Eight Methods for Decomposing the Aggregate Energy Intensity of the Economic Structure

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SUMMARY

The energy intensity of East-Central Europe has greatly improved in the last two decades for two main reasons. The first is that after the change of regime the heavy industry collapsed, and there was a shift from agriculture towards the service sector, while the second is the technological development of the economy, which increased the energy efficiency of the economic sectors. The subject of this paper is to provide a comprehensive index decomposition analysis of the energy intensity of the economy in four East-Central European nations (the Czech Republic, Slovakia, Slovenia, Poland and Hungary) between 1990 and 2009.
Keywords: energy consumption; energy efficiency; index decomposition analysis; East-Central Europe; change of regime
Journal of Economic Literature (JEL) code: O13, Q49

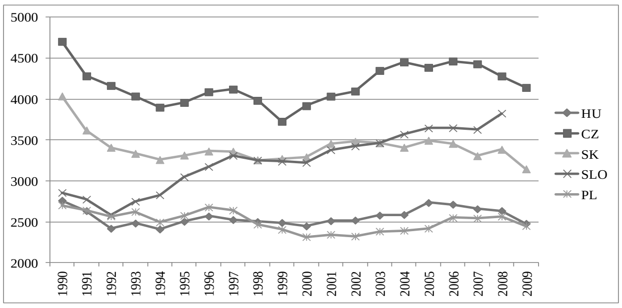
INTRODUCTION

The energy consumption of an economy is affected by many factors: the climate, living standards, national income, different consumption patterns, furthermore the structural change. The literature analyzing the structural change mainly examines the sectors' relative weight alteration and the relationship of economic growth and restructuring within the manufacturing industry (e.g. Szalavetz, 2003). The subject of this paper is to identify the factors which affect the changes in energy intensity after the change of regime in East-Central Europe (Czech Republic, Slovakia, Slovenia, Poland and Hungary).

GENERAL CHARACTERISTICS OF THE COUNTRIES EXAMINED

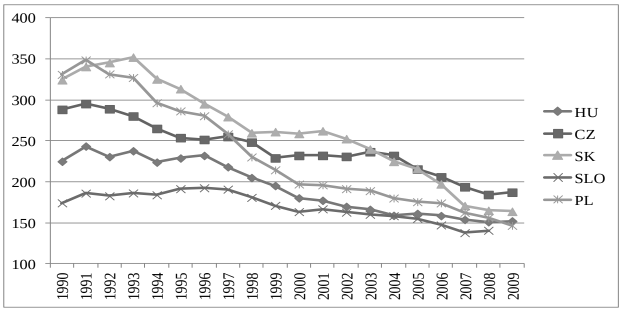
According to the Hungarian Central Statistical Office's definition, "energy intensity means the ratio of the gross inland energy use to GDP in a year, where the unit of energy use is the ton of oil equivalent (toe). A decrease in the index means the increase of energy intensity, so the smaller the value is, the more intensive the country's resource use is." (KSH, 2008: 20). Energy efficiency is the reciprocal of this indicator and it means the ratio of GDP to energy use (how much GDP can be produced with one unit of energy use).

The energy consumption per capita decreased drastically after the change of regime in every country (Figure 1) investigated. However, this decline did not become permanent; the values strongly fluctuate after a few years and show an increasing trend.



Source: World Bank database

Figure 1. Energy use (kg of oil equivalent per capita), 1990-2009



Source: World Bank database

Figure 2. Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP), 1990-2009

The energy intensity of the countries analyzed has greatly improved in the last two decades, as shown in Figure 2. There are two main reasons for this: (1) after the change of regime the heavy industry collapsed, and there was a shift towards the service sector. The second is the technological development of the economy, which increased the economic sectors' energy efficiency. My purpose is to quantify the degree of these two effects (the structural and the intensity effects). My hypothesis is that in East-Central Europe after the change of regime the energy intensity (both in the industrial sector and in the whole of the economy) was significantly affected both by the structural change and by the changes in the energy intensity of the economic sectors as well.

BACKGROUND

The effects of economic activities on energy intensity were a central research topic of energy and environmental economics after the first oil price shock (Boyd and Roop, 2004). The Index Decomposition Analysis is a widespread method used for the analysis of energy consumption and emission in both energy and environmental economics; furthermore, in the past few years it has appeared as a toolbar of human resource economics (Achao and Schaeffer, 2009). This method offers new contributions to the examination of income inequalities. It can be easily interpreted and nowadays it is a frequently used tool for decision-makers (Ang 1995, 2000; Hoekstra et al., 2003; Zhao et al., 2010; Liu and Ang, 2003, Unander, 2007). Table 1 contains the relevant publications of this topic I have reviewed, which include not only a methodology survey, but empirical results as well. Apart from some exceptions, these studies use only one method each and do not aim to check their results with others. The area analyzed is quite wide: Achao and Schaeffer (2009) attempt an explanation of the income inequalities in Brazil, Mairet and Decellas (2009) decompose the energy intensity of the French service sector, and Ang (2005) studies emission in the Canadian industry sector. The number of subsectors examined fluctuates heavily: in the reviewed papers the minimum is 3 and the maximum is 28, but Ang mentions that analyses of 2 to 400 subsectors are also found.

