S. Jevons rebound effect analysis. Theoretical approaches, good practices and possible solutions for Romania

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Abstract: *This paper determines the rebound effect from a comparative perspective on the Romanian economy: before and after accession to the European Union.The empirically determined rebound effect is a defined analysis of the link between production factors in order to present the non-singularity of energy in determining the economy. Therefore, factors such as capital, labor force and technological progress are included in the analysis.The rebound effect on the Romanian economy shows that it had high values when there was a lower increase in energy consumption compared to GDP growth, indicating the impact of economic sustainability in energy use. Since 2015, Romania has recorded a constant level of rebound effect involving an irrational action of energy use.*

Keywords: *rebound effect, energy consumption, Data Envelopment Analysis*

JEL Classification*: Q43, P28, C80, C67*

Introduction

The improvements of energy efficiency have technology as an important source, with many concepts of sustainable development highlighting the depth of improvement through the visible technological progress in recent decades (Berkhout, Muskens, & Velthuijsen, 2000; Binswanger, 2001).The technology is perceived as the one that can maintain the current standard of living or it can develop living at a low consumption of resources and energy. Those desiderates determined the economic agents to react, having a behavioral response that can generate the possibility of not collecting the total profit of energy conservation. However, a price reduction can have effects such as: if the use of a technologically advanced product involves a lower energy consumption bill, then a larger number of products will be used, so there is an increase in purchasing power, but which it can have a negative effect on the intense use of energy through the product, which makes the action of conserving energy disappear; a low-energy bill for a product may involve an increase in purchasing power for other types of goods which higher energy consumption is required.In a broader spectrum, changing the use of other types of goods at the level of households and companies can affect energy demand in a positive or negative way.The effects mentioned above are those that will help to familiarize the concept of rebound effect (Berkhout, Muskens, & Velthuijsen, 2000).

Berkhout, Muskens, & Velthuijsen (2000) mention the expression *ceteris paribus* to help analyze the previous process.However, changes occur because the efficiency of the

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equipment causes a decrease in the price per unit of product, implicitly leading to an increase in consumption.The trend of consuming productive services, as well as the additional demand for them that involves higher energy consumption causes some of the *ceteris paribus* gains to dissipate.This loss of energy conservation is called the rebound effect.Also, this improvement of energy efficiency that leads to an increase in energy consumption is also called *The Jevons Paradox* (Jaume & Ignasi, 2015).

Jaume & Ignasi (2015) define the rebound effect as the result of economic responses to the behavior of economic agents when there is a decrease in the cost of providing energy services due to improved energy efficiency. Berkhout, Muskens, & Velthuijsen (2000) exemplify the definition of the rebound effect through the mobility of a car.Therefore, a car optimized in terms of energy efficiency that has a low energy consumption will determine the travel of several kilometers observing how the rebound effect becomes visible.The rebound effect mentioned above attracts other changes, such as:increasing the cost of maintenance which leads to a higher profit for producers and services and also a decrease in the earnings of optimized car owners, who again travel shorter distances to reduce the costs.The previous example shows that the rebound effect can generate serious changes in the economy, which denotes the interdependent connection of unitary concepts in society.

The rebound effect has been intensively studied in recent decades, as evidenced by the literature concentrated in its analysis.

The dimensions of the rebound effect

The history of the rebound effect (years 1980 and 1990) through empirical analyzes confirms the objective reality of the rebound effect of improving the energy efficiency of heating, insulation and transport systems. In contrast, its actual importance is contested by economists because the rebound effect is considered to derive from the single service model, the result of which is the one concluding the disagreement. The fact that the model neglects the substitution effects between services and thus the effect of income, and econometric studies based on the single service model may lead to a false representation of the situation in fact entails a lack of agreement on existence (Binwanger, 2001).

Due to the evolution over time, since his plea (Jevons, 1865) for the rebound effect based on the study of coal power, Khazzoom (1980) based on studies, has claimed that the rebound effect is empirically highlighted and has an influence on energy consumption (Binswanger, 2001). In addition to this, Khazzoom (1980) argues that an energy-efficient product does not need a higher initial cost, giving the example of a small car that has a lower cost and efficiency in terms of mobility – lower fuel consumption. owever, his work (Khazzoom, 1980) led many economists to study the rebound effect in 1980 and 1990, predominantly in the years 1980, because the recovery effect was heavily debated at the expense of high oil and gas prices. Their level has led to increased interest in investing in energy saving mechanisms (Walker & Wirl, 1993). In 1986, the investment impulse decreased due to the fall in oil and gas prices and from 1987 it was noted that energy prices were unchanged in large proportions (Binwanger, 2001).

