ENERGY AND ECONOMIC RELATIONS IN A POSITIVE ECONOMY

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Abstract: Depending on the specific economic structure of the country, the energy sector plays a more or less important role in terms of added value, jobs and other indicators, but more importantly is the role of energy products in the production processes and end use of other industries. Being one of the branches of the economy, energy sector is also an integral part of the concept of economy both in terms of national economy and research discipline.

As shown in the following analysis, attempts to separate energy from the economy can only be very conditional. The concept of economics used in this work in the context of energy relations should be understood not as one of two completely separate objects, but as a sort of enveloping element. Here, it is also useful to remember the concept of the remaining economy, which describes the economy of the country, except energy - all other economic activities, their products, institutional sectors.

Keywords: economic relation; energy sector, economic growth; energy consumption; economic models.

Introduction

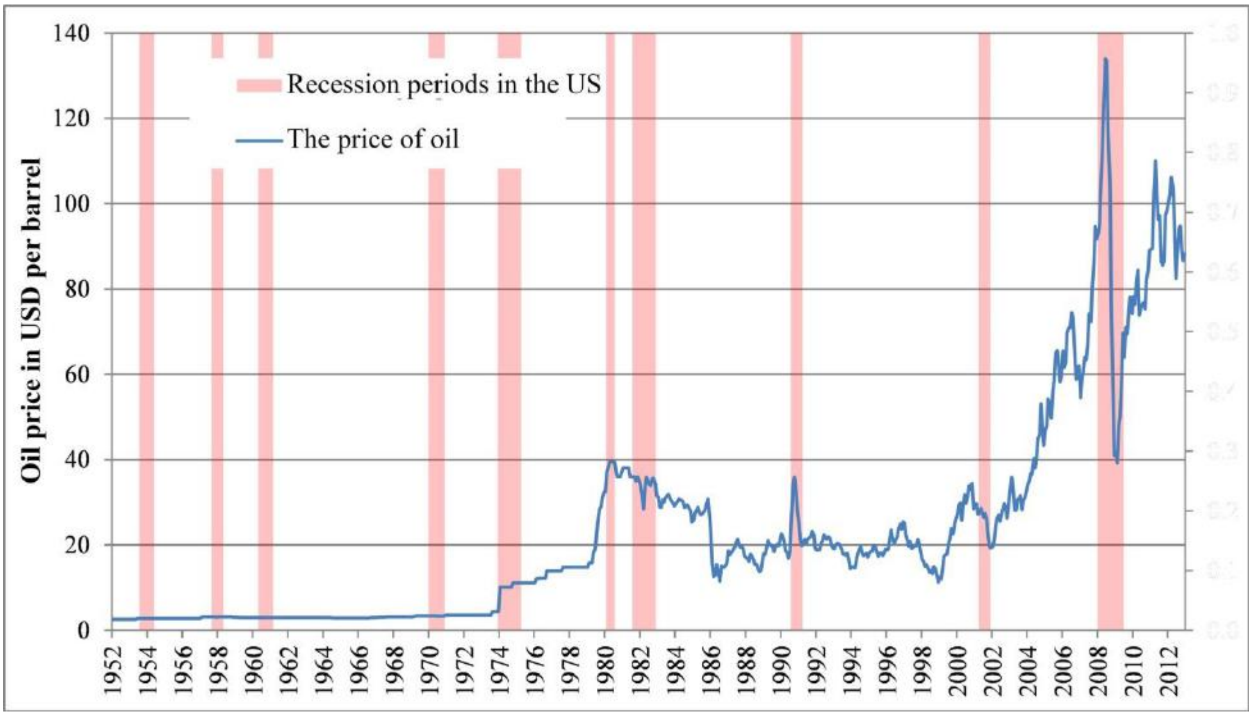
Energy relations with the rest of the economy are perceived intuitively: energy is considered "the blood of a modern economy", because in virtually all economic activities energy resources are an element of higher or lower importance. Changes in the supply of energy resources in this article are understood as displacements in the supply curve of resources provided by the energy sector, leading to internal and external factors. Taking into account the objectives of the analysis, the methods of positive and normative economy discussed in this article are used to assess energy relations with the rest of the economy.

