

Substitutability of Energy in Austrian Agriculture

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- ▶ Adopt to new price relations through **other technologies** and thrifty energy use.
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Elasticity of Substitution many inputs:

Allen Elasticity of Substitution: change in one quantity to change in another while output is constant.

$$\sigma_{ij}^{AES} = \frac{\sum_i x_i f_i}{x_i x_j} \frac{F_{ji}}{F}$$

- ▶ Substitutes if $\sigma_{ij}^{AES} > 1$.
- ▶ Complements if $\sigma_{ij}^{AES} < 1$.
- ▶ Otherwise unrelated.

To derive σ_{ij}^{AES} need production function.

Translog very flexible function:

$$\ln(y) = \beta_0 + \sum_{n=1}^N \beta_n \ln(x_n) + \frac{1}{2} \sum_{n=1}^N \sum_{m=1}^N \beta_{nm} \ln(x_n) \ln(x_m)$$

where y output and x_i inputs and $\beta_{ij} = \beta_{ji}$.

Some restrictions for Translog:

- ▶ Linear Homogeneity.
- ▶ Homogeneity.
- ▶ Homotheticity.
- ▶ Separability.
- ▶ Separability to Cobb-Douglas.

Panel Data: Time and Cross sections.

$$y_{it} = \alpha + X'_{it}\beta + \mu_i + \nu_{it}$$

- ▶ Fixed Effects inefficient if Random Effects possible.
- ▶ Random Effects needs $E(\mu|\mathbf{X}) = E(\mu)$.
- ▶ Can be tested with Hausman Specification test.
- ▶ If rejected, Husman-Taylor model (Special type of IV-estimation).
- ▶ Choice of HT instruments by by economic reasoning and tests.

Data used for Estimation

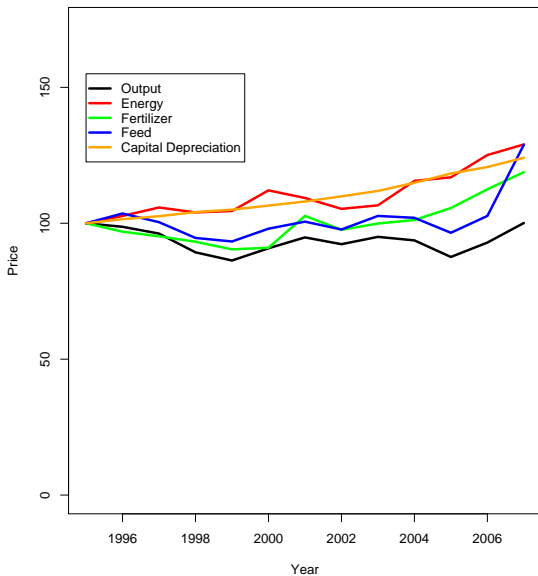
Over 17.000 obs. of 2800 farms from a stratified survey of Austrian farms 1998-2006. Farm services $> 10\%$ output, dropped.

Variables:

- ▶ **Output:** earnings from land, livestock, forest and tourism in Euro.
- ▶ **Land:** ha of reduced agricultural area.
- ▶ **Labor:** work-person-days.
- ▶ **capital:** yearly depreciation in Euro.
- ▶ **Intermediate goods:** in Euro.
- ▶ **Energy:** in Euro.

All Euro values are denominated by product specific price development to measure **quantities only**.

Price developments 1995-2007 (LBG, 1995-2007)



