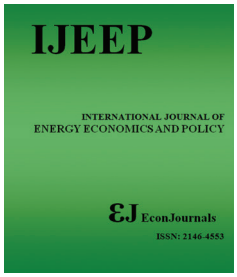

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Financial Development and Energy Consumption: Evidence from Germany

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ABSTRACT

This paper investigates the influence of several variables of financial development on electricity consumption in case of Germany. We assume that financial market development, economic growth and urbanization lead to an increase in energy consumption. The hypothesis is tested on example of Germany for the period 1990-2018. The results partly confirm the hypothesis. We found that economic growth and urbanization positively affect the energy consumption, while financial market development does not show statistical significance.

Keywords: Financial Market, Energy Consumption, Urbanization, Economic Growth
JEL Classifications: D53, Q41, P25, O47

1. INTRODUCTION

Nowadays, advanced economies show slower economic growth. In such circumstances, in order to achieve set goals of economic growth, diversification is required. There are a lot of various macroeconomic indicators and tools which could contribute to the macroeconomic stability and high rates of economic growth, as well as the overall economic well-being of the national economy. It is also true that if such indicators remain undervalued, the economy may work under capacity. Most developed and developing countries need to maintain high productivity across different sectors of their national economies in order to sustain economic growth.

In developed countries, such as Germany, the service sector plays an important role and its productivity is a key to sustainable economy and high rates of economic growth.

One of the main factors that have a significant impact on the development of the service sector is the financial market. With rising financial development along with its byproduct of economic growth, other sectors of the national economy perform more economic activities and, therefore, require more energy.

The growing volume of trading on the stock exchange, the increase in the number of approved loan applications from households, the increase in the need for working capital and investment needs on the part of economic entities, leads to the development of national financial markets (Mikhaylov et al., 2018; Mikhaylov, 2018a). The growth of financial markets thus spurs the growth of the national economy, which in turn leads to an increase in energy consumption by various economic agents.

Increasing growth rates lead to more opportunities and resources for investment and industrial expansion. It causes internal labor migration from rural to urban centers. This, in turn, affects economic growth in certain cities of the country, which inevitably leads to an increase in energy consumption. Thus, the multiplication of economic growth rates occur.

On balance, financial development positively influences energy consumption both directly and indirectly. The growth of financial

markets leads to an increase in energy consumption as well as investment and employment. They, in turn, on the one hand, cause an increase in energy consumption, and on the other, affect migration. Migration also can have a significant impact on the consumption of energy.

In this regard, the study of the relationship between the development of financial markets, economic growth, urbanization and energy consumption seems relevant. Thus, this study is devoted to the comparative analysis, as well as the search for the relationship between the financial development and energy consumption in Germany.

2. LITERATURE REVIEW

In the relevant literature review, Ozturk (2010) examines the relationship between energy, electricity consumption and economic growth in the light of the results of previous studies. According to the results of his research, in the academic environment on this issue there is no unambiguous point of view in connection with the existence of ambivalent and heterogeneous results of the studies dedicated to the research of the relationship between income, growth and energy consumption. Moreover, Ozturk (2010) proposes to improve methodological aspects of ongoing research on this issue, as well as to improve the methods and tools of analysis. This applies both to the selection of control variables and to econometric tests used to test hypotheses (see also following recent studies: Al-Mulali et al., 2015a; Rafindadi and Ozturk, 2016; Al-Mulali et al., 2015b; Nasreen et al., 2017).

For example, in the study by Adom (2011), the relationship between electricity consumption and economic growth rates in Ghana for the period 1971-2008 was tested. As a result of the study, he concludes that economic growth has a positive impact on the consumption of electricity, not vice versa. Acaravci and Ozturk (2012) using the data for Turkey for the period 1968-2006 confirmed the fact that electricity consumption increases economic growth and the reverse relationship can be considered statistically insignificant. Adebola (2011) in his study on the example of Botswana for the period 1980-2008 comes to the conclusion about the existence of this relationship, adding capital as the third control variable. According to the results of the study, electricity consumption supports economic growth, strengthens it. At the same time, the opposite effect-that is, the impact of economic growth on electricity consumption-is statistically insignificant. Moreover, capital has a significant impact on economic growth. Ali et al. (2015), using quarterly time series for the period 1971-2011 on the example of Nigeria, concludes that the development of financial markets has a positive but insignificant impact on the consumption of electricity in the long term, along with a negative but statistically significant effect of economic growth on electricity consumption. Moreover, electricity prices also have a positive impact on electricity consumption.

Using data for the period 1970-2012, Solarin et al. (2016) explores the relationship between urbanization and electricity consumption and economic growth on the example of Angola. As a result of research, they conclude that economic growth, urbanization and trade have a significant impact on economic growth in the long term. However, they also conclude that economic growth is strengthened by the growth in consumption of electric energy, urbanization, migration and trade. Khobai et al. (2017) and Mikhaylov (2019) explore the production function using electricity supply, trade and electricity prices as additional variables on the example of South Africa for the period 1985-2014. As a result of research, they conclude that the price of electricity and capital have a significant impact on the supply of electricity. Moreover, income, trade and electricity prices have a significant impact on employment.

Acaravci et al. (2015) explores the relationship between the variables on the example of Turkey for the period 1974-2013. As a result of the study, they conclude that electricity has a significant impact on economic growth, but the opposite effect is not statistically significant. Moreover, they have found a link between trade and foreign investment. At the same time, trade has an impact on foreign investment. Liaquat and Mahmood (2017) in the study presented an augmented model of electricity consumption and growth, by adding the debt cycle, accounting the problem in the energy electric sector of Pakistan. The study was conducted for the period 2005-2015. As a result of their research, they came to the conclusion that the circulation of debt and economic growth causes energy consumption. In this way, the use of electricity is enhanced by increasing economic growth in Pakistan. Moreover, circular debt and electricity consumption are also a cause of economic growth. Thus, this study presents the result of the bidirectional relationship between economic growth, energy consumption and changes in the debt burden.

Rahimi and Rad (2017) in their study on the relationship between electricity consumption and economic growth added an additional variable in the form of Internet usage. The study was conducted on the example of 8 developing countries for the period 1990-2013. The result of their study shows that the use of the Internet and economic growth have a significant impact on electricity consumption in the long run, while, national income has a positive impact on energy consumption only in the short term. They came to the conclusion that electricity consumption affects Internet usage and the last has an impact on the level of income. Al-Mulali and Ozturk (2015) investigated events that led to environmental degradation in the Middle East and North Africa (MENA) regions. To achieve the goal of the study, a panel model was used, in which environmental footprint was used to reflect environmental degradation, as the best indicator. The study was conducted for the period 1996-2012 and consisted of 14 MENA countries. The results of the Pedroni cointegration test revealed that ecological footprint, energy consumption, urbanization, trade openness, industrial development and political stability are cointegrated. Moreover, the results of fully modified ordinary least square showed that, energy consumption, urbanization, trade openness and industrial development increase environmental damage, while political stability reduces it in the long run. Shahbaz et al. (2014) explored the relationship between economic growth, electricity consumption, environmental degradation and urbanization on the example of the United Arab Emirates over the period 1975-2011. The study concluded that an inverted U-shaped

relationship between economic growth and CO_2 emissions exist, i.e., economic growth raises energy emissions initially and after achieving a threshold point of income per capita it declines (environmental Kuznets curve exists). Electricity consumption declines CO_2 emissions. The relationship between urbanization and CO_2 emissions was found to be positive.

In the case of Saudi Arabia, Alkhateeb et al. (2017a) and Alkhateeb et al. (2017b) found out that the energy sector has a positive significant impact on employment. Nyangarika et al. (2019a; 2019b) came to the conclusion that trade has a negative impact on pollution emissions. Economic growth positively affects the level of pollution emissions. Lopatin (2019a, 2019b), Meynkhard (2019) and Senan et al. (2018) have found positive effects of economic growth, urbanization and financial market development on the energy consumption in long and short run analyses.

Bass (2018) in his study devoted to Russia has approved the hypothesis that financial markets development gives birth to an increased level of electricity consumption.

Denisova et al. (2019) assumed the link between crypto currency implementation in the financial sector and energy consumption worldwide. The study showed that bitcoin mining as an element of financial development might possibly have a positive impact on environment.

However, even taking into account such a large amount of research on this issue, unfortunately the number of studies devoted to the relationship between the consumption of electricity and the development of financial market is limited. Moreover, there is no study on the search for these relationships on the example of Germany. In this regard, the study seems relevant and timely.

3. MATERIALS AND METHODS

Financial markets support economic activities through various channels and directions. For example, financial markets can enhance economic growth by providing loans (Mikhaylov, 2018b; Mikhaylov et al., 2019). As the business grows, it needs more energy. Thus, the expansion or growth of economic activity or of economic entities implies the increasing need for energy consumption.

Moreover, expansion implies internal migration, and urbanization can also increase the demand for energy, both from households and from economic entities. Thus, energy consumption may grow due to the growth of urbanization in the country. Moreover, income, as well as its changes, can have a significant impact on the level of energy consumption (Nyangarika et al., 2018). Given the difficulty of inter linkages of this specification, we follow Senan et al. (2018) and model the impact of the development of financial markets, urbanization and national income on the consumption of electricity of the following type:

$$lEC_t=f(lGDP_t, lFM_t, lURB_t) \quad (1)$$

t is showing a time period 1990-2018. The l is for logarithm. Most of economic relationships are not linear in nature. Therefore, we are supposing a log-linear relationship. EC_t, GDP_t, URB_t, and FM_t are for EC and gross domestic product (GDP) per capita (a proxy of economic income growth), urbanization (a proportion of population in city area) and financial market development (proxy by private credit as proportion to GDP) respectively. All series for Germany are collected from Thomson Reuters Datastream for a period 1990-2018.