For a long time, changes in oil demand have been seen as a kind of an indicator for all changes in energy demand because the prices of other fossil fuels and their potential demand relate directly to oil. This is also due to practical reasons: most energy technologies can use both petroleum products (mazut) and natural gas. Because of effectiveness parameters of the technologies, the environmental impact, prices of pollution permits and similar factors, the prices of petroleum products and natural gas are linked, therefore in some studies are generalized and analyzed as hydrocarbon resources (van Ruijven and van Vuuren, 2009).

In connection with that, it makes sense to start the analysis of the relationship (such is the purpose of the study) between energetics and the rest of the economy from the impact oil prices have on the economy.

Studies of the relationship between energetics and the economy

The relations between energetics and the economy are illustrated in fig. 1, which portrays the dynamic of the spot price of probably the most representative energy source – oil – (Spot Oil Price: West Texas Intermediate) and the periods of economic recession in the USA (as defined by (National Bureau for Economic Research, 2012)).



The source of the information in the graph: (Federal Reserve Bank of St. Louis, 2012)

Fig. 1 The dynamic of oil prices and periods of recession in the USA 1946-2012

As seen in fig. 1, in the last few decades, increasing oil prices have been accompanied by a recession in the USA. On the one hand, Hamilton (2013) observes that ten out of eleven periods of recession in the USA occurred after an abrupt increase in oil prices. On the other hand, fig. 1 also shows that during some periods of recession or immediately afterwards oil prices went down. Although data from other countries are not as abundant, due to globalization a similar situation (economic development slows down as the prices of energy sources rise) can be seen in other countries that import oil and other energy sources (opposite effect – decrease of oil prices – is usually conditioned only by the situation in large economies).

Some causes for peaks of oil prices shown in fig. 1 are explained by the information on the most prominent global oil supply disruptions of the 20th century, provided in table 1.

Table no. 1 External disruptions of global oil demand

Date	The event	Decrease in global oil production, %	Change in US Real GDP, %
1956, November	The Suez Crisis	10,1	-2,5
1973, November	Arab-Israeli War	7,8	-3,2

1978, November	The Iranian Revolution	8,9	-0,6
1980, October	Iran-Iraq War	7,2	-0,5
1990, August	Gulf War	8,8	-0,1

Source: (Hamilton, 2008)

From the elasticity and energy share of GDP it is calculated that the direct impact increasing oil prices have on the economy of the USA could not exceed 0.4 pct., although because during the typical years of the period presented, the economy of the USA grew 3.4 pct., it is stated that in practical observations the resulting numbers are completely different – 4 pct. instead of 0.4 pct. The big difference is explained by such indirect causes as complications resource reallocating between the sectors of economy that had experienced oil shock. An often mentioned and greatly illustrative consequence of oil shock is the decrease in demand for fuel-inefficient cars, which leads to poorer utilization of their factories. Because reallocating the resources of work and, especially, of capital require additional costs, a part of recourses is not utilized and that increases the impact oil shocks have on the economy (Hamilton, 2008).

There has been a lot of research trying to empirically evaluate the energetics-economics relations, especially using the same methods for the time series of different countries (in studies of this kind the initial application of methodology is probably the most time consuming stage). Different methods of econometrics are utilized; the studies include different time periods and countries or their groups. There are four widespread main hypotheses tested in empirical studies of the relationship between energetics and the economy (Yildirim and Aslan, 2012; Ozturk, 2010; Salahuddin, M., Gow, J. 2014):

- **Conservation hypothesis**: the dynamic of economic growth determines the consumption of energy sources. This hypothesis is validated by uni-directional causality when economic growth determines the consumption of energy.
- **Growth hypothesis**: the consumption of energy plays an important direct or indirect (complementing work and capital) role in the process economic growth. The growth hypothesis shall be deemed to have been validated if uni-directional causality is established when energy consumption leads to economic growth (e.g. as energy consumption increases, the real GDP increases).

- **Feedback hypothesis**: presupposes the variables in question are mutually dependent. The validation of this hypothesis – the existence of bi-directional causality.
- **Neutrality hypothesis**: states that there is no causal link between energy consumption and economic growth. The hypothesis is validated if it is proven that there is no causal link between the variables of economic growth and energy consumption.

From a practical point of view, the validation of one of these hypotheses is greatly significant for the choice of policy instruments. In case of the growth hypothesis, austerity policies might negatively affect economic growth. Meanwhile, if the conservation and neutrality hypotheses are validated, it is to be expected that saving energy would not have such consequences. Finally, the validation of the feedback hypothesis shows that saving energy would have a negative effect on general economic growth, therefore policy instruments should be applied in a less aggregated way, taking into account different types of energy or the economic sectors of a country (Yildirim and Aslan, 2012). Explicit validation of one of these hypotheses would also have implications for the optimal integration of energy technologies: the validation of the conservation hypothesis suggests that as the development of the energy sector is being modeled, the rest of the economy can be seen as an exogenous factor, which determines energy consumption. Meanwhile, the validation of the feedback or growth hypotheses presupposes energy sector's impact on the rest of the economy.

Causality from electricity consumption to economic growth

Research solely on the relations between the consumption of electric power and economic growth has shown that the prevalent direction of causality is from the consumption of electricity to economic growth, therefore, a conclusion is drawn that electric energy is a limiting factor for economic growth (Ozturk, 2010). However, Payne (2010) conducted an immensely broad review (broader than Ozturk (2010)) of studies on consumption of this energy source and economic growth and found that, not taking into account the countries analyzed, time periods and methodologies used, 31.15 pct. of articles validate the neutrality hypothesis, 27.87 pct. – the conservation hypothesis, 22.95 pct. – the growth hypothesis and 18.03 pct. the feedback hypothesis. Such even distribution is explained by choice of variables, model specifications, different time periods analyzed and econometric views. Greater granularity of variables (for example, in the environment of the production model or by including other variables, such as formation of fixed capital, population growth, etc.) is suggested as one of the possible solutions to the problem of inconsistency in the studies (Ozturk, 2010). The premise that granularity of variables is significant is confirmed in a study conducted by Gross (2011), which shows that the determination of causation in econometric models depends on the level of aggregation of variables. In the opinion of the scientist, because of the Simpson paradox (a situation where statistical dependence is valid for subpopulations, but disappears on a population level), two-dimensional models that analyze causality on a macro level only are not suited for the analysis of the relations between energetics and economics, especially in those cases where coverage of variables differs. Excessive aggregation can interfere with correct evaluation of the relations when economic growth (recession) is determined by different sectors of economy. For example, if economic boom is achieved due to the impact of energy-intensive industries and economic decline is primarily affected by industries that consume energy relatively not as intensely, it is obtained that during the recent period a country's economic growth did not affect energy consumption (Medlock, 2009). Analysis of a whole chain of periods like these derives distorted results, although on a subpopulation (in this case – a country's economic sectors) level identification of clear links between energy consumption and economic growth would be possible.

Results may also be distorted by indicators of the shadow economy, which are highly unstable (Karanfil, 2008). Moreover, at least a few authors in their works conclude that an econometric analysis, when the same methods and variables are utilized, and only the time period analyzed is changed, does not have great potential to expand knowledge of the relations between energetics and economics (Ozturk, 2010).

It should be noted that empirical assessment of such a structure of the energetics-economics relationship is also quite complicated due to its cyclic nature and the complexity of the time series, when econometric methods are simply unable to abstract the effects of the factors under consideration. Generally, the time series in question spans over more than thirty years and in that time technologies operating in the energy sector change greatly, alongside the structure of economic sectors, manufacturing technologies in some sectors of the economy, therefore the nature of the relations can change. From a methodical point of view, different objects are covered in different sections of the time series; therefore their econometric analysis is also only partly correct.

This problem is well illustrated by studies that analyze the relations between renewable energy resources and economic growth, because as practice has shown, twenty years ago precisely technologies of renewable energy resources could be called "energy technologies of the future". Because the rapid development of renewable energy resources has started relatively recently, it impossible to use time series that span over many years in studies. Bobinaite et al. (2011a) analyzed Lithuania's GDP growth and the volume of consumption of renewable energy resources and found that consumption of renewable energy resources has a short term positive effect on real GDP. Using data from Russia and twelve other countries of Eurasia from 1992-2007, Apergis and Payne (2010c) identified bi-directional relations between the consumption of energy from renewable resources and economic growth, thus validating the feedback hypothesis. This hypothesis is also validated by data from countries of the OECD from the 1985-2005 period (Apergis and Payne, 2010b), data from countries in Central America from the 1980-2006 period (Apergis and Payne, 2011b). A study by the same authors, covering 80 countries and the 1990-2007 time period, also confirms bi-directional relations for both renewable energy sources and fossil fuels (Apergis and Payne, 2011a).