A well-known debate is that between Khazzoom (1980) and Lovins (1988), the latter challenging his support (Khazzoom, 1980) by saying: *That return of demand is generally not a significant* one. Although most of his claims (Lovins, 1988) do not have an empirical analysis, Binswanger (2001) argues that the argument challenging the existence of the rebound effect is relevant because it involves the impediments to the aforementioned single service model. According to him (Lovins, 1988), the return effect is felt on income rather than on price, adding that substitution effects between services should only be validated alongside the revenues from increased energy efficiency.

Brookes (1990) is the energy economist who carried out the first work with the aim of developing the argument of the importance of the rebound effect from a macroeconomic point of view (Allan, Hanley, McGregor, Swales, & Turner, 2007). It calls for the possibility of a rebound effect at an economic level, the effects of which may be satisfactory in order to fully compensate for the energy savings resulting from improved energy efficiency (Sorrell & Dimitriopoulos, 2008). In other words, the reduction in resource use through increased energy efficiency is offset by the rebound effect, which results in an increase in resource use rather than a decrease (Figge & Thorpe, 2019).

Postulat Krazzoom — Brookes (Khazzoom, 1980; Brookes, 1990; Saunderders, 1992), presents the rebound effect in a macro-economic perspective: Reducing energy consumption through energy efficiency measures can offset the increases associated with energy demand. If energy efficiency measures generate higher energy consumption, the rebound effect will be defined as *the backfire* effect (Saunders, 2000).

Figge & Thorpe (2019) discover a third dimension and a gap in the literature regarding the rebound effect due to this additional dimension. Demand has been identified as the main mechanism underpinning the boom ebb in previous research: Higher efficiency produces higher demand, leading to increased involuntary consumption of resources. The authors suggest that these unforeseen changes in resource consumption could be driven by changes in production, notably through changes in resource flows into production resulting from environmental efficiency. As a result, production is perceived as a potential rebound factor.

Typology of the rebound effect

Empirical studies note the distinction of three types of cumulative rebound effects from the improving energy efficiency: direct rebound effect, indirect rebound effect and rebound effect throughout the economy.

The direct rebound effect

The improving energy efficiency for an energy service decreases its actual price and it may result in increased consumption of the reported service.As a result, there will be a tendency to compensate for the decrease in energy consumption resulting from improved energy efficiency (Barker, Dagoumas, & Rubin, 2009). Sorrell (2007) notes that many cases of energy efficiency improvements do not reduce energy consumption as much as simplistic engineering models indicate.These improvements have made energy services cheaper, leading to an increase in the consumption of these services.A good example would be the situation of vehicles: low-fueled vehicles make travel more accessible, with consumers being able to choose to travel more kilometers and / or more frequently, partially offsetting energy savings.In the same way of perceiving the direct rebound effect, a similar example is the situation of a factory that uses energy more efficiently, becoming more profitable, which stimulates additional investment and increased production.

Greening, Greene, & Difiglio (2000) show the direct rebound effect for consumers, being limited to the microeconomic level.Therefore, the direct effect of a price reduction can be decomposed into substitution effect and income effect.In this regard, if the price of energy services falls, consumers should replace certain energy services indefinitely.However, the above disregards the potential for satisfaction for a particular service, limiting the potential level of substitution and the choices consumers make with other spending when faced with a budget constraint.

Sorrell (2007) decomposes the direct rebound effect for improving energy efficiency by both consumers and producers.In the case of the direct effect on the consumer, the decomposition is related to the substitution effect, so the consumption of energy service relative to a lower price that can replace the consumption of other goods and services, while maintaining a utility or consumer satisfaction at a constant level , as well as the income effect in which a higher degree of utility is obtained by increasing the consumption of goods, services and energy service, as a result of the increase in real income generated by the improvement of energy efficiency.Similarly, in the case of the direct rebound effect for the producer, the substitution effect by which low-cost energy services replace the use of capital, labor and materials in achieving a constant level of production, the output effect being different.This, through the costs saved by improving energy efficiency, allows the creation of a higher level of output, while increasing the consumption of all inputs, including energy.

