

# Studying the efficiency of the agriculture sector: an application to the Balkan post-communist countries

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# Outline

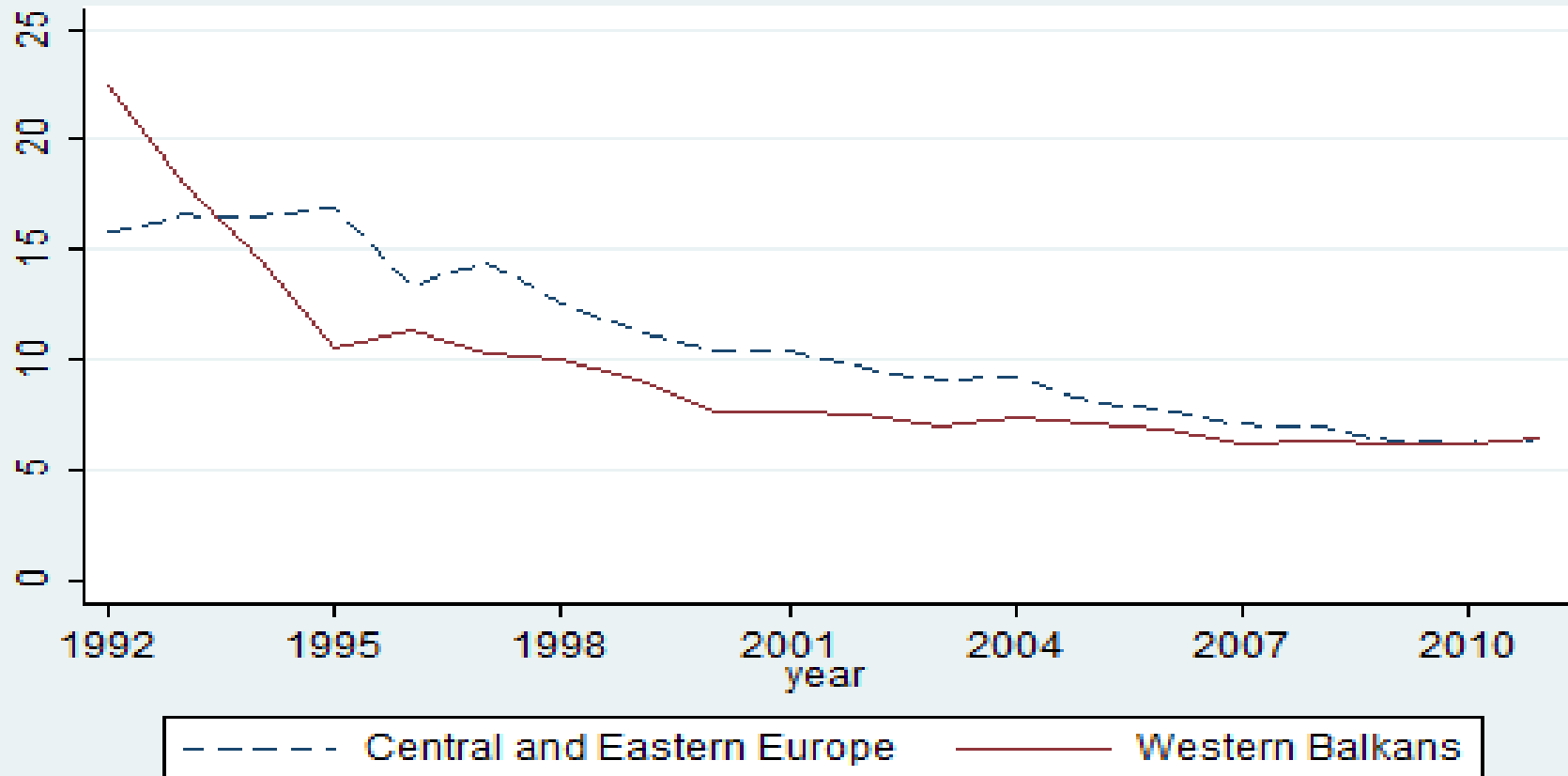
- Introduction, motivation and objectives of the study
- Literature Review
- Data, descriptive statistics, and stylized facts
- Estimation strategy
- Preliminary results
- Conclusions and policy implications

