[STIMUL] Input taxation at different spatial scales

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Motivation

- Nitrogen (N) as a source of negative externalities in Europe:
  - Erisman et al. (2008): N fertilizer feed $\sim$ half of the global population;
  - Sutton et al. (2011): Costs to society $>$ Agricultural product ;
    $\sim$ 50% of N is lost to the environment;

Motivation

- N pollutants affect environment at different scales: nitrates (NO_3) are local pollutants and nitrous oxide (N_2O) is a global greenhouse gas.
  - NO_3 pollution from agriculture is addressed by the EU Nitrates Directive;
  - Water is regulated following the subsidiarity principle: in France, applied at the water agency level (River-Basin District, RBD);
  - Member states (MS) define their Nitrate Vulnerable Zones (NVZ) where animal manure on field application is limited.
- Dichotomy and synergies in regulating a local and a global pollutant through input-based taxes.
- Climate change is supposed to exacerbate further pollution problems (for US, Sinha et al., 2017).

Motivation

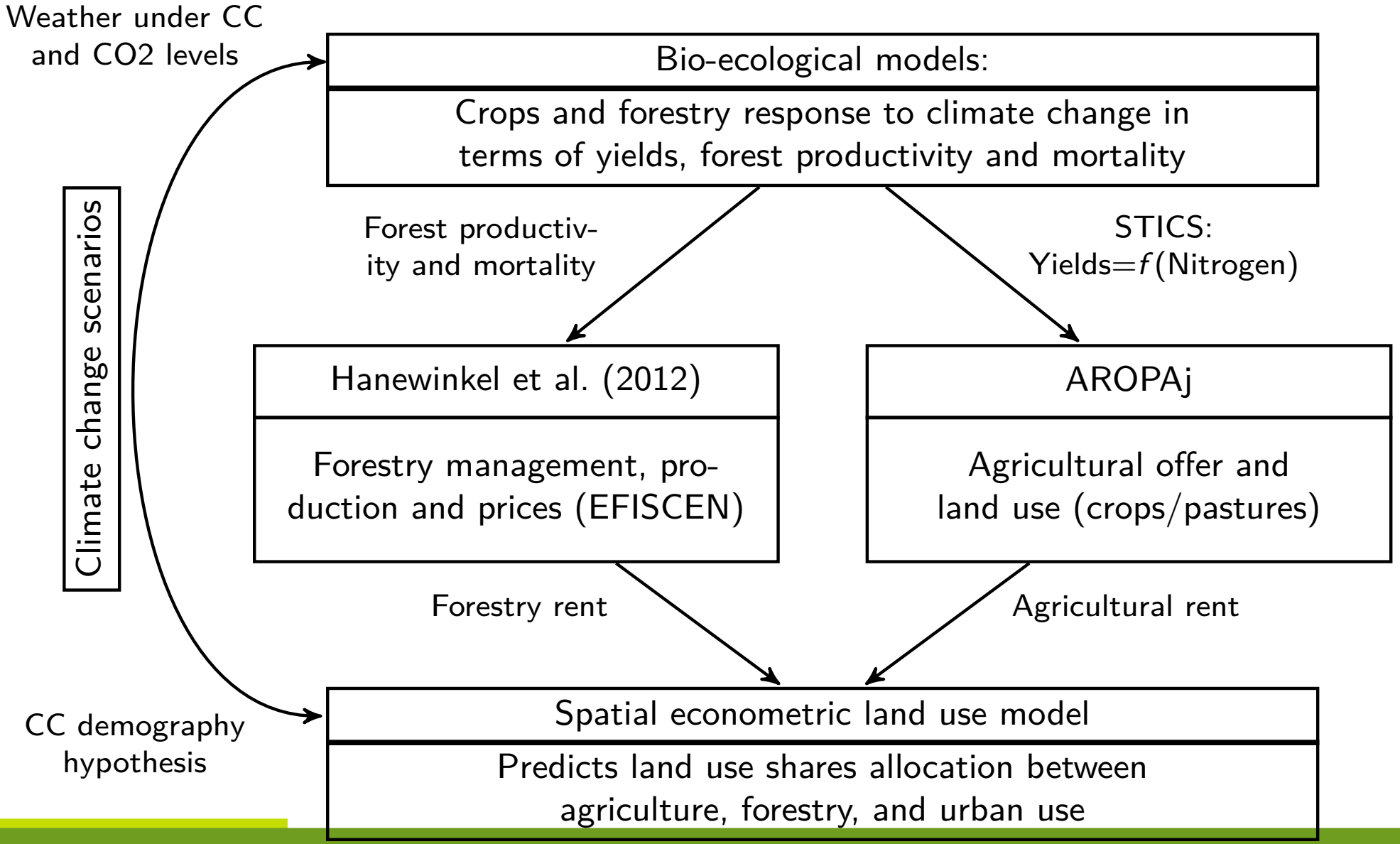

NVZ designated areas (2015)
NVZ_Designation_rep2015
NVZ_Designation_Art3_5
Norwegian Sea
SWEDEN
FINLAND
NORWAY
Oslo
Stockholm
Helsinki
Lake Ladoga
Saint Petersburg
ESTONIA
LATVIA
North Sea
DENMARK
Baltic Sea
Copenhagen
LITHUANIA
Vilnius
Minsk
BELARUS
UNITED KINGDOM
Dublin
IRELAND
Amsterdam
Berlin
POLAND
London
Brussels
GERMANY
Cologne
Warsaw
Kiev
Paris
CZECH REPUBLIC
UKRAINE
Vienna
Budapest
AUSTRIA
HUNGARY
FRANCE
Milan
ROMANIA
Bucharest
Black Sea
ITALY
BULGARIA
Barcelona
Rome
Istanbul
Madrid
PORTUGAL
SPAIN
GREECE
Athens
Lisbon
Algiers
Tunis

Objectives

This study:

- Provides cost estimates for:
  - two (*A2*, **B1**) climate change scenarios;
  - and three public policy scales: EU, MS, and FADN region.
- Integrates land use change feedback concerning policy and climate change impacts on agricultural profits.

