

The World's Largest Open Access Agricultural & Applied Economics Digital Library

#### This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<a href="http://ageconsearch.umn.edu">http://ageconsearch.umn.edu</a>
aesearch@umn.edu

Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.

# Factors influencing the spatial distribution of biogas production in Germany

<sup>a</sup> Lukas Scholz, <sup>a</sup> Andreas Meyer-Aurich, <sup>b</sup> Dieter Kirschke

lscholz@atb-potsdam.de

a Leibniz Institute for Agricultural Engineering

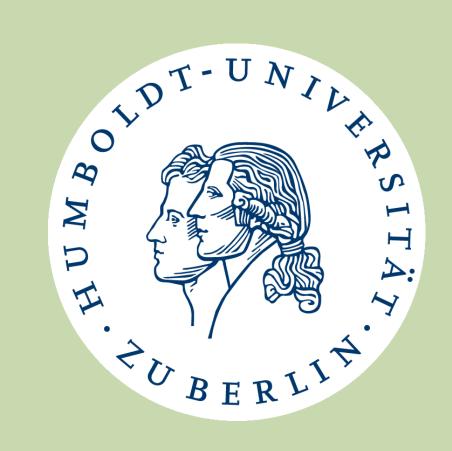
b Humboldt University Berlin

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

Copyright 2013 by Lukas Scholz, Andreas Meyer-Aurich and Dieter Kirschke. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.



## Factors Influencing the Spatial Distribution of Biogas Production in Germany

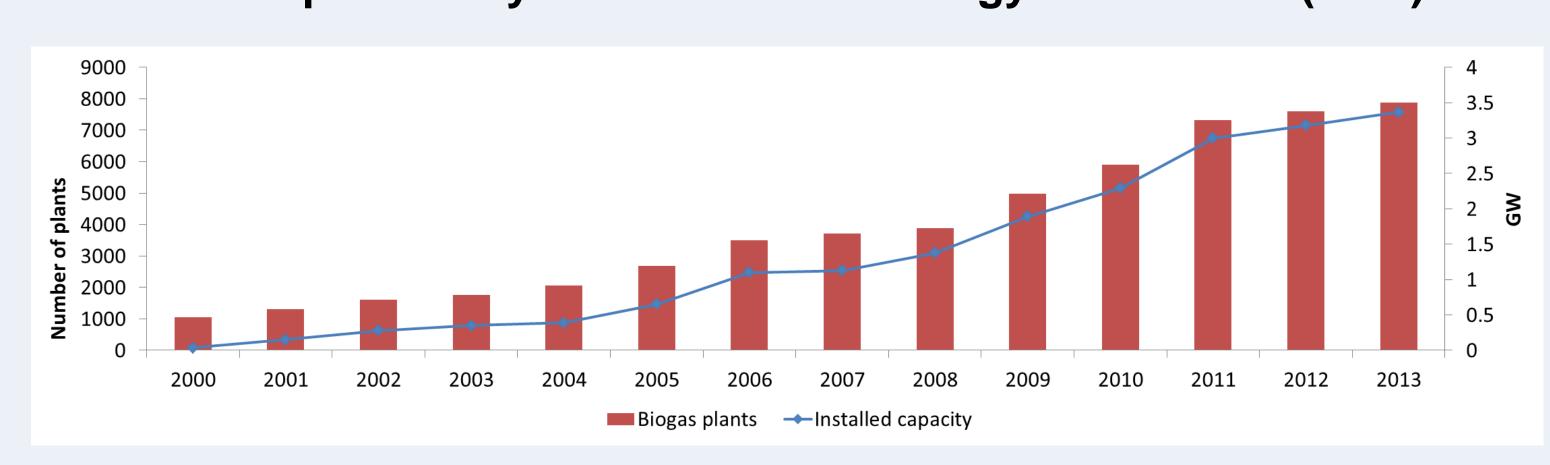


Lukas Scholz<sup>1</sup>, Andreas Meyer-Aurich<sup>1</sup>, Dieter Kirschke<sup>2</sup>

<sup>1</sup> Leibniz-Institute for Agricultural Engineering, Potsdam, Germany <sup>2</sup> Humboldt University Berlin, Germany