# Introduction, motivation and objectives of the study

- Few studies on agriculture sector in WB, while a plethora of works in EEC after the fall of the Berlin Wall.
- At the same time, common and different historical path!
- Western Balkans countries are alternatively new EU members, accessing country, candidates or potential candidates.
- Agriculture is very important in these countries: (i) adapting to EU laws/standards and new CAP; (ii) opportunity of more export and economies of scale.
- => importance of a comparative analysis between two regions in terms of agricultural productivity

# Importance of Agriculture

Trend of agriculture as share of GDP (%)

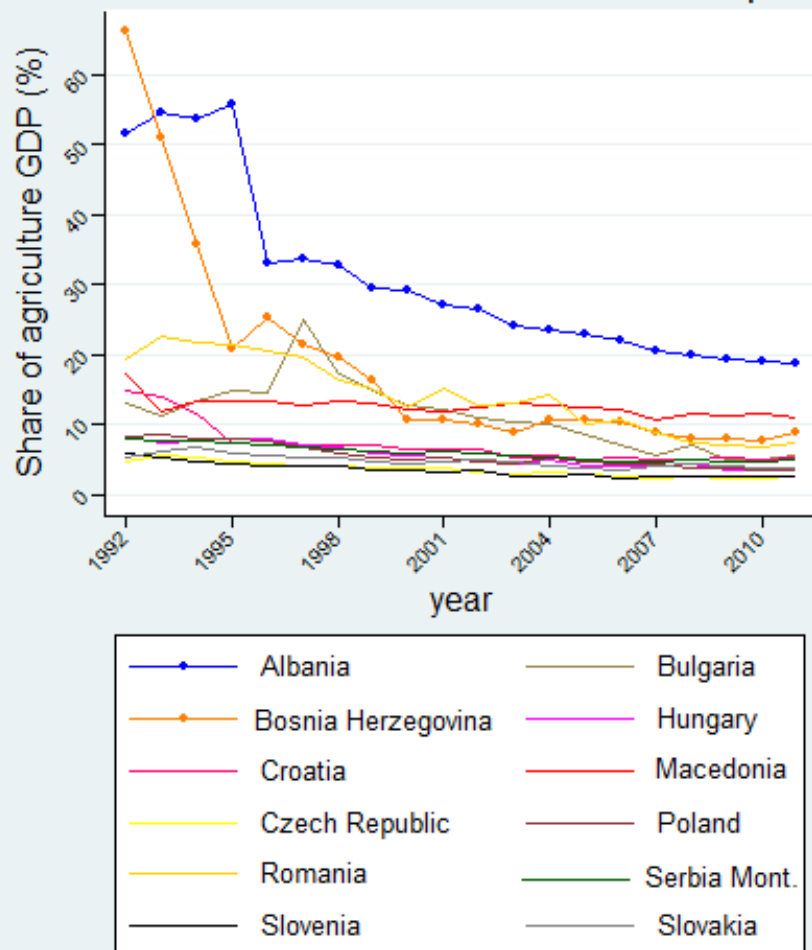


EU-average around 2% during 2001-2010.

Source: Author's Calculation based on World Bank.

# Trend of agriculture as share of GDP (%)

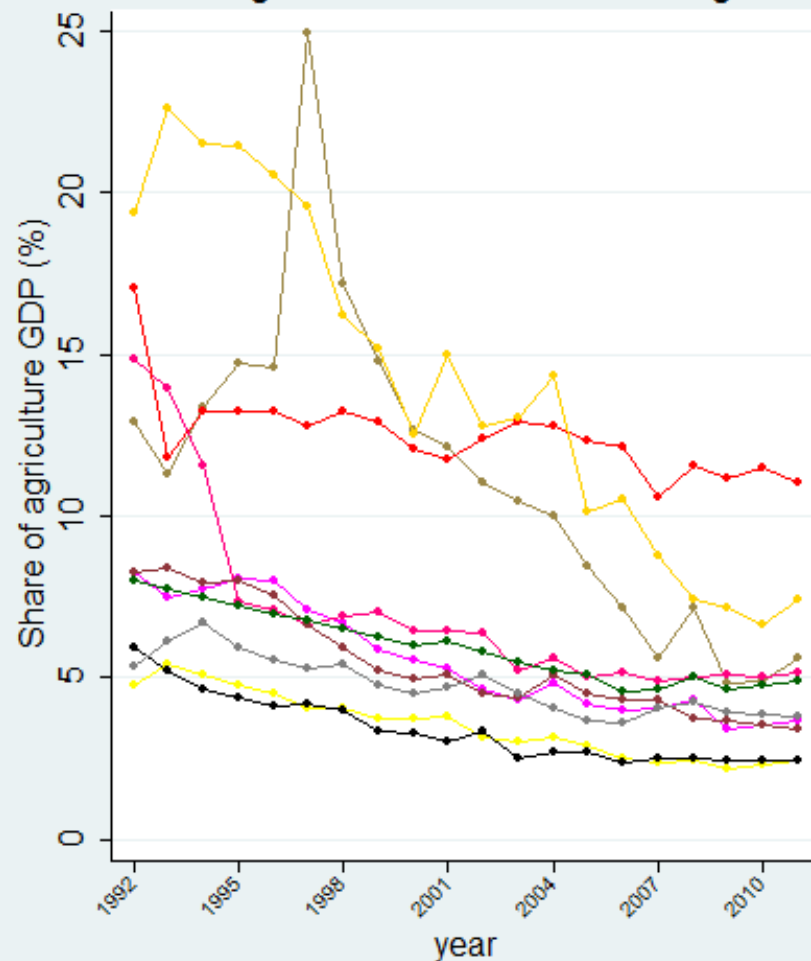
## W. Balkans and Central Eastern Europe



