Lithuanian Centre for Social Sciences

Institute of Economics and Rural Development

COMPARATIVE ANALYSIS OF ENERGY EFFICIENCY IN LITHUANIAN FARMS

Dabkienė Vida, Štreimikienė Dalia, Baležentis Tomas

Kuriame Lietuvos ateitį

2014–2020 metų Europos Sąjungos fondų investicijų veiksmų programa

This research is funded by the European Social Fund according to the activity ‘Improvement of researchers’ qualification by implementing world-class R&D projects’ of Measure No. 09.3.3-LMT-K-712

THE TOPICALITY OF RESEARCH

- In the European Union (EU), the policy actions are taken to meet the commitments of Paris Agreement (UNFCCC 2015), turning the EU into a low carbon economy and directing its energy sector's transition into a carbon zero energy system (Su et al. 2020).
- The EU agricultural sector is undertaking meeting the objectives via Common Agricultural Policy (CAP) Strategic Plan, where for 2021–2027 it includes the objective: "*Contribute to climate change mitigation and adaptation, including by reducing greenhouse gas emissions and enhancing carbon sequestration, as well as promote sustainable energy*" (EC 2021).
- On the one hand, the energy is an indispensable input in various processes and operations on farms and to convert efficiently energy inputs to outputs is a challenging task for farmers. On the other hand, the energy sector is the most significant source of greenhouse gas emissions in the EU and the second largest source is agricultural sector, which accounted 77% and 11% of total emissions in 2019, respectively (UNFCCC 2021).
- Lithuanian National Climate Change Management Agenda (LRS 2021) in case of agriculture, is aiming to abandon the use fossil fuels by 2040.
- In Lithuanian agriculture, the energy costs will become higher due to the gradual reduction of excise duty on gas oil used in agricultural activities and the abolition of excise duty by 2030.
- The support in terms of excise duty relief plays a significant economic role for Lithuanian farmers and any attempt to increase excise duty rate induce the debates and even protests (Vitkauskaitė-Ramanauskienė 2020).

THE AIM OF RESEARCH

is to present energy intensity indicators, constructing the composite energy performance score (EPS) and measuring managerial energy efficiency and the technology gap for Lithuanian farms within types of farming.

The research is subdivided into three SECTIONS:

- Energy intensity in Lithuanian farms by types of farming
- Energy intensity in Lithuanian farms in the EU context
- Energy efficiency in Lithuanian farms by types of farming

THE RESEARCH DATA

- The research combines micro and macro level data. At the micro level, it was focused on the case of Lithuanian family farms, whereas the country-level data for the EU countries are used at the macro level.
- The research data time frame covers years from 2004 to 2019 for Lithuanian FADN sample and from 2004 to 2018 for the EU FADN.
- The entire data time frame (2004–2018 and 2004–2019) was divided into two sub-periods taking 2015 as the break year in order to capture the effect of the exemption of excise duty for fuels used in Lithuania's agriculture change into the reduction in excise duty.
- The research is carried out for the two livestock-oriented farming types and three crop farming-oriented ones following the EU FADN grouping: COP, field crops, orchards-fruits, milk and cattle.
- The analysis of the underlying energy efficiency is also carried out for each of the five farming types independently so as to ensure the homogeneity of the decision making units.
- The inputs include labour (AWU), intermediate consumption less energy costs (in EUR), energy costs (in EUR) and assets (the average book value of buildings and machinery in EUR). In addition, herd size (in LU) is included as an input for the livestock farms, whereas UAA (in ha) is used as an input for the crop farms. The total output (in EUR) is used as the output in the DEA model.

