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Decomposing Dynamics in the Farm Profitability: An Application to Lithuanian FADN Sample

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Outline

- Introduction
- Lithuanian farms in the European context
- Methods and data
- Results

Introduction

- CEE countries relatively small farms.
- Smaller farms often face lower productivity and profitability.
- We propose a methodology for decomposition of the profitability change:
  - DuPont identity
  - Shapley value
- The case of Lithuanian family farms is considered.
- The aggregate data for 2005-2016 are applied.

Farm size and its dynamics in selected EU countries, 2005-2016

	Economic size, 10000 EUR	Total Utilised Agricultural Area, ha	Total output, EUR	Farm Net Income, EUR	Total assets, EUR	Net worth, EUR
Average						
(NED) Netherlands	372.4	35.3	422167	51384	2065995	1335299
(DAN) Denmark	295.9	93.3	371053	12028	2354637	1026715
(DEU) Germany	216.2	84.0	219573	36877	813050	651501
(EST) Estonia	73.2	121.6	88892	14549	223024	152735
(LTU) Lithuania	23.4	43.7	31600	12743	99404	84683
(LVA) Latvia	33.9	66.4	47672	11801	119345	80992
(POL) Poland	24.2	18.4	26727	8646	132633	123326
Rate of growth (%)						
(NED) Netherlands	4.0	1.3	5.0	6.2	4.8	5.1
(DAN) Denmark	5.3	1.7	4.8	6.8	3.6	2.1
(DEU) Germany	1.9	1.5	4.4	2.7	2.9	2.2
(EST) Estonia	6.7	2.4	7.0	-3.9	7.8	6.7
(LTU) Lithuania	7.0	3.6	7.1	1.6	7.0	6.3
(LVA) Latvia	4.6	0.7	4.6	0.6	6.3	6.2
(POL) Poland	4.1	0.5	2.4	1.8	8.5	9.1

Relative farm performance indicators in selected EU countries, 2005-2016

	Land productivity, EUR/ha	Asset intensity, EUR/ha	ROA, %	ROE, %
	Averages			
(DAN) Denmark	3951	25108	0.6	1.4
(DEU) Germany	2600	9656	4.5	5.6
(EST) Estonia	722	1809	7.4	10.4
(LTU) Lithuania	710	2241	13.2	15.3
(LVA) Latvia	718	1794	10.4	15.3
(NED) Netherlands	11883	58183	2.5	3.8
(POL) Poland	1447	7167	7.0	7.6
	Rates of growth (%)		*Rates of change (p.p.)*	
(DAN) Denmark	3.1	1.8	0.1	0.2
(DEU) Germany	2.9	1.4	0.0	0.0
(EST) Estonia	4.6	5.4	-0.9	-1.3
(LTU) Lithuania	3.5	3.3	-0.7	-0.7
(LVA) Latvia	3.9	5.6	-0.6	-0.9
(NED) Netherlands	3.7	3.5	0.0	0.0
(POL) Poland	1.9	8.0	-0.5	-0.6

Average UAA across different economic size groups in selected EU countries, 2005-2016

Total Utilised Agricultural Area (SE025)	Denmark	Germany	Estonia	Lithuania	Latvia	Netherlands	Poland
(03) 4 000 - < 8 000 EUR			21.8	16.2	24.0		7.8
(04) 8 000 - < 15 000 EUR			34.2	26.8	33.7		11.6
(05) 15 000 - < 25 000 EUR	20.7		52.6	46.0	50.6		17.2
(06) 25 000 - < 50 000 EUR	35.0	28.8	94.0	76.3	83.2	15.5	26.6
(07) 50 000 - < 100 000 EUR	61.5	39.6	172.3	142.2	159.2	21.7	45.0
(08) 100 000 - < 250 000 EUR	99.6	67.5	335.6	286.8	324.0	32.5	79.7
(09) 250 000 - < 500 000 EUR	137.5	109.8	626.1	586.4	673.4	46.9	204.0
(10) 500 000 - < 750 000 EUR	176.9	168.8	751.0	854.1	1072.9	45.8	334.8
(11) 750 000 - < 1 000 000 EUR	209.5	250.1	933.2	1154.3		46.5	491.6
(12) 1 000 000 - < 1 500 000 EUR	249.8	423.0	1185.1			40.0	695.5
(13) 1 500 000 - < 3 000 000 EUR	333.5	1010.5	1682.7	1539.4		33.7	1460.0
(14) >= 3 000 000 EUR	345.6	1729.4				29.6	
Average	93.3	84.0	121.6	43.7	66.4	35.3	18.4
Ratio (10)/(6)	506	586	799	1120	1290	295	1260