#### Dynamic expansion of biogas production

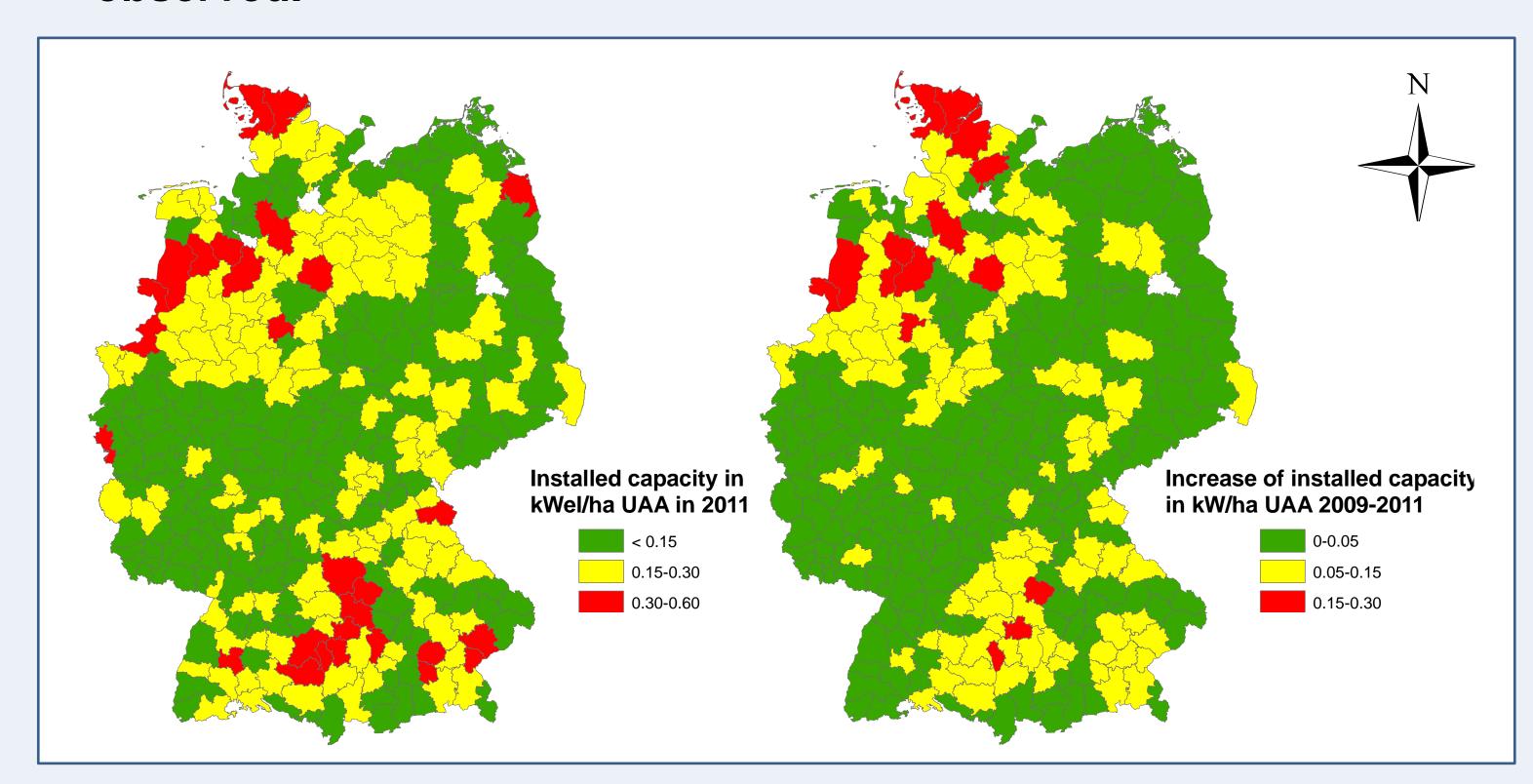
• The dynamic expansion of biogas production in Germany within the last decade was mainly driven by the economic-supportschemes provide by the Renewable-Energy-Source-Act (EEG).



- The amendments of the EEG in 2004 and 2009 triggered a boom in the development of biogas production in Germany.
- A further amendment of the EEG in 2012 and the accompany change of economic-support-schemes decelerated the dynamic development.

#### Spatial distribution of biogas production

 Even though the economic-frame-conditions provided by the EEG are homogeneous among the German counties, a heterogeneous distribution and development of biogas production can be observed.