METHODS AND ENERGY INTENSITY INDICATORS

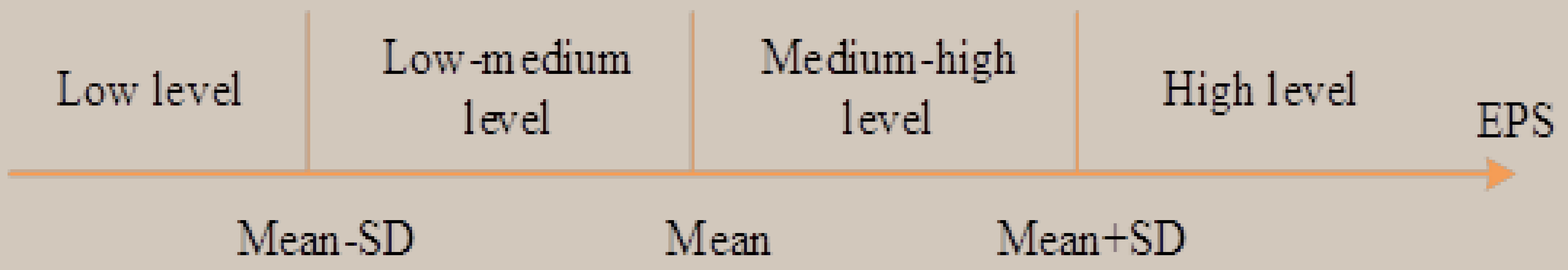
Table 1. Energy intensity indicators based on EU FADN data

No.	Indicator	FADN variables	Description	Reference
1.	Energy/total output	SE345/SE131	Energy costs ratio to total output (EUR/thsd. EUR)	Czyżewski et al. (2018)
2.	Energy/total intermediate consumption	SE345/SE275	Energy costs share in total intermediate consumption (%)	Parzonko et al. (2019)
3.	Energy/LU	SE345/SE080	Energy costs per LU (EUR/LU)	Sevinchan and Dincer (2018)
4.	Energy/total UAA	SE345/SE025	Energy costs per total UAA (EUR/ha)	El-Gafy (2017)

METHODS : MULTICRITERIA ANALYSIS

- The comparative analysis of energy intensity in the EU relies on the energy performance scores (EPS). EPS are calculated for farming types of the individual EU countries following the Simple Additive Weighting (SAW) method.
- The energy intensity indicators used for the development of the EPS were treated as equally important.
- A higher value of energy intensity indicators corresponds to higher intensity of energy use on farms.
- The normalization results in the values of the energy intensity indicators ranging from 0 (highest energy intensity) to 1 (lowest energy intensity).
- The EPS is calculated based on three energy intensity indicators for each type of farming, thus the maximum value of EPS is 3.

The EPS were classified into four energy intensity levels



METHODS : EFFICIENCY ANALYSIS

- The sub-vector DEA model (Färe et al. 1994) was used to estimate the energy efficiency for Lithuanian family farms.
- The resulting efficiency score, falls within interval [0,1] where unity indicates full efficiency, i.e., the energy costs cannot be further reduced for the given input and output vectors for and the underlying technology.
- The use of the DEA allows conditioning the minimum (optimal) energy requirement on the input and output quantities. Specifically, the energy input observed for farms using not more than observed quantities of inputs and producing not less than observed output quantities is taken as a benchmark for each farm when calculating efficiency scores.
- The farming type and global technology are used to benchmark the farms. Thus, the energy input is adjusted with regards to the efficiency scores ensuring that all the farms of a certain farming type are efficient. Still, inefficiency may exist across the farming types as one farming type may exploit energy input better than others.

