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FDI Inspired Energy Consumption in Selected Emerging Markets: Does Financial Development Matter?

Abstract

The study investigated the impact of the complementarity between foreign direct investment (FDI) and financial development on energy consumption in emerging markets. Although the relevance of the FDI-led energy consumption hypothesis is no longer contestable, the combined influence of FDI and financial development on energy consumption is not yet resolved. Random and fixed effects show that the interaction between outstanding domestic private debt securities and FDI had a significant positive influence on energy consumption whereas pooled ordinary least squares (OLS) noted that the interaction between FDI and outstanding domestic public debt securities positively and significantly affected energy consumption. The dynamic generalized methods of moments (GMM) shows that the interaction between (1) FDI and stock market capitalization and (2) FDI and stock market value traded had a significant negative influence on energy consumption. The study urges emerging markets to deepen the bond sector market in order to enhance FDI-led energy consumption.

Keywords*: energy consumption; FDI; financial development; emerging markets*

JEL*: F21; E44; Q4*

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1. Introduction

Background of the study, Research gap and Contribution of the study: Bowden and Payne (2009) noted that energy is one of the engines that spur economic growth. Despite the importance of energy consumption in the economic growth process as unequivocally noted by other authors such as Yildirim and Aslan (2012), Tsani (2010), Wei and Gang (2012), Odhiambo (2010) and Okafor (2012), empirical studies to a larger extent have ignored the determinants of energy consumption, especially in emerging markets. The understanding and knowledge of which factors determine energy consumption are of paramount importance when it comes to the formulation of energy policies that enhance economic growth. One of the prominent determinants of energy consumption is FDI inflows, an area given full attention in the current study because of the availability of several inadequacies in the FDI-led energy consumption hypothesis as it stands now.

The available empirical research on the FDI-energy consumption nexus (see Table 1) reveals quite diverse, divergent and mixed findings, a clear indication that the matter is not yet conclusive and, therefore, a lot of empirical investigations still need to be done to settle the issue. Moreover, the literature on the FDI-energy consumption nexus shied away from emerging markets, a bloc of countries which received the biggest amount of FDI and experienced the most economic growth during the last two decades (Cavusgil et al. 2013). To the author's best knowledge, Zhu et al. (2016) is the only study which recently explored the interrelationships between FDI and energy consumption in emerging markets (Malaysia, Philippines, Indonesia, Thailand and Singapore). The current study differs from the one done by Zhu et al. (2016) in the following ways: (1) it focuses on 16 emerging markets, (2) it uses panel data analysis methods such as fixed effects, pooled OLS and random effects, (3) it employs the dynamic GMM approach, whose twin advantages are that it takes into account the dynamic nature of energy consumption data and it addresses the endogeneity issue prevalent in most FDI-energy consumption relationships. In fact, no other empirical study that the author is aware of has investigated whether FDI influences energy consumption through the financial development channel using the dynamic GMM, fixed effects, pooled OLS and random effects approaches.

Organization of the paper: The rest of the paper is structured as follows: Part 2 focuses on the influence of FDI on energy consumption from both the theoretical and empirical literature viewpoints whilst. Part 3 discusses other factors which affect energy consumption apart from FDI. Part 4 is the research methodology, which covers data description, pre-estimation diagnostics, econometric model specification, panel root tests, panel co-integration, data analysis and interpretation. Part 5 concludes the paper. Part 6 is the bibliography.

2. Impact of FDI on energy consumption - literature review

On the theoretical front, Tang (2009) argued that FDI inflows increase industrialization, manufacturing levels and transport sector activities, all of which are major users of energy. The view was supported by Doytch and Narayan (2016), Bekhet and Othman (2011), Mielnik and Goldemberg (2000), Mielnik and Goldemberg (2002), Abdouli and Hammami (2017), among others. Antweiler et al. (2001) noted that FDI influences energy consumption through the scale, technique and composition effect. The scale effect is when FDI affects energy consumption through its positive impact on economic growth whilst the technique effect is when FDI introduces new techniques and technologies used for the production processes which requires more energy consumption. An example of the scale effect is when FDI changes the structure of the economy from being a labor-intensive to a capital-intensive economy, which by its nature uses a lot of energy.