EU-average around 2% during 2001-2010.

Source: Author's Calculation based on World Bank.

## Excluding Albania and Bosnia Herzegovina

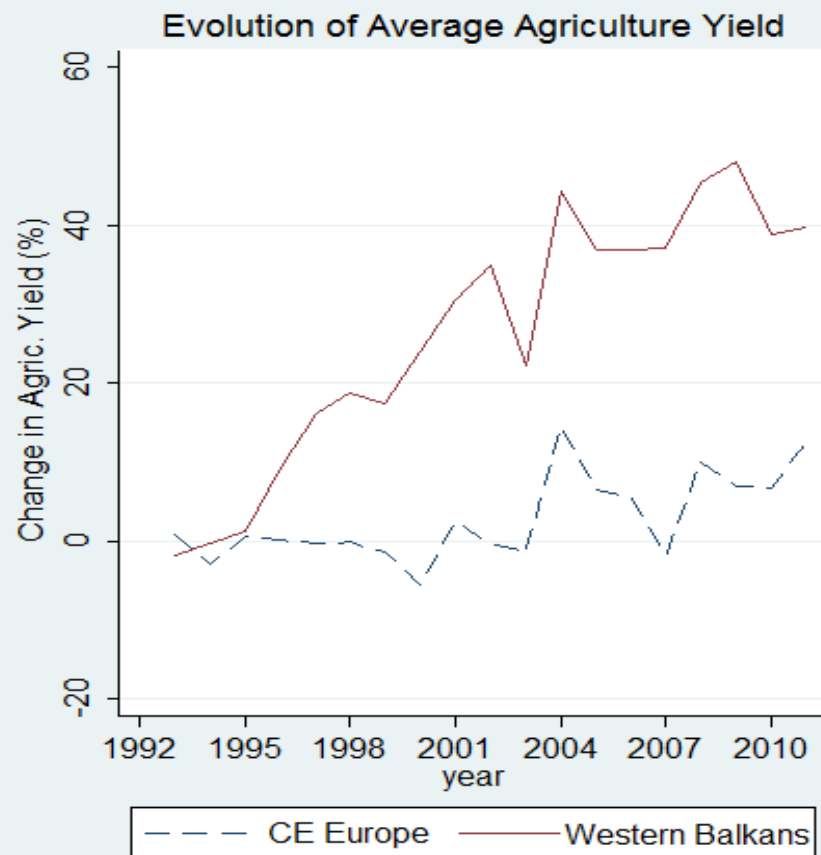
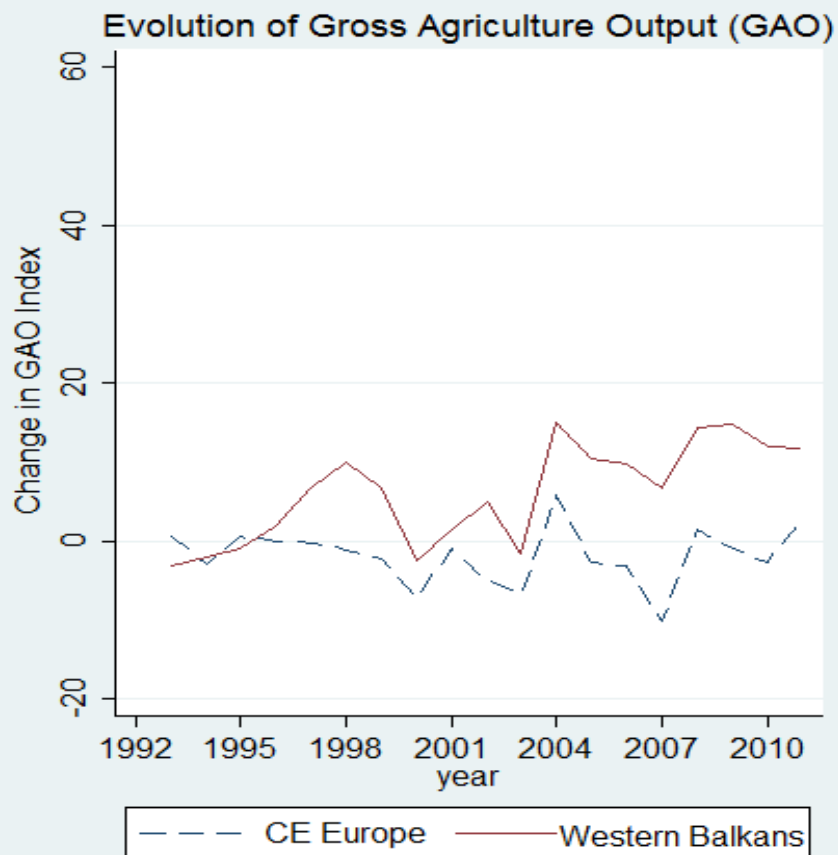