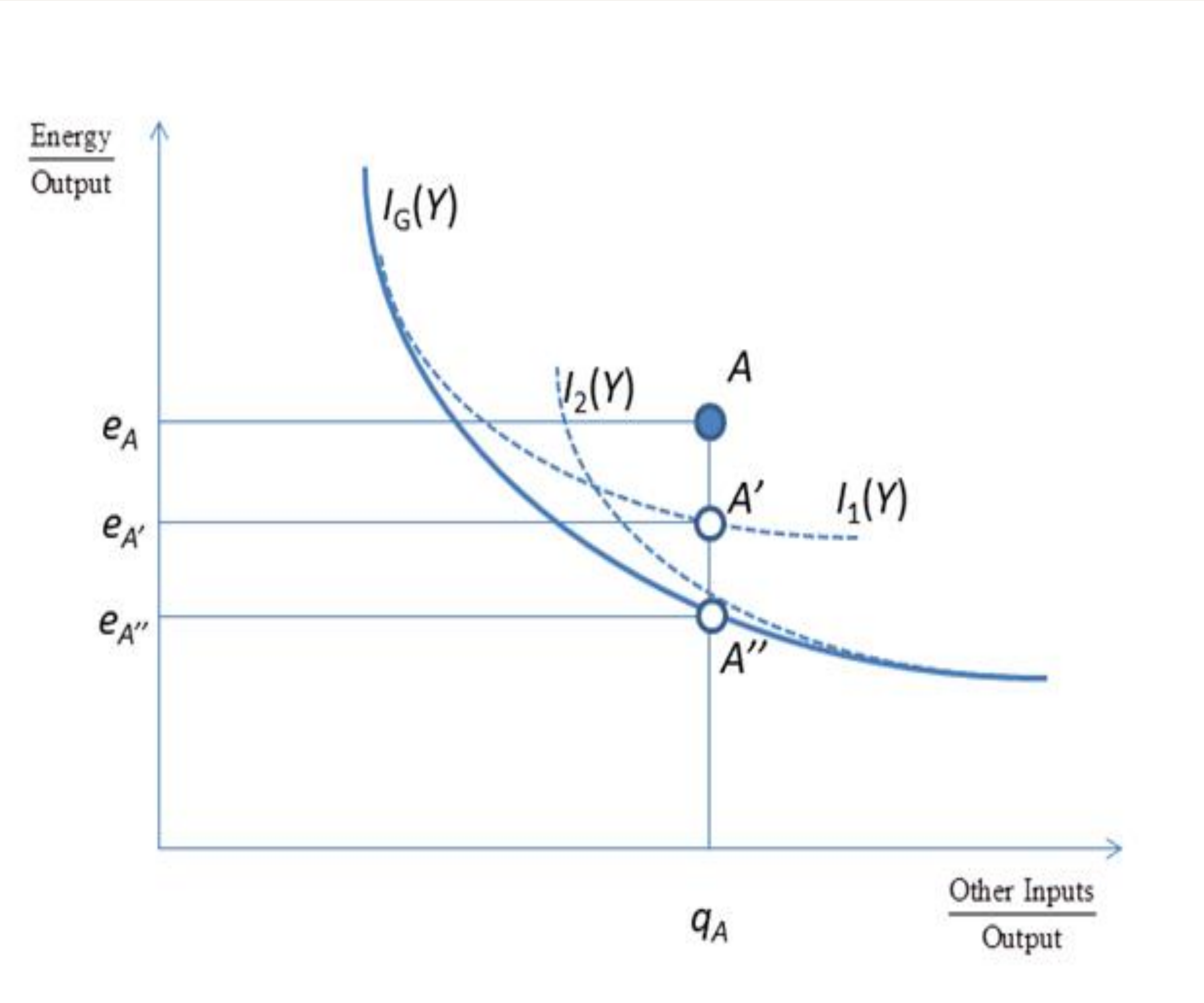


Figure 1. Energy efficiency measured against the farming type (dashed line) and global (bold line) frontiers

RESULTS: Energy intensity in Lithuanian farms by types of farming

Table 2.The average values and growth rates for the energy costs to total output ratio