The indirect rebound effect

Assuming energy use to the same extent, there are reasons why overall energy savings may be lower than the basic calculations suggest.Drivers of fuel-efficient cars, for example, can spend the money saved on other energy-consuming goods and services, such as an international flight.To the same extent, any decrease in energy demand will lead to lower energy prices, encouraging increased use of energy consumption.Previous processes are known as indirect rebound effects (Sorrell, 2007). Orea, Llorca, & Filippini (2015) argue that the indirect rebound effect measures the reallocation of energy savings to other goods and services that require energy.For example, the savings generated by home use of energy efficient appliances can be used to finance holidays, leading to an increase in energy consumption and greenhouse gas emissions.

Regarding the economic actors, the indirect rebound effect is felt differently.For consumers, lowering the effective price of energy will cause changes in demand for other goods and services that require energy for their supply, thus leading to an indirect effect on aggregate energy consumption.For producers, the indirect rebound effect is felt by improving energy efficiency which involves changes in demand for other production factors.At the same time, lowering production costs in one sector can reduce entry costs in another sector leading to increased production and consumption in an entire economy (Barker & Foxon, 2006).

Also, indirect rebound effect is broken down in turn in embodied energy and indirect energy consumption needed to increase energy efficiency and side effects occurring as a result of increased energy efficiency.The energy efficiency improvements can be understood as a substitute for energy capital based on possible energy saving estimates in different industries.Currently, the estimates of energy savings omit the energy consumption needed to generate and maintain the relevant capital also called embedded energy. By replacing capital with energy, the energy consumption is shifted from the sector in which it is consumed in the sectors of the economy that create that capital, which can increase in other sectors of the economy (Sorrell, 2007).

The economy-wide rebound effect

Individual energy efficiency improvements can have a small indirect impact. By contrast, the overall impact of the various energy efficiency gains across the economy can be considered significant.A decrease in the real cost of energy services will reduce the cost of intermediate and final goods across the economy, resulting in a series of price and quantity adjustments, with energy-intensive goods and sectors gaining at the expense of the least energy consuming.In particular, energy efficiency improvements are likely to reduce energy prices, resulting in an increase in aggregate global energy demand (Barker & Foxon, 2006).

Typically, the rebound effect across the economy is defined in relation to the national economy, although changes in business patterns and energy costs at the international level could have an impact in other countries as well.As markets, technology, and human behavior are constantly adapting, rebound effects can also be expected to increase (Sorrell, 2007).

The economy-wide rebound effect of energy can be defined as additional energy consumption resulting from increased production as a result of advances in energy efficiency, especially the demand for goods or services determines energy consumption.Due to energy efficiency, the effective price of energy service is reduced, while lowering the cost of distributing goods or services and stimulating demand, followed by promoting increased production.As a consequence, energy consumption increases, partially canceling out initial energy savings (Lin & Du, 2015). In developed countries, energy consumption has expanded at a slower pace than the (overall) economy as a whole, with the result that current technological advances have increased the efficiency with which energy is used, helping to separate energy consumption from economic growth.Thus, when different energy sources are measured in terms of their relative quality or economic productivity, the link between energy consumption and economic growth is considered much stronger (Sorrell, 2007).

The aggregate description of the three effects

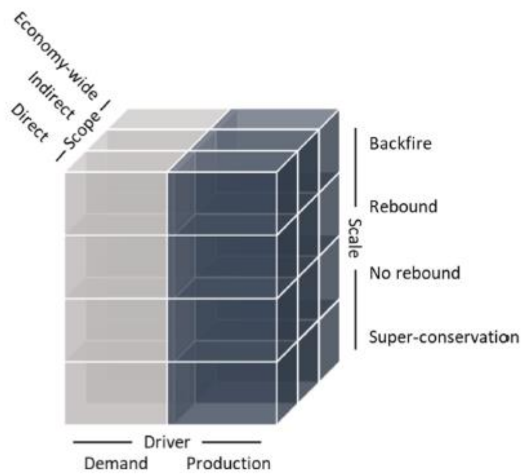
Sorrell & Dimitropoulos (2008) argue that the three rebound effects mentioned above are hotly contested by many analysts, the argument given by(Schipper &Grubb, 2000) is that the effects have a lack of importance for most energy services, in contrast to Greening, Greene, & Difiglio (2000), which support their existence and importance by analyzing the effect of fuel consumption on an energy service.However, in recent years, methodological research on the rebound effect has been limited to the indirect rebound effect and the economy-wide rebound effect to the detriment of the direct rebound effect (Jaume, 2017).