Average land productivity in selected EU countries, 2005-2016

Total output per ha, Eur/ha	Denmark	Germany	Estonia	Lithuania	Latvia	Netherlands	Poland
(03) 4 000 - < 8 000 EUR				519	375		831
(04) 8 000 - < 15 000 EUR			379	504	394		902
(05) 15 000 - < 25 000 EUR	3498		355	501	556		1042
(06) 25 000 - < 50 000 EUR	2833	1694	399	578	523	6037	1321
(07) 50 000 - < 100 000 EUR	2803	2081	510	658	573	6033	1594
(08) 100 000 - < 250 000 EUR	2450	2588	546	797	700	6484	2046
(09) 250 000 - < 500 000 EUR	3315	3154	722	881	1019	8457	2294
(10) 500 000 - < 750 000 EUR	4099	3235		1127		14004	3209
(11) 750 000 - < 1 000 000 EUR	4647	3093		1193		20135	1810
(12) 1 000 000 - < 1 500 000 EUR	5314	2584				35880	2504
(13) 1 500 000 - < 3 000 000 EUR	6191	2026		1993		70429	1925
(14) >= 3 000 000 EUR		2651				238168	
Average	3951	2600	722	710	718	11883	1398
Ratio (10)/(6)	145	191	181	195	195	232	243
(9) for Latvia, Estonia							

Index Decomposition Analysis

- Multiplicative relationships among the variables.
- Decomposes the change in the resulting variable.
- “Ideal” decomposition technique should satisfy several properties:
  - Perfect decomposition,
  - Time reversal,
  - Path independency.
- Two groups of techniques (Ang et al., 2009):
  - techniques linked to the Divisia index (e.g. LMDI) and
  - techniques linked to Laspeyres index (e.g. Shapley index).

Shapley/Sun Index

- Shapley (1953) value – game theory.
- Sun (1998) applied it for energy intensity.
- Let 0 and *T* be the two time periods.
- Assume that a variable is decomposed into three terms (*i* = 1, 2, 3):

$$\Delta V = V^T - V^0 = x_1^T x_2^T x_3^T - x_1^0 x_2^0 x_3^0 = \Delta V_{x_1} + \Delta V_{x_2} + \Delta V_{x_3}$$

- A general formula for decomposition is

$$\Delta V_{x_i} = \sum_{s=1}^{3} \frac{(s-1)!(3-s)!}{3!} \sum_{S: x_j \in S, |S|=s} \left(V(S) - V(S \setminus x_i) \right)$$

$$V(S) = \prod_{j \in S} x_j^T \prod_{j \notin S} x_j^0 \qquad j \subseteq i$$

Shapley/Sun Index

- Specifically:

$$\Delta V_{x_1} = \frac{1}{3}\left(x_1^T x_2^0 x_3^0 - x_1^0 x_2^0 x_3^0\right) + \frac{1}{6}\left(x_1^T x_2^T x_3^0 - x_1^0 x_2^T x_3^0\right) + \frac{1}{6}\left(x_1^T x_2^0 x_3^T - x_1^0 x_2^0 x_3^T\right) + \frac{1}{3}\left(x_1^T x_2^T x_3^T - x_1^0 x_2^T x_3^T\right)$$

Marginal contribution of x1, when **two** other variables remain fixed

Marginal contribution of x1, when **one** other variable remains fixed
- Case 1: x3 is fixed
- Case 2: x2 is fixed

Marginal contribution of x1, when **no** other variables remain fixed

DuPont Identity (1)

- Returns on Equity decompose as:

$$\frac{R_t}{E_t} = \frac{R_t}{A_t}\frac{A_t}{E_t}$$

- *t* is time period
- *R* – returns (profit)
- *E* – equity
- *A* – assets

DuPont Identity (2)

- *S* – sales
- *C* – production costs
- The DuPont identity can be revised as:

$$\frac{R_t}{E_t} = \frac{S_t - C_t}{S_t}\frac{S_t}{A_t}\frac{A_t}{E_t} = P_t N_t L_t$$