EU-average around 2% during 2001-2010.

Source: Author's Calculation based on World Bank.

# Performance Agric. Output and Productivity

## Comparison between Changes in Agric. Output and Productivity



Source: Author's Calculation based on FAOSTAT

# Summary of Main Literature

EEC	MACRO LEVEL SSA – ASIA – WORLD
<ul style="list-style-type: none"><li>✓ Lerman, Csaki and Feder (2004).</li><li>✓ Csaki and Kray (2005).</li><li>✓ Swinnen and Mathis (2005).</li><li>✓ Swinnen and Vranken (2006).</li><li>✓ Swinnen, Van Herck and Vranken (2012).</li><li>✓ Macours and Swinnen (2000) (Macro)</li></ul>	<ul style="list-style-type: none"><li>✓ Mundlak, Larson and Butzer (2012).</li><li>✓ <b>Fulginiti, Perrin and Yu. (2003, 2007).</b></li><li>✓ <b>Xu, Tu and Shaik (2007).</b></li><li>✓ <b>Rezek, Campbell and Rogers (2011).</b></li><li>✓ <b>Nkamleu (2008).</b></li><li>✓ Coelli and Rao (2003).</li></ul>

# Speed and mechanism of productivity growth and reforms





Output variable	Unit	Source
Gross production value of crops and livestock.	Constant 2004 -2006 million US\$	FAOSTAT
<b>Input variables</b>		
Land - Total agricultural area.	Hectares	FAOSTAT
Labor - Total economically active population in agriculture.	Units	ILO - FAOSTAT
Capital - Net stock in agriculture.	Millions of US\$ at constant 2005 prices	FAOSTAT
Ag. mach - Agri. Machinery Tractors.	Units in use	World Bank - FAOSTAT
Fertilizers - Sum of the Nitrogenous, Phospate and Potash in use.	Tons of nutrients	FAOSTAT
<b>Variables affecting efficiency</b>		
Polity2 (as categorical variable).	(from -10 to + 10 but here from 2 to 5 to solve Transiition regimes)	Polity IV Project
Dummy for Western Balkans.	1 for Bosnia H., Croatia, Macedonia, Serbia Montenegro, Slovenia.	

Dataset covers 12 countries during the transition period (1992-2006).

	Central and Eastern Europe	Western Balkans	Total
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Growth rates (%)

Output	-0.81	1.05	-0.03
Land	-3.14	-1.29	-2.37
Agri. Tractors	-4.04	0.84	-2.01
Capital	-4.59*	-0.15*	-2.74
Fertilizers	-6.39	-2.09	-4.6
Labor	-7.05	-6.54	-6.84
Output	-0.80	-0.15	-0.53
Land	-1.25	-1.55	-1.38
Agri. Tractors	0.96	3.82	2.15
Capital	-1.23	-0.05	-0.73
Fertilizers	6.44	-2.39	2.76
Labor	-3.25***	-6.50***	-4.61

1992/1999

2000/2006

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

# Estimation Strategy

- Battese and Coelli (1995) – Explanatory variables for inefficiency

$$y_{it} = \mathbf{x}'_{it}\beta + v_{it} - u_{it}$$

$$\text{where } u_{it} \sim N^+(z_{it}\delta, \sigma^2)$$

$z$  ( $1 \times m$ ) vector of explanatory variables and  $\delta$  unknown coefficients.