Methodology: Lungarska and Chakir (2018)



Bio-ecological models

- Leclère et al. (2013) Crop model STICS: estimation of dose-response functions for N (*CC scenarios A2 & **B1***);
  Twofold interest:
  - Integrates climate change impact on crop yields;
  - Endogenous N input decision for farmers.
- Hanewinkel et al. (2012) estimate the tree species distribution across Europe (*CC scenarios A1Fi, A1B, & **B1***);

Economic models

- AROPAj : agricultural profitability and climate change autonomous adaptation; public policy simulations (tax on N).
- EFISCEN : growth, harvest, prices, costs for Europe $\rightarrow$ Land Expectation Value (LEV) for forests.

Econometric land use shares model

- Land use shares as a logistic specification:

$$y_{ki} = p_{ki} + \epsilon_{ki} \tag{1}$$

$$p_{ki} = \frac{e^{\beta_k' X_i}}{\sum_{j=1}^{K} e^{\beta_j' X_i}} \tag{2}$$

  - y_{ki} share of land use k in region i ;
  - p_{ki} estimated share ;
  - X_i is the matrix of explanatory variables, β_k' are the associated coefficients.

Linearize via Zellner (1965) where y_{Ki} is the reference land use:

$$\tilde{y}_{ki} = ln(y_{ki}/y_{Ki}) = \beta_k' X_i + u_{ki} \tag{3}$$

Econometric land use shares model: spatial effects

- Because of measurement issues (*e.g.*, scales of variables), we control for spatial correlation.
- We use a spatial Durbin Error model:
  - spatial autocorrelation in the error terms (Wu_{ki});
  - indirect effects of explanatory variables (spatially lagged, WX_i).
- Neighborhood weight matrix based on queen contiguity rules.
- MS specificities of real estate markets: captured through country-wise dummy variables (Germany as reference).

Land uses and explanatory variables

- Corine Land Covers 2012 aggregated into 4 classes for each EU NUTS 3 (= French *département*):
  - Agriculture (crops and pastures) ;
  - Forest ;
  - Urban ;
  - Other (reference usage).
- Explanatory variables :
  - Climatic variables (sum of rain, *pr*, and sum of temperatures, *tas*);
  - Soils: average texture class (*TXT*), average available water content (*AWC*), and average *slope*;
  - Population *density* and *revenues*;
  - **Agricultural land *dual* value, (Leclère et al., 2013)**;
  - **Forest land expectation value (*LEV*, Hanewinkel et al., 2012)**.

Climate change and public policy scenarios

- AROPAj: Scenarios A2 et **B1** (Leclère et al., 2013), EU of 15 MS;
  - Tax on N fertilizers: from 0.1 to 6 €/kg$N$);
- Hanewinkel et al. (2012): Scenarios A1B and **B1**.
- Country-wise demographic projections: Center for International Earth Science Information Network (2002).