- *P* – profit margin
- *N* – asset turnover
- *L* – leverage

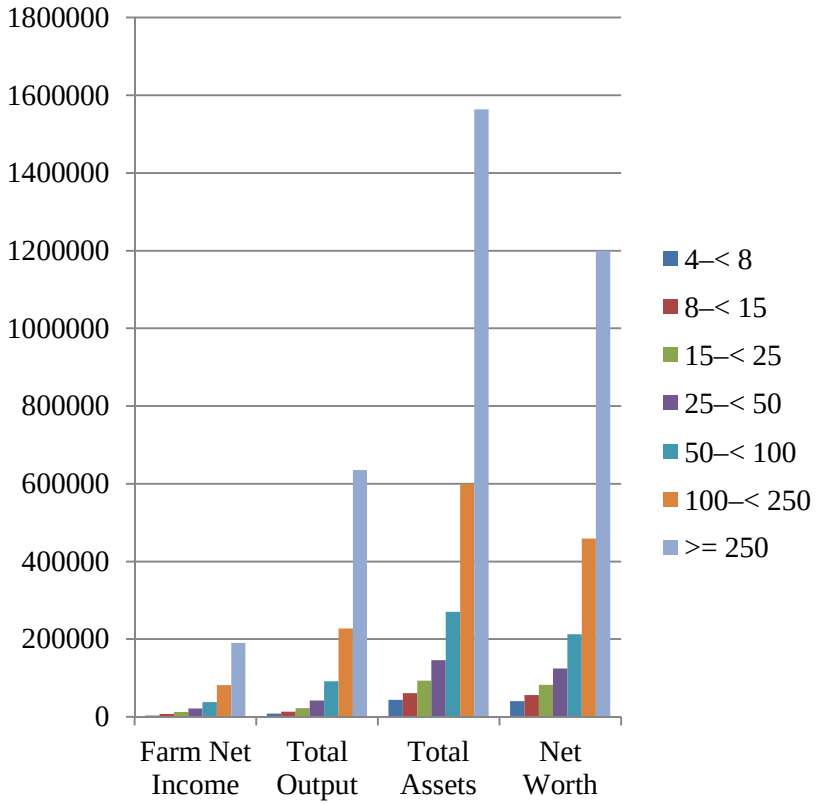
Data Used

- Aggregate FADN data for 2005-2015 are used.
- Farm size in UAA and SO is considered.
- Variables used for the DuPont identity:

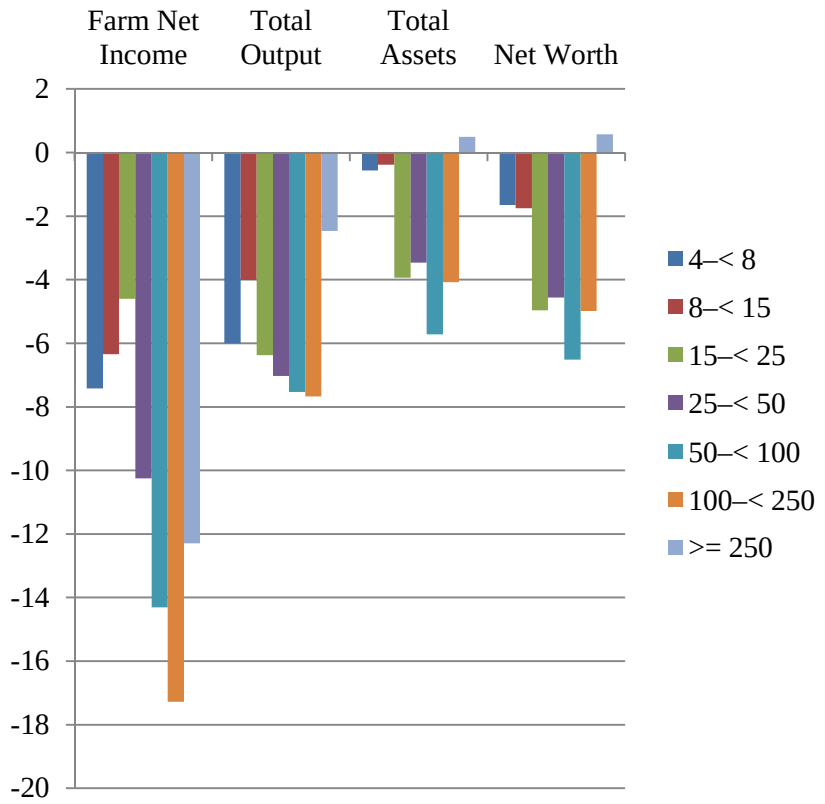
Variable	FADN variable
Farm Net Income, EUR	SE420
Total output, EUR	SE131
Total assets, EUR	SE436
Net worth, EUR	SE501
Profit margin (PT)	SE420/SE131
Assets turnover (AT)	SE131/SE436
Leverage (L)	SE436/SE501
Return on Equity (ROE)	PT*AT*L or SE420/SE501
Economic size, EUR	SE005
Total Utilised Agricultural Area, ha	SE025