METHODOLOGY OF INDEX DECOMPOSITION ANALYSIS

The index decomposition method has many characteristics similar to shift-share analysis, which is presented by Nemes Nagy (1995). However, shift-share analysis is an additive approach, while index decomposition can be additive and multiplicative as well. The objectives of both are the decomposition of aggregate data into components. While shift-share analysis can be mainly observed in regional studies, index decomposition analysis is the result of the increasing interest in energy caused by the 1973 oil crisis. At that time the general objective of the governments was to restrain energy consumption and enhance energy efficiency. The first step was to determine factors that have an influence on energy consumption and to work out the appropriate methodology, with special regard to the index decomposition analysis.

The essence of this method is that it can explain the changes of an indicator at the sectoral level, and another advantage is the lowest data requirement (Hoekstra et al., 2003). The starting point is the final intensity in the economic structure (aggregate energy intensity), which is essentially affected by two factors: changes in energy intensity of the economic sectors (intensity effect) and the shift in the mix of products or activities (structural effect) (Liu and Ang, 2003). The method disaggregates the economy into sectors and then weights sectoral energy intensity by their output shares. In this paper final intensity in the economic structure means the ratio of the final energy use of the primary, secondary and tertiary sectors to the added value produced by those sectors.

Table 1
Summary of the publications reviewed

Publication	Examined country	Time period	Method	Type of method	Subsector number
Zhao et al., 2010	China	1998-2006	LMDI	Additive	15
Mairet and Decellas, 2009	France	1995-2006	LMDI	Additive	7
Achao and Shaeffer, 2009	Brazil	1980-2007	LMDI	Additive	4
Hatzigeorgiou et al. 2008	Greece	1990-2002	AMDI LMDI	Additive	3
Mercados-EMI et al. 2007	Cyprus, Estonia, Hungary, Lithuania, Latvia, Poland, Czech Republic, Slovakia, Slovenia	1995-2004	Divisia	Additive	10
Unander, 2007	Australia, Denmark, Finland, France, Italy, Japan, Norway, Sweden, Great Britain, USA	1973-1998	Laspeyres	-	7
Ang, 2005	Canada	1990-2000	LMDI	Multiplicative	23
Boyd and Roop, 2004	USA	1983-1998	AMDI Fisher Ideal	Multiplicative	19
Farla and Blok, 2000	Netherlands	1980-1995	simple average parametric Divisia method 2 (AVE-PDM2)	Additive	5 and 21
Ang, 1995	Singapore	1982-1990	general parametric Divisia 1	Additive	28

Source: author's own work

Index decomposition analysis is a truly wide research topic; many kinds of methods exist and are being used. I used the most popular ones: the Laspeyres, Paasche, Marshall-Edgeworth, Walsh, Fisher Ideal, Drobish, LMDI and the AMDI methodologies. The Laspeyres index shows the changes in the examined time period and uses the weights based on values in the base year. In contrast, the Paasche index uses values of the current year as weight. The Marshall-Edgeworth index calculates the arithmetic average of basic and target years, while the Walsh index uses the geometric means. The Fisher Ideal index is the geometric mean of the results of the Laspeyres and Paasche method, while the Drobish index argues for the arithmetic average of them (Liu et al., 2003). According to Boyd and Roop (2004), the perfect index decomposition method is the Fisher Ideal index, because it fits all of the strict requirements and the value of residual term is one. Both the AMDI and LMDI are integral index numbers and they have a great many advantages such as "path independency, ability to handle zero values and consistency in aggregation" (Zhao et al., 2010:1382).

Let V be an energy-related aggregate. We assume that it is affected by n variables, so $x_1, x_2, \ldots x_n$. The aggregate can be divided into i subsectors where the changes take place (structural and intensity changes).The connection among the subsectors can be described as follows:

$$V=\sum_i V_i = x_{1,i}x_{2,i}\ldots x_{n,i}$$

By the multiplicative method we decompose the relative changes (Ang 2005:867):

$$D_{tot}=\frac{V^T}{V^0}=D_{x1}D_{x2}\ldots D_{xn}$$

where:

$$V^0=\sum_i x^0_{1,i}x^0_{2,i}\ldots x^0_{n,i}$$

$$V^T=\sum_i x^T_{1,i}x^T_{2,i}\ldots x^T_{n,i}$$

By the additive method we decompose the absolute changes:

$$\Delta V_{tot}=V^T-V^0=\Delta V_{x1}+\Delta V_{x2}+\ldots+\Delta V_{xn}$$

where:

$$V^0=\sum_i x^0_{1,i}x^0_{2,i}\ldots x^0_{n,i}$$

$$V^T=\sum_i x^T_{1,i}x^T_{2,i}\ldots x^T_{n,i}$$

Here I will present the methodology of index decomposition analysis using the Laspeyres index. I have chosen this one because this is the most frequently used method (Ang, 2000; Mairet and Decellas, 2009), and the methodology can be easily implemented using this.

