New Land Laws and Scale Efficiency of Polish Farms: Nonparametric Regression Evidence

Tomasz Gerard Czekaj and Arne Henningsen

Department of Food and Resource Economics,
University of Copenhagen, Denmark

25th PACIOLI-workshop, Helsingør, Denmark, 01 October 2017

Introduction

The Act on Formation of Agricultural System (Dz.U. 2015 poz. 1433) introduced a reform of the agricultural land market in Poland which may affect competitiveness of Polish farms. According to the *Act* a family farm is:

- =< 300 ha (both owned and leased land)
- is managed personally by a natural person, who:
  - is the owner or leaseholder of the farm,
  - has agricultural qualifications,
  - has lived for at least 5 years in the commune, where at least part of his/her property is located.

Introduction

Research question:
What is *technically optimal farm size* in Poland?

Application:
Polish family farms specialised in crop production.

Method:
Production function - a workhorse of microeconomic production analysis.

Applied Production Analysis: Parametric Approach

- predominant approach
- most common: Cobb-Douglas:

$$\ln y = \alpha_0 + \sum_{i=1}^{N} \alpha_i \ln x_i$$

Translog:

$$\ln y = \alpha_0 + \sum_{i=1}^{N} \alpha_i \ln x_i + 0.5 \sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_{ij} \ln x_i \ln x_j$$

Advantages

- easy to estimate
- easy to interpret results

Disadvantages

- possibility of functional form misspecification
- Translog only *locally* flexible

Modern Approach to Econometric Production Analysis: Nonparametric Approach

Advantages

- no functional form is assumed
- globally flexible

Disadvantages

- larger number of observations required
- bandwidth selection in kernel regression computationally demanding $\Rightarrow$ time consuming

Optimal firm size

Elasticity of scale

Definition:
Elasticity of scale (ε) measures the elasticity of output with respect to (all) inputs:

$$\varepsilon \equiv \frac{\partial f(\lambda x)}{\partial \lambda} = \sum_{i=1}^{N} \varepsilon_i .$$

where, ε_i is a partial output elasticity with respect to i-th input

Optimal firm size

Size at which:

$$\varepsilon = 1.$$

i.e. CRS $\rightarrow$ no economies or diseconomies of scale

Data used

- Polish FADN data on specialised crop farms
- 12 years (2004–2015)
- Unbalanced panel (T >= 9)
- 688 crop farms
- 7425 observations

Economic Model

Production Function:

$$Y = f(L, A, V, K)$$

Dependent variable:

- Y - total agricultural production in PLN (2004)

Independent variables:

- L - labor in Annual Work Units (2200 h/year) [SE010]
- A - utilized agricultural area in ha [SE025]
- V - intermediate inputs in PLN (2004) [SE281+SE336]
- K - capital (stock) in PLN (2004) [SE441 - SE446]

Parametric Models

Functional forms:

- Cobb-Douglas
- Translog

Panel data specifications:

- Pooled OLS
- Fixed Effects (two-ways)

Non-parametric Kernel Regression Model

- local-linear kernel-based regression
- nonparametric regression method for both categorical and continuous proposed by (Racine and Li, 2004)
  - second-order Epanechnikov kernel for continuous regressors (production inputs)
  - Wang and van Ryzin (1981) kernel for ordered categorical regressors (year)
  - Li and Racine (2003) kernel for unordered categorical regressors (farm IDs)
- data-driven bandwidth selection according to the expected Kullback-Leibler cross-validation criterion (Hurvich et al., 1998)
- R package “np” (Hayfield and Racine, 2008)
- Constraint Weighted Bootstrapping (CWB) (Hayfield and Racine, 2008) to impose monotonicity