Absolute financial indicators for Lithuanian family farms (by SO groups), 2010-2016

Averages (EUR)



Trend coefficients (%)



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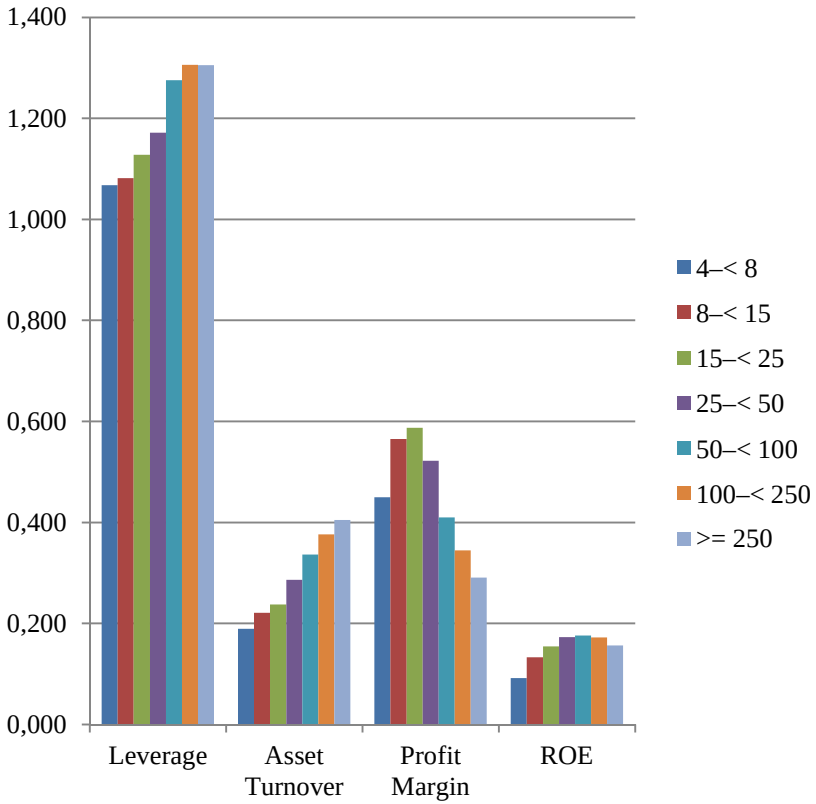

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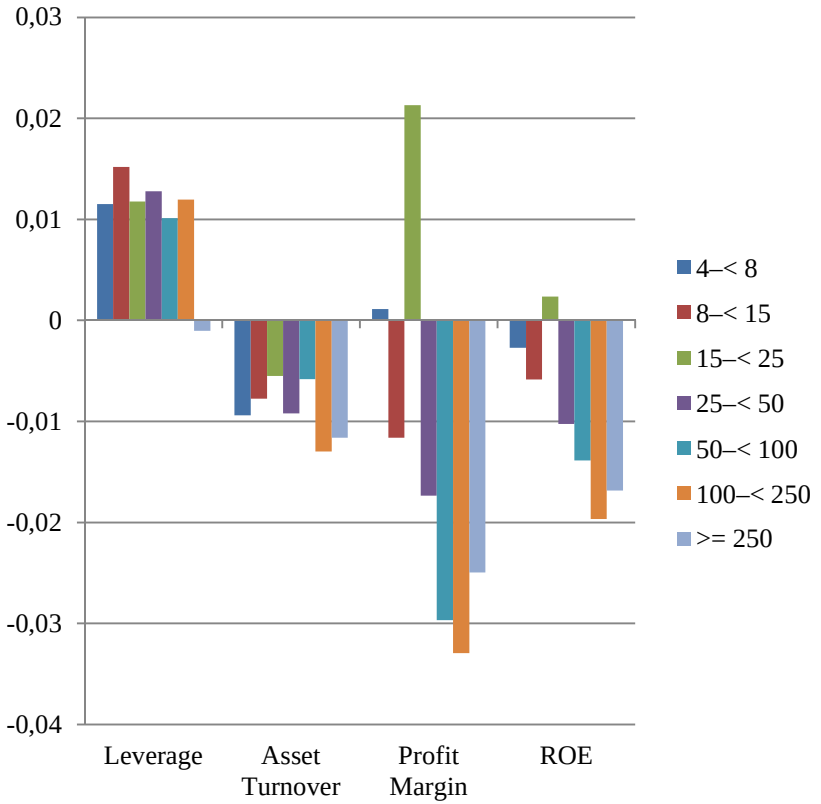

