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The Nexus between Energy Consumption and Financial Development with Asymmetric Causality Test: New Evidence from Newly Industrialized Countries

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ABSTRACT: In this study, the relationship between energy consumption and financial development is investigated via Hatemi-J asymmetric causality test (2012) which is able to separate positive and negative shocks in analysis. In order to determine different dimensions of financial system, deposit money bank assets to GDP (dbagdp), financial system deposits to GDP (fdgdp) and private credit to GDP (pcrdbgdp) were used as three different indicators. As a result of this study on Newly Industrialized 7 Countries spanning the period 1971 till 2010, both positive and negative shocks existed for Malaysia and Mexico, causality from energy consumption to financial developments emerged for Philippines in only negative shocks. While two-way causality occurred for India, Turkey and Thailand, there was not for South Africa.

Keywords: energy consumption; financial development; newly industrialized countries; asymmetric causality
JEL Classifications: C32; O13; Q43

1.Introduction and Literature Review

By the rapid development of technology and hence the increasing significance of energy consumption, the determination of factors affecting energy consumption has become the subject of many studies. The one of the most important causes of this situation is that energy is being used in all most all wares and services. Therefore, the increase rate of energy consumption in developing countries in the period 2015-2040 is predicted as 1.8% annually, about 40% totally (IEA, 2007). As supporting these predictions, European Commission has stated in report published in 2010 that energy consumption will increase by 20% till 2020. The demand on energy consumption increases especially in areas like coal, oil and natural gas as the most vital needs. Thus, in order to understand the dynamics of energy consumption, the examination of situation in developing countries will be more accurate choice.

In his study, Sadorsky (2011) explained the several different possible causes of relationship between these two variables as following; prices and consumption costs of tools which require energy consumption like automobile, house, dishwasher and refrigerator can affect need of money. Therefore, the way of pricing energy consumption can reflect indirectly on indicators of financial developments.

For the opposite directional relationship, financial development can cause the more economical use of energy sources and thus, decrease on costs of energy consumption. Moreover, increasing economic prosperity depending on financial development causes the motive of money spending comfortably and therefore, causes increase on energy consumption.

In literature, the relationship between financial and economic development was examined by many studies (Arestis and Demetriades, 1997; Levine and Zervos, 1998; Khan and Senhadji, 2000; Merton, 2004; Giannetti et al. 2002; De Fiore and Uhlig, 2011; Shahbaz et al., 2013a; Ozturk and

Acaravci, 2013; Shahbaz et al., 2013b). At the same time, while the relationship between energy consumption and economic development is taking wide part in the literature (Karanfil, 2009; Bartleet and Gounder, 2010; Chontanawata et. al., 2008; Ozturk and Acaravcı, 2010; Altunbas and Kapusuzoglu, 2011; Belloumi, 2009; Apergis and Payne, 2010; Apergis and Tang, 2013; Narayan and Smyth, 2008; Ozturk et al., 2010; Narayan et al., 2010; Sarı and Soytas, 2007, Saatci and Dumrul, 2013), the relationship between financial development and energy consumption is pristine area whom about there are not many studies. In these studies, strong relationships have been identified both between financial-economic developments and between energy consumption-economic developments. This situation led us to investigate the relationship between financial development and energy consumption.

In literature, the relationship between energy consumption and financial development was examined by several methods such as Granger Causality, generalized method of moments (GMM) and panel causality.

In his study using GMM model, Sadorsky (2010) has investigated the relationship between financial development and energy consumption for 22 developing countries and he identified positive directional meaningful relationship within these two variables. In his following study using GMM model, Sadorsky (2011) investigated 9 Central and Eastern European frontier economies and encountered with same findings. Via same model, Çoban and Topçu (2013) researched European Union (EU) countries and while there was significant relationship between these two variables for former EU countries, there was not for other countries. In another study using GMM model, Brunnschweiler (2009) analyzed 119 non-OECD countries and observed positive effect of financial development on renewable energy. Wu et al. (2012) realized same results for China. By using Vector Error Correction Model (VECM), Islam et al. (2013) used Granger causality test and observed results that energy consumption had affected from both financial and economic development, in their study on Malaysia. Shahbaz and Lean (2012) in their study investigating Tunisian economy, applied Granger causality test and found that energy consumption was in a relationship with financial development and industrialization.