Results

Panel data tests

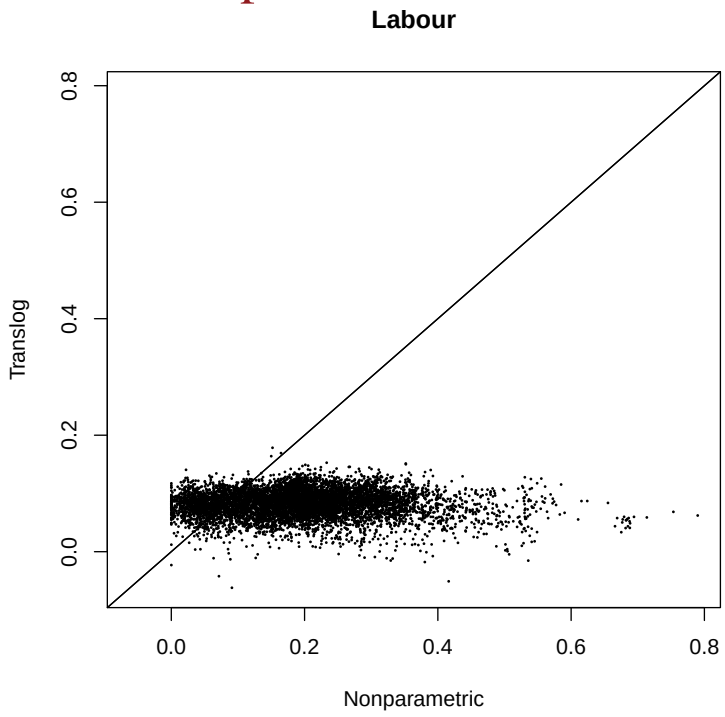
- Pooled OLS rejected (Cobb-Douglas + Translog)

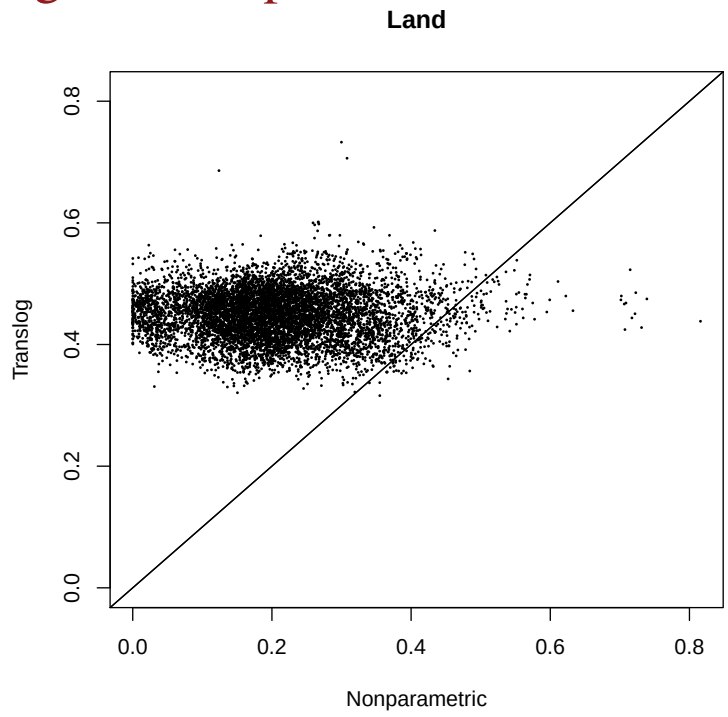
$\Longrightarrow$ Fixed Effects

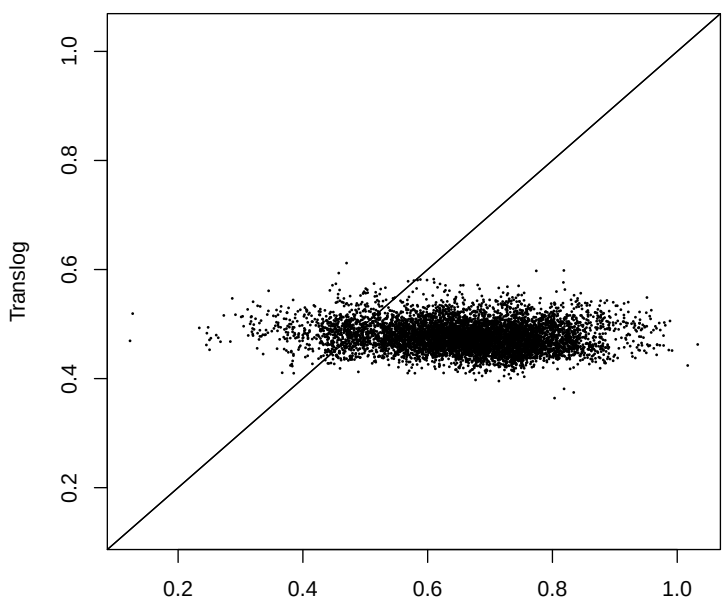
Specification tests:

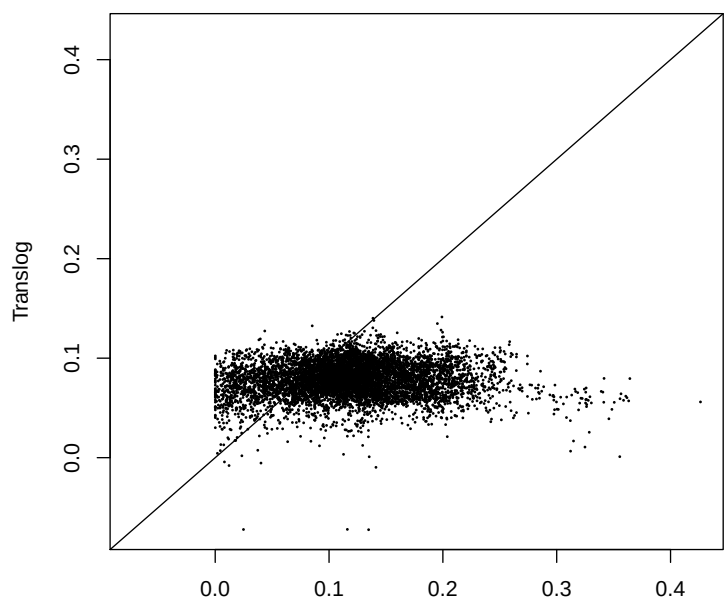
- Cobb-Douglas rejected against Translog (Wald test)
- Cobb-Douglas and Translog functional from are not valid (RESET test)
- Translog vs. Non-parametric (t.b.a.)