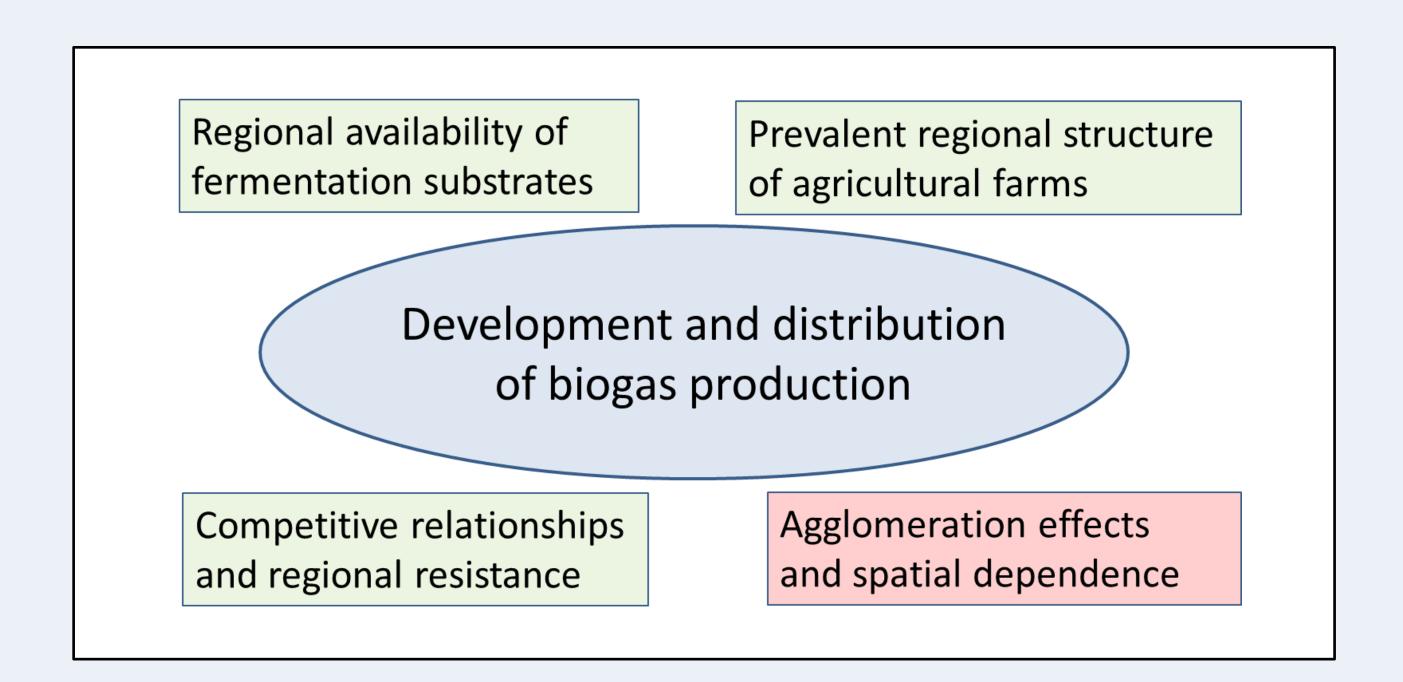
#### **Research Questions**

- Why is the regional distribution and the development of biogas production not homogeneuos among the german counties even though governemental economic-support-schemes of biogas production provided by the EEG are?
- Can we explain the distribution and the dynamic development of biogas production in Germany by the concept of spatial dependence and heterogeneity?

#### Methodological approach

- An econometric model that estimates the increase of installed capacity in  $kW_{\rm el}/ha$  UAA (Utilized Agricultural Area) between 2009-2011 on the county level is used in order to answer the research questions.
- We hypothesis that heterogeneous location factors as well as spatial interactions between neighbouring counties influence the distribution and development of biogas production in Germany.
- If necessary, spatial effects will be incorporated in the econometric model in order to get unbiased and efficent estimates.

### Potential drivers of the development and distribution of biogas production



- For the potential drivers of the spatial distribution and development of biogas production proxy variables are identified.
- In a first step, a linear regression model using all proxy variables is estimated by the OLS-method (N=301).
- Diagnostic tests for spatial dependence suggest the incorporation of spatial effects in the regression analysis.
- Based on robust LM-tests, we choose a spatial-lag-model in order to express and test for spatial dependencies.