Table 2
Multiplicative methods of index decomposition analysis

Laspeyres	$D_{x_1}=I_L=\frac{\sum_i x^T_{1i}*x^0_{2i}\ldots x^0_{ni}}{\sum_i x^0_{1i}*x^0_{2i}\ldots x^0_{ni}}$
Paasche	$D_{x_1}=I_P=\frac{\sum_i x^T_{1i}*x^T_{2i}\ldots x^T_{ni}}{\sum_i x^0_{1i}*x^T_{2i}\ldots x^T_{ni}}$
Marshall-Edgeworth	$D_{x_1}=I_{ME}=\frac{\sum_i x^T_{1i}*(x^0_{2i}+x^T_{2i})*(x^0_{3i}+x^T_{3i})\ldots(x^0_{ni}+x^T_{ni})}{\sum_i x^0_{1i}*(x^0_{2i}+x^T_{2i})*(x^0_{3i}+x^T_{3i})\ldots(x^0_{ni}+x^T_{ni})}$
Walsh	$D_{x_1}=I_W=\frac{\sum_i x^T_{1i}*\sqrt{x^0_{2i}*x^T_{2i}}*\sqrt{x^0_{3i}*x^T_{3i}}\ldots\sqrt{x^0_{ni}*x^T_{ni}}}{\sum_i x^0_{1i}*\sqrt{x^0_{2i}*x^T_{2i}}*\sqrt{x^0_{3i}*x^T_{3i}}\ldots\sqrt{x^0_{ni}*x^T_{ni}}}$
Fisher 1(Fisher Ideal)	$D_{x_1}=I_F=\sqrt{I_L*I_P}$
Drobish	$D_{x_1}=I_D=\frac{I_L+I_P}{2}$
AMDI (Arithmetic Mean Divisia Index)	$D_{x_1}=\exp(\sum_i\frac{\frac{V^0_i}{V^0}+\frac{V^T_i}{V^T}}{2}*\ln(\frac{x^T_{1i}}{x^0_{1i}}))$ $L(a,b)=\frac{a-b}{\ln(a)-\ln(b)}$, $a\neq b$
LMDI 1 (Log Mean Divisia Index 1)	$D_{x_1}=\exp(\sum_i\frac{L(V^0_i, V^T_i)}{L(V^0,V^T)}*\ln(\frac{x^T_{1i}}{x^0_{1i}}))$ $L(a,b)=\frac{a-b}{\ln(a)-\ln(b)}$, $a\neq b$

where: t=0 (year 0); t=T (year T); i: economic sector
Source: author's own work based on Granel, 2003, p. 35

Using the Laspeyres index the other methods can also be easily conducted (Ang and Zhang, 2000: 1157). In every case I supported the multiplicative type because it is insensitive to units (in contrast with the additive type, which can result in serious differences) and the results can be perfectly illustrated. Ang et al. (2003) recommend also this choice in every case when the researchers analyze long time series. Every method has three main parts:

$$D_{tot}=D_{int}*D_{str}*D_{res}=\frac{I_t}{I_0}$$

where: E_t: total energy consumption; $E_{i,t}$: energy consumption of sector i; Y_t: GDP; $Y_{i,t}$: GDP of sector i; $S_{i,t}$: share of sector i $(=\frac{Y_{i,t}}{Y_t})$; I_t: energy intensity of the economy, $(=\frac{E_t}{Y_t})$; $I_{i,t}$: energy intensity of sector i $(=\frac{E_{i,t}}{Y_{i,t}})$.

The first part shows the changes of energy intensity D_{tot} in the economy in two years.

$$D_{str} = \frac{\sum_i S_{i,T} I_{i,0}}{\sum_i S_{i,0} I_{i,0}}$$

The next two indicators (D_{str}, D_{int}) are the difference of final intensity in the economic structure belonging to year 0 and year t. The difference between them is what factor is unchanged (basic year) in the counter. The D_{str} leaves the energy intensity of subsectors unchanged and so it shows the structural effect, which means the size of the effect in the final intensity (in the economic structure) caused by the shift in the economic structure (from the agriculture and industry sector towards the service sector).

$$D_{int} = \frac{\sum_i S_{i,0} I_{i,T}}{\sum_i S_{i,0} I_{i,0}}$$

D_{int} leaves the share of subsectors unchanged and it presents the effect of energy intensity changes (intensity effect), which means how the changes of the energy intensity of the subsectors affect the final intensity in the economic structure. The nearer D_{str} and D_{int} are to the value 1, the smaller the effect is. The equation includes a residual term for every method, which shows that not all of the effects are explained by the model. The value of the residual term is ideal if it is near to 1 (in the multiplicative method).

DATABASE

I used the final energy intensity of economic structures (primary, secondary, tertiary sector, 1000 toe) and the added value of these sectors (constant 2000 USD; % of GDP). The countries and time periods examined are: Hungary (1990-2008), Poland (1993-2009), Czech Republic (1990-2008), Slovakia (1993-2009), Slovenia (1990-2008). I used the Eurostat and the World Bank databases, which allows for the comparability of the results.