The already discussed series of studies by Apergis and Payne contrasts with a study by Menegaki (2011), which analyzed 27 countries of the European Union in the 1997-2007 time period and found only a very weak connection between the consumption of renewable energy resources and economic growth. The author notes that such validation of the neutrality hypothesis should not be applied to the future because an assessment of the past does not indicate the future situation, especially bearing in mind the EU's commitments to the development of RES, in the background of which "cost-minimizing consumers and profit-maximizing manufacturers will be governed by an improved regulatory environment".

The role of change in energy technologies is also emphasized by Beaudreau (2010), who points out that, even though historians and growth theorists see the evolution of the steam engine, the electromagnetic motor and the development of energetics that followed afterwards as a crucial factor in economic growth, current econometric tests weakly support such a point of view. According to this scientist, the Granger test (the same could be applied to other evaluation methods of econometric causality) does not have a solid theoretical basis; therefore the economic interpretation of the results is problematic. Although many studies show that the consumption of energy has an effect on economic growth, they do not show by what mechanism that is achieved. As the consensus on the treatment of energy resources in the production function is lacking, studies on causality should be seen as speculative and serviceable for studies of exploratory nature, but not for a more in-depth analysis. As Beaudreau (2010) notes, most non-economists believe that causality works from energy consumption to GDP growth, while from the point of view of most economists, GDP growth leads to energy consumption, considering energy resources as elements of intermediate consumption. Meanwhile, from the perspective of energy consumption, the most important factor is availability of energy, and not energy consumption as such. Noteworthy is that, in this case, not only the change in energy technologies is significant, but also the change in economic sectors of a country. It is possible that different elements of the time series represent completely different levels of energy intensity due to integrated measures to increase efficiency of energy consumption.

While analyzing the relations between oil prices and economics using econometric methods, their weakening was recorded by the end of the 20th century, which is explained by a decrease of the input of the energy sector to gross domestic product during some periods, increasing productivity, also from past experience connected to improvement of policy instruments intended to neutralize price shocks (Brown and Yücel, 2002), although the recession of the recent period (see Fig. 1) denies the premise of weakening relations. Also, although most studies show a negative impact increasing oil prices have on importing countries, there are studies with opposite results. Results, interesting from a theoretical and practical point of view alike, from a study conducted in China showed that both inflation and GDP growth are positively correlated to oil price (if oil price increased by 100 pct., GDP would grow by 9 pct. and inflation would increase by 2.08 pct., although China is an importing country (Du, Yanan and Wei, 2010)).

An aspect related to the use of economic models, especially concerning the "net" econometric models – the so called Lucas critique. Its essence is that if an econometric model's structure consists of optimal decision rules of economic agents and if the optimal decisions systematically change due to the decision makers' impact, it means that changes in policy have to systematically change the structure of econometric models (Lucas, 1976). This way any policy changes change the parameters of econometric models. The Lucas critique can also be applied in the case of change in technologies: if the parameters of an econometric model were assessed with one kind of technology, they might not be valid if the technology park changes more significantly. Lithuania's example illustrates this very clearly: the closure of the Ignalina nuclear power plant not only meant change in the structure of electricity generation, but the loss of a power plant that generated over 70 pct. of consumed electricity in the country. Changes of this magnitude in the structure of the energetic sector greatly limit the application of econometric methods due to the lack of relevant time series.

The arguments that are presented to reject the Lucas critique can also be used as arguments against modeling as a way of knowing reality.

Conclusion

Studies have shown, that any methodologic approach is good when it is chosen based on what questions are desired to be (or can be) answered. In conclusion, it can be said that econometric studies of energy consumption and economic growth allow the identification of fundamental tendencies (therefore can be used for forecasting in a relatively stable environment) and regularities and also produce valuable material for economic interpretation. Improving such studies, more attention should be payed to economic interpretation of the results, which is also related to the need for disaggregation of the time series. Econometric models can summarize past data well, but their use for a deeper *ex-ante* analysis is limited by the ever-changing nature of the relations under consideration and, in the case of most countries, limited statistical data. It should be noted that a complex approach to energetics and a detailed analysis of the energetics-economics relations on a technology and economic activity type level might not only contribute to optimal integration of energy technology, but also (when applied retrospectively) might be useful in studies of the positive economy.

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