Farm-level GHG emissions and the CAP.
An econometric assessment on an Italian panel.

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Policy framework

Eu policy	Emission reduction target (baseline)	Sectors (baseline)	HOW
Europe **2020**	-20% (1990)	• ETS-Emission Trading System: -21% (2005) • Non ETS (including Agriculture) : **10%** (2005). Italy -13%	Incentives: **C**ommon **A**gricultural **P**olicy  climate change challenge both in pillar I and II
Europe **2030**	-40% (1990)	• ETS (-43% - 2005) • Non ETS (including Agriculture): **-30%** (2005) • **LULUCF-Land Use Land Use Change and Forestry** [Dec. n.529/2013/UE]	
Europe **2050**	-80/95% (1990)	• Agri GHG emissions **-42/49%**	

Research question

Agricultural GHG emission in Italy (and in Europe) have declined from 1990 to 2012 (EEA, 2014).

Do we observe a decline at the farm level? Why?

- Define a methodology for the reconstruction of agricultural GHG emissions (i.e. Carbon Footprint-CF) at farm level and of its evolution over time.
- Interpretations of the differences observed across farm typologies and territories and, above all, of the farm-level CF evolution over time with specific reference to the possible role of the CAP:
  - ❖ the 2003 Reform of its First Pillar
  - ❖ those Second Pillar's measures targeted to activities and practices that have a direct impact on the CF

The FADN sample

Constant sample of farms yearly observed over the pre and post-2005 period: balanced panel extracted from the FADN-Farm Accountancy Data Network (RICA) database:

- **6,542** farms observed over years 2003-2007 with all the needed information to compute the respective Carbon Footprint (CF)
- Capture the effect of policy measure on production choices and consequently (joint badput) on GHG emissions.

GHG emissions at farm level

- **What:** emissions on which the farmer has a direct control/makes choices (no Supply Chain/Life Cycle Assessment)
- **How:** using Intergovernmental Panel on Climate Change (1997, 2000, 2006) methodolody adapted at farm level (Coderoni *et al.*, 2013), FADN activity data & ISPRA/IPCC default emission factors

  → **one synthetic farm-level emission measure: the farm CF**

IPCC CATEGORY	SOURCE	GHG
4A	Enteric Fermentation	CH_4
4B	Manure Management	N_2O, CH_4
4C	Rice	CH_4
4D	Agricultural Soils	N_2O, CH_4
1A	Energy	CO_2
5A	Forest land	CO_2
5B	Cropland	CO_2
5C	Grassland	CO_2

5 Carbon Footprints categories

GHG emission sources and the respective FADN activity data

Emission sources	CF category	FADN data
N_2O manure management	CF livestock	Animal numbers
CH_4 manure management	CF livestock	Animal numbers
CH_4 enteric fermentation	CF livestock	Animal numbers
CH_4 rice crops	CF crops	Rice area (UAA)
N_2O agricultural soils	Various	
Direct emissions		
Use of synthetic fertilisers	CF fertilizer	Fertilisers expenditure
Biological N fixation	CF crops	N-fixing crop area
Crop residues	CF crops	Crop area (UAA)
Indirect emissions		
Atmospheric deposition	CF fertilizer/ CF crops	Fertil. expe . & animal numbers
Leaching and run-off	CF fertilizer/ CF crops	Fertil. expe . & animal numbers
CO_2 Energy	CF Fuel	Fuel expenditure
CO_2 Forest land	CF Land use (A, B)	UAA
CO_2 Cropland	CF Land use (A, B)	UAA
CO_2 Grasslands	CF Land use (A, B)	UAA

2003-2007 evolution of the 5 CF categories

CF category	2003	2004	2005	2006	2007	Var. 2007-2003 (%)
CF Fuel	25,9	27,1	29,8	31,4	32,6	88,6
CF Crops	14,1	14,3	14,3	14,8	14,9	53,9
CF Fertilizers	45,0	57,6	58,8	58,3	64,8	2,1
CF Livestock	99,2	100,4	101,0	101,6	100,0	0,07
CF Land Use – A	-3,3E-03	-3,3E-03	-3,1E-03	-3,1E-03	-3,1E-03	0,02
CF Land Use – B	5,8E-03	6,0E-03	6,0E-03	6,0E-03	6,0E-03	0,04
CF Total – A	184,1	199,3	203,9	206,1	212,4	14,3
	(563,7)	(584,5)	(623,7)	(642,9)	(644,3)	
CF Total – B	184,1	199,3	203,9	206,1	212,4	14,3
	(563,7)	(584,5)	(623,7)	(642,9)	(644,3)	

ton CO_{2e} per farm avg.; st. dev. in parenthesis. A: ISPRA IEF; B: JRC based IEF. Source: own elaborations (-;emissions)