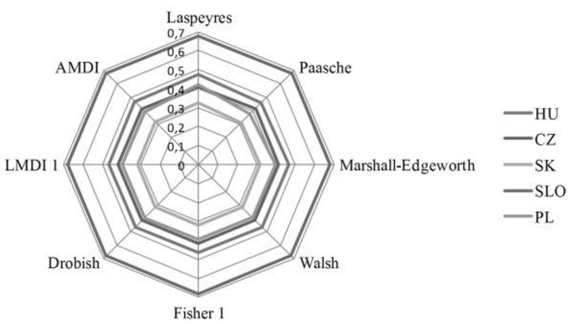


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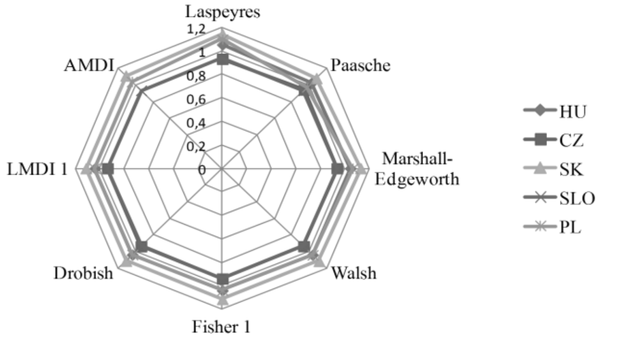
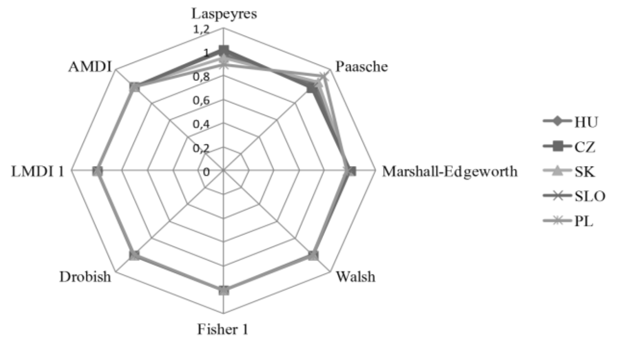
Figure 3. Results of index decomposition analysis (Dint, 1990-2009)



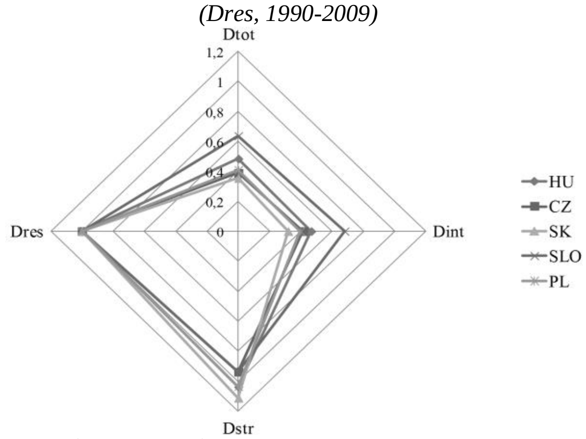
Source: author's own work

Figure 4. Results of index decomposition analysis (Dstr, 1990-2009)



Source: author's own work

Figure 5. Results of index decomposition analysis (Dres, 1990-2009)



Source: author's own work

Figure 6. Results of index decomposition analysis (Fisher I, 1990-2009)

EMPIRICAL RESULTS

For my analysis I used the Lapeyres, Paasche, Marshall-Edgeworth, Walsh, Fisher 1, Drobish, LMDI and AMDI methods. The results are displayed for Dint (Figure 3), Dstr (Figure 4) and Dres (Figure 5). The deviation of the results is really small, which relieves interpretation and increases confidence. The sum of my results is presented in a graphical illustration of the Fisher

I index (Figure 6). This model resulted in the smallest residual term (the residual term is one), which is significant. According to my calculations, in the time period 1990-2009 in every country the effect of the changes of the sectoral energy intensity was more significant in terms of the final intensity in the economic structure than the effect of the shift in the economic structure. This finding confirms Ang's conclusion that "… for the industrialized countries, declining sectoral energy intensity has generally been found to be the main contributor to decreases in the aggregate energy intensity … The impact of structural change is smaller in comparison" (Ang and Zhang, 2000:1162). It also supports Kuttor's statement that "it is important to state and emphasize that in spite of the vigorous tertiarisation of the economies, the industry has maintained its significance in the economies of the region [Visegrad countries], both in terms of the employment of workers and of the production of added value." (Kuttor, 2011: 51).

I made calculations for shorter time horizons as well: I divided the long time period into shorter periods of 5 years. Uliha (2011) recommends, based on Leamer E. E., the extreme bounds analysis (EBA) as an appropriate method: "EBA addresses the issue of specification uncertainty by computing the maximum and minimum values on a large set of model specifications. The highest and lowest estimates are called the upper and lower bounds." (Uliha 2011: 237). In the end these intervals are the result. In Table 3, I apply this method and present the maximum and minimum values.

Table 3
The results of index decomposition analysis with regard to the aggregate energy intensity

		1990-1995		1995-2000		2000-2005		2005-2009		1990-2009	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
HU	D_{int}	0.8418	0.8476	0.7876	0.803	0.8402	0.8469	0.8374	0.839	0.4598	0.4723
	D_{str}	0.9763	0.9829	1.022	1.042	0.9994	1.004	1.0069	1.0087	1.0245	1.0523
	D_{res}	0.9934	1.0066	0.98	1.02	0.992	1.008	0.9981	1.0019	0.9736	1.0271
CZ	D_{int}	0.8657	0.8774	0.7778	0.7797	0.7962	0.7964	0.7626	0.7724	0.4106	0.4173
	D_{str}	0.8668	0.8884	1.022	1.0235	1.0023	1.0026	1.0271	1.0403	0.9301	0.9452
	D_{res}	0.9757	1.025	0.9974	1.0026	0.9997	1.0003	0.9874	1.0128	0.9839	1.0036
PL	D_{int}	0.8682	0.875	0.7019	0.7124	0.8325	0.833	0.7664	0.7747	0.3741	0.4196
	D_{str}	1.041	1.0491	0.9832	0.9979	0.9974	0.998	0.9993	1.0102	0.9779	1.0971
	D_{res}	0.9923	1.0078	0.9853	1.0149	0.9994	1.0006	0.9893	1.0101	0.8914	1.1218
SK	D_{int}	0.8095	0.8098	0.7737	0.7751	0.6862	0.6882	0.6874	0.7321	0.3101	0.3267
	D_{str}	0.993	0.9932	0.9878	0.9896	1.0872	1.0904	1.0499	1.1181	1.0834	1.1416
	D_{res}	0.9998	1.0003	0.9982	1.0018	0.9971	1.0029	0.939	1.065	0.9491	1.0537
SLO	D_{int}	0.9841	0.9968	0.9792	0.9805	0.8869	0.8873	0.7912	0.7937	0.3101	0.3267
	D_{str}	0.8938	0.9001	1.0181	1.0193	1.0062	1.0066	1.0097	1.0129	1.0834	1.1416
	D_{res}	0.9873	1.0129	0.9988	1.0013	0.9996	1.0001	0.9968	1.0032	0.9491	1.0537

Source: author's own work

In the first period (1990/1993-2005) the aggregate energy intensity in East-Central Europe decreased, but the extent of the decrease varied. In Hungary, Slovakia, Poland and Slovenia the decline was caused mainly by the changes in energy intensity of the economic sectors (the Fisher Ideal index's results are 0.844; 0.81; 0.87; 0.89, respectively), not by the shift of the sectors (the Fisher Ideal index's results are 0.98; 0.99; 1.04; 0.98, respectively). In the Czech Republic the strength of these two effects was nearly equal (according to the Fisher Ideal index the results are 0.88 for both of these effects). For example in Hungary these values mean that as a result of intensity effect the aggregate energy intensity in 1995 would have been 0.84 times the value in 1990 and as a result of the structural effect in 1990 it would have been 0.98 times the value in 1990, so finally the aggregate energy intensity changed to 0.83 times at the end of the period.

In the period of 1995-2000, excluding Slovakia, the intensity effect became stronger: the value of the Fisher Ideal index averages out at around 0.78 (Hungary: 0.795, Slovakia: 0.774, Czech Republic: 0.779, and Poland: 0.707). The value of the structural effect is near 1, which means that during this period it does not significantly affect the aggregate energy intensity. In Slovenia this tendency is the opposite; the aggregate energy intensity did not change because the two effects exactly offset each other (the Fisher Ideal index with regard to the structural effect was 1.02 and the intensity effect was 0.98).

These trends were the same in the later periods (2000-2008/2009) but it is interesting that the structural effect in Slovakia exceeds the value of 1 (the Fisher Ideal index is 1.08), which is probably the consequence of the development of its automobile industry.

Analyzing the whole time period, in Hungary the aggregate energy intensity is 0.484 times in 2008 compared to 1990, which is mainly caused by the intensity effect (Fisher Ideal index 0.466), while the structural effect is quite weak (Fisher Ideal index 1.04). Elek (2009) examined the Hungarian energy intensity (1992-2007) – using the additive approach – and also concludes that the intensity effect is more significant than the structural effect.

The same tendencies can be observed in the other countries (strong intensity and weak structural effect), except that in Poland and Slovakia the structural effect is under 1 (for both of them the Fisher Ideal index is 0.94). In Poland and Slovakia the structural effect would have impaired the energy intensity (Fisher Ideal index 1.04 and 1.11, respectively), but it was offset by the intensity effect.

CONCLUSION

The main difference between neoclassical and energy economics is their different opinions about the role of energy in economic development. According to the neoclassical approach, energy is just an intermediary input among other production factors (land, capital and workers), which determine economic development directly or indirectly. According to energy economists (Cleveland, Herring, and Stern), though, energy significantly affects revenue and the economy depends on the changes in energy consumption. The relationship of economic development and energy use has been a core topic for many centuries.

In this paper I examined how aggregate energy intensity is influenced by the shift in the mix of products or activities (structural effect) and the changes in energy intensity of economic sectors (intensity effect). My hypothesis was that both of these effects are significant. I performed the examination using eight different methods of index decomposition analysis. Significant differences between the results did not appear, and the size of the residual term was manageable. Since my objective was to determine the major effects I did not attempt to explain the size of residuum.