Partial Output Elasticities of Translog and Nonparametric models

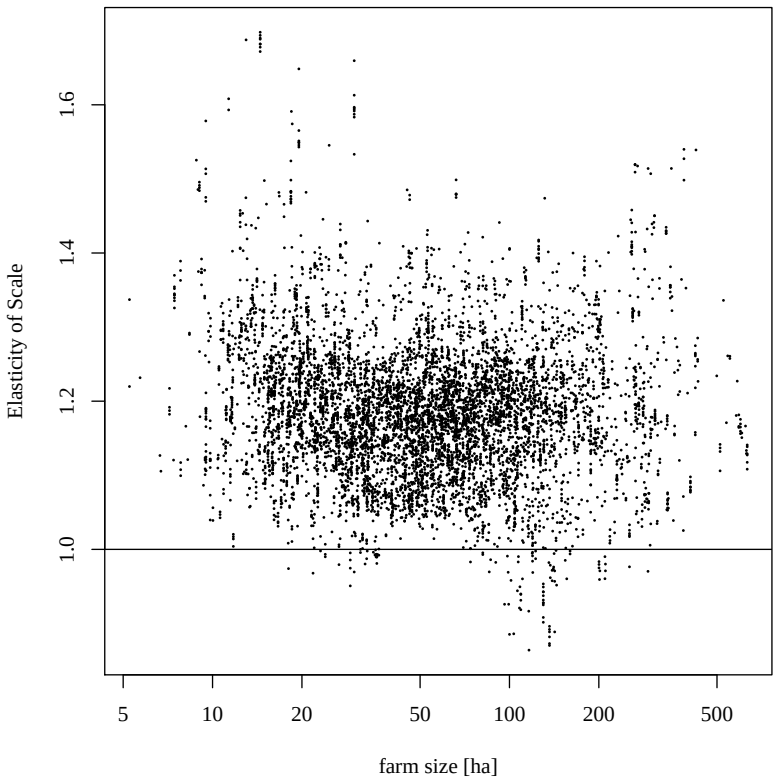




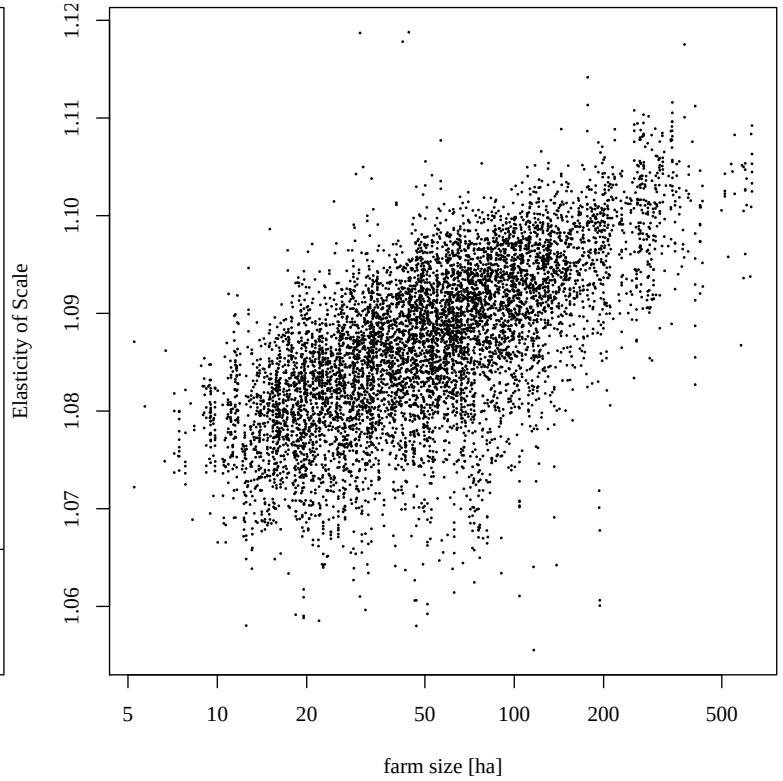




Elasticity of Scale vs. Farm size



Non-parametric



Translog

Conclusions

- optimal size of Polish crop farms is at least as large as the largest farms in our sample, i.e. larger than 500 ha,
- the new law on agricultural land market will negatively affect the competitiveness of crop farming in Poland,
- caution when using Translog investigating optimal size (linear relationship between size and elasticity of scale),
- use RESET test to test functional form!

Hayfield, T. and Racine, J. S. (2008). Nonparametric econometrics: The np package. *Journal of Statistical Software*, 27(5):1–32.

Hurvich, C. M., Simonoff, J. S., and Tsai, C. L. (1998). Smoothing parameter selection in nonparametric regression using an improved Akaike information criterion. *Journal of the Royal Statistical Society Series B*, 60:271–293.

Li, Q. and Racine, J. S. (2003). Nonparametric estimation of distributions with categorical and continuous data. *Journal of Multivariate Analysis*, 86:266–292.

Racine, J. S. and Li, Q. (2004). Nonparametric estimation of regression functions with both categorical and continuous data. *Journal of Econometrics*, 119(1):99–130.

The Act on Formation of Agricultural System (2015). (Ustawa z dnia 5 sierpnia 2015 r. o kształtowaniu ustroju rolnego). Dz.U. 2015 poz. 1433.

Wang, M.-C. and van Ryzin, J. (1981). A class of smooth estimators for discrete distributions. *Biometrika*, 68:301–309.

Hayfield, T. and Racine, J. S. (2008). Nonparametric econometrics: The np package. *Journal of Statistical Software*, 27(5):1–32.

Hurvich, C. M., Simonoff, J. S., and Tsai, C. L. (1998). Smoothing parameter selection in nonparametric regression using an improved Akaike information criterion. *Journal of the Royal Statistical Society Series B*, 60:271–293.

Li, Q. and Racine, J. S. (2003). Nonparametric estimation of distributions with categorical and continuous data. *Journal of Multivariate Analysis*, 86:266–292.

Racine, J. S. and Li, Q. (2004). Nonparametric estimation of regression functions with both categorical and continuous data. *Journal of Econometrics*, 119(1):99–130.

The Act on Formation of Agricultural System (2015). (Ustawa z dnia 5 sierpnia 2015 r. o kształtowaniu ustroju rolnego). Dz.U. 2015 poz. 1433.

Wang, M.-C. and van Ryzin, J. (1981). A class of smooth estimators for discrete distributions. *Biometrika*, 68:301–309.