In terms of empirical analysis, the indirect rebound effect and the rebound effect across economies include equilibrium adjustments that are susceptible to research, while the direct rebound effect is in opposition due to quasi-experimental studies and of econometric analysis of secondary data.Such studies are those subject to challenges in the literature, being a deficit of definitions and basic methodological problems of the rebound effect that could be influenced (Sorrell & Dimitropoulos, 2008).

Jaume (2017) argues that analyzes show that a low level of direct rebound effect can trigger indirect rebound effect depending on the actions taken by economic agents and the economic structure of economies.In this sense, it can be seen that in the context of improving energy efficiency, the indirect rebound effect can be classified as a complement to the direct rebound effect than another type of rebound effect. Also, Barker, Dagoumas, & Rubin (2009) show that the indirect effect and that of the entire economy are at the macroeconomic level, being categorized as a macroeconomic rebound effect. Jin & Kim (2019) empirically analyze the rebound effect in terms of macroeconomic growth.In this sense, the decrease of energy intensity determines the decrease of the amount of energy needed to create an economic production, being related to the increase of energy efficiency.For a microeconomic level, the direct rebound effect is the only one targeted (Sorrell & Dimitropoulos, 2008).

In conclusion, existing research on the rebound effect can be divided into two categories: the field of applicability represented by the contrast between the three effects, and also the scale represented by the direction and size of the effect from an expected use of reduced resources (super-conservation) to a higher utilization than the previous use of resources (backfire) (Figge & Thorpe, 2019).

Figure 1. Systematization of the rebound effect



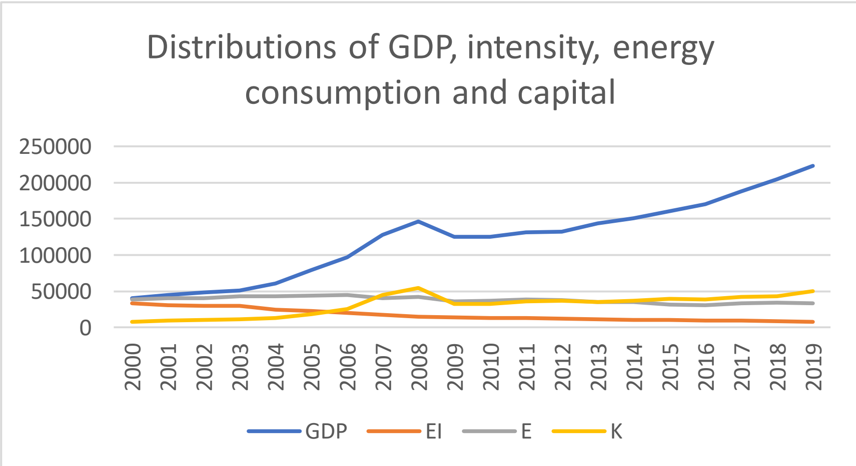
Source: Figge & Thorpe, 2019, page 62

Exploratory analysis of the macroeconomic level rebound effect in Romania

It is known that Romania became a member of the European Union on January 1, 2007, ending the fluctuating period of the economy subject to the transition from communist government to democracy.The period 2000 - 2006 represented an intense preparation and an opportunity for the Romanian economy to develop. Although this whole process was a pressure, Romania's integration into the European Union brought a socio-economic expansion that involved an increased involvement of trade relations, increases in production and technology. The post-accession period was marked by an increase in the quality of life and economic modernization, the main objectives of the European Union being those of economic and social cohesion (Albu et al., 2017).