Empirical studies which investigated the direct influence of FDI on energy consumption are still very scant. The majority of the previous similar studies explored (1) the role of FDI on carbon emissions and (2) the impact of FDI and other variables on energy consumption. Table 1 provides a summary of the empirical research which focused on the impact of FDI on energy consumption.

Table 1. The impact of FDI on energy consumption – An empirical perspective

Author	Country/Countries of study	Methodology	Results
Omri and Kahouli (2014)	65 countries (1990–2011)	Dynamic panel data analysis	A unidirectional causality relationship running from FDI towards energy consumption was detected in middle-income countries. The same study noted that high-income countries experienced a feedback effect between FDI and energy consumption.
Zhu et al. (2016)	Malaysia. Singapore, Thailand, Indonesia and Philippines	Panel quantile regression model	FDI had a negative influence on energy consumption and consequently carbon emissions except in the 5th quantile.
Sbia et al. (2014)	United Arab Emirates (UAE)	Autoregressive Distributive Lag (ARDL) and Vector Error Correction Model (VECM)	FDI was found to have led to a decrease in energy consumption in the UAE.

Author	Country/Countries of study	Methodology	Results
Bekhet and Othman (2011)	Malaysia	Regression analysis	A long run relationship was observed between FDI and energy consumption. A causality running from electric energy consumption towards FDI was also noted in the same study.
Keho (2016)	Selected African countries	ARDL	Energy intensity was found to have been Granger caused by FDI inflows in the short run in Cote d'Ivoire and Nigeria. The same study noted that FDI inflows were behind the decline in energy efficiency in Togo and Cote d'Ivoire.
Anwar and Nguyen (2010)	Vietnam's 61 provinces	Panel data analysis	A feedback effect was found between energy consumption and FDI in all the 61 provinces of Vietnam.
Khan et al. (2014)	Middle- and high-income countries	Panel data analysis	Energy consumption was positively affected by FDI in both middle and high-income countries.
Bento (2011)	Portugal	Regression analysis	FDI was found to have had a negative influence on energy consumption in Portugal.
Mielnik and Goldemberg (2002)	Developing countries	Panel data analysis	Energy usage was found to have been accelerated by FDI inflows in developing countries.
Abidin et al. (2015)	Selected ASEAN countries	ARDL	Energy consumption was found to have been positively influenced by FDI in the short run only. In the long run, FDI and energy consumption affected each other in the ASEAN countries.
Lee (2013)	19 countries in G20 group	Panel data analysis	No evidence of a causal relationship between FDI and energy consumption was detected.
Elliot et al. (2013)	China	Random effects model	FDI and energy consumption were found to be negatively related in the case of China.

Author	Country/Countries of study	Methodology	Results
Amri (2016)	Developed and developing countries	Panel data analysis	A bi-directional causality relationship between renewable energy consumption and FDI was observed in developed countries. In developing countries, energy consumption in general was found to have been positively influenced by FDI.
Ibrahiem (2015)	Egypt	ARDL	No linkage was detected between FDI and energy consumption in the case of Egypt.
Hassaballa (2014)	Developing countries	Fixed effects panel data analysis	A two-way causality relationship was observed between energy consumption/emissions from energy usage and FDI inflows.
Gokmenoglu and Taspinar (2015)	Turkey	Toda-Yamamoto (1995) model	FDI and energy consumption were found to have affected each other in Turkey.
Han et al. (2011)	China	Regression analysis	FDI led to reduced energy consumption intensity in China.
Salim et al. (2017)	China	ARDL	The study found that FDI increased energy consumption in the short run whilst in the long run, energy consumption declined in response to FDI inflows in China.
Mohamed and Mamat (2016)	Yemen	ARDL	Energy consumption was increased by FDI inflows in Yemen both in the short and long run.
Belmokaddem et al. (2014)	65 countries	Panel data analysis	The causality relationship between FDI and energy consumption was found to be non-existent. The study instead observed that FDI had a significant positive impact on economic growth.