Estimated Parameters

	Dairy		Crops		Perennials		Meat	
	parameter	pVal	parameter	pVal	parameter	pVal	parameter	pVal
interc.			4.16	0.14	3.44	0.54		
land	1.37	0.00	1.34	0.00	0.70	0.36	1.24	0.02
labor	0.57	0.03	0.19	0.59	-1.71	0.13	-0.07	0.87
capital	-0.59	0.04	0.11	0.81	0.62	0.49	-1.49	0.00
intermed.	-0.21	0.35	-0.16	0.67	0.56	0.41	0.94	0.06
energy	0.08	0.74	0.18	0.63	-0.52	0.58	-0.21	0.58
land-land	0.09	0.00	0.23	0.00	0.12	0.23	0.16	0.02
land-labor	0.03	0.39	-0.04	0.38	-0.10	0.21	-0.06	0.17
land-capital	-0.00	0.95	-0.06	0.22	0.05	0.53	-0.11	0.04
land-intermed.	-0.12	0.00	-0.05	0.17	-0.01	0.91	-0.07	0.18
land-energy	-0.03	0.28	-0.10	0.01	-0.16	0.07	0.03	0.58
labor-labor	0.02	0.56	0.11	0.01	-0.06	0.66	-0.04	0.50
labor-capital	-0.01	0.81	0.03	0.36	0.39	0.00	-0.04	0.46
labor-intermed.	-0.07	0.01	-0.02	0.49	0.02	0.82	0.05	0.31
labor-energy	0.01	0.61	-0.01	0.88	-0.14	0.22	0.02	0.72
capital-capital	0.13	0.00	0.09	0.11	-0.03	0.83	0.10	0.17
capital-intermed.	-0.04	0.17	-0.10	0.03	-0.18	0.06	0.03	0.60
capital-energy	-0.01	0.66	0.04	0.30	0.15	0.26	0.07	0.19
intermed.-intermed.	0.10	0.00	0.27	0.00	0.18	0.00	0.08	0.23
intermed.-energy	0.05	0.07	-0.11	0.01	-0.03	0.72	-0.15	0.00
energy-energy	-0.04	0.39	0.13	0.02	0.01	0.95	0.14	0.05
year2	0.01	0.28	0.03	0.02	-0.06	0.14	0.04	0.00
year3	0.03	0.00	-0.09	0.00	-0.13	0.00	0.02	0.14
year4	0.02	0.02	-0.02	0.15	-0.15	0.00	0.03	0.03
year5	0.01	0.13	-0.05	0.00	-0.16	0.00	0.05	0.00
year6	0.08	0.00	-0.06	0.00	0.10	0.03	0.04	0.01
year7	0.10	0.00	0.06	0.00	0.06	0.20	0.04	0.00
year8	0.10	0.00	0.03	0.05	-0.06	0.21	0.11	0.00
adjR ²	0.37		0.97		0.90		0.60	
Obs.	5778		2039		1128		1501	

	Energy
Land	0.71
Labor	-5.70
Capital	-3.11
Intermediate	0.77

Output:	<i>consists of:</i>	<i>shares</i>
	plants	0.10
	meat	0.27
	anim.prod.	0.53
	non-agri	0.07
Capital:	<i>consists of:</i>	<i>shares</i>
	tools	0.55
	buildings	0.43
Intemed.:	<i>consists of:</i>	<i>shares</i>
	seeds	0.03
	energy	0.13
	ferti.&pesti.	0.04
	feed	0.26
Energy:	<i>consists of:</i>	<i>shares</i>
	electr.	0.36
	fuel	0.64

	Energy
Land	-2.83
Labor	-11.90
Capital	-21.38
Intermediate	1.27

Output:	<i>consists of:</i>	<i>shares</i>
	plants	0.69
	meat	0.17
	anim.prod.	0.05
	non-agri	0.05
Capital:	<i>consists of:</i>	<i>shares</i>
	tools	0.61
	buildings	0.37
Intemed.:	<i>consists of:</i>	<i>shares</i>
	seeds	0.13
	energy	0.12
	ferti.&pesti.	0.18
	feed	0.16
Energy:	<i>consists of:</i>	<i>shares</i>
	electr.	0.19
	fuel	0.81

σ^{AES} Perennials

	Energy
Land	-1.52
Labor	2.32
Capital	4.99
Intermediate	-2.79

Output:	<i>consists of:</i>	<i>shares</i>
	plants	0.82
	meat	0.05
	anim.prod.	0.01
	non-agri	0.09
Capital:	<i>consists of:</i>	<i>shares</i>
	tools	0.56
	buildings	0.39
Intemed.:	<i>consists of:</i>	<i>shares</i>
	seeds	0.07
	energy	0.11
	ferti.&pesti.	0.13
	feed	0.05
Energy:	<i>consists of:</i>	<i>shares</i>
	electr.	0.23
	fuel	0.77

σ^{AES} Meat producers

	Energy
Land	6.46
Labor	-11.29
Capital	9.74
Intermediate	-1.99

Output:	<i>consists of:</i>	<i>shares</i>
	plants	0.27
	meat	0.64
	anim.prod.	0.04
	non-agri	0.03
Capital:	<i>consists of:</i>	<i>shares</i>
	tools	0.47
	buildings	0.51
Intemed.:	<i>consists of:</i>	<i>shares</i>
	seeds	0.05
	energy	0.09
	ferti.&pesti.	0.08
	feed	0.48
Energy:	<i>consists of:</i>	<i>shares</i>
	electr.	0.40
	fuel	0.60

Conclusions

If energy prices raise.

Who must intensify which input to cope with it?

- ▶ Dairy and Livestock farms: Land.
- ▶ Perennial farms: Labor.
- ▶ Livestock and Perennials farms: Capital .
- ▶ Dairy and Crop farms: Intermediate.

Results still preliminary: Issues

- ▶ Influence of choice of possible Hausman-Taylor instruments.
- ▶ Confidence Intervals of σ^{AES} estimates.
- ▶ Magnitude of σ^{AES} estimates.