- Battese and Coelli (1988) – Time Invariant model:

*(with all unobserved heterogeneity considered as inefficiency)*

$$y_{it} = \mathbf{x}'_{it}\beta + v_{it} - u_i$$

- Battese and Coelli (1992) – Time decay model:

$$y_{it} = \alpha + \mathbf{x}'_{it}\beta + v_{it} \pm u_{it}$$

where  $u_{it} = g(t) \cdot u_i$  and  $g(t) = \exp[-\gamma(t - T_i)]$

## OLS

	(1)	(2)
Land	0.294** (2.27)	0.213** (2.95)
Labor	0.175** (2.66)	0.072 (1.52)
Ag. machinery	0.027 (0.52)	
Capital		0.416*** (3.81)
Fertilizers	0.302*** (5.96)	0.228*** (3.85)
D_wbalk	-0.282** (-2.82)	0.062 (0.55)
_cons	-2.842** (-2.60)	-2.612*** (-5.26)
N	180	180
Log-likelihood	1.611	44.04
F-test	91.37	163.9
R-squared	0.944	0.965
Adj.R-squared	0.942	0.964

## FIXED EFFECTS

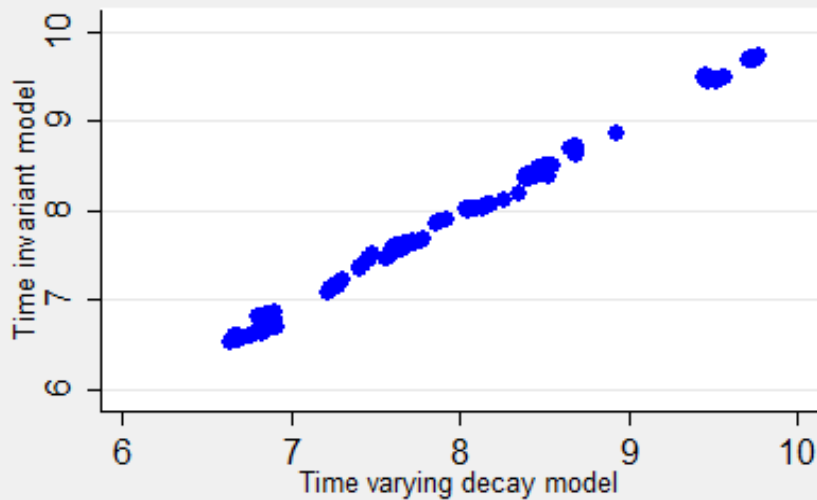
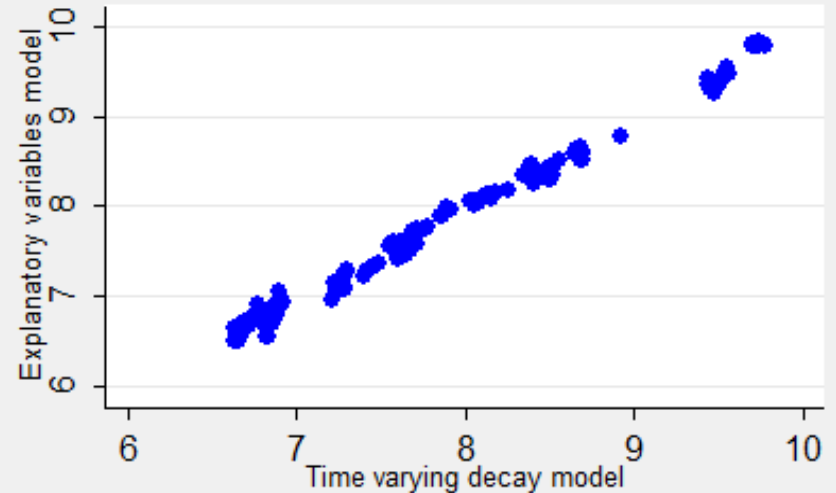
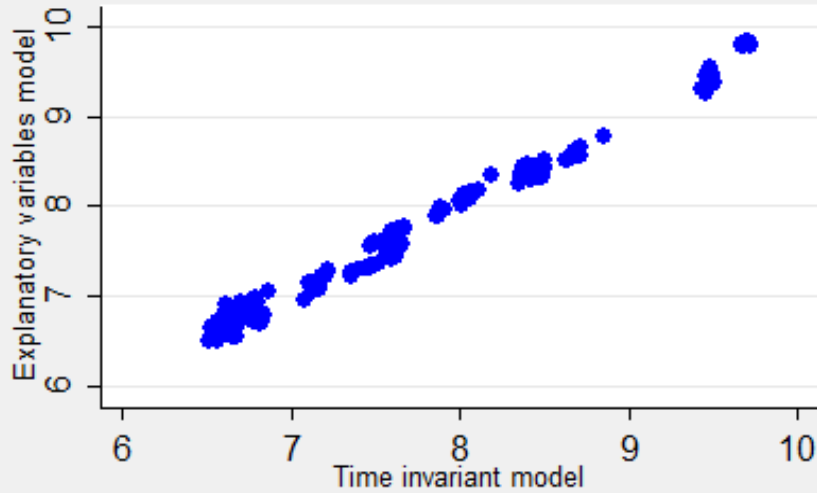
	(1)	(2)
Land	0.230* (1.99)	-0.062 (-0.62)
Labor	-0.042 (-0.43)	-0.076 (-1.24)
Ag. Machinery	0.027 (0.53)	
Capital		0.503*** (4.57)
Fertilizers	0.0248 (0.70)	0.0281 (0.98)
_cons	4.423*** (3.27)	5.047*** (4.45)
N	180	180
Log-likelihood	172.5	197.9
F-test	2.987	6.207
R-squared	0.084	0.309
Adj. R-squared	0.063	0.293