Kakar et al. (2011) studied Pakistan and determined that financial development is an effective instrument of measurement for efficiency of energy consumption. Dan and Lijun (2009) observed one-directional causality from financial development to energy consumption in their study investigating China.

Mulali and Sab (2012a) researched Sub Saharan African countries via granger causality test and discovered the vital role of energy consumption on financial and economic development. Mulali and Sab (2012b) found same results in their other study consisting 19 developed and developing countries. Unlike other studies, Chtioui (2012) determined as a result of his study for Tunis that energy consumption is Granger cause of financial development. By the aid of ARDL cointegration test, Mehrara and Musai (2012) investigated Iran and observed integrated structure of these variables in the long-run as a result of their study.

Compared with other studies in the literature, the unique part of this study is analyzing after distribution of positive and negative shocks by taking into account asymmetric information problem at financial markets via Hatemi-J (2012) asymmetric causality test. Therefore, the different effects occurred by effect of positive and negative shocks will not be ignored. When analyzed the studies in literature, there are very few studies both using Hatemi-J (2012) asymmetric causality test and about the relationship between energy consumption and financial development. This situation represents the original part of our study.

2. Methodology

In Hacker-Hatemi-J (2006) bootsrap granger causality test, Toda- Yamamoto causality test (1995) is applied in order to determine causality between variables. However, critical values are verified via bootstrap due to possible normal non-distribution of errors. The weak spot of this model is that it cannot split positive and negative shocks. In this respect, when there exist asymmetric knowledge in financial markets and markets participants are heterogenic, the results of this test may be misleading due to non-similar responses of participants to positive and negative shocks of same size. This model is the distributed negative and positive shocks version of Hacker-Hatemi (2006) bootstrap granger causality test.

Suppose causality analysis between two cointegrated series such as y_{1t} and y_{2t} was tested:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{10} + \sum_{i=1}^{t} \varepsilon_{1i},$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{20} + \sum_{i=1}^{t} \varepsilon_{2i}$$

Here $y_{1,0}$ and $y_{2,0}$ are representing the initial values. Positive and negative shocks can be shown as following:

$$\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0), \varepsilon_{2i}^{+} = \max(\varepsilon_{2i}, 0), \varepsilon_{1i}^{-} = \min(\varepsilon_{1i}, 0), \varepsilon_{2i}^{-} = \min(\varepsilon_{2i}, 0)$$

In the respect of this information, the equalities of y_{1t} and y_{2t} can be expressed by arranging as following:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-},$$

And similarly;

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-}.$$

Positive and negative shocks of each variable can be shown as following in the cumulative form:

$$y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+}, \quad y_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-}, \quad y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+}.$$

3. Data and Empirical Results

In this study investigating causality relationship between energy consumption and financial development, annual data in period of 1971-2010 for India, Malaysia, Mexico, South Africa, Philippines, Thailand and Turkey defined as Newly Industrialized Countries by IMF. These data was gained from http://stats.oecd.org/ which is statistic database of OECD. The data of energy consumption is measured as energy use in kg of oil equivalent per capita and real GDP per capita. We examined the indicators of financial development over 3 different variables.

These variables are deposit money bank assets to GDP (dbagdp), financial system deposits to GDP (fdgdp), private credit to GDP (pcrdbgdp) (Sadorsky, 2010; Sadorsky, 2011; Çoban ve Topçu, 2013). Before proceeding to analysis, logarithmic transformations of all variables are taken. Bootstrap critical values are obtained from 10,000 replications.

3.1. Results of Unit Root Test

Since the period of sample is 40, the results of tests like ADF (1979), PP (1988) and KPSS (1992) may cause deviation. But Ng-Perron test (2001) can solve the problem of over-rejection of null hypothesis and can be applied on small sample size (Ng and Perron, 2001).

For energy consumption, while all series seem stationary at first level, there are other situations for rest of variables. Another noteworthy issue is that, all variables are stationary at first difference for Thailand and Turkey. The results of analysis are visible on Table 1. First, the results of Hacker-Hatemi Bootstrap (2006) causality test were shown below in order to investigate the relationship between three different variables representing energy consumption and financial development. Then, the results of Hatemi-J (2012) Asymmetric Causality test which is a distinguishing positive and negative shocks version of the same test.

