Economic repercussions of irrigation restrictions. The case of the lower Po River Basin

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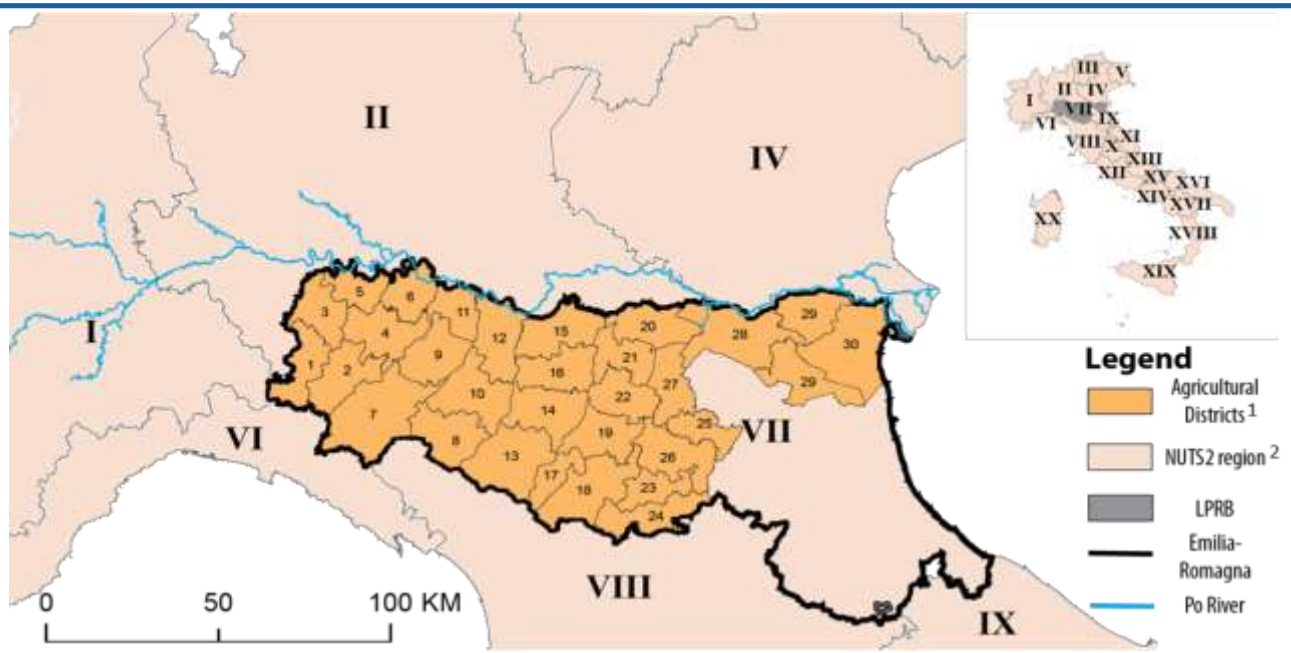
The context: droughts in the Lower Po River Basin



> Expanding irrigation use

> Climate change and shrinking supply

> Increasingly frequent and intense droughts

> State of Emergency declared three times (2003, 2006, 2007) for a total of 21 months

> Economic (Agriculture) and environmental (mostly in the delta) impacts

Drought management in the LPRB

> Step 1: *Memorandum of Understanding* & *Drought Steering Committee*

> Participated by major users and institutions in the basin

> Negotiate *voluntary* reductions in water use

> In some cases insufficient to restore the balance

> Step 2: C&C approach

> Decision makers informed through a hydrological model

> This management of water resource is common to other areas

> Research objective: inform the local and economy-wide repercussions of irrigation restrictions

Modelling framework

> Modular approach, connects micro- and macroeconomic models

> **Multi-attribute Revealed Preference Model**

  > The model estimates GVA impacts on the LPRB

> **MultiRegional Impact Assessment Model (Input Output)**

  > Reproduces micro estimates in a macro context through a productivity shock

  > Assesses the economy-wide repercussions on GVA

> **Simulation**:

  > Micro: Strengthen water allocation constraint in micro model [1%, …, 50%]

  > Macro: Capacity of the agricultural sector is reduced accordingly and becomes binding

Microeconomic model

$$\underset{x}{\text{Max}}\ U(x) = U(z_1(x);\ z_2(x); z_3(x) \ldots\ z_m(x))$$

s.t.: $0 \leq x_i \leq 1$

$\sum_{i=1}^{n} x_i = 1$

$X \in F(x)$

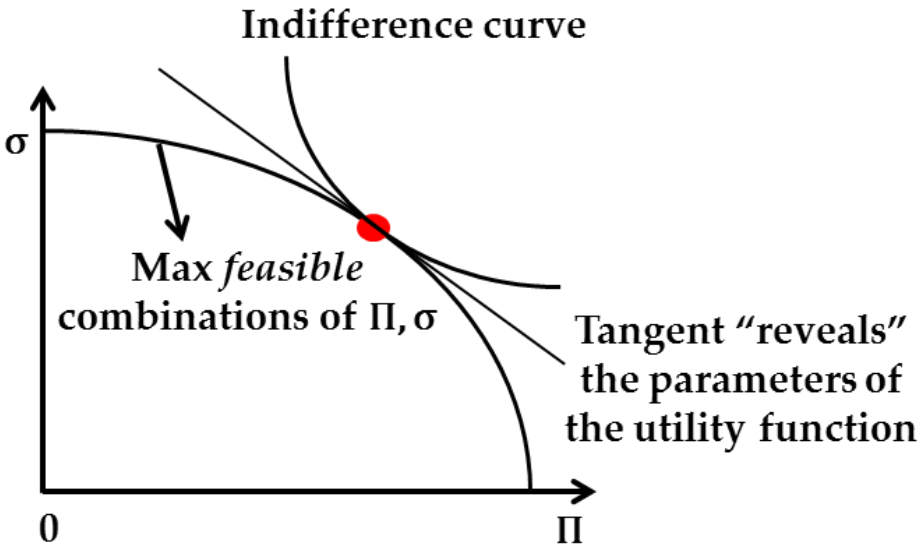
$z = z(x) \in R^m$

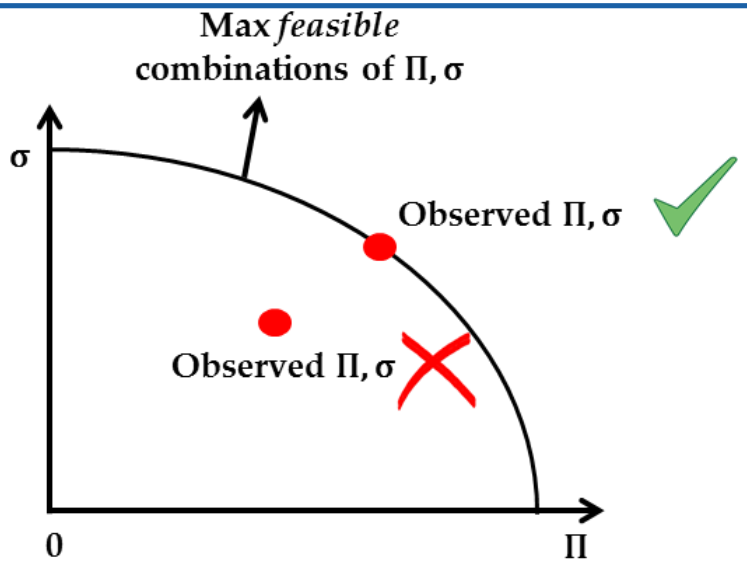
> Preferences are revealed in three stages for every agent (AgriDist):
>
> > First, the efficient frontier and tangency points are obtained for a finite set of attributes
>
> > Second, utility functions are calibrated for every possible subset
>
> > The objective function maximizes accuracy

Microeconomic model

1. Efficient frontier

Five attributes explored: *Profit, Risk avoidance, Total labor avoidance, hired labor avoidance, Variable costs avoidance*





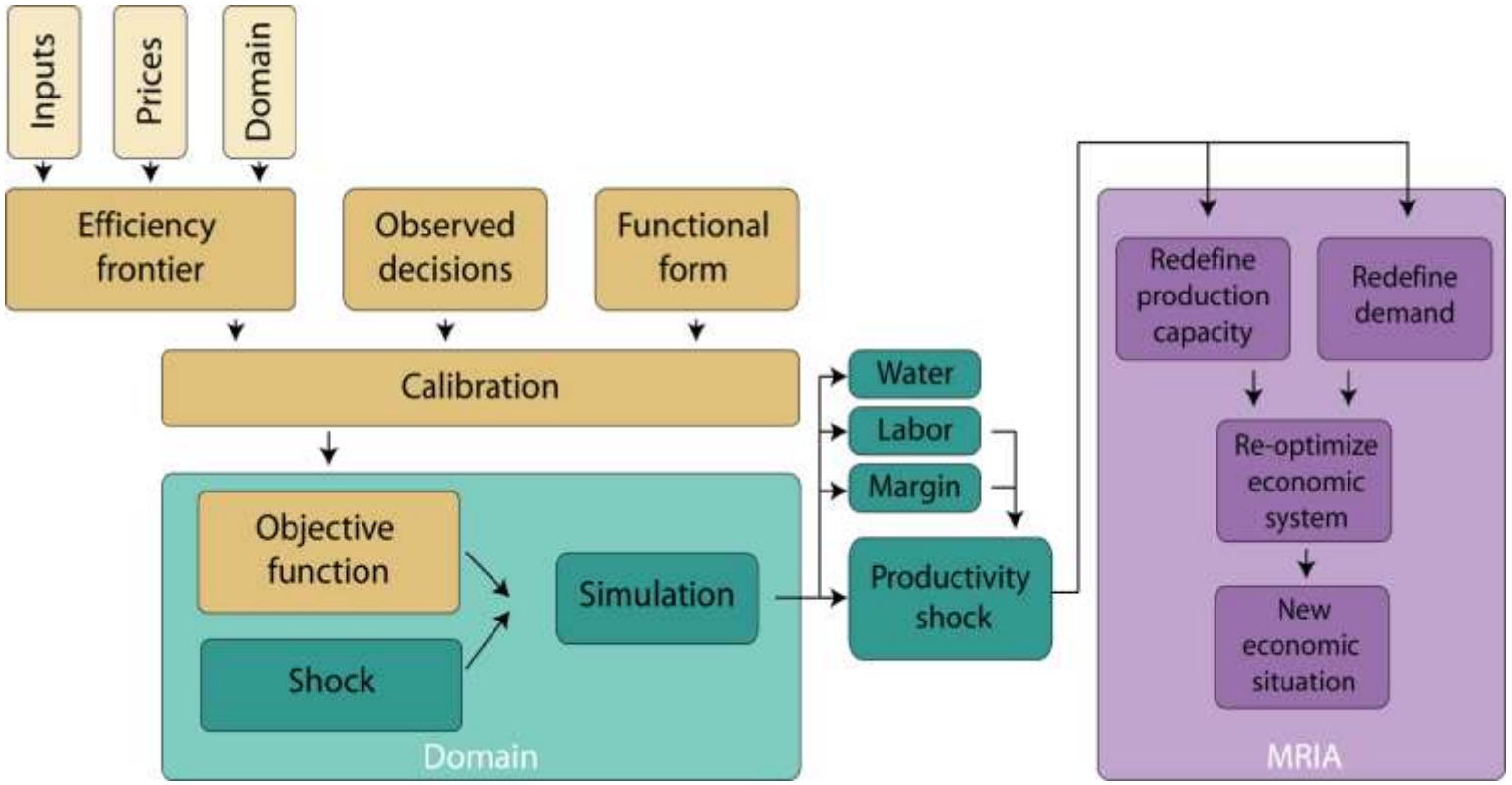
2. Calibration of utility functions

The parameters of a Cobb-Douglas utility function are estimated for every possible combination of selected attributes

3. Objective function

The relevant attributes are those that more accurately resemble the observed behavior (i.e. those that minimize the distance between observed and calibrated values).

Coupling


Inputs
Prices
Domain
Efficiency frontier
Observed decisions
Functional form
Calibration
Objective function
Shock
Simulation
Domain
Water
Labor
Margin
Productivity shock
Redefine production capacity
Redefine demand
Re-optimize economic system
New economic situation
MRIA

Macroeconomic model

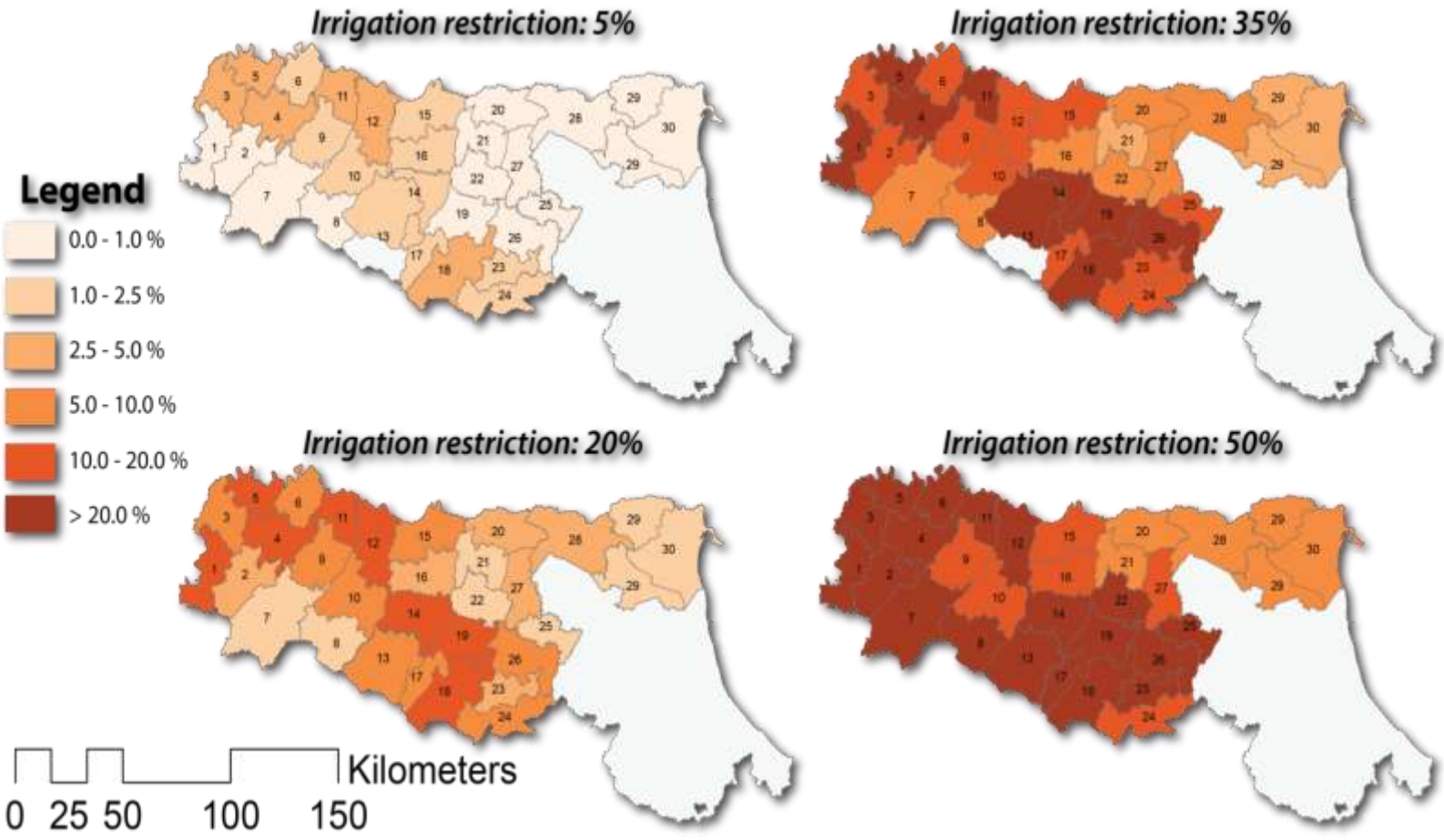
> 256 NUTS 2 regions, 59 products and 14 sectors

> Industry minimizes costs given a demand for products and technology

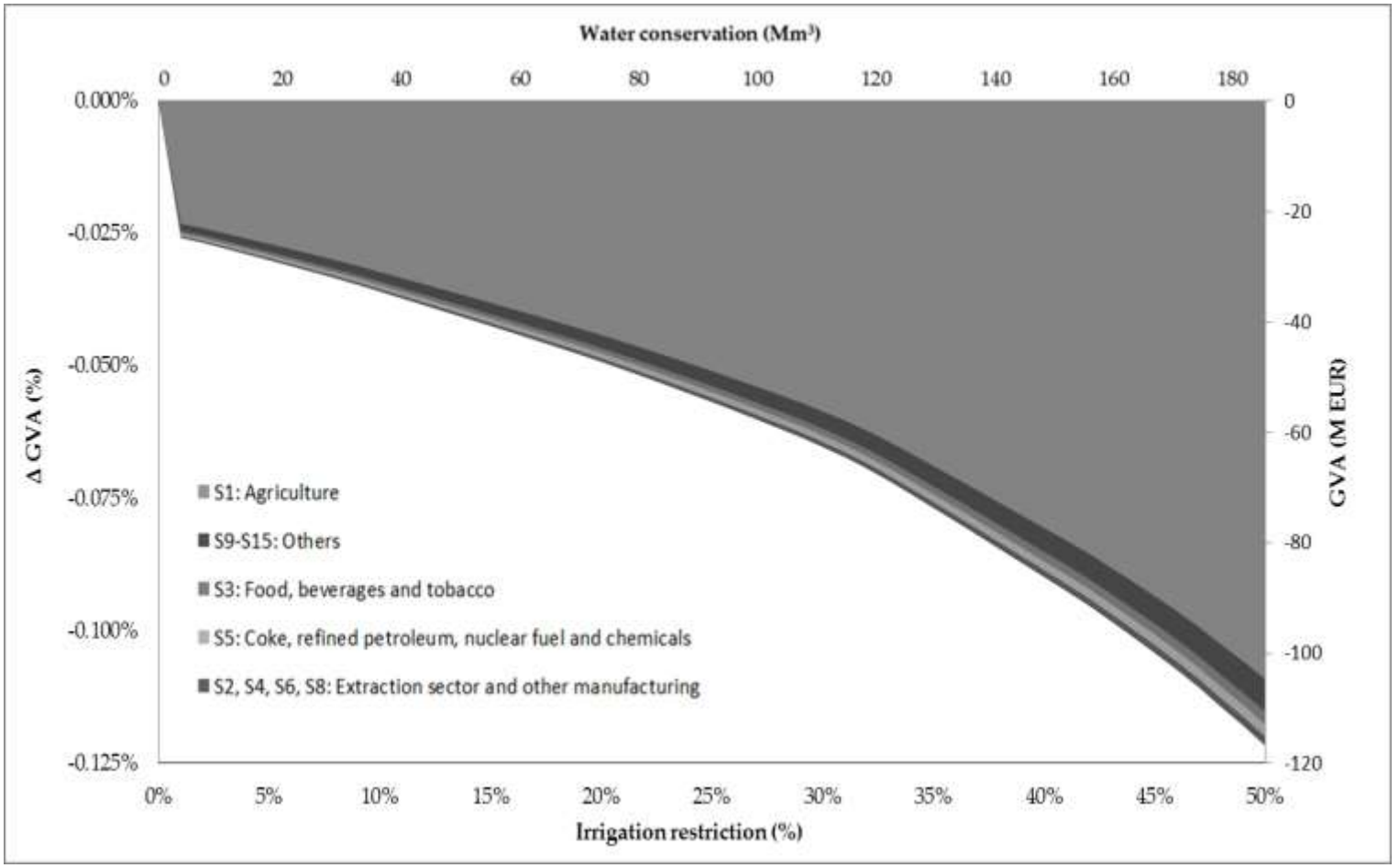
> