
LGDI	-3.8991***	-0.2626	-3.6240***	-5.0459***
USA (1970-2012)				
LEN	-1.2706	-1.8387	-4.5219***	-4.6539***
LGDS	-5.3683***	-1.7357	-6.3374***	10.3622***
LGDI	-1.4768	-1.3131	-4.3840***	-4.4782***

Note: (i) The EVeiws 9 has been used for performing the unit root tests with Newey-West using Bartlett Kernel.. (ii) The Phillips-Perron unit root test was performed both at level and first differenced (intercept, and both the trend and intercept) (iii)*, **, *** represents significant at 10%, 5%, and 1%.

In the next step, the long run relationship can be ascertained by using F-test proposed by Pesaran et al. (2001). Table 3 reveals the results of computed F-statistics which has been compared with the F- critical values from Pesaran et al. (2001).

Table 3. Results of Bound test to Co-integration

Countries	F-Statistics	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
		10%		5%		1%	

Canada	6.14***	2.63	3.35	3.1	3.87	4.13	5
France	5.72**	3.38	4.02	3.88	4.61	4.99	5.85
Germany	4.15**	2.63	3.35	3.1	3.87	4.13	5.00
Great Britain	4.85**	2.63	3.35	3.1	3.87	4.13	5.00
Italy	7.09***	2.63	3.35	3.1	3.87	4.13	5
Japan	12.05***	3.38	4.02	3.88	4.61	4.99	5.85
USA	6.37***	3.38	4.02	3.88	4.61	4.99	5.85

The above table shows the different F-statistics values for different countries at different optimal lags by using AIC computed by using Eviews 9 along with the CV from Pesaran et al. (2001) .
** represents 5% significance level.
*** represents 1% significance level.

The estimation showed that for all G-7 countries, the computed F statistics is greater than both the F-lower and F-upper critical values suggesting the existence or the presence of long run relationship between the variables. It suggests that, the Energy consumption per capita, gross domestic savings and the gross domestic income, are cointegrated and are having long run relationship. This implies that all the variables move together in long run.
The long run coefficient can be estimated by using equation 3. The AIC[†] criterion is used to select the optimum lag. The third column of the table represents the ARDL models selected on the basis of AIC. The table represents the estimated long run coefficients of the independent variables for all G7 countries. Table 4 clearly showed that increase in Gross domestic savings, *lngds*, contributes to decrease in energy consumption per capita pattern in most of the countries except for Great Britain, Canada and France in which the coefficients of *lngds*, are statistically insignificant, hence have no effect. In case of other countries, more precisely a 1% rise in savings leads to -0.12% to -1.38% decrease in energy consumption. The results are consistent as were expected according to the equation and signs that is applicable in the long run, in which consumption is the function of difference of income and savings.

Table 4. Estimation results using the ARDL approach

Dependent Variable: LnEN							
Country	Sample	AIC-Based ARDL	Trend	Constant	LnGDS	LnGDI	EC_{t-1}
Canada	1970-2012	ARDL(2,0,1)	-	-11.6012 (23.0729)	-0.6247 (0.7500)	1.3156 (1.5194)	-0.0794*** (0.0149)
France	1970-2012	ARDL(1,5,2)	-0.0347*** (0.0058)	-25.2734*** (4.997)	0.0979 (0.0589)	1.6933*** (0.2966)	-0.6190*** (0.1224)
Germany	1970-2012	ARDL(1,2,2)	-	0.5056 (9.5693)	-0.2247 (0.1731)	0.4877 (0.4985)	-0.2205*** (0.0825)
Great Britain	1970-2012	ARDL(1,1,1)	-	15.8272 (10.2066)	-0.0014 (0.2029)	-0.2851 (0.5258)	-0.0867*** (0.0189)
Italy	1970-2012	ARDL(3,7,7)	-	-60.7803*** (23.3066)	-1.3792** (0.6485)	3.7725*** (1.4378)	0.1628 (0.1050)
Japan	1970-2012	ARDL(1,9,9)	-0.0704*** (0.0074)	-145.7091*** (20.5874)	-1.1436*** (0.1392)	5.4883*** (0.5741)	-1.0183*** (0.2365)
USA	1970-2012	ARDL(5,1,0)	-0.0318*** (0.0057)	-10.2027*** (2.2636)	-0.1223*** (0.0399)	1.2359*** (0.2292)	-0.4283*** (0.0001)

NOTE:** represents 5% significance level.
*** represents 1% significance level .

The sign of the variable *lngds* is negative in most of the countries that are having significant coefficients as expected. Table 4 illustrates the coefficient of gross domestic income, *lngdi*, is statistically significant and has positive signs as expected. Regarding gross domestic income the result suggests that rise in gross domestic income can lead to an increase in the energy consumption per capita of most countries which is in accordance with the findings on the basis of consumption as the function of difference of income and savings. The coefficient of *lngdi* in case of Great Britain, Germany and Canada is statistically insignificant and has no effect on the energy

[1] The AIC criterion was selected because as W. Ender (2010) suggested that AIC performs better in small samples then SBC.