Table 1. Results of NG-Perron Unit Root Test (MZα)

Variable	India	Malaysia	Mexico	S.Africa	Philippines	Thailand	Turkey
ln(ec)	-1.30	-10.35	-1.38	-4.37	-7.06	-6.97	-10.78
Δln(ec)	-18.83**	-18.72**	-18.10**	-18.82**	-17.02*	-17.15*	-18.42**
ln(dba)	-35.57***	-5.92	-22.81**	-3.66	-24.69***	-7.86	-1.35
Δln(dba)	-	-18.25**	-	-17.73**	-	-28.96***	-33.6***
ln(pcrdb)	-257.5***	-3.90	-10.50	-15.42*	-26.25***	-7.80	-10.45
Δln(pcrdb)	-	-18.21**	-14.90*	-	-	-18.53**	-17.12*
ln(fd)	-7.24	-5.18	-17.12*	-7.59	-38.19***	-8.97	-3.61
Δln(fd)	-15.01*	-40.63***	-	-17.69**	-	-23.76**	-18.01**

*, **, *** denote rejection of null hypothesis at the %1, %5, %10 level respectively.

3.2. Results for First Financial Indicator (Private Credit to GDP)

Compared with other two indicators, energy consumption has higher impact on financial development according to relationship between energy consumption and private credit to GDP (pcrdbgdp), which is first indicator of financial development. For India, Malaysia and Thailand, energy consumption is granger cause of financial development according to Hacker-Hatemi (2006) bootstrap causality test (Table 2). These results were supported in a more detailed way via Hatemi Asymmetric Causality test (2012) (Table 3). The causalities for India were valid for positive shocks and for Thailand were valid for negative shocks. But for Malaysia, impact is valid for both positive and negative shocks. Furthermore, for Turkey, where there was not any causality in Hacker-Hatemi test, positive shocks of energy consumption were obtained cause of financial development.

Table 2. Results of Hacker-Hatemi Causality Test (2006)

	India	Malaysia	Mexico	S.Africa	Philippines	Thailand	Turkey
ec>pcrdb	5.53*	3.61*	0.81	0.60	2.51	6.52*	0.29
Btstrap at 1%	11.1	7.39	7.57	7.44	10.9	11.1	7.54
Btstrap at 5%	6.61	4.05	3.99	4.13	6.60	6.64	4.03
Btstrap at 10%	4.95	2.81	2.78	2.81	4.91	5.02	2.85
Ec<pcrdb	1.53	0.09	0.08	2.92	0.45	0.57	4.25
Btstrap at 1%	11.1	7.51	7.46	8.06	11.0	11.1	7.89
Btstrap at 5%	7.02	4.11	4.17	4.25	6.93	6.54	4.17
Btstrap at 10%	5.18	2.84	2.95	2.97	5.18	4.97	2.86

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

Table 3. Results of Hatemi-J Asymmetric Causality Test (2012)

	India	Malaysia	Mexico	S.Africa	Philippinnes	Thailand	Turkey
ec>pcrdb(+)	19.7***	3.12*	12.3***	0.28	0.22	2.25	7.60**
Btstrap at 1%	15.0	8.47	9.50	8.40	13.3	8.30	7.98
Btstrap at 5%	9.79	4.24	4.51	4.41	7.69	4.18	4.20
Btstrap at 10%	7.48	2.92	2.88	3.01	5.69	2.84	2.84
ec>pcrdb(-)	0.41	3.39*	3.03*	1.57	4.50	12.2***	2.14
Btstrap at 1%	11.7	8.34	8.89	10.5	12.9	10.9	8.06
Btstrap at 5%	4.92	4.44	4.43	6.54	7.71	5.06	4.25
Btstrap at 10%	2.88	2.98	2.93	4.91	5.37	3.14	2.84
ec<pcrdb (+)	6.81	0.01	0.09	0.01	0.99	4.25**	0.93
Btstrap at 1%	14.7	7.82	7.99	8.03	12.4	9.03	8.28
Btstrap at 5%	9.15	4.16	4.19	4.27	7.39	4.24	4.15
Btstrap at 10%	7.13	2.86	2.94	2.97	5.56	2.78	2.88
ec<pcrdb (-)	0.61	0.25	1.93	1.93	0.48	0.16	0.51
Btstrap at 1%	11.5	7.85	8.65	10.9	12.7	7.69	9.62
Btstrap at 5%	4.75	4.12	4.27	6.99	7.32	4.12	4.37
Btstrap at 10%	2.85	2.80	2.88	5.25	5.47	2.84	2.91

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

3.3. Results for Second Financial Indicator (Deposit Money Bank Assets to GDP)

According to the relationship between energy consumption and deposit money bank assets to gdp (dbagdp) as our second indicator of financial development, the results of Hacker-Hatemi test differ from Hatemi asymmetric causality (2012) test for other countries except Turkey (table 4). In this perspective, there was seen causality from positive shocks of energy consumption to financial development for India, and from negative shocks of energy consumption to financial development for both Mexico and Thailand. The causality from financial development to energy consumption according to Hacker-Hatemi (2006) test was supported by the finding from Hatemi asymmetric causality (2012) test that both positive and negative shocks make this impact for Turkey (table 5).

Table 4. Results of Hacker-Hatemi Causality Test (2006)

	India	Malaysia	Mexico	S.Africa	Philippinnes	Thailand	Turkey
ec>dba	0.127	1.17	0.25	0.28	2.44	3.41*	0.22
Btstrap at 1%	7.48	7.40	7.36	7.66	10.3	7.51	7.21
Btstrap at 5%	4.10	4.04	4.28	4.14	6.56	4.23	4.09
Btstrap at 10%	2.80	2.78	2.96	2.87	4.95	2.9	2.91
ec<dba	4.64**	0.83	1.14	4.65**	0.37	0.61	3.72*
Btstrap at 1%	7.56	7.71	7.58	7.67	11.2	7.81	7.46
Btstrap at 5%	4.17	4.21	4.18	4.27	6.97	4.26	4.14
Btstrap at 10%	2.84	2.86	2.86	2.94	5.25	2.91	2.88

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

Table 5. Results of Hatemi-J Asymmetric Causality Test (2012)

	India	Malaysia	Mexico	S.Africa	Philippinnes	Thailand	Turkey
ec>dba(+)	26.4***	2.48	0.06	0.17	0.45	1.15	1.18
Btstrap at 1%	17.9	9.00	8.16	9.22	13.2	8.08	8.55
Btstrap at 5%	11.6	4.42	4.14	4.30	7.90	4.12	4.33
Btstrap at 10%	9.18	2.86	2.86	2.89	5.60	2.84	2.82
ec>dba(-)	0.59	2.89	3.13*	1.29	5.14	7.76**	1.40
Btstrap at 1%	12.8	8.03	9.27	8.48	12.8	11.1	7.93
Btstrap at 5%	5.00	4.23	4.58	4.39	7.31	4.88	4.18
Btstrap at 10%	2.83	2.92	3.05	2.94	5.36	3.10	2.88
ec<dba (+)	6.28	0.08	1.29	0.20	1.74	3.06*	3.98*
Btstrap at 1%	16.6	8.30	8.41	9.41	12.2	8.59	8.75
Btstrap at 5%	11.2	4.24	4.47	4.38	7.37	4.26	4.21
Btstrap at 10%	8.65	2.98	3.00	2.84	5.48	2.78	2.80
ec<dba (-)	0.16	0.01	1.29	1.09	0.61	0.07	3.62*
Btstrap at 1%	11.7	7.75	8.51	8.61	11.7	7.72	9.00
Btstrap at 5%	4.63	4.15	4.26	4.24	6.93	4.07	4.49
Btstrap at 10%	2.72	2.82	2.88	2.86	5.30	2.80	2.93

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

3.4. Results for Third Financial Indicator (Financial System Deposits to GDP)

When looked at the relationship between energy consumption and the third and last indicator of financial development which is financial system deposits to gdp (fdgdp), the results of Hacker-Hatemi (2006) test were supported by the positive shocks obtained from Hatemi asymmetric causality test (2012) for India. Moreover, while there was no causality relationship for Malaysia according to Hacker-Hatemi causality test (2006), the effect of positive shocks of energy consumption on financial development was determined. The results of analysis are visible on Table 6 and 7. The effect of negative shocks on financial development was observed via Hatemi-J asymmetric causality test (2012) for both Philippines and Thailand.

Table 6. Results of Hacker-Hatemi Causality Test (2006)

	India	Malaysia	Mexico	S.Africa	Philippinnes	Thailand	Turkey
ec>fd	0.02	1.01	0.10	1.08	3.19	0.12	2.91*
Btstrap at 1%	6.72	7.58	11.0	7.04	10.8	7.83	7.59
Btstrap at 5%	4.01	4.05	6.92	4.19	6.61	4.35	4.17
Btstrap at 10%	2.72	2.79	5.07	2.87	4.91	3.04	2.89
ec<fd	4.89**	1.88	3.72	0.29	0.24	0.22	1.15
Btstrap at 1%	7.51	7.76	11.7	7.70	11.2	7.27	7.19
Btstrap at 5%	4.13	4.05	6.97	4.13	6.95	4.13	4.12
Btstrap at 10%	2.79	2.89	5.07	2.84	5.20	2.84	2.85

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

Table 7. Results of Hatemi-J Asymmetric Causality Test (2012)

	India	Malaysia	Mexico	S.Africa	Philippinnes	Thailand	Turkey
ec>fd(+)	0.14	3.40*	0.91	0.03	0.85	0.58	0.02
Btstrap at 1%	11.8	9.69	15.8	9.09	13.1	7.63	8.06
Btstrap at 5%	7.10	4.49	8.50	4.31	7.66	4.03	4.45
Btstrap at 10%	5.27	2.85	5.93	2.86	5.61	2.76	2.85
ec>fd(-)	0.28	0.55	2.40	2.18	14.9***	3.23*	0.50
Btstrap at 1%	8.45	8.18	15.3	7.58	14.1	9.96	8.06
Btstrap at 5%	4.26	4.20	8.74	4.28	7.81	4.67	4.16
Btstrap at 10%	2.90	2.86	6.18	2.92	5.58	2.93	2.93
ec<fd (+)	11.5**	0.32	3.53	0.00	1.15	6.80**	11.2***
Btstrap at 1%	11.8	8.49	13.1	9.11	12.9	9.38	9.15
Btstrap at 5%	7.04	4.22	7.37	4.25	7.67	4.71	4.24
Btstrap at 10%	5.09	2.86	5.19	2.90	5.76	3.01	2.80
ec<fd (-)	0.29	0.17	4.57	0.10	1.00	0.05	6.22**
Btstrap at 1%	8.59	7.82	11.2	7.88	12.3	7.84	8.05
Btstrap at 5%	4.37	2.80	6.76	4.28	7.21	4.14	4.40
Btstrap at 10%	2.90	1.15	5.07	2.92	5.23	2.88	2.94

***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively

4. Conclusion

Together with economic development, the studies in literature emphasize the significance of financial development for developing countries. Without doubt, the fundamental sectors have bigger share among the factors contributing to the development of the country economies. Therefore, the dynamics of energy economics have more importance for developing countries.

The original side of this study is that we assume it is first study analyzing the relationship between financial development and energy consumption via Hatemi-J (2012) asymmetric causality test. By the existence of asymmetric information in financial time series and having heterogeneous structure of market, these series differentiate from economic series. Therefore, the leading to different results of positive and negative shocks in financial time series and necessity of analyzing shocks separately, represent the significance of effect of this test over obtained findings.

The aim of this study is analysis of the causality relationship between energy consumption and financial development via Hatemi asymmetric causality test (2012) which can split positive and negative shocks by eliminating existence of asymmetric information at financial markets. For this topic which was not studied much previously in the literature, annual data of Newly Industrialized 7 Countries in the period of 1971-2010 was used. In this study for both three situations, first the results of Hacker-Hatemi (2006) bootstrap causality test were given, and then effect of distribution of positive and negative shocks was examined by Hatemi-J asymmetric causality test.

As findings of this study, causality was observed from energy consumption to financial development for Malaysia and Mexico in both positive and negative shocks, and for Philippines in only negative shocks. There was mutual causality in only positive shocks for India. For Turkey, there was again two-way causality. While the negative shocks of energy consumption are effecting financial development for Thailand, positive shocks of financial development are cause of energy consumption. But for South Africa, there was no causality for both three financial indicators.

As a result, despite of the fact that these countries have similar economic structures, results of causalities differ from each other. While in literature, there was seen mainly causality from financial development to energy consumption, in this study more developed and new evidences were obtained by taking into account the existence of asymmetric information of markets & heterogeneity of market participants and distinguishing positive and negative shocks via Hatemi-J asymmetric causality test (2012).

These results are supported by the findings stated by Sadorsky (2011). Financial development may lead to the more efficient use of energy sources and thus decrease the costs of energy consumption. Moreover, increasing economic prosperity depending on increasing financial development may also cause the motive of spending money comfortably and consequently increase in energy consumption. Therefore, including the financial development into the cycle of energy consumption and economic development will lead to more rational results instead of thinking the relationship between energy consumption and economic development as two variables affecting each other staying unaffected from outer factors.

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