Source: Author's own compilation.

3. Other factors that influence energy consumption

Table 2. Theory intuition and a priori expectation

Variable	Proxy used	Theory intuition	Expected sign
Financial development (FIN)	Stock market turnover (%), stock market capitalization (% of GDP), stock market value traded (% of GDP), domestic credit to private sector by banks (% of GDP), domestic credit provided by financial sector (% of GDP), outstanding domestic private debt securities (% of GDP), outstanding domestic public debt securities (% of GDP)	According to Sadorsky (2010), a developed financial sector enables consumers to borrow money for purchasing big items such as automobiles and houses, among others. The use of automobiles by consumers increases the demand and consumption of energy since they are powered by petroleum-related products. Energy products are also used to cool or heat the houses bought by consumers using financial sector secured loans (Sadorsky. 2010: 2529). The developed financial sector offers low-cost debt finance or equity finance to the business sector to enable the expansion of operations and purchasing or building of new plants, all of which require the consumption of more energy. On the other hand, a developed financial sector avails cheaper loans to enterprises that are engaged in the development of energy-saving innovative products, thereby reducing the amount of energy that the economy might have consumed overall.	+/-
Economic growth (GROWTH)	GDP per capita	According to the conservation hypothesis as advanced by Nindi and Odhiambo (2014), economic growth increases energy consumption in the economy. In other words, the growth of the real sector of the economy drives up the energy consumption levels, especially in a low energy-reliant economy. The hypothesis was supported by other recent studies, namely Odhiambo (2014), Sharma and Bruce (2013) and Ouedraogo (2013). On the other hand, Huang et al. (2008) found that economic growth had a negative impact on energy consumption in high-income countries.	+/-

Variable	Proxy used	Theory intuition	Expected sign
Population growth (POP)	Population growth (annual %)	When a population increases, governments inevitably have to respond by investing in more infrastructure (transport, healthcare, education, power) in order to meet the demands of the growing population, all of which increases the levels of energy consumption (Liu et al. 2015: 905). On the other hand, Fan et al. (2006) observed that the working age population (15 to 64 years) had a negative impact on both energy consumption and carbon emissions in developed countries. Moreover, a study by Liddle (2004) revealed that household size had a negative influence on road energy consumption in Organisation for Economic Cooperation and Development (OECD) nations.	+/-
Trade openness (OPEN)	Total of exports and imports (% of GDP)	Trade openness increases the movement of goods produced in one country to another for consumption or use in manufacturing processes. According to Shahbaz et al. (2014), the production of such goods or inputs requires additional energy use. An increase in domestic production due to the availability of inputs from other countries under conditions of trade openness (scale effect) also means more energy is needed (Shahbaz et al. 2014: 126).	+
Infrastructure development (INFR)	Electric consumption (% of GDP)	According to Samimi (1995) and Reddy et al. (2001), the largest consumer of energy in the economy is the transport infrastructure. The majority of other types of infrastructure also use a lot of energy. These include industry infrastructure, communication infrastructure, and education and health infrastructure, among others.	+

Source: Author compilation.

4. Research Methodology

Data and Data Sources: The study used panel data ranging from 1999 to 2014. The data was extracted from Global Financial Indicators, the International Monetary Fund (IMF), World Development Indicators and International Financial Statistics databases. In line with the IMF (2015) and subject to data availability considerations, the current study focused on 16 emerging markets (Argentina, Brazil, China, Colombia, Hong Kong, Indonesia, India, Mexico, Malaysia, Peru, the Philippines, South Korea, Thailand, Turkey, Singapore and South Africa).

Pre-estimation diagnostics: Table 3 shows the results of the correlation analysis. In line with the theory (see Parts 2 and 3), variables such as FDI, financial development, economic growth, trade openness and infrastructural development are positively and significantly correlated with energy consumption. The positive but non-significant correlation between population growth and energy consumption is also supported by the theoretical literature (see Part 3).