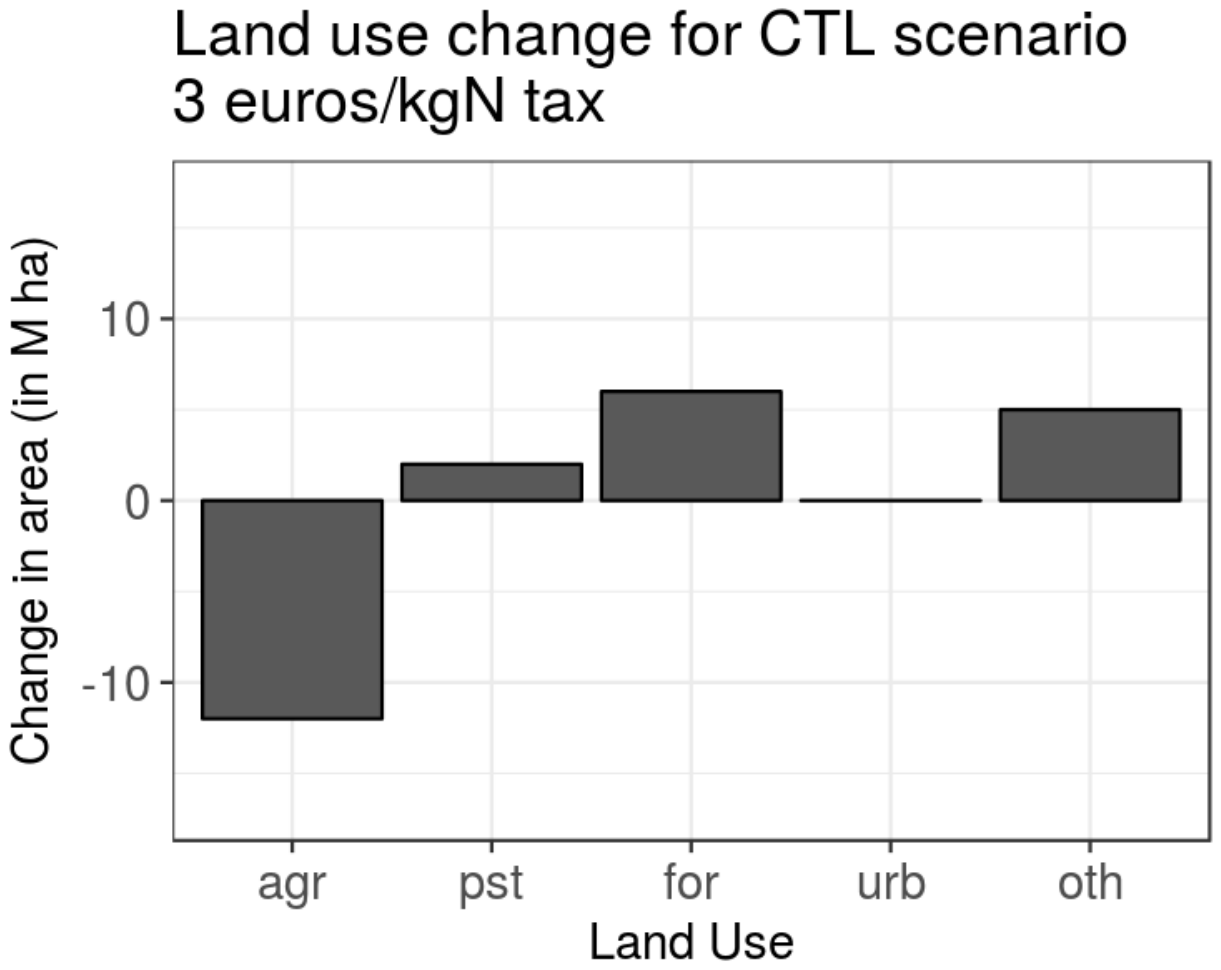
Results: EU level policy

Table : Summary results for the different tax levels for the EU (14 MS)

Tax	Dual value per ha (k €)			$N/N_{baseline}$ (No LUC)			$N/N_{baseline}$ (LUC)			$GM/GM_{baseline}$		
	CTL	B1	A2	CTL	B1	A2	CTL	B1	A2	CTL	B1	A2
0.00	0.599	0.830	0.842	1.000	1.066	1.166	1.000	1.127	1.136	1.000	1.180	1.187
1.00	0.504	0.725	0.727	0.888	0.964	1.054	0.859	0.991	0.994	0.930	1.102	1.102
2.00	0.422	0.630	0.623	0.718	0.852	0.925	0.671	0.852	0.845	0.870	1.032	1.026
3.00	0.364	0.550	0.540	0.527	0.709	0.760	**0.478**	0.692	0.676	**0.825**	0.972	0.963
3.30	0.350	0.529	0.519	**0.481**	0.675	0.704	0.433	0.653	0.620	**0.813**	0.956	0.947
4.00	0.324	0.488	0.477	0.353	0.531	0.572	0.312	0.506	**0.497**	0.792	0.925	**0.915**
4.10	0.320	0.483	0.471	0.337	0.516	0.554	0.297	**0.491**	0.480	0.789	**0.921**	0.910
4.20	0.317	0.478	0.466	0.321	**0.496**	0.534	0.283	0.470	0.462	0.786	**0.917**	0.906
4.40	0.312	0.469	0.457	0.290	0.469	**0.491**	0.256	0.443	0.421	0.781	0.910	**0.899**
5.00	0.296	0.443	0.433	0.241	0.407	0.410	0.212	0.380	0.347	0.768	0.890	0.879
6.00	0.276	0.409	0.401	0.177	0.324	0.312	0.155	0.298	0.260	0.749	0.862	0.852

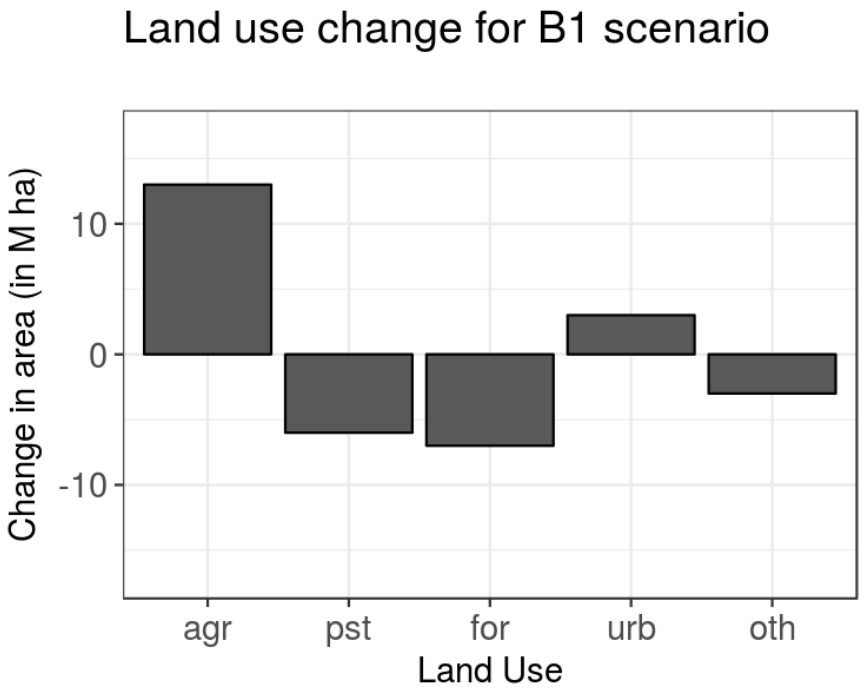
Results: Land use feedbacks, CTL CC scenario