Financial markets allow to extend the budget constraint of the households, thereby increasing the demand for goods and services. In this regard, we expect that the development of financial markets should lead to an increase in demand for electricity from households and economic entities. Also, urbanization, as a manifestation of internal migration in the national economy, should also lead to an increase in demand for electricity, due to the fact that the urban residents need more energy for their production function. National income reflects total economic activity in national economies, and energy is one of the main factors of production and consumption in order to ensure the continuity of the production or life cycle of an economic agent.

Thus, growing income in the national economy may require greater consumption of electricity for both consumption and production purposes (Denisova, 2019). In this regard, we expect that all sampled variables should have a positive impact on electricity consumption.

For time series analysis, the first step is to determine the stationarity of the sampled variables. In this regard, we use the unit root test to determine the stationarity or nonstationary of time series. Therefore, augmented Dickey-Fuller (ADF) test might be used. The ADF equation is following:

$$\Delta z_t = y_0 + y_1 z_{t-1} + \sum_{i=0}^{k} y_{2i} \Delta z_{(t-i)} + \omega_t \quad (2)$$

z_t can utilize all of our proposed variables one by one in the equation 2 to test the unit root. The negative and significant $\gamma 1$ can be claimed for a stationary series.

Then, we can proceed to cointegration analysis once we verify the series to be stationary. As the first step, the null hypothesis of no cointegration should be tested (H_0: $\alpha_1=\alpha_2=\alpha_3=\alpha_4=0$).

For the further analyses, we are employing simple linear regression with the following equation:

$$EC=\alpha+\beta x_t+\varepsilon_t \quad (3)$$

which describes a line with slope β and y-intercept α, ε_t is error term.

4. RESULTS AND DISCUSSION

The results of the study, presented in Table 1, show that variables do not fulfill the stationarity requirement at level, only primary energy consumption shows some stationarity with trend. Financial market development (no trend) and GDP become stationary after being first differenced. As for urbanization, it needs second-order difference to show stationarity.

Table 1: Augmented Dickey-Fuller test

Variable	C	C and T
lEC_t	−1,7594 (1)	−3,9215 (0)**
lFM_t	−1,8328 (3)	−1,8747 (3)
$lGDP_t$	−1,0621 (0)	−3,0415 (9)
$lURB_t$	−1,9907 (1)	−0,9512 (1)
ΔlEC_t	−8,6604 (0)***	−8,5325 (0)***
ΔlFM_t	−3,5216 (0)**	−1,1669 (2)
$\Delta lGDP_t$	−8,6604 (0)***	−8,5325 (0)***
$\Delta lURB_t$	−1,0208 (0)	−1,9701 (0)
$\Delta 2lFM_t$	−8,2661 (1)***	−8,4800 (1)***
$\Delta 2lURB_t$	−4,9655 (0)***	−5,2214 (0)***

, * 10%, 5%, 1%. Source: Thomson Reuters Datastream, calculated by author

Table 2: Regression statistics

Indicators	GDP	URB	FM
Multiple R	0,793867694	0,770768761	0,215528839
R square	0,630225916	0,594084483	0,046452681
Adjusted R square	0,61653058	0,579050575	0,011136113
Standard error	0,163446449	0,012573699	0,076776385
Observations	29	29	29
Significance F	2,762E-07	9,98779E-07	0,261495283

Source: Thomson Reuters Datastream, calculated by author. GDP: Gross domestic product

The results of the unit root test allow to assume heterogeneous order of integration.

Now we proceed to running regression (Table 2).

Multiple R shows how strongly the variables and EC are correlated. Thus, GDP with 0,794 and urbanization with 0,771 show a strong positive linear relationship, whereas financial market development have a weak linear relationship (0, 216).

If the energy consumption caused by different factors, then 63% of the variation caused by GDP, 59% by urbanization, 5% by financial market development.

Significance F value of GDP and urbanization is <0,05, which means these variables are statistically significant and we can reject the null hypothesis, while the value of financial market development is >0,05, i.e., this variable is not significant for the model and should not be used.

5. CONCLUSION

In this study, we were testing the relationship between the development of financial markets and electricity consumption on the example of Germany for the period 1990-2018. This included testing the correlation between energy consumption and GDP per capita, level of urbanization, and financial market development. The base period for the sample variables is 1 year.

The results of the study partly confirmed the hypothesis. We have found that financial market development is not significant for the model and should not be used, it showed a weak linear relationship with energy consumption. Meanwhile, national income and urbanization perform a strong positive linear relationship.

Thus, we can assume that the financial development has a positive impact on energy consumption in Germany, i.e., financial development leads to an increase in energy consumption. The results of the study can be useful in forecasting the consumption of energy in light of the growth of national income and internal migration processes. Taking into account, albeit slow, financial development in Germany, it is recommended to take into account the potential impact of these areas of the national economy on the energy sector. Taking into account the obtained results is important in forecasting the need for energy on the one hand, as well as in determining the strategy for the development of energy security of the national economy on the other.

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