Table 3. Correlation analysis

	ENERGY	FDI	FIN	POP	GROWTH	OPEN	INFR
ENERGY	1.00						
FDI	0.3252[a]	1.00					
FIN	0.2535[a]	–0.0796	1.00				
POP	0.0125	–0.0057	–0.2565[a]	1.00			
GROWTH	0.7124[a]	0.7513[a]	0.0708	0.0526	1.00		
OPEN	0.5552[a]	0.8398[a]	–0.0503	0.1671[a]	0.7971[a]	1.00	
INFR	0.9418[a]	0.4832[a]	0.2540[a]	–0.0639	0.8261[a]	0.6426[a]	1.00

Note: [a]/[b]/[c] denotes statistical significance at the 1%/5%/10% level respectively.

Source: Author's own compilation from E-Views.

Table 4 shows the results of the descriptive statistics. Whilst the probabilities of the Jarque-Bera criteria show that the data for all variables are not normally distributed, the range and standard distribution of the variables such as energy consumption, economic growth, trade openness and infrastructural development indicate the existence of extreme values. The author has converted the data for all variables used into natural logarithms in order to deal with the problems of extreme values and abnormally distributed data.

Table 4. Descriptive statistics

	ENERGY	FDI	FIN	POP	GROWTH	OPEN	INFR
Mean	1803.40	4.81	61.95	1.26	9361.38	104.93	2926.53
Median	1513.26	2.58	38.99	1.28	5691.12	56.55	2066.58

	ENERGY	FDI	FIN	POP	GROWTH	OPEN	INFR
Maximum	7370.65	39.87	306.50	5.32	56284.33	455.28	10552.19
Minimum	414.08	0.06	2.39	0.01	451.09	20.98	356.97
Standard deviation	1361.27	7.13	60.83	0.59	10884.46	111.63	2523.41
Skewness	1.43	2.94	1.57	1.87	2.15	1.91	1.25
Kurtosis	4.62	11.42	5.00	13.13	7.67	5.38	3.64
Jarque-Bera	115.71	1123.58	147.72	1242.50	429.29	215.76	70.47
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	256	256	256	256	256	256	256

Source: Author's own compilation from E-Views.

Econometric Model Specification: Equation 1 represents the general econometric model specification for the current study.

$$ENERGY_{i,t} = \beta_0 + \beta_1 FDI_{i,t} + \beta_2 X_{i,t} + \mu_i + \varepsilon it \quad (1)$$

ENERGY stands for energy consumption as proxied by energy use (kilogram of oil equivalent per capita), FDI is foreign direct investment whilst X represents the explanatory variables (financial development, population growth, economic growth, trade openness and infrastructural development). β_0 , β_1 and β_2 stands for the coefficients of the intercept term, FDI and explanatory variables respectively. εit and μ_i respectively stands for the error term and the time-invariant and unobserved country-specific effects. Subscript i represents the country and t is the time.

Equation 2 introduced the interacting term $(FDI_{i,t}. FIN_{i,t})$ whose coefficient is β_4 in order to explore if financial development is a channel through which FDI affects energy consumption. In other words, equation 2 allows the author to estimate whether financial development is a condition that must be available in emerging markets before FDI influences energy consumption.

$$ENERGY_{i,t} = \beta_0 + \beta_2 FDI_{i,t} + \beta_3 FIN_{i,t} + \beta_4 (FDI_{i,t}. FIN_{i,t}) + \beta_5 POP_{i,t} + \beta_6 GROWTH_{i,t} + \beta_7 OPEN_{i,t} + \beta_8 INFR_{i,t} + \mu_i + \varepsilon it \quad (2)$$

Fixed effects, pooled OLS and random effects frameworks are the three-panel data analysis methods which were used to estimate equation 2.