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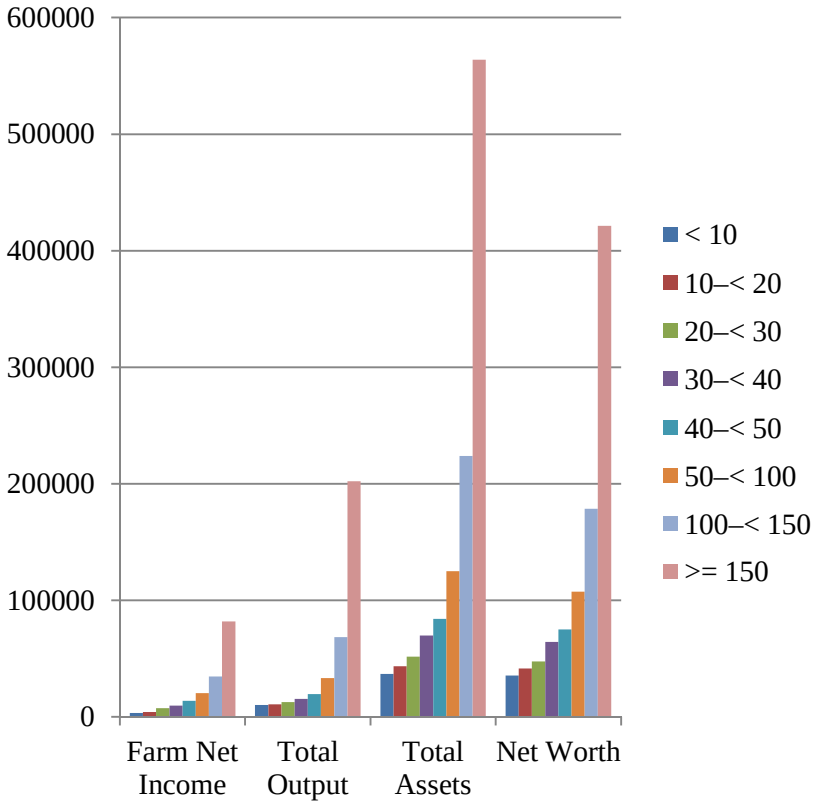

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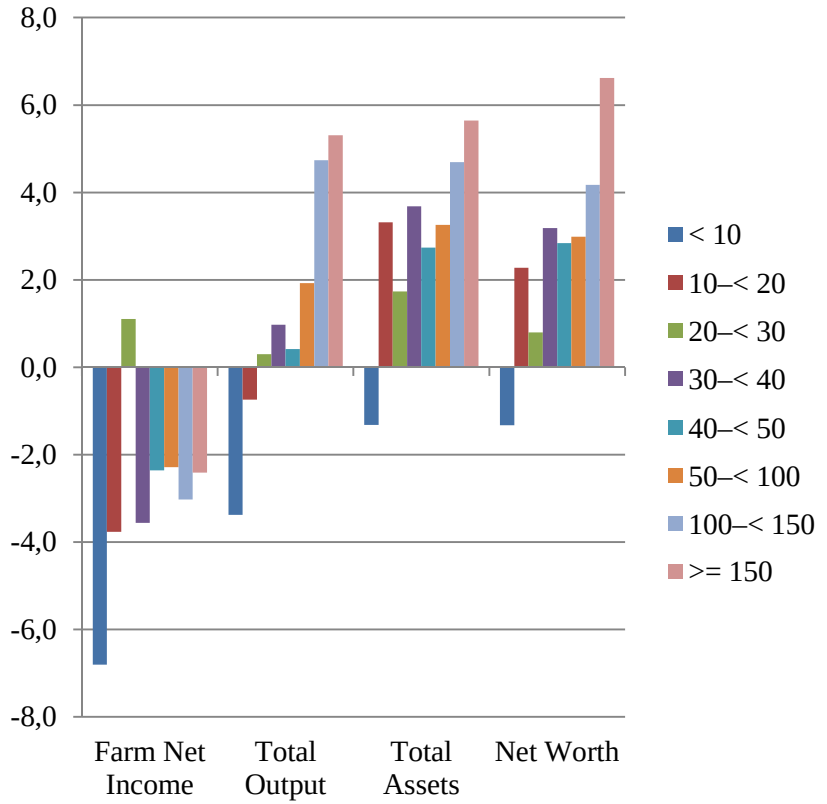