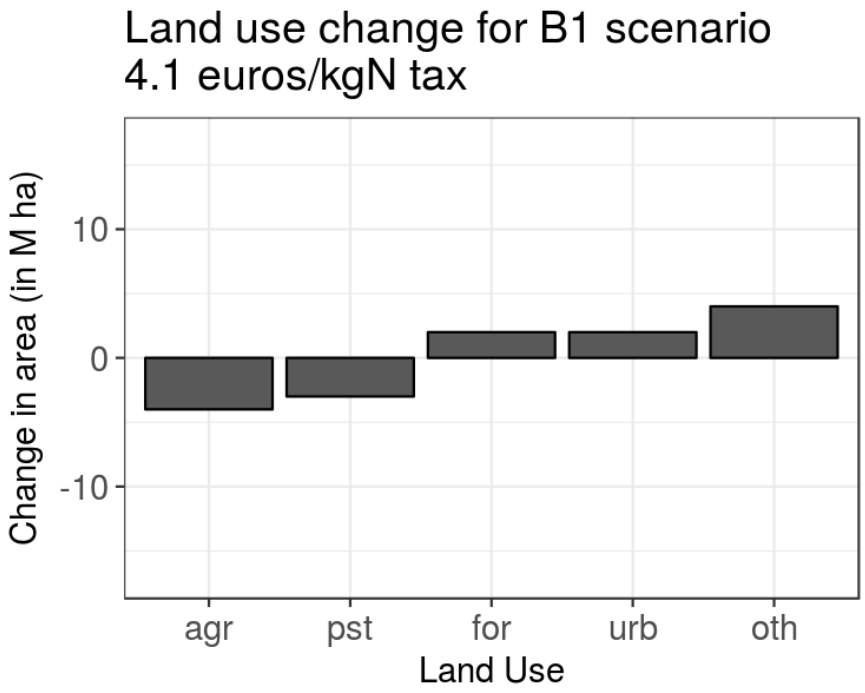
(At least) 50% reduction in N use for EU15, $\sim$130 Mha total area



Results: Land use feedbacks, B1 CC scenario

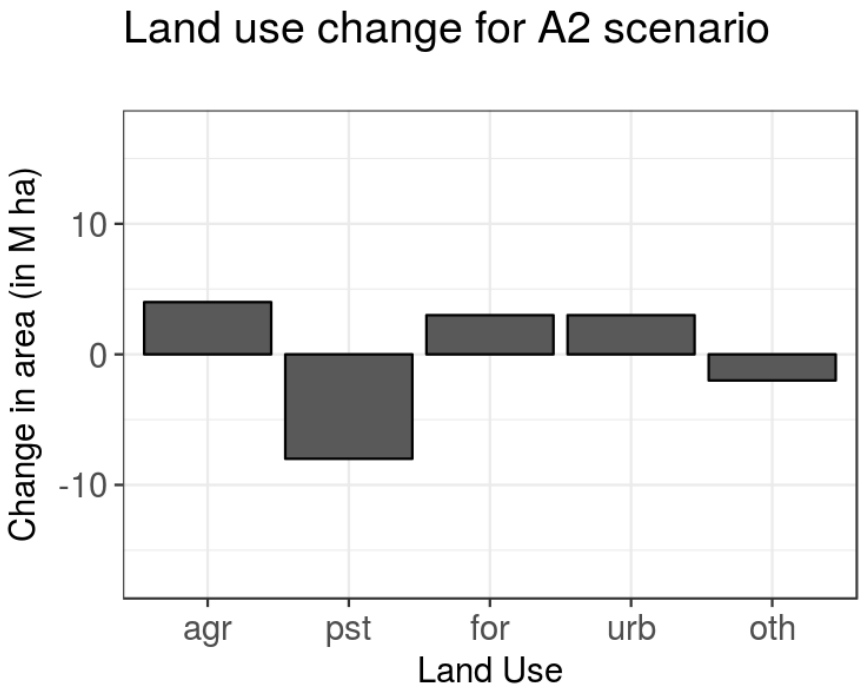
(At least) 50% reduction in N use for EU15, $\sim$130 Mha total area