Farming Type	Statistics	2004–2014		2015–2019		2004–2019	
		EUR/ thsd. EUR	GR	EUR/ thsd. EUR	GR	EUR /thsd. EUR	GR
COP	**Weighted Mean**	208	-0.1	194	5.5	204	-0.4
	Mean	162	-2.1	139	2.8	155	-1.7
Field crops	**Weighted Mean**	154	2.8	205	19.9	170	3.4
	Mean	162	-2.1	139	2.8	155	-1.7
Orchards-fruits	**Weighted Mean**	218	9.9	211	5.3	216	4.0
	Mean	239	4.8	244	6.9	240	2.3
Milk	**Weighted Mean**	104	0.8	146	-0.4	117	3.0
	Mean	88	0.2	110	-1.8	95	1.8
Cattle	**Weighted Mean**	116	0.6	162	-2.0	130	2.9
	Mean	122	2.7	163	0.0	135	3.2

RESULTS : Energy intensity in Lithuanian farms by types of farming

Table 3. Energy costs per ha of UAA average values and growth

Farming Type	Statistics	2004–2014		2015–2019		2004–2019	
		EUR/ha	GR	EUR/ha	GR	EUR/ha	GR
COP	**Weighted Mean**	61	4.7	93	1.5	71	5.0
	Mean	63	5.3	87	2.3	70	4.4
Field crops	**Weighted Mean**	75	5.8	113	5.3	87	5.4
	Mean	76	5.9	112	6.0	87	5.4
Orchards-fruits	**Weighted Mean**	91	4.8	123	1.7	101	4.4
	Mean	82	6.9	111	-3.4	92	4.8

RESULTS : Energy intensity in Lithuanian farms by types of farming

Table 4. Energy costs share in intermediate consumption average values and growth

Farming Type	Statistics	2004–2014		2015–2019		2004–2019	
		%	GR	%	GR	%	GR
COP	**Weighted Mean**	30	1.7	30	-2.3	30	0.5
	Mean	24	-0.1	23	-2.3	24	-0.7
Field crops	**Weighted Mean**	25	3.8	26	-2.4	26	1.4
	Mean	21	0.9	22	-1.6	22	0.4
Orchards-fruits	**Weighted Mean**	36	5.0	45	3.0	39	3.7
	Mean	38	3.3	49	-1.3	41	3.2
Milk	**Weighted Mean**	18	1.4	22	-2.2	19	1.9
	Mean	16	0.6	18	-3.4	17	1.0
Cattle	**Weighted Mean**	19	0.2	22	-7.5	20	1.3
	Mean	19	1.5	22	-3.0	20	1.8

RESULTS : Energy intensity in Lithuanian farms by types of farming

Table 5. Energy costs per livestock unit average values and growth

Farming Type	Statistics	2004–2014		2015–2019		2004–2019	
		EUR/LU	GR	EUR/LU	GR	EUR/LU	GR
Milk	**Weighted Mean**	143	7.5	248	1.0	176	7.1
	Mean	125	6.3	190	2.0	145	5.6
Cattle	**Weighted Mean**	142	4.3	242	-13.1	173	5.2
	Mean	128	2.7	187	-8.4	147	3.5