In every short time period – apart from the first period for the Czech Republic and Slovenia – the intensity effect was more important than the structural effect in each country. Thus, I have found that in the analyzed countries of East-Central-Europe between 1990 and 2009 the intensity effect contributed to a greater extent to the improvement of final intensity in the economic structure than the structural effect. The magnitude of the structural effect is smaller than that of the intensity effect from the energy intensity perspective.

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Appendix 1
Results of index decomposition analysis

HU

1990-1995	Dtot	Dint	Dstr	Dres
Laspeyres	0,8273912	0,8418156	0,976395	1,0066267
Paasche	0,8273912	0,847394	0,9828652	0,993417
Marshall-E	0,8273912	0,8445715	0,9793522	1,0003123
Walsh	0,8273912	0,844583	0,9791287	1,0005269
Fisher 1	0,8273912	0,8446002	0,9796247	1
Drobish	0,8273912	0,8446048	0,9796301	0,9999891
LMDI 1	0,8273912	0,8439735	0,9792486	1,0011269
AMDI	0,8273912	0,8476375	0,9796029	0,9964389
1995-2000	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,8206498	0,8029869	1,0419186	0,9808794
Paasche	0,8206498	0,7876333	1,0219965	1,0194933
Marshall-E	0,8206498	0,7951525	1,033046	0,9990513
Walsh	0,8206498	0,7952371	1,0319365	1,000019
Fisher 1	0,8206498	0,7952731	1,0319095	1
Drobish	0,8206498	0,7953101	1,0319576	0,9999068
LMDI 1	0,8206498	0,7954202	1,0319218	0,9998031
AMDI	0,8206498	0,7952584	1,0319576	0,9999719
2000-2005	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,8435033	0,8469679	1,0038759	0,9920644
Paasche	0,8435033	0,8402466	0,9959095	1,0079991
Marshall-E	0,8435033	0,8436007	1,0002227	0,9996619
Walsh	0,8435033	0,8438081	0,9994228	1,0002161
Fisher 1	0,8435033	0,8436005	0,9998848	1
Drobish	0,8435033	0,8436072	0,9998927	0,9999841
LMDI 1	0,8435033	0,8441799	0,999406	0,9997924
AMDI	0,8435033	0,8439281	0,999475	1,0000217
2005-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,844768	0,8374483	1,0068626	1,0018651
Paasche	0,844768	0,8390102	1,0087406	0,9981384
Marshall-E	0,844768	0,8382319	1,0077185	1,0000784
Walsh	0,844768	0,8382303	1,0078063	0,9999932
Fisher 1	0,844768	0,8382289	1,0078012	1
Drobish	0,844768	0,8382292	1,0078016	0,9999991
LMDI 1	0,844768	0,8382987	1,007773	0,9999446
AMDI	0,844768	0,8382148	1,0077978	1,0000201
1990-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,4838303	0,4722561	1,0522928	0,9735963
Paasche	0,4838303	0,4597868	1,0245084	1,0271198
Marshall-E	0,4838303	0,4658626	1,0433804	0,9953884
Walsh	0,4838303	0,4659876	1,039496	0,9988398
Fisher 1	0,4838303	0,4659797	1,0383077	1
Drobish	0,4838303	0,4660214	1,0384006	0,999821
LMDI 1	0,4838303	0,4685391	1,0390441	0,9938325
AMDI	0,4838303	0,4690771	1,0382465	0,9934554

CZ

1990-1995	Dtot	Dint	Dstr	Dres
Laspeyres	0,7691081	0,8872777	0,8884348	0,9756684
Paasche	0,7691081	0,8656888	0,8668177	1,0249384
Marshall-E	0,7691081	0,877121	0,8782718	0,998387
Walsh	0,7691081	0,8771443	0,8769638	0,9998496
Fisher 1	0,7691081	0,8764168	0,8775597	1
Drobish	0,7691081	0,8764832	0,8776263	0,9998483
LMDI 1	0,7691081	0,8774089	0,8765653	1,0000024
AMDI	0,7691081	0,8772838	0,8766962	0,9999956
1995-2000	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7969483	0,7797926	1,0246775	0,9973872
Paasche	0,7969483	0,7777552	1,0220003	1,0026196
Marshall-E	0,7969483	0,7787615	1,0235045	0,9998524
Walsh	0,7969483	0,7787772	1,0236137	0,9997257
Fisher 1	0,7969483	0,7787732	1,023338	1
Drobish	0,7969483	0,7787739	1,0233389	0,9999983
LMDI 1	0,7969483	0,7788055	1,0234574	0,9998419
AMDI	0,7969483	0,779153	1,0233227	0,9995275
2000-2005	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7982021	0,7964035	1,002563	0,9996961
Paasche	0,7982021	0,7961615	1,0022584	1,000304
Marshall-E	0,7982021	0,7962823	1,002428	0,9999829
Walsh	0,7982021	0,7962829	1,0024075	1,0000026
Fisher 1	0,7982021	0,7962825	1,0024107	1
Drobish	0,7982021	0,7962825	1,0024107	1
LMDI 1	0,7982021	0,7963126	1,0024085	0,9999644
AMDI	0,7982021	0,7962794	1,0024096	1,0000049
2005-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7933336	0,7723954	1,0402562	0,9873607
Paasche	0,7933336	0,7626329	1,0271081	1,0128011
Marshall-E	0,7933336	0,7674179	1,0345264	0,9992689
Walsh	0,7933336	0,7671318	1,0341524	1,0000031
Fisher 1	0,7933336	0,7674987	1,0336613	1
Drobish	0,7933336	0,7675142	1,0336822	0,9999596
LMDI 1	0,7933336	0,7670205	1,034321	0,9999852
AMDI	0,7933336	0,7670167	1,0343141	0,9999968
1990-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,388138	0,4106221	0,9300635	1,016322
Paasche	0,388138	0,4173242	0,945244	0,9839401
Marshall-E	0,388138	0,4138517	0,9344824	1,0036223
Walsh	0,388138	0,4138799	0,9371364	1,0007118
Fisher 1	0,388138	0,4139596	0,937623	1
Drobish	0,388138	0,4139732	0,9376537	0,9999345
LMDI 1	0,388138	0,4154329	0,9369306	0,9971899
AMDI	0,388138	0,4147505	0,9380263	0,9976639