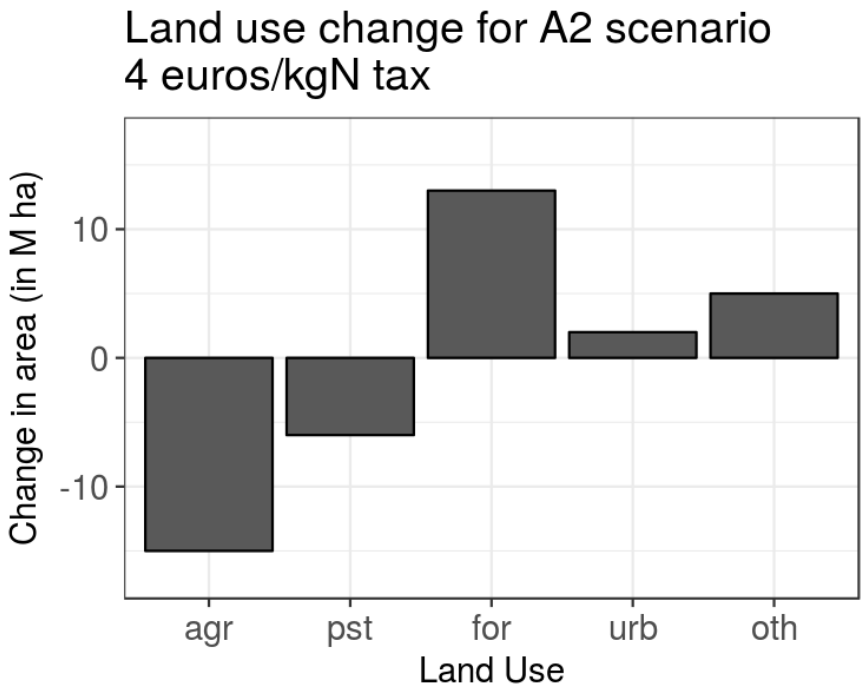




Results: Land use feedbacks, A2 CC scenario

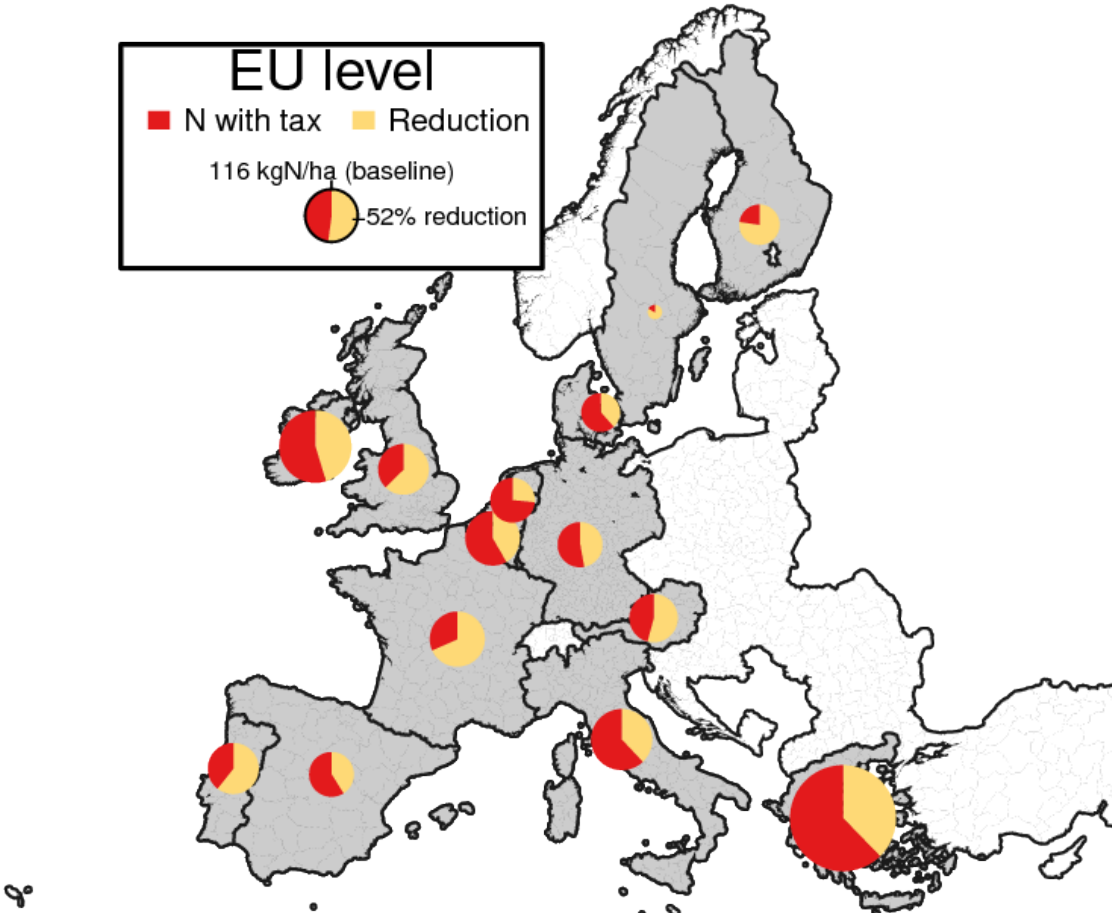
(At least) 50% reduction in N use for EU15, $\sim$130 Mha total area





Results: Regional disparities in abatements

Reductions in N use per MS for EU-wide policy
Scenario CTL, tax 3€/kgN, LUC feedback