According to Coban and Topcu (2013) and Sadorsky (2010), energy consumption is influenced by its lag hence giving rise to equation 3 below.

$$ENERGY_{i,t} = \beta_0 + \beta_1 ENERGY_{i,t-1} + \beta_2 FDI_{i,t} + \beta_3 FIN_{i,t} + \beta_4 (FDI_{i,t}. FIN_{i,t}) + \beta_5 POP_{i,t} + \beta_6 GROWTH_{i,t} + \beta_7 OPEN_{i,t} + \beta_8 INFR_{i,t} + \mu_i + \varepsilon it \quad (3)$$

In line with Nor et al. (2015), equation 3 is estimated using Arellano and Bond's (1991) dynamic panel GMM approach. The advantages of this approach are that it captures the dynamic element of the energy consumption data and also addresses any endogeneity issues that might characterize the FDI-energy consumption relationships.

Panel unit root and co-integration tests: Table 5 shows that the data for all the variables studied were integrated of order 1 (all stationary at first difference).

Table 5. Panel unit root tests – Individual Intercept

	Level				First difference			
	LLC	**IPS**	**ADF**	**PP**	**LLC**	**IPS**	**ADF**	**PP**
LENERGY	–0.64	2.41	20.50	34.15	–4.53[a]	–4.60[a]	78.55[a]	173.47[a]
LFDI	–6.84[a]	–5.20[a]	85.24[a]	103.18[a]	–12.53[a]	–12.00[a]	177.01[a]	277.36[a]
LFIN	–3.16[a]	–2.94[a]	58.11[a]	79.71[a]	–7.81[a]	–8.26[a]	125.90[a]	208.75[a]
LPOP	–0.34	0.71	53.97[a]	67.23[a]	–17.05[a]	–9.97[a]	69.20[a]	93.31[a]
LGROWTH	–0.82	3.27	7.43	7.77	–7.74[a]	–5.10[a]	81.98[a]	104.99[a]
LOPEN	–1.50[c]	0.15	27.64	44.73	–7.48[a]	–5.60[a]	90.38[a]	201.47[a]
LINFR	–2.66[a]	2.23	22.90	49.28[b]	–7.42[a]	–5.66[a]	93.72[a]	192.01[a]

Note: LLC, IPS, ADF and PP stands for Levin, Lin and Chu; Im, Pesaran and Shin; ADF Fisher Chi Square and PP Fisher Chi Square tests respectively. [c], [b] and [a] denote 1%, 5% and 10% levels of significance, respectively.

Source: Author's own compilation from E-Views.

On the other hand, the Kao-Residual co-integration test whose results are presented in Table 6 indicates the rejection of a hypothesis which says that there is no long-run relationship between and among the variables under study. These two crucial characteristics of the data allowed the author to carry out further analysis using fixed effects, pooled OLS, random effects and dynamic GMM estimation techniques.

Table 6. Kao Residual Co-integration Test – Individual intercept

	T-statistic	**Probability**
Augmented Dickey-Fuller (ADF)	–3.1035	0.0010

Source: Author's own compilation from E-Views.

Main Data Analysis: Stock market turnover ratio, stock market capitalization ratio, stock market value traded ratio, domestic private credit ratio, domestic credit by financial sector ratio, outstanding private debt securities ratio and outstanding public debt securities ratio are the measures of financial development that were used in models 1, 2, 3, 4, 5, 6 and 7 respectively.

Table 7. Determinants of energy consumption in emerging markets – Fixed Effects

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
FDI	0.01	–0.02	–0.004	–0.03	–0.01	–0.02[c]	–0.01
FIN	0.03[b]	–0.04[a]	–0.002	–0.002	–0.02	0.01	–0.01
FDI.FIN	0.004	0.003	–0.001	0.007	0.00008	0.01[b]	0.002
POP	–0.03[a]	–0.03[a]	–0.029[a]	–0.03[a]	–0.03[a]	–0.03[a]	–0.03[a]
GROWTH	0.0004	0.03	0.01	0.006	0.01	0.01	0.01
OPEN	0.08[a]	0.098[b]	0.07[b]	0.06[b]	0.07[b]	0.06[b]	0.08[b]
INFR	0.56[a]	0.53[a]	0.54[a]	0.55[a]	0.54[a]	0.53[a]	0.55[a]
Adjusted R-squared	0.99	0.99	0.99	0.99	0.99	0.99	0.99
F-statistic	1374	1404	1334	1338	1338	1389	1336
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: [a], [b] and [c] denote 1%, 5% and 10% levels of significance, respectively.

Source: Author's compilation from E-Views.

Under both fixed and random effects frameworks, the interaction between FDI and outstanding domestic private debt securities had a significant positive influence on energy consumption in selected emerging markets. In other words, FDI and outstanding domestic private debt securities complemented each other in influencing energy consumption. Although not in a significant manner, the interaction between (1) FDI and stock market turnover, (2) FDI and stock market capitalization, (3) FDI and domestic private credit, (4) domestic credit by the financial sector and (5) FDI and outstanding domestic public debt securities had a positive impact on energy consumption in selected emerging markets. These findings resonate with Havrylchyk and Poncet (2007), whose study noted that a well-developed financial sector is more able to increase foreign capital productivity through its ability to allocate financial resources to projects with a high rate of return. According to Levine (1997), such a characteristic of financial markets enhances economic growth and consequently boosts energy consumption in line with Antweiler et al. (2001). When the stock market value traded was combined with FDI, the finding shows that the interaction term had a negative effect on energy consumption under both fixed and random effects approaches.

Table 8. Determinants of energy consumption in emerging markets – Random Effects

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
FDI	0.01	–0.02	–0.003	–0.04	–0.01	–0.02[b]	–0.02
FIN	0.03[a]	–0.04[a]	0.0003	0.001	–0.02	0.01	–0.01
FDI.FIN	0.004	0.003	–0.001	0.008	0.001	0.01[b]	0.003
POP	–0.03[a]	–0.03[a]	–0.03[a]	–0.03[a]	–0.03[a]	–0.02[a]	–0.03[a]
GROWTH	–0.01	0.01	–0.01	–0.01	–0.01	–0.01	–0.01
OPEN	0.08[a]	0.08[a]	0.06[b]	0.06[b]	0.07[b]	0.05[b]	0.07[b]
INFR	0.60[a]	0.58[a]	0.57[a]	0.60[a]	0.59[a]	0.57[a]	0.60[a]
Adjusted R-squared	0.78	0.78	0.77	0.77	0.77	0.78	0.77
F-statistic	130	133	124	125	124	130	125
Prob(F-statistic)	0.00	0.00	0.22	0.00	0.00	0.00	0.00

Note: [a], [b] and [c] denote 1%, 5% and 10% levels of significance, respectively.

Source: Author's compilation from E-Views.

Under the pooled OLS approach (Table 9), the combination between FDI and stock market capitalization, FDI and stock market value traded, FDI and domestic private credit and FDI and outstanding domestic public debt securities had a significant negative influence on energy consumption in selected emerging markets. Energy consumption was negatively but non-significantly affected by the interaction between (1) FDI and domestic credit by financial sector and (2) FDI and outstanding domestic private debt securities. These findings are consistent with Hailu (2010), who argued that in a well-developed financial sector, foreign investors opt for portfolio investment which then crowds out FDI, slows down economic growth and consequently reduces energy consumption levels in the economy.

The pooled OLS also shows that the combination between FDI and outstanding domestic public debt securities had a significant positive effect on energy consumption in selected emerging markets. Table 9 also reveals that the combination between stock market turnover and FDI had a non-significant positive impact on energy consumption. The findings are in tandem with Havrylchyk and Poncet (2007) in as far as the impact of the relationship between FDI and financial development on economic growth is concerned.