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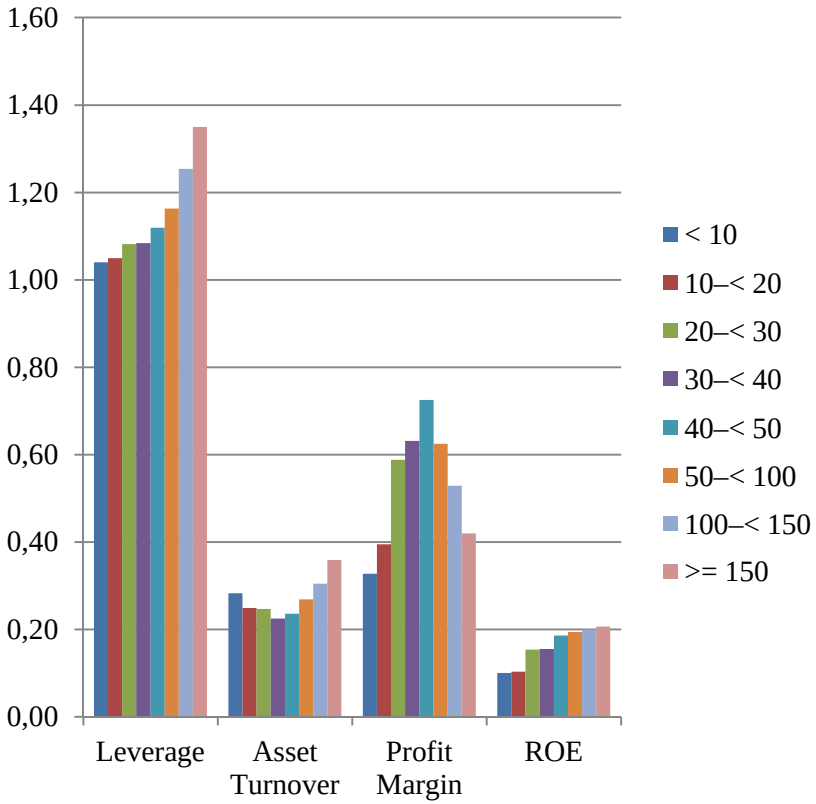