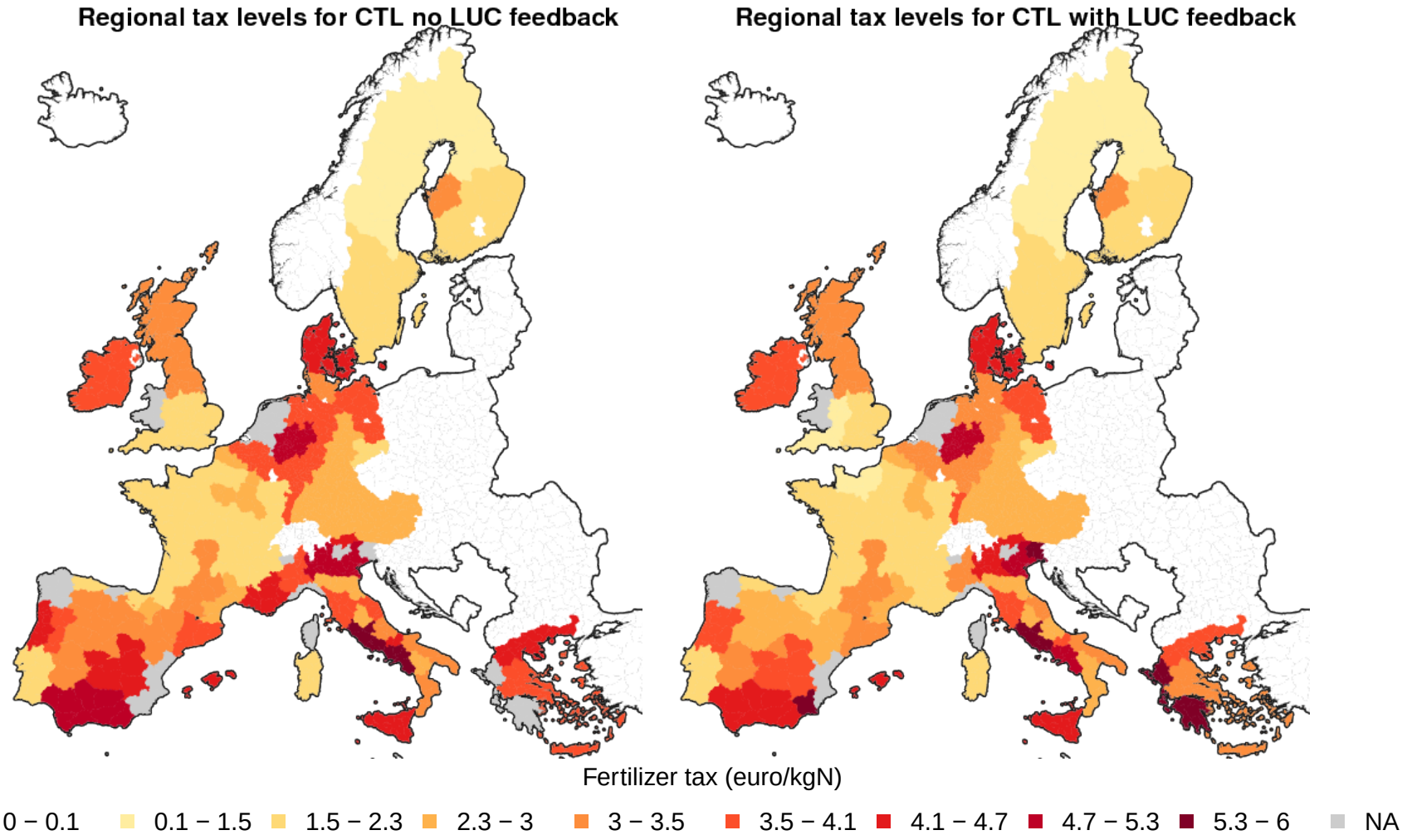
Results: MS-wise policy

MS	Tax (no LUC) $€ \cdot kgN^{-1}$			Tax (LUC) $€ \cdot kgN^{-1}$			$GM/GM_{baseline}$ (no LUC)			$GM/GM_{baseline}$ (LUC)		
	CTL	B1	A2	CTL	B1	A2	CTL	B1	A2	CTL	B1	A2
AT	3	NS*	5.1	2.9	6	4.7	0.82	NS	0.98	0.82	0.86	0.99
BE	3.8	NS	5.6	3.5	5.8	4.6	0.81	NS	0.79	0.83	0.78	0.83
DE	3.4	6	5.2	3.2	5.7	4.6	0.85	1.02	0.96	0.85	1.03	0.98
DK	4.4	NS	4.9	4.3	NS	3.8	0.76	NS	0.88	0.76	NS	0.92
EL	4.2	4.3	NS	3.8	4.4	5.6	0.83	1.04	NS	0.84	1.04	0.89
ES	3.7	4.8	5.4	3.5	4.4	5.3	0.74	0.79	0.89	0.75	0.8	0.89
FI	1.5	1.7	1.7	1.5	1.5	0.7	0.88	0.95	0.92	0.88	0.96	1
FR	2.4	3.8	3.4	2.3	3.7	3.2	0.8	0.9	0.91	0.81	0.9	0.92
IE	3.9	3.9	3.9	3.8	3.4	3.5	0.81	0.85	0.84	0.81	0.86	0.85
IT	3.9	4.9	5	3.6	4.4	4.5	0.87	0.93	0.93	0.88	0.94	0.94
NL	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PT	2.7	3.8	2.7	1.9	3.2	3.1	0.83	0.89	0.97	0.87	0.93	0.97
SE	1.8	2.6	2	1.8	2.9	1.9	0.87	0.86	0.87	0.87	0.86	0.87
UK	2.9	3.5	3.8	2.8	3.5	3.8	0.76	0.83	0.79	0.77	0.83	0.79

* NS – No solution for tax levels inferior or equal to 6 $€ \cdot kgN^{-1}$.