In order to analyze the rebound effect, macroeconomic data from 2000 to 2019 were selected from the EUROSTAT website, highlighting the periods 2000-2007 and 2008-2019. Energy consumption (E) in the main economic sectors (industry, agriculture, services) is expressed in thousand tones, while energy intensity (EI) is kilograms of oil equivalent (KGOE) per thousand euro. Capital (K), respectively labor force are determined by the sum of capital input, respectively labor input expressed in thousands of employees from the three sectors mentioned above; Gross domestic product (GDP). Although gross domestic product is influenced by the employed population, the variable number of employees was selected to highlight technological progress and the contribution of economic sectors to the payment of taxes on employment contracts. To illustrate them in graphic format (Figure 2), the data has changed as follows: Intensity was multiplied by 10, and the energy consumed was multiplied by 100.

Figure 2. Distributions of GDP, intensity, energy consumption and capital in Romania



Source :Made by the authors based on data taken from EUROSTAT

The Cobb-Douglas production function and the efficiency score calculation function in the RStudio software were used for the exploratory analysis of the rebound effect. Below are how they are integrated into the analysis to determine the rebound effect.

In this study, the macroeconomic rebound effect is determined by energy consumption, more precisely by the ratio of energy consumed and the potential of energy consumed that could have been saved in order to have a definite economic growth of energy. The rebound effect from an empirical point of view is determined as follows:

$$R_{E,t} = \frac{E_{t,actual}}{E_{t,potential}} - 1, \qquad (1)$$

where $E_{t,actual}$ and $E_{t,potential}$ represent the actual energy consumption, respectively the potential energy consumption calculated based on the DEA function from RStudio (Data Envelopment Analysis).This function involves the analysis of units in order to determine an efficient decision (efficiency score) according to the factors of production represented by technology, energy, capital and labor, in order to have a strong output in the country's economy.To determine the technological factor used in the DEA function input, the Cobb-Douglas production function is used as follows:

$$Y_t = Ae^t L_t^{\alpha} K_t^{\beta} E_t^{\gamma} \varepsilon_t, \qquad (2)$$

where Ae^t represents the variable of technological progress in the reference year t, Y_t represents the GDP, E represents the energy consumption, respectively K and L represents the capital and the labor force from the three economic sectors.α, β and γ represent the outputs of the elasticities corresponding to the production factors.

Therefore, the potential energy consumption is calculated as follows:

$$E_{t,potențial} = EF_t \times Y_t \times EI_t, \tag{3}$$

where EF_t represents the efficiency score, Y_t and EI_t dentote GDP, respectively energy intensity. The rebound effect is thus determined by the potential energy consumption derived from factors of production and GDP. An advantage of this approach is the accuracy of the estimate, because the rebound effect is determined by several factors and not just energy intensity. Thus, the rebound effect is well defined with the country's economy.

The rebound effect at macroeconomic level in Romania is determined calculating the potential energy savings based on the improvement of energy intensity.

First, the variable of technological progress is determined using the Cobb-Douglas production function as described in equation (2).The coefficients of elasticity of each variable (α, β, γ) will be established by applying linear regression after the logarithmic transformation from equation (1) to equation (4) in the Eviews software.

The logarithmic transformation is:

$$\ln Y_t = \ln A + t + \alpha \ln L_t + \beta \ln K_t + \gamma \ln E_t + \varepsilon_t \tag{4}$$

Results of the linear regression of the Cobb-Douglas production function are presented in the table below.

Table 1. Results of the linear regression of the Cobb-Douglas production function

Explanatory variable	OLS estimation Coefficient
Constant (A)	9,470711
Labor force (L)	0,204510
Capital (K)	0,415204
Energy consumption (E)	-0,729113
R-Squared	0,995370

Source: Made by the authors based on results from Eviews

Therefore, the Cobb-Douglas production function is:

$$Y_t = 9{,}470711 e^t L_t^{0{,}204510} K_t^{0{,}415204} E_t^{-0{,}729113} \varepsilon_t. \tag{5}$$

The value of the regression coefficients are presented in the table number 2.