Table 9. Determinants of energy consumption in emerging markets – Pooled OLS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
FDI	–0.15[b]	0.07	0.02	0.07	0.04	–0.07[a]	–0.29[a]
FIN	0.02	–0.10[a]	0.001	–0.08[a]	–0.04	0.03[a]	–0.02
FDI.FIN	0.02	–0.03[b]	–0.02[a]	–0.03[c]	–0.03	–0.004	0.07[a]
POP	0.05[b]	0.03	0.03	0.01	0.02	0.05[b]	0.01
GROWTH	–0.06[c]	–0.09[a]	–0.09[a]	–0.14[a]	–0.12[a]	–0.06[b]	–0.08[a]
OPEN	0.06[b]	0.19[a]	0.12[a]	0.13[a]	0.10[a]	0.07[a]	0.07[a]
INFR	0.83[a]	0.90[a]	0.87[a]	0.94[a]	0.91[a]	0.81[a]	0.84[a]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Adjusted R-squared	0.91	0.93	0.91	0.92	0.91	0.92	0.92
F-statistic	387	472	391	400	384	395	413
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: [a], [b] and [c] denote 1%, 5% and 10% levels of significance, respectively

Source: Author's compilation from E-Views.

Under fixed effects, pooled OLS and random effects, trade openness (see Shahbaz et al. 2014) and infrastructure development (see Reddy et al. 2001) positively and significantly influenced energy consumption in line with the theoretical predictions summarised in Table 2.

Both fixed and random effects show that population growth had a significant negative impact on energy consumption, in line with Fan et al. (2006). Under the pooled OLS, model 1 and 6 show that population growth had a significant positive impact on energy consumption whilst model 2, 3, 4, 5 and 7 indicate that population growth had a non-significant positive effect on energy consumption. The findings resonate with Liu et al. (2015) who argued that when population increases, governments inevitably must invest more money into expanding infrastructure (which increases energy consumption levels) in a bid to satisfy the infrastructural needs of the increased population.

Consistent with the conservation hypothesis propounded by Nindi and Odhiambo (2014), all seven models under the fixed effects framework show that economic growth positively but non-significantly affected energy consumption. Energy consumption was negatively but non-significantly impacted by economic growth in all seven models under random effects. The pooled OLS approach shows that economic growth had a significant negative influence on energy consumption across all seven models, following Huang et al. (2008), whose study observed that energy consumption was negatively affected by economic growth in high-income countries.

Table 10. Determinants of energy consumption in emerging markets – Dynamic GMM

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
ENERGYLag	0.98[a]	0.97[a]	0.98[a]	0.98[a]	0.98[a]	0.98[a]	0.98[a]
FDI	–0.003	0.03[b]	0.03[a]	0.02	0.03	0.002	–0.003
FIN	0.001	0.002	0.01[b]	0.002	0.004	0.002	0.001
FDI.FIN	0.002	–0.006[b]	–0.01[a]	–0.004	–0.01	0.001	0.002
POP	–0.02[a]	–0.02[a]	–0.02[a]	–0.02[a]	–0.02[a]	–0.02[a]	–0.02[a]
GROWTH	–0.02[b]	–0.01[c]	–0.01	–0.02[c]	–0.02[c]	–0.01[c]	–0.02[b]
OPEN	–0.004	0.01	0.002	–0.002	–0.002	–0.005	–0.004
INFR	0.03[c]	0.03[c]	0.02	0.03	0.03	0.03	0.03[c]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Adjusted R-squared	0.99	0.99	0.99	0.99	0.99	0.99	0.99
J-statistic	247	247	247	247	247	247	247
Prob(J-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: [a], [b] and [c] denote 1%, 5% and 10% levels of significance, respectively

Source: Author's compilation from E-Views.

Consistent with the literature **(**Sadorsky 2010; Coban and Topcu 2013), the lag of ENERGY had a significant positive effect on energy consumption (see Table 10). Under the dynamic GMM approach, the interaction of (1) FDI and stock market turnover, (2) FDI and outstanding domestic private debt securities and (3) FDI and outstanding domestic public debt securities had a positive but insignificant impact on energy consumption in selected emerging markets. No interaction between FDI and financial development across all the seven models was found to have had a significant positive influence on energy consumption. The combination between (1) FDI and stock market capitalization and (2) FDI and stock market value traded had a significant negative influence on energy consumption. On the other hand, the combination between (3) domestic private credit and FDI and (4) domestic credit by the financial sector and FDI had a non-significant negative influence on energy consumption in selected emerging markets. The findings support Hailu's (2010) arguments.