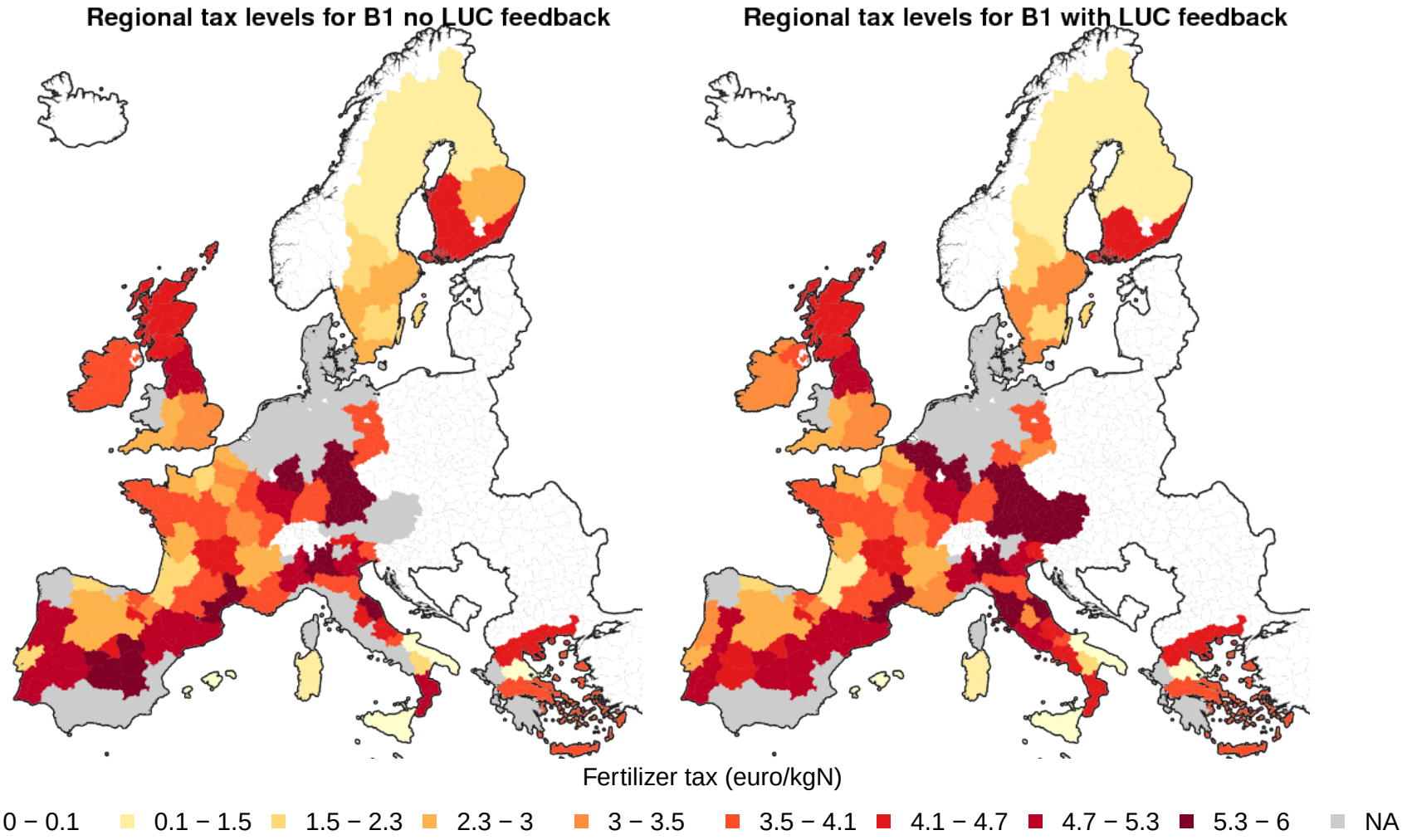
Results: FADN regions wise policy

CTL scenario



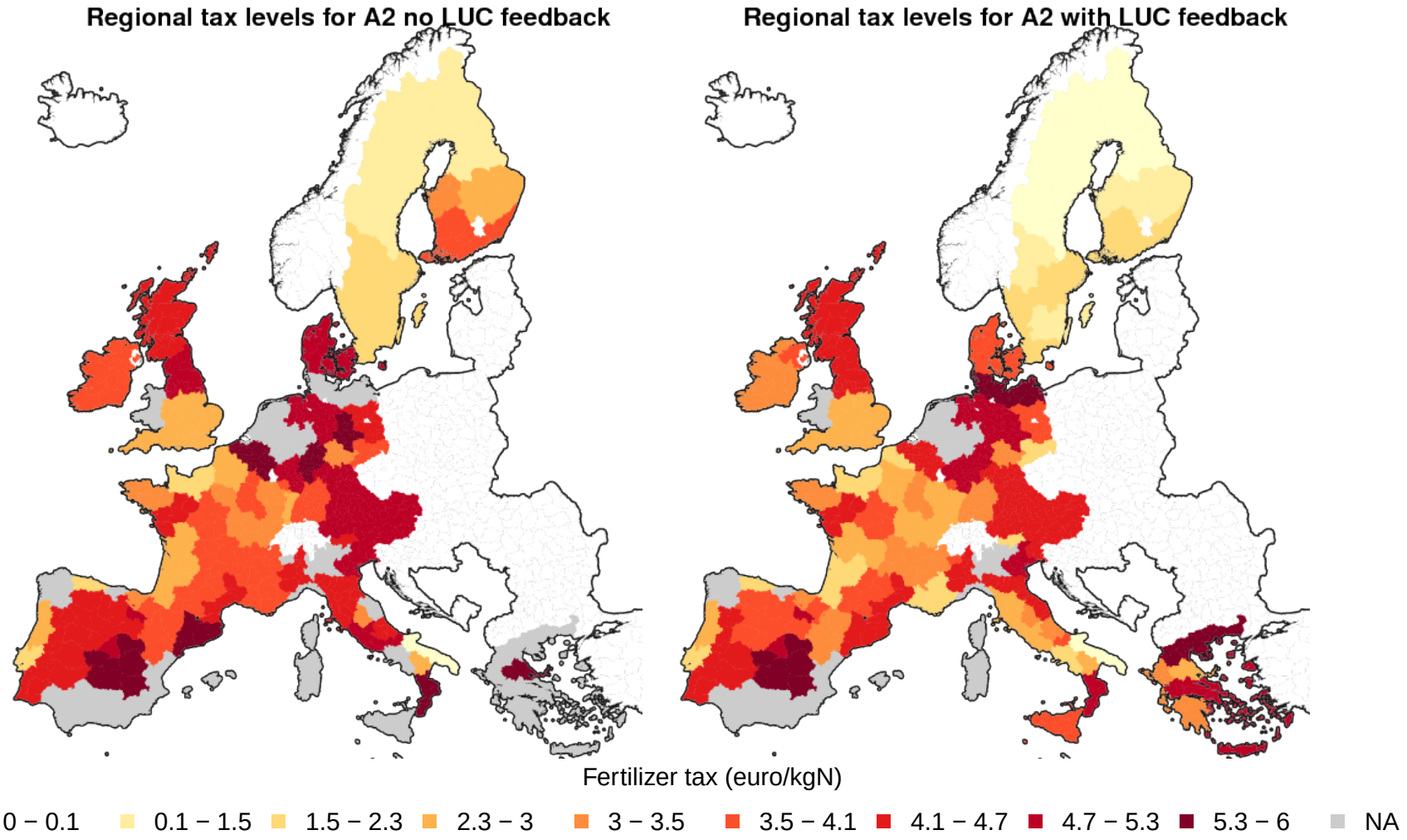
Results: FADN regions wise policy

B1 scenario



Results: FADN regions wise policy

A2 scenario



Scenario comparison

Scenario	$GM/GM_{baseline}$ (No LUC)	$GM/GM_{baseline}$ (LUC)	$N/N_{baseline}$ (No LUC)	$N/N_{baseline}$ (LUC)
CTL 50% @ EU	0.81	0.825	0.484	0.48
CTL 50% @ MS	0.808	0.816	0.481	0.493
CTL 50% @ FADN	0.808	0.814	0.453	0.454
2002 M€	23.055	22.334		
B1 50% @ EU	0.913	0.917	0.494	0.49
B1 50% @ MS	0.903	0.907	0.495	0.504
B1 50% @ FADN	0.907	0.91	0.501	0.496
2002 M€	32.800	32.440		
A2 50% @ EU	0.895	0.91	0.489	0.497
A2 50% @ MS	0.892	0.909	0.499	0.494
A2 50% @ FADN	0.896	0.912	0.496	0.496
2002 M€	34.936	33.015		

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Results: Impacts of explanatory variables

Variable	*ln((agr+pst)/oth)*			*ln(for/oth)*		