Table 2. Regression coefficients

Year	GDP (millions euro)	Energy consumption (E) (KGOE)	Labor Force (L) (thousands of persons)	Capital (K) (millions euro)	Technological progress
2000	40.594,9	337,15	3.869,9	7.761,7	0,890251
2001	45.143,6	309,74	3.352,2	9.498,1	0,880489
2002	48.695,7	300,38	2.990,3	10.451,9	0,877738
2003	51.108,5	298,19	2.920,6	11.622,1	0,874172
2004	60.402,0	249,72	2.551,3	13.466,8	0,861288
2005	79.223,9	230,77	2.812,3	18.509,0	0,84605
2006	97.215,6	205,97	2.747,9	25.875,0	0,829876
2007	127.632,0	176,37	2.426,6	45.108,4	0,806729
2008	146.590,6	148,41	2.373,3	54.658,5	0,792078
2009	125.213,9	136,09	2.352,4	32.552,6	0,802389
2010	125.472,3	134,62	1.821,6	32.713,8	0,806029
2011	131.841,6	133,05	1.714,2	35.919,2	0,803881
2012	132.711,2	125,17	1.762,5	36.541,6	0,79913
2013	143.690,4	111,89	1.755,8	35.493,6	0,794671
2014	150.708,6	107,46	1.627,5	36.715,4	0,793145
2015	160.149,8	103,71	1.557	39.703,6	0,790078
2016	170.063,4	95,85	1.787,9	39.024,4	0,7846
2017	187.772,7	91,93	1.716,8	42.076,5	0,781959
2018	204.496,9	87,03	1.694,3	43.050,6	0,779658
2019	222.997,6	78,86	1.625,7	50.446,8	0,770712

Source: Made by the authors based on results from Eviews

The value of the coefficient suggests that the three independent variables (labor force, capital stocks and energy consumption) explain the variance of gross domestic product in a proportion of 99.53%.

The previous results present the theory according to which Romania's GDP is positively influenced by labor force and capital stocks and in a negative sense by energy consumption. When energy consumption decreases by one unit, Gross Domestic Product increase by 0.729 unit, while an increase of one unit in labor and capital increases GDPO. Thus, the Romanian economy is positively influenced by the growth of labor market inclusion and the resilience of the capital market. On the other hand, the increase in energy consumption is leading to a decrease in GDP.

Next, the efficiency score for each year will be determined using the data Envelopment analysis (DEA) method in the RStudio software to derive the potential energy consumption. THE FORMULA DEA used to estimate the efficiency score shall be as follows:

Max $\theta_j = \frac{\sum_{m=1}^{M} y_m^j u_m^j}{\sum_{n=1}^{N} x_n^j v_n^j}$, Where y_1^j,...,y_m^j represents the GDP series,u_1^j .u_m^j, represents the GDP weights, x_1^j ..,x_n^j represent the exogenous variables and v_1^j , ..,v_n^j represent their weights

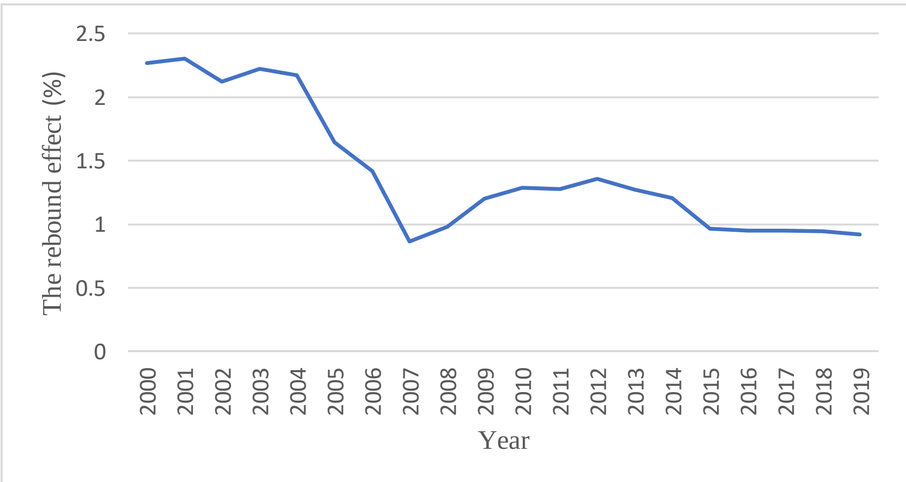
Table 3. DEA efficeiency score

Year	DEA efficeiency score	Year	DEA efficeiency score
2000	0,8657249	2010	0,9561834
2001	0,8753231	2011	0,9561834
2002	0,8780662	2012	0,9644389
2003	0,8816482	2013	0,9698500
2004	0,8948366	2014	0,9717162
2005	0,9109529	2015	0,9754889
2006	0,9287069	2016	0,9822992
2007	0,9553545	2017	0,9856174
2008	0,9730251	2018	0,9885263
2009	0,9605213	2019	1,0000000

Source:Made by the author based on results from RStudio

The above table provides the efficiency coefficients for each year, which will determine the potential energy consumption by equation (3). This method is of high economic relevance as the potential consumption is derived from the technological factor, economic growth and energy intensity. The rebound effect will also be analyzed from the perspective of both the energy sector and the factors of production.