*t* statistics in parenthesis. Robust standard errors

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

# Scatter distribution

Difference between observed output and technical inefficiencies estimates



	(1) Battese - Coelli (1995)	(2) Battese - Coelli (1988)	(3) Battese - Coelli (1992)
<i>Frontier model</i>			
Land	0.209***	0.317***	0.180*
Labor	0.060	-0.123**	0.061
Capital	0.400***	0.494***	0.487***
Fertilizers	0.270***	0.060**	0.043
D_wbalk	-2.649***	0.0239	0.137
<i>Conditional mean model</i>			
D_wbalk	-2.901***		
Policy	0.133*		
_cons	2.124***	-0.851	0.284
<i>Inefficiency variance function</i>			
_cons	-3.942***		
<i>Idiosyncratic error variance function</i>			
_cons	-3.791***		
<i>Time-decay parameter</i>			
_cons			0.022***
Log-likelihood	48.22	141.3	147.7
Chi2 test	15987.8	1105075.9	122631.8
Sigma_u ( $\sigma_u$ )	0.139	0.714	0.302
Sigma_v ( $\sigma_v$ )	0.150	0.095	0.091
Lambda ( $\sigma_u/\sigma_v$ )	0.927	7.516	3.319

Robust standard errors

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

Ranking based on the difference between observed outcomes and technical inefficiency estimates

country	BC-1995	BC-1988	BC-1992	rankbc95	rankbc88	rankbc92
FYR of Macedonia	6.651	6.571	6.689	1	1	1
Slovenia	6.770	6.747	6.843	2	2	2
Bosnia & Herzegovina	6.814	6.758	6.875	3	3	3
Albania	7.147	7.161	7.269	4	4	4
Croatia	7.396	7.526	7.549	5	5	5
Slovakia	7.706	7.625	7.719	6	6	6
Bulgaria	8.068	8.002	8.071	7	7	7
Serbia & Montenegro	8.371	8.401	8.450	8	8	8
Czech Republic	8.441	8.504	8.531	9	9	9
Hungary	8.578	8.680	8.682	10	10	10
Romania	9.387	9.470	9.491	11	11	11
Poland	9.814	9.695	9.734	12	12	12

# Provisional conclusions and policy implications

- Capital factor measured as value of stock in agriculture performs better than the units of agricultural tractors in use.
- Scatter plots of three different models show technical inefficiency in the agricultural production unchanged in this period ( $\Rightarrow$  necessary large sample for efficiency estimation in the agriculture sector).
- Western Balkans countries appear at top in the ranking for technical efficiency estimation (i.e. lower technical inefficiency).
- Trying to separately estimate agricultural productivity performances since observed outcomes show a bimodal distribution.



Thanks for your attention!

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