	Direct impact	Indirect impact	Total impact	Direct impact	Indirect impact	Total impact
pr	-5e-04	7e-04*	2e-04	1e-04	0.0012***	0.0013***
	(2e-04)	(4e-04)	(4e-04)	(3e-04)	(4e-04)	(4e-04)
tas	0	-1e-04	-1e-04	1e-04	-2e-04	-1e-04
	(1e-04)	(1e-04)	(2e-04)	(2e-04)	(2e-04)	(2e-04)
AWC	-0.0365	-0.027	-0.0636	-0.0611	0.0344*	-0.0267
	(0.0111)	(0.0156)	(0.0181)	(0.0119)	(0.0177)	(0.0211)
slope	-0.1957	-0.0553	-0.2509	-0.0478	-0.0548	-0.1026
	(0.0313)	(0.0401)	(0.0394)	(0.0343)	(0.0438)	(0.0461)
dens2011	-0.4979	-0.1967	-0.6946	-0.3962	0.0411	-0.3551
	(0.0508)	(0.1008)	(0.0957)	(0.0531)	(0.1125)	(0.1124)
eury2011	-0.0133	0.0872***	0.0738***	0.0228	0.0594*	0.0822**
	(0.0238)	(0.0321)	(0.0315)	(0.0248)	(0.0358)	(0.0378)
fcur	-0.3877	0.2273	-0.1603	-0.1956	-0.0425	-0.2381
	(0.1077)	(0.1534)	(0.1282)	(0.1141)	(0.1713)	(0.1545)
txt_mmean.dual	0.4158***	0.1575	0.5733***	0.2842***	-0.1296	0.1547
	(0.1111)	(0.1782)	(0.1884)	(0.1171)	(0.1966)	(0.2134)
Note:						*p<0.1; **p<0.05; ***p<0.01