Figure 3. The macroeconomic rebound effect in Romania in the period 2000-2019



Source: Made by the authorbased on results from Microsoft Excel

The rebound effect in the first 5 years was high due to the almost constant and implicit energy consumption of economic growth, Romania being characterized by a sustained consumption of oil products in agriculture and fossil fuel in the 3 sectors: Industry, agriculture and services. The high effect is due to the rate of decrease in energy consumption which is below the growth rate of the gross domestic product. In 2005 and 2006, the rebound effect decreased sharply due to the rapid growth of GDP in constant energy consumption.

In 2007, following Romania's accession to the European Union, the capital market grew significantly, while the typology of energy consumption changed. These behavioral changes in the Romanian economy have been caused by Romania as an EU country. Thus, through accession, Romania has achieved a number of benefits, such as: access to European funds and adherence to programs for the development of a sustainable society. On the other hand, the economic crisis has led to a sharp fall in labor market supply, with the effect of rising unemployment being felt at its real magnitude in 2009. The downward slope of the rebound effect may be an indication of the onset of the economic crisis in the coming years (Figure 3).

In the period 2009-2014 the rebound effect was over 1%, which implies an increase in energy intensity and energy consumption, economic production recording a loss. During this period, Romania accepted the pressures of the energy policy to increase energy efficiency in the conditions of low energy consumption, but this implies a low level production. However, the issue of carbon emissions caused by increased energy consumption in previous years, led Romania to decrease energy consumption, energy efficiency having a period of decline in 2009 and 2010. Since 2010, it is assumed that was made a switch to reusable energy and a rational use of energy.

Conclusions

Romania's economy prior to accession was mostly influenced by electricity, natural gas and oil products consumption, with industry and services making important contributions to GDP. However, the efficiency of energy use and inputs in the energy sector was very low, with exports and consumption of fossil fuels having a negative effect on gross domestic product.

Romania's accession to the European Union is marked by increased foreign investment. During this period, Romania has experienced high consumption of electricity and fossil fuels, but with low efficiency, resulting in low productivity. The economy has experienced a period of upswing after the recession marked by the development of digitalisation, which has had a positive impact on the economy.

The analysis of the rebound effect in the Romanian economy shows that it has seen an upward trend when energy consumption decreased in relation to the growth rate of gross domestic product.The situation changed in 2007, with the rebound effect low due to the level of economic growth compared to energy intensity. The period 2007-2019 has shown fluctuations in the rebound effect, with the economy trying to recover from the global recession and to respect resource-efficient energy policies. Although energy consumption has fallen since the previous period, it is concluded that this has not been achieved through a coherent strategy that also reduces the economic disparities between Romania and the more developed countries of the European Union.

Romania must consider shaping a strategy with the main objective of "energy efficiency". To achieve this, the strategy must focus on the transition of fossil fuel energy consumption to renewable energy consumption.

However, before formulating a medium- or long-term strategy, account must be taken of the existing disparities in the territorial profile of Romania. The problem of disparities is a complex one, which is why a holistic strategy is needed that takes account of all resources (human, natural, institutional, even geographical). Using a holistic strategy, it is closer to the transition to the circular/green economy, which means better use of resources. There are countries with a low rate of resource productivity or domestic extraction and, despite all these, they are developed countries from an economic perspective. These countries use renewable resources and have a well-articulated transition strategy for the circular economy. In addition, a holistic strategy covering renewable resources and the circular economy is probably at the level of these countries' economic strategies. For this reason, it is important that Romania takes into account the opportunities of the circular economy and also invest in the entrepreneurial ecosystem sector. In addition, another argument in favor of the circular economy is the threat of the rebound effect. The rebound effect could be reduced if the economy is based on alternative and renewable energy sources and a good waste management strategy.

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