SK

1993-1995	Dtot	Dint	Dstr	Dres
Laspeyres	0,8040714	0,809582	0,9929739	1,000221
Paasche	0,8040714	0,8097609	0,9931933	0,9997791
Marshall-E	0,8040714	0,8096711	0,993072	1,000012
Walsh	0,8040714	0,8096803	0,9931282	0,9999441
Fisher 1	0,8040714	0,8096714	0,9930836	1
Drobish	0,8040714	0,8096714	0,9930836	1
LMDI 1	0,8040714	0,8097329	0,9931058	0,9999016
AMDI	0,8040714	0,8094826	0,993061	1,000256
1995-2000	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7655698	0,775057	0,9895544	0,9981861
Paasche	0,7655698	0,7736511	0,9877595	1,0018172
Marshall-E	0,7655698	0,7743577	0,9887707	0,9998794
Walsh	0,7655698	0,7743711	0,9886409	0,9999933
Fisher 1	0,7655698	0,7743537	0,9886565	1
Drobish	0,7655698	0,774354	0,9886569	0,9999992
LMDI 1	0,7655698	0,7744554	0,9886401	0,9998853
AMDI	0,7655698	0,7743419	0,9886002	1,0000722
2000-2005	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7482041	0,6881915	1,0903924	0,9970755
Paasche	0,7482041	0,6861788	1,0872035	1,0029331
Marshall-E	0,7482041	0,6871416	1,0890924	0,9997908
Walsh	0,7482041	0,6871453	1,0888101	1,0000446
Fisher 1	0,7482041	0,6871844	1,0887967	1
Drobish	0,7482041	0,6871851	1,0887979	0,9999979
LMDI 1	0,7482041	0,6874802	1,0886575	0,9996975
AMDI	0,7482041	0,6871633	1,0886996	1,00012
2005-2009	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7685925	0,7320512	1,1181237	0,9389983
Paasche	0,7685925	0,6873949	1,0499163	1,0649646
Marshall-E	0,7685925	0,7084778	1,0892959	0,995919
Walsh	0,7685925	0,708391	1,0858955	0,9991601
Fisher 1	0,7685925	0,7093717	1,0834834	1
Drobish	0,7685925	0,709723	1,08402	0,9990102
LMDI 1	0,7685925	0,7077727	1,0861615	0,9997881
AMDI	0,7685925	0,707889	1,0858764	0,9998862
1990-2009	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,3539938	0,326746	1,1415514	0,9490517
Paasche	0,3539938	0,3100989	1,0833913	1,0536833
Marshall-E	0,3539938	0,3178723	1,1272279	0,9879416
Walsh	0,3539938	0,3178696	1,1142534	0,9994539
Fisher 1	0,3539938	0,3183137	1,1120912	1
Drobish	0,3539938	0,3184225	1,1124713	0,9993167
LMDI 1	0,3539938	0,3192032	1,112601	0,9967565
AMDI	0,3539938	0,3168399	1,1136742	1,0032234