- Large heterogeneity, but some robust evidence emerges
- Land Use does not matter much (at least with IPCC approach)
- Only CF livestock (and LU) is almost stable

Total farm-level CF evolution: farm size

Farm typology:	2003	2004	2005	2006	2007	Var. 2007-2003 (%)
Economic Size:						
ES 3-4	25,2	29,3	30,0	32,1	32,6	33,7
ES 5-6	120,0	132,7	134,3	120,3	124,8	0,8
ES>=7	887,4	932,8	992,1	965,4	989,2	0,7
UAA:						
UAA < 10 ha	46,6	53,3	54,1	53,7	53,9	29,2
UAA 10-50 ha	145,2	157,8	157,3	158,1	166,9	0,8
UAA >50 ha	719,0	762,7	784,0	791,7	804,9	0,5
Correlation coefficient UAA-ΔCF						0.2

ton CO_{2e} per farm avg. Source: own elaborations

Total farm-level CF evolution: farm typologies

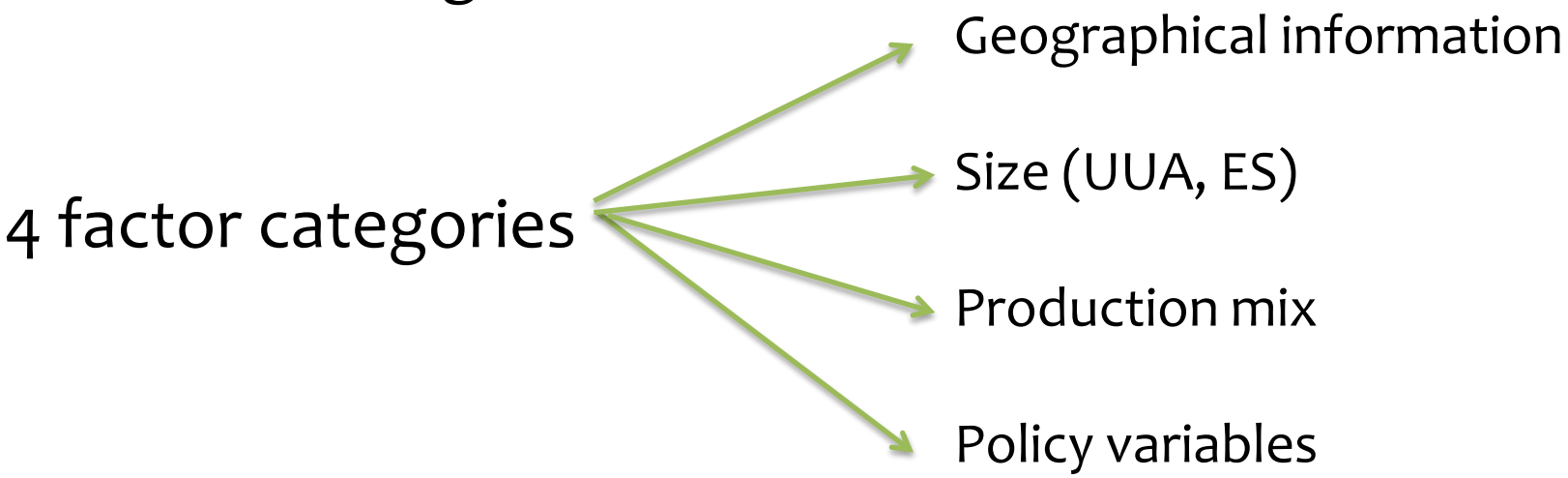
Farm typology:	2003	2004	2005	2006	2007	Var. 2007-2003 (%)
Crops	149,2	168,4	174,4	175,4	185,1	1,0
Permanent Crops	44,4	59,8	62,1	64,2	70,0	1,3
Livestock	425,2	434,5	439,8	442,8	442,8	0,1
Mixed crops and livestock	196,2	211,6	216,4	219,9	229,2	83,3

ton CO_{2e} per farm avg. Source: own elaborations

The potential role of the CAP

- first pillar payments (FPP/GPV)
- second pillar 2003-2007 payments (i.e. 2000-2006 Programming Period): low impact, organic, afforestation