RESULTS : Energy intensity in Lithuanian farms in the EU context

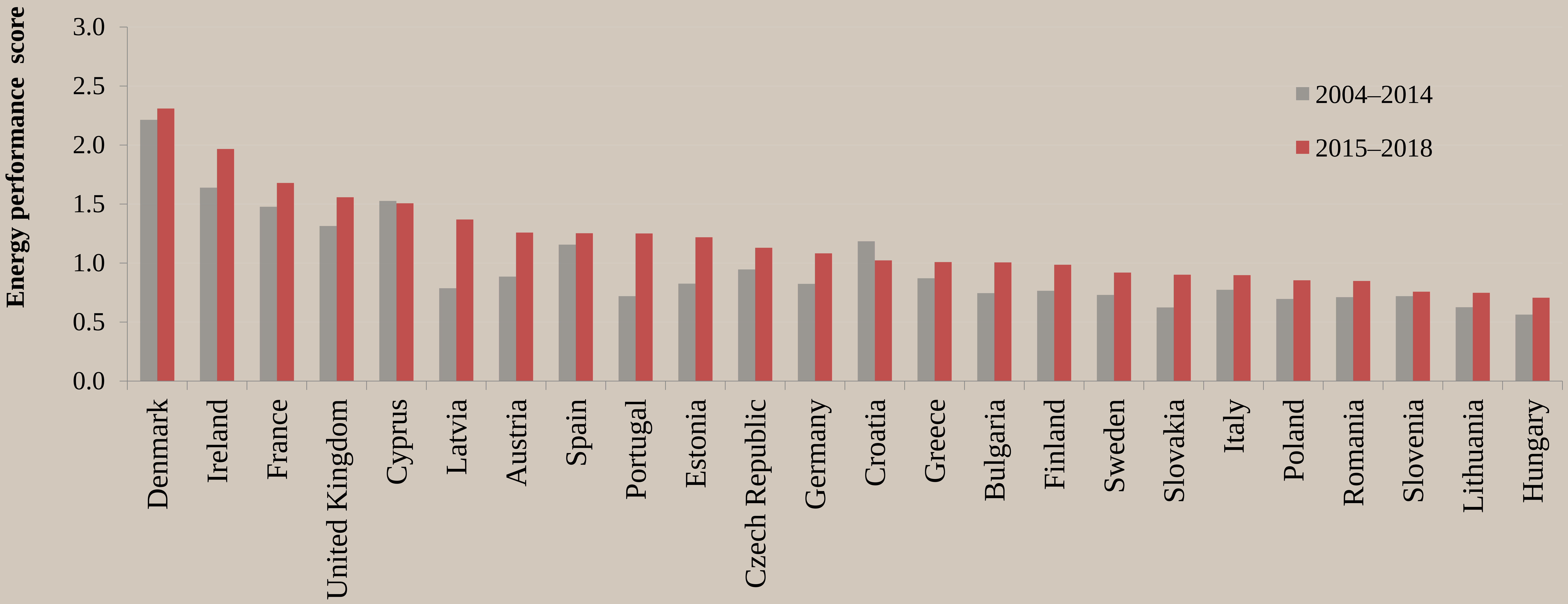


Figure 2. EPSs for the EU COP farms

RESULTS : Energy intensity in Lithuanian farms in the EU context

Figure 3. EPSs for the EU field crop farms

RESULTS : Energy intensity in Lithuanian farms in the EU context

Figure 4. EPSs for the EU orchards-fruit farms

RESULTS : Energy intensity in Lithuanian farms in the EU context