SLO

1990-1995	Dtot	Dint	Dstr	Dres
Laspeyres	0,8909305	0,9840858	0,8937895	1,0129211
Paasche	0,8909305	0,9967893	0,9053273	0,9872676
Marshall-E	0,8909305	0,9900813	0,8995121	1,0003822
Walsh	0,8909305	0,9901784	0,8993019	1,0005179
Fisher 1	0,8909305	0,9904172	0,8995399	1
Drobish	0,8909305	0,9904376	0,8995584	0,999971
LMDI 1	0,8909305	0,9901496	0,8996679	1,0001401
AMDI	0,8909305	0,9911317	0,9001045	0,9986644
1995-2000	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,9981996	0,9804643	1,0193454	0,9987671
Paasche	0,9981996	0,9792432	1,0180758	1,0012596
Marshall-E	0,9981996	0,9798479	1,0187168	1,000012
Walsh	0,9981996	0,9798556	1,0187198	1,0000013
Fisher 1	0,9981996	0,9798536	1,0187104	1
Drobish	0,9981996	0,9798538	1,0187106	1,0000122
LMDI 1	0,9981996	0,9798951	1,0187195	0,9999613
AMDI	0,9981996	0,9798564	1,0186817	1,0000379
2000-2005	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,8927727	0,8869153	1,0061923	1,0004094
Paasche	0,8927727	0,8872784	1,0066042	0,9995907
Marshall-E	0,8927727	0,8870974	1,0063859	1,0000116
Walsh	0,8927727	0,8870883	1,0064052	1,0000027
Fisher 1	0,8927727	0,8870968	1,0063982	1
Drobish	0,8927727	0,8870968	1,0063983	1
LMDI 1	0,8927727	0,8872443	1,006415	0,9998171
AMDI	0,8927727	0,8870036	1,0063973	1,0001061
2005-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,8014004	0,7937303	1,0128943	0,9968101
Paasche	0,8014004	0,7911984	1,0096633	1,0032001
Marshall-E	0,8014004	0,7924563	1,0114646	0,999824
Walsh	0,8014004	0,7924255	1,011357	0,9999692
Fisher 1	0,8014004	0,7924634	1,0112775	1
Drobish	0,8014004	0,7924644	1,0112788	0,9999974
LMDI 1	0,8014004	0,7924367	1,0113674	0,9999447
AMDI	0,8014004	0,7924232	1,0113534	0,9999756
1990-2008	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,6362692	0,6795306	0,9352569	1,0011543
Paasche	0,6362692	0,6803149	0,9363365	0,9988471
Marshall-E	0,6362692	0,6799096	0,9356937	1,000129
Walsh	0,6362692	0,679448	0,9359181	1,0005686
Fisher 1	0,6362692	0,6799226	0,9357965	1
Drobish	0,6362692	0,6799227	0,9357967	0,9999997
LMDI 1	0,6362692	0,6807545	0,9366528	0,9978651
AMDI	0,6362692	0,6801727	0,9367505	0,9986143

PL

1993-1995	Dtot	Dint	Dstr	Dres
Laspeyres	0,9109153	0,8750081	1,049157	0,9922599
Paasche	0,9109153	0,8682354	1,0410364	1,0078005
Marshall-E	0,9109153	0,8715405	1,0453674	0,9998192
Walsh	0,9109153	0,8714248	1,0457689	0,9995681
Fisher 1	0,9109153	0,8716152	1,0450888	1
Drobish	0,9109153	0,8716218	1,0450967	0,9999849
LMDI 1	0,9109153	0,871494	1,0455874	0,9996622
AMDI	0,9109153	0,8708666	1,0454665	1,000498
1995-2000	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7004589	0,7123928	0,9978888	0,9853284
Paasche	0,7004589	0,7019408	0,9832483	1,01489
Marshall-E	0,7004589	0,7071723	0,991798	0,998698
Walsh	0,7004589	0,7069491	0,9908664	0,9999527
Fisher 1	0,7004589	0,7071475	0,9905415	1
Drobish	0,7004589	0,7071668	0,9905685	0,9999454
LMDI 1	0,7004589	0,7070778	0,9910045	0,9996313
AMDI	0,7004589	0,7070509	0,9909546	0,9997197
2000-2005	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,8307531	0,8324668	0,99738	1,000563
Paasche	0,8307531	0,8329355	0,9979414	0,9994374
Marshall-E	0,8307531	0,8327008	0,997635	1,000026
Walsh	0,8307531	0,8327012	0,9976526	1,000008
Fisher 1	0,8307531	0,8327011	0,9976607	1
Drobish	0,8307531	0,8327011	0,9976607	0,9999999
LMDI 1	0,8307531	0,8329377	0,9976577	0,9997189
AMDI	0,8307531	0,8330331	0,9976605	0,9996016
2005-2009	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,7741616	0,7746549	1,0101637	0,9893081
Paasche	0,7741616	0,7663724	0,9993631	1,0108075
Marshall-E	0,7741616	0,7704927	1,0054491	0,9993163
Walsh	0,7741616	0,7704572	1,0047523	1,0000554
Fisher 1	0,7741616	0,7705025	1,0047489	1
Drobish	0,7741616	0,7705137	1,0047634	0,9999711
LMDI 1	0,7741616	0,7706737	1,0047746	0,9997524
AMDI	0,7741616	0,7706403	1,0047037	0,9998663
1993-2009	**Dtot**	**Dint**	**Dstr**	**Dres**
Laspeyres	0,4103593	0,4196194	1,0970571	0,8914141
Paasche	0,4103593	0,3740546	0,9779322	1,121813
Marshall-E	0,4103593	0,3957826	1,0618455	0,9764416
Walsh	0,4103593	0,3943504	1,0414667	0,9991636
Fisher 1	0,4103593	0,3961825	1,0357835	1
Drobish	0,4103593	0,396837	1,0374947	0,9967041
LMDI 1	0,4103593	0,3949725	1,0431828	0,9959487
AMDI	0,4103593	0,3940426	1,0426847	0,9987761

Source: author's own work