consumption. But as whole in other countries, if the Gross domestic income increases by 1%, then the energy consumption per capita will rise by 1.23-5.48%. But the estimated coefficient of Canada is zero, which means that Canada is having even no long run relationship between the energy consumption and savings. Our results further showed that the estimated coefficients of each country's constant term is significant and negative in case of France, Italy, Japan, and USA. The trend estimated for Japan, France and USA is statistically significant and negative. The findings showed that the savings are having negative relationship with the energy consumption per capita followed by the gross domestic income which is having a positive relationship in most of the countries which is in accordance with the long run equation of consumption as the function of difference of income and savings The positive relationship of consumption with gross domestic income which is in accordance with theory of Keynes of marginal propensity to consume, confirming the absolute income hypothesis. The confirmation of long run relationship among the estimated variables indicates the representation of an error correction. If the error correction term is negative and smaller then unity in absolute term, so indicating the estimated model is stable enough to converged back to its original state after shock run shock. This condition is satisfied in Canada, France, Germany, Great Britain, and U.S.A. This means that deviation from the long term equilibrium is corrected within year. The correction of dis equilibrium following a short run shock back to the equilibrium depends upon the speed of adjustment. The estimated coefficients of the error correction term are also presented in the table 4. As it can be seen from the table, that except for Italy and Japan, the coefficients of error correction terms are negative, and in absolute value smaller then unity. The Parameters of ECT in USA and France is -0.4283 and -0.6190 respectively. Its suggests that deviation from the long run equilibrium after a short run shock is adjusted more quickly as half in a year. The coefficient of ECT in countries like USA and France the adjustment speed is very high resulting in returning back to the equilibrium level very quickly as compared to other countries. While countries like Canada, Germany, and Great Britain are having the parameters of the error correction term as -0.0794, -0.2205, and -0.0867 respectively. The findings suggest that the system is stable enough to get back to the steady state, if the system is ever shocked. The values of coefficients is very low revealing that the speed of adjustments is fairly very small and would take time to return to its equilibrium position. While the error correction coefficient in case of Japan is equal to -1.0183, and also statistically significant showing that convergence is more elastic. Any deviation from the long run equilibrium after a short run is almost corrected completely. It means the speed of adjustment from the last year's disequilibrium in energy consumption behavior to the present period's equilibrium is 100%.

The reliability and validity of our estimations results, can be confirmed by performing the diagnostic tests. The relevant diagnostics tests include Breusch-Godfrey serial correlation LM test, Jarque-Bera normality test, Breusch-Pagan-Godfrey and Arch tests for heteroscedasticity. The results of all the diagnostic tests are reported in Table 5. From the table it is evident that all selected countries pass all the diagnostic tests. The normality behaviours of the estimated residuals were confirmed by the Jerque-Bera statistics. No country has got any problem with the LM test for serial correlation. The ARCH test in our estimations confirms that the residuals are white noise and homoscedastic. There is absence of autocorrelation at any by viewing the Q statistics. This implies that the residuals are white noise. The diagnostic tests further strengthen the reliability of our findings and estimation results.

Table 5. Diagnostic tests for estimated ARDL model

Test	**Canada**	**France**	**Germany**	**Great Britain**	**Italy**	**Japan**	**USA**
χ^2_{SC}	0.5657 (0.7536)	0.4316 (0.8059)	0.4443 (0.8008)	1.9809 (0.3714)	5.3449 (0.0691)	1.1607 (0.5597)	1.0551 (0.5900)
χ^2_{N}	1.5615 (0.4580)	4.5089 (0.1049)	0.3271 (0.8490)	0.0969 (0.9527)	1.1353 (0.5668)	4.1561 (0.1251)	0.3491 (0.8398)
χ^2_{H}	3.6268 (0.8891)	7.6872 (0.7410)	2.9376 (0.8907)	10.1210 (0.0719)	21.5051 (0.3096)	14.2592 (0.8920)	13.8903 (0.1263)
χ^2_{AR}	1.5155 (0.2183)	0.9235 (0.3365)	0.7408 (0.3894)	0.0357 (0.8500)	0.0446 (0.8327)	0.1503 (0.6982)	0.6158 (0.4326)
Ramsey reset F-statistics	0.3523 (0.5565)	0.0319 (0.8595)	0.6955 (0.4105)	0.0093 (0.9234)	1.5365 (0.2342)	4.3191 (0.0644)	0.1825 (0.6725)

NOTE: χ^2_{SC}, χ^2_{N}, χ^2_{H}, and χ^2_{AR} are the Lagrange multiplier value for serial correlation, normality test based on Kurtosis of residuals and skewness, Arch tests for heteroscedasticity based on the regression of squared residuals on squared fitted values respectively. Ramsey's RESET test using the square of the fitted values. The numbers in the brackets is the P-Values.

Furthermore we conduct Ramsey reset test functional-form misspecification, stability for each country and confirm the existence of cointegration relationship from the EC term's estimated coefficients. In Ramsey reset test the F values are taken into the account to confirm the stability of the functional form of the model. As the results in the table showed that all the countries passes the stability tests. The functional form confirmed the models stability.

6. Conclusion

This study aims at investigating the relationship between the energy consumption per capita, gross domestic income and gross domestic savings for G7 countries using the time series data from 1970 to 2012. The empirical method implied in the study was recently developed bound testing approach to cointegration developed with in Auto regressive distributive lag. (ARDL) frame work and ECM to analyze the presence of long run relationship between energy consumption per capita, gross domestic savings and gross domestic income. The results provide strong evidence that gross domestic income, gross domestic savings and energy consumption are cointegrated in all G7 countries. The empirical results suggested that in most of the countries the relationship of consumption per capita and gross domestic income is positive, that means when the income rises the consumption will also rise but not necessarily at the same rate, which is in accordance with theory of Keynes of marginal propensity to consume, confirming the absolute income hypothesis. On the other hand the gross domestic savings has a negative relationship with the energy consumption per capita which confirms the same relationship of consumption as the function of difference of income and savings in long run. Results reveal that energy consumption function in Italy, Japan, United States of America, and France has been more successful in explaining the changes income with respect to their savings. The study suggests that although France, Canada, USA, Germany are industrially advanced countries as production is mostly based on industries. The income generated on the basis of the energy consumption in their industries may be used as forced savings to further boost the economy that will definitely affects their growth performance positively in the long run.

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