Figure 5. EPSs for the EU milk farms

RESULTS : Energy intensity in Lithuanian farms in the EU context

Figure 6. EPSs for the EU cattle farms

RESULTS: Energy efficiency in Lithuanian farms by types of farming

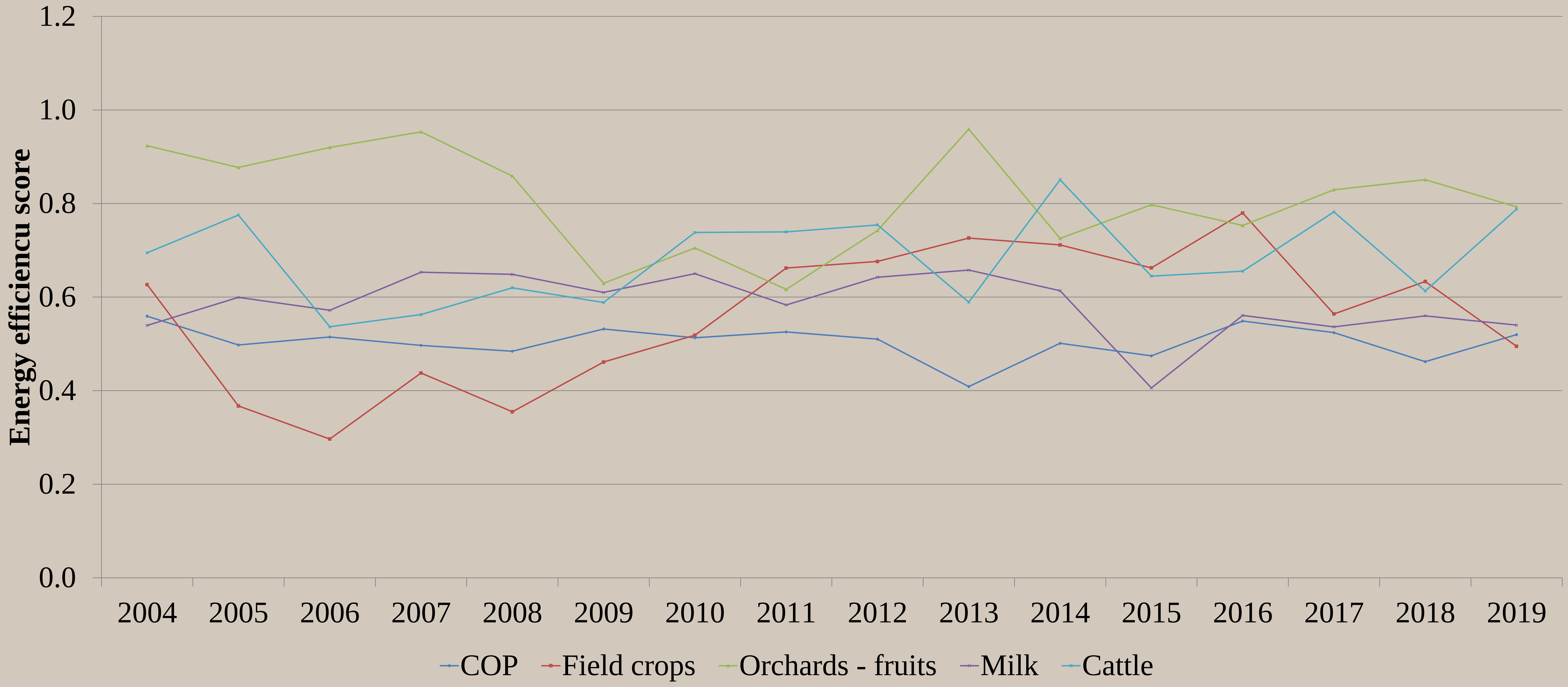


Figure 7. Dynamics in the average energy efficiency scores for Lithuanian family farms (relative to the farming type frontiers)