5. Conclusion

The paper studied the impact of the complementarity between FDI and financial development on energy consumption in selected emerging markets using panel data analysis (fixed effects, pooled OLS, random effects and dynamic GMM). Although the impact of FDI on economic growth through its positive influence on energy consumption (technique, scale, composition effects) is no longer a disputable matter in the literature, there are still very few empirical studies that have so far investigated the direct impact of FDI on energy consumption. These few available studies on the FDI-energy consumption nexus produced divergent findings, and these are: (1) FDI has a positive influence on energy consumption, (2) Energy consumption has a direct impact on FDI inflows, (3) There is no relationship between FDI and energy consumption, (4) The influence of FDI on energy consumption goes indirectly through other channels, such as economic growth and financial development, among others. The divergent findings show that the relationship between FDI and energy consumption is a matter which is not yet conclusive in the

literature. It is against this background that the current study investigated if financial development is a channel through which FDI affects energy consumption.

Both random and fixed effects show that the interaction between outstanding domestic private debt securities and FDI had a significant positive influence on energy consumption whereas the pooled OLS approach noted that the interaction between FDI and outstanding domestic public debt securities positively and significantly affected energy consumption in selected emerging markets. Under the pooled OLS and random and fixed effects, both trade openness and infrastructural development had a significant positive influence on energy consumption in selected emerging markets. The study, therefore, urges emerging markets to implement policies that enhance the development of both private and public bond markets in order to trigger more FDI inspired energy consumption, which will ultimately lead to increased economic growth. They should also embrace and implement policies aimed at increasing trade openness and infrastructural development in order to push up energy consumption, a condition which is one of the cornerstones for economic growth, following Wei and Gang (2012). Future studies should investigate which other conditions, apart from financial sector development, must be available in the host country before energy consumption triggered by FDI happens.

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Streszczenie

ZUŻYCIE ENERGII WYWOŁANE PRZEZ BIZ NA WYBRANYCH RYNKACH WSCHODZĄCYCH: CZY ROZWÓJ FINANSOWY MA ZNACZENIE?

W opracowaniu przedstawiono wyniki badania wpływu komplementarności bezpośrednich inwestycji zagranicznych (BIZ) i rozwoju finansowego na zużycie energii na rynkach wschodzących. Chociaż trafność hipotezy o wpływie BIZ na zużycie energii nie podlega już dyskusji, kwestia połączonego wpływu BIZ i rozwoju finansowego na zużycie energii nie została jeszcze rozwiązana. Metoda efektów losowych i metoda efektów stałych wskazują, że interakcja pomiędzy krajowymi prywatnymi dłużnymi papierami wartościowymi a bezpośrednimi inwestycjami zagranicznymi miała znaczny pozytywny wpływ na zużycie energii, podczas gdy rozległa klasyczna metoda najmniejszych kwadratów (OLS) wykazała, że interakcja BIZ i krajowych publicznych papierów dłużnych pozytywnie i znacząco wpłynęła na konsumpcję energii. Estymacja dynamicznych modeli panelowych przy wykorzystaniu uogólnionej metody momentów (GMM) wskazuje, że związki pomiędzy (l) BIZ a kapitalizacją giełdową oraz między (2) BIZ a wartością obrotów giełdowych miały znaczący negatywny wpływ na zużycie energii. Opracowanie zawiera wezwanie skierowane do rynków wschodzących do pogłębienia rynku obligacji w celu zwiększenia zużycia energii będącego rezultatem BIZ.

***Słowa kluczowe**: zużycie energii; BIZ; rozwój finansowy; rynki wschodzące*