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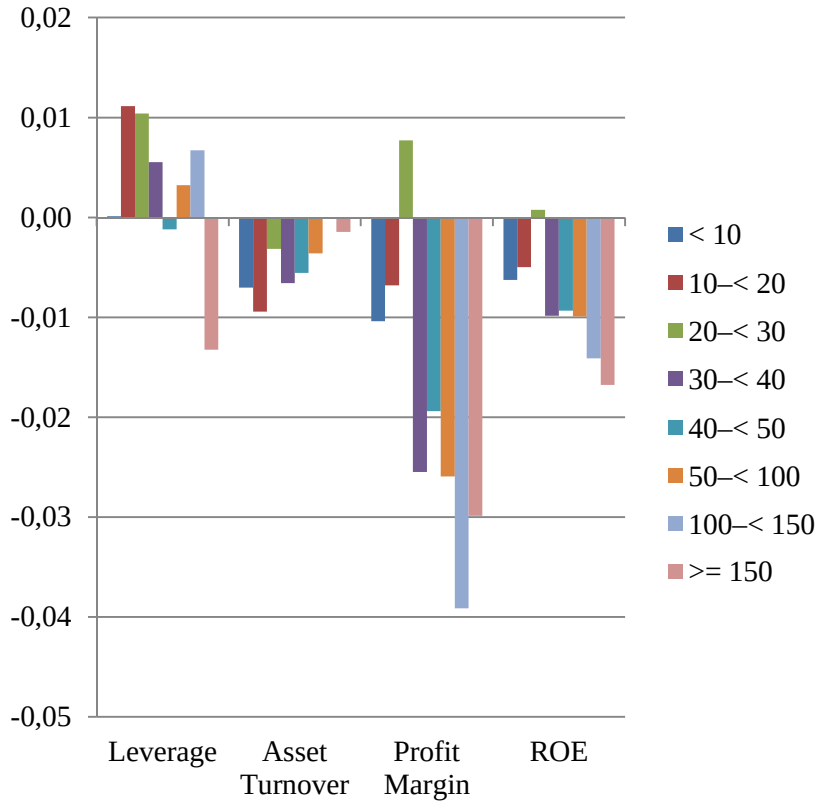
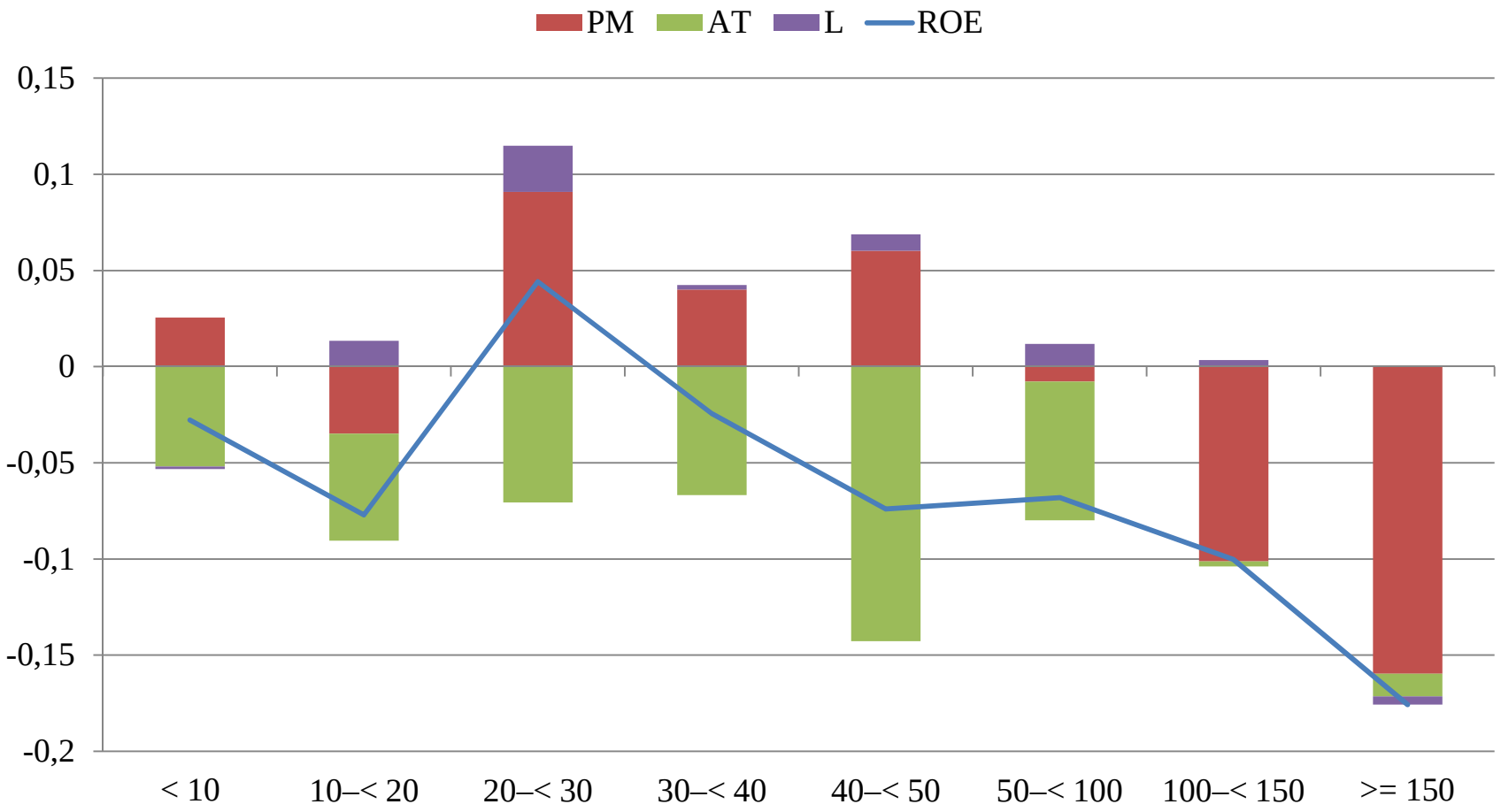
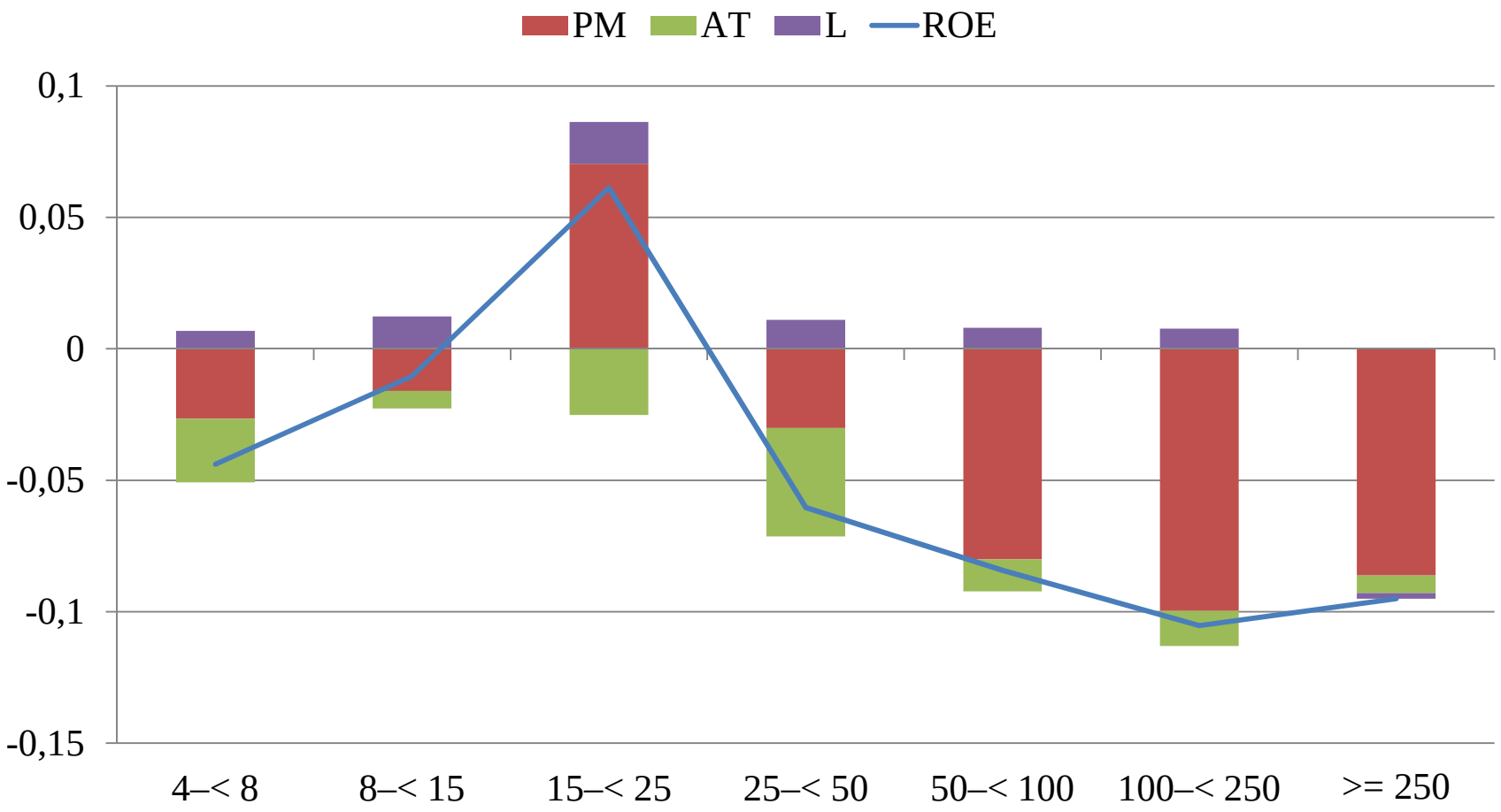


Profitability change by UAA groups, 2005-2016



Profitability change (by SO groups), 2010-2016



Conclusions

- Lithuanian small farms are less profitable in general.
- Leverage is rather low for small farms thus indicating low integration into credit markets.
- Decline in profitability of Lithuanian family farms shows increasing extent with farm size.
- For small (resp. large) farms, the asset turnover (resp. profit margin) component appeared more important
- Farm-level analysis and determinants of profitability change.

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