RESULTS : Energy efficiency in Lithuanian farms by types of farming

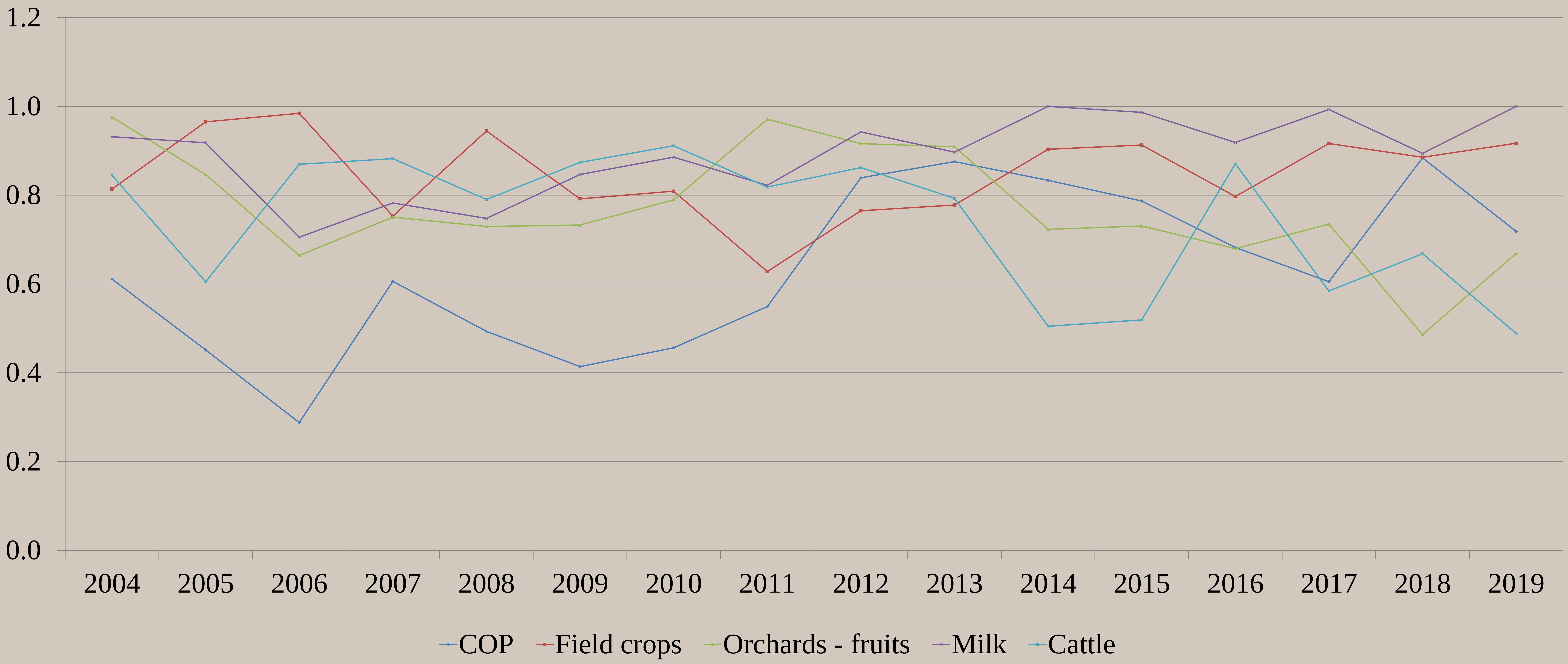


Figure 8. Technological gap ratio for Lithuanian family farms (energy costs)

THE MAIN CONCLUSIONS

- On one hand, it is possible to confirm, that COP, milk and cattle farms, which show relatively low levels of energy intensity across Lithuanian farms are not competitive in terms of energy intensity amongst the EU countries. On the other hand, the orchards-fruit farms result highest energy intensity across Lithuanian farms, though in the EU context these farms performed better than Lithuanian COP, milk and cattle farms. Nevertheless, the decoupling of production and energy intensity is needed in all considered farming systems. The obtained energy efficiency scores for 2015–2019 suggest that energy costs can be reduced by some 49%, 48%, 37%, 30% and 20% in Lithuanian COP, milk, field crops, cattle and orchards-fruit farms, respectively.
- Efficiency analysis suggests that Lithuanian family farms show substantial energy inefficiency. In this research, the overall inefficiency was decomposed into managerial inefficiency and technological gap ratio. In general, the managerial efficiency levels are lower than technological gaps (with exception for orchard-fruit farms). This indicates that on-farm innovations remain the major issue to improve energy efficiency if opposed to sector-wide transition. COP farms show the lowest average managerial efficiency levels that imply the need for technological innovations in regards to energy in those farms. The lowest technological gap ratio is also observed for this farming type. Thus, the best-performing farms also require innovations in order to push the production frontier towards the best practice defined by all the farming types.

Lithuanian Centre for Social Sciences

Institute of Economics and Rural Development
tomas.balezentis@laei.lt

Thank You!

Kuriame Lietuvos ateitį
2014–2020 metų Europos Sąjungos fondų investicijų veiksmų programa

This research is funded by the European Social Fund according to the activity ‘Improvement of researchers’ qualification by implementing world-class R&D projects’ of Measure No. 09.3.3-LMT-K-712