Multinomial logit model:



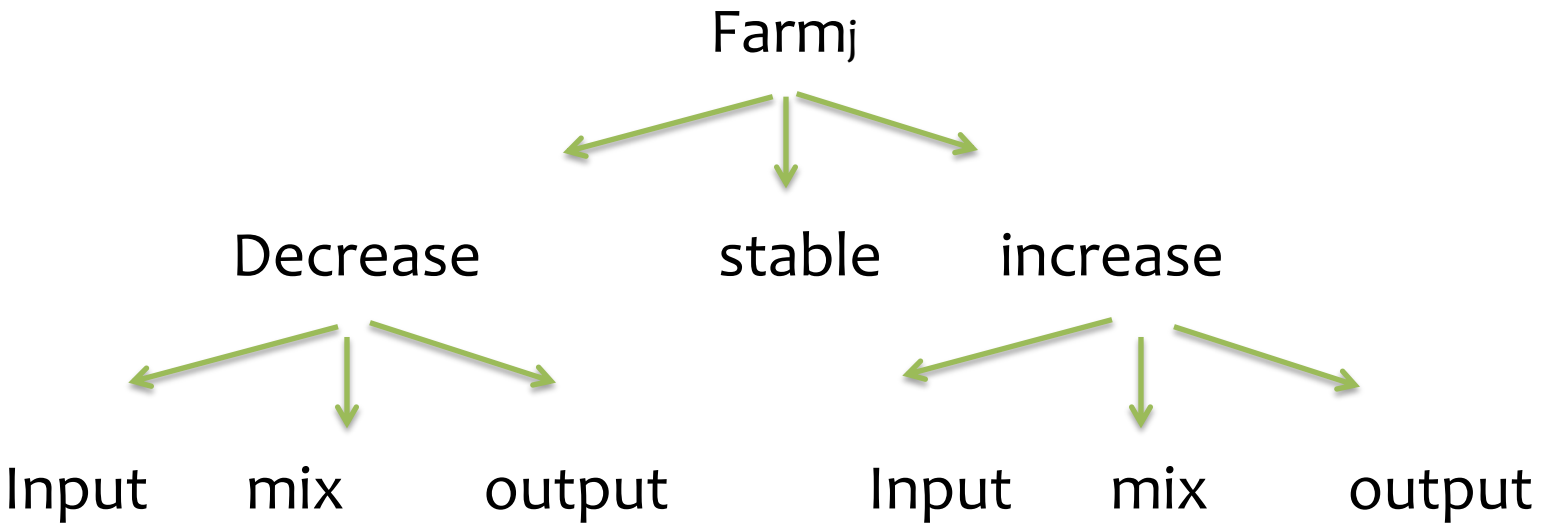
Estimation results

3 groups of farms (threshold 5%):

	Marginal effects	*p*
1 - GHG decrease (no. 1801)		
1nd pillar payments	0.0002	*
2nd pillar payments	-0.0018	*
2 - GHG stable (no. 516)		
1nd pillar payments	-0.0001	
2nd pillar payments	0.0004	
3 – GHG increase (no. 4225)		
1nd pillar payments	-7,00E-05	*
2nd pillar payments	0.0013	*

Next steps

- Ordered logit model: as estimation show «coherence» between choices, seems usefull to test the probability associated with «ranked» choices
- Two steps choice tree (nested logit):



Some concluding remarks

- Novelty of the paper: farm-level GHG emission calculation
  - A methodology based on international standards applied to an Italian FADN balanced panel
- This allows assessing:
  - Whether/How emission performance evolves over time at the farm-level
  - What drives this evolution: what is the impact of the CAP on production choices and so on GHG level
- Still several data and methodological issues to be fixed (e.g. land use changes) but some evidence emerges:
  - Apparently farms more supported by 1st pillar payments show better emission performances

Thank you

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