#### Diagnostic tests for spatial dependence

Test statistic	$\sqrt{oldsymbol{y}}$
Moran's I (Transformed dependent variable)	0.42 ***
LM (spatial error)	2.86 *
Robust LM (spatial error)	8.97 **
LM (spatial lag)	16.10 ***
Robust LM (spatial lag)	22.22 ***

Source: Own calculations  $\sqrt{y}$ = transformed dependent variable installed capacity in kW<sub>el</sub> / ha UAA; First-order queen-contiguity neighbourhood matrix was used. \*\*\*,\*\* indicates statistical significance at p< 0.001, 0.01, 0.1

## Estimation of the increase of installed capacity in kW<sub>el</sub>/ha UAA (2009-2011)

$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			
Constant $0.55 \text{ ***}$ $-1.54 \text{ ***}$ Share of set aside-area (% of total UAA), 2003 $0.12 \text{ n.s.}$ $0.08 \text{ n.s.}$ Silage maize to wheat yield-ratio, 2003-2008 $-0.02 \text{ **}$ $-0.02 \text{ *}$ Share of managers 45+ (total farm), 2010 $-0.42 \text{ ***}$ $-0.31 \text{ ***}$ Installted capacity (kW <sub>el</sub> /ha UAA), 2008 $0.37 \text{ ****}$ $0.32 \text{ ****}$ Share of silage maize (ha UAA), 2003 $0.12 \text{ n.s.}$ $-0.05 \text{ n.s.}$ Share of grassland (ha UAA), 2007 $-0.11 \text{ ****}$ $-0.08 \text{ *}$ Number of poultry (ha UAA), 2007 $0.01 \text{ n.s.}$ $-0.01 \text{ n.s.}$ Number of cattle (ha UAA), 2007 $0.07 \text{ ****}$ $0.06 \text{ ****}$ Number of pigs (ha UAA), 2007 $0.01 \text{ ***}$ $0.01 \text{ ***}$ Population density (km²) $0.01 \text{ n.s.}$ $0.01 \text{ n.s.}$ $0.01 \text{ n.s.}$ Spatial dependence $0 \text{ ***}$ $0.00 \text{ ***}$ Likelihood ratio $0 \text{ ***}$ $0.00 \text{ ***}$ Likelihood ratio $0 \text{ ***}$ $0.00 \text{ ***}$ AlC $0.43 \text{ 0.50}$ AlC $-644.90 \text{ -}660.12$	Variable	<b>Estimate</b>	Estimate
Share of set aside-area (% of total UAA), 2003       0.12 n.s.       0.08 n.s.         Silage maize to wheat yield-ratio, 2003-2008       -0,02 **       -0.02 *         Share of managers 45+ (total farm), 2010       -0.42 **       -0.31 **         Installted capacity (kW <sub>e</sub> /ha UAA), 2008       0.37 ***       0.32 ***         Share of silage maize (ha UAA), 2003       0.12 n.s.       -0.05 n.s.         Share of grassland (ha UAA), 2007       -0.11 ***       -0.08 *         Number of poultry (ha UAA), 2007       0.01 n.s.       -0.01 n.s         Number of cattle (ha UAA), 2007       0.07 ***       0.06 ***         Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12		<b>OLS-model</b>	spatial-lag-model
Silage maize to wheat yield-ratio, 2003-2008	Constant	0.55 ***	-1.54 ***
Share of managers 45+ (total farm), 2010 $-0.42^{**}$ $-0.31^{**}$ Installted capacity (kW <sub>el</sub> /ha UAA), 2008 $0.37^{***}$ $0.32^{***}$ Share of silage maize (ha UAA), 2003 $0.12 \text{ n.s.}$ $-0.05 \text{ n.s.}$ Share of grassland (ha UAA), 2007 $-0.11^{***}$ $-0.08^{*}$ Number of poultry (ha UAA), 2007 $0.01 \text{ n.s.}$ $-0.01 \text{ n.s.}$ Number of cattle (ha UAA), 2007 $0.07^{***}$ $0.06^{***}$ Number of pigs (ha UAA), 2007 $0.01^{*}$ $0.01^{*}$ $0.01^{*}$ Population density (km²) $0.01 \text{ n.s.}$ $0.01 \text{ n.s.}$ Spatial dependence p $0.30^{***}$ Likelihood ratio $0.01^{*}$ $0.000^{*}$	Share of set aside-area (% of total UAA), 2003	0.12 n.s.	0.08 n.s.
Installted capacity (kW <sub>el</sub> /ha UAA), 2008 0.37 *** 0.32 *** Share of silage maize (ha UAA), 2003 0.12 n.s0.05 n.s. Share of grassland (ha UAA), 2007 -0.11 *** -0.08 * Number of poultry (ha UAA), 2007 0.01 n.s0.01 n.s Number of cattle (ha UAA), 2007 0.07 *** 0.06 *** Number of pigs (ha UAA), 2007 0.01 * 0.01 * 0.01* Population density (km²) 0.01 n.s. 0.01 n.s. Spatial dependence $\rho$ / 0.30 *** Likelihood ratio $\chi^2$ / 16.31 Prob. > $\chi^2$ / 0.00 R² 0.43 0.50 AIC -644.90 -660.12	Silage maize to wheat yield-ratio, 2003-2008	-0,02 **	-0.02 *
Share of silage maize (ha UAA), 2003       0.12 n.s.       -0.05 n.s.         Share of grassland (ha UAA), 2007       -0.11 ***       -0.08 *         Number of poultry (ha UAA), 2007       0.01 n.s.       -0.01 n.s         Number of cattle (ha UAA), 2007       0.07 ***       0.06 ***         Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $χ²$ /       16.31         Prob. > $χ²$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Share of managers 45+ (total farm), 2010	-0.42 **	-0.31 **
Share of grassland (ha UAA), 2007       -0.11 ***       -0.08 *         Number of poultry (ha UAA), 2007       0.01 n.s.       -0.01 n.s         Number of cattle (ha UAA), 2007       0.07 ***       0.06 ***         Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $\chi^2$ /       16.31         Prob. > $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Installted capacity (kW <sub>el</sub> /ha UAA), 2008	0.37 ***	0.32 ***
Number of poultry (ha UAA), 2007       0.01 n.s.       -0.01 n.s         Number of cattle (ha UAA), 2007       0.07 ***       0.06 ***         Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $\chi^2$ /       16.31         Prob. > $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Share of silage maize (ha UAA), 2003	0.12 n.s.	-0.05 n.s.
Number of cattle (ha UAA), 2007       0.07 ***       0.06 ***         Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $χ²$ /       16.31         Prob. > $χ²$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Share of grassland (ha UAA), 2007	-0.11 ***	-0.08 *
Number of pigs (ha UAA), 2007       0.01 *       0.01*         Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $\chi^2$ /       16.31         Prob. > $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Number of poultry (ha UAA), 2007	0.01 n.s.	-0.01 n.s
Population density (km²)       0.01 n.s.       0.01 n.s.         Spatial dependence ρ       /       0.30 ***         Likelihood ratio $χ²$ /       16.31         Prob. > $χ²$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Number of cattle (ha UAA), 2007	0.07 ***	0.06 ***
Spatial dependence ρ       /       0.30 ***         Likelihood ratio $\chi^2$ /       16.31         Prob. > $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Number of pigs (ha UAA), 2007	0.01 *	0.01*
Likelihood ratio $\chi^2$ /       16.31         Prob. > $\chi^2$ /       0.00         R²       0.43       0.50         AIC       -644.90       -660.12	Population density (km²)	0.01 n.s.	0.01 n.s.
Prob. > $\chi^2$ / 0.00 R <sup>2</sup> 0.43 0.50 AIC -644.90 -660.12	Spatial dependence ρ	1	0.30 ***
R <sup>2</sup> 0.43 0.50 AIC -644.90 -660.12	Likelihood ratio χ <sup>2</sup>	1	16.31
AIC -644.90 -660.12	Prob. $> \chi^2$	1	0.00
	R <sup>2</sup>	0.43	0.50
BIC -596.70 -608.46	AIC	-644.90	-660.12
	BIC	-596.70	-608.46

Source: Own calculations  $\sqrt{y}$ = transformed dependent variable installed capacity in kW<sub>el</sub> / ha UAA; First-order queen-contiguity neighbourhood matrix was used. \*\*\*,\*\* indicates statistical significance at p< 0.001, 0.01, 0.1

#### Conclusions

- Heterogeneous location factors as well as the existence of spatial interactions between neighbouring counties can explain the spatial distribution and development of biogas production to a certain extent.
- Ignoring the existence of spatial dependencies leads to an overestimation of the impact of heterogeneous location factors on the distribution and development of biogas production in Germany.
- Possible explanation for the spatial dependencies observed might be knowledge-spill-over between operators of biogas plants as well as the activities of local consulting companies.
- On the policy level, the further development of the EEG should focus on the promotion of biogas production based on animal manure.

#### **Further information**

Please contact Ischolz@atb-potsdam.de for more information. The results shown are preliminary, please do not cite without permission. We greatly thank and acknowlegde the financial support by the German Academic Exchange Service (DAAD).

Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V. (ATB)

Max-Eyth-Allee 100 | 14469 Potsdam | Germany | atb@atb-potsdam.de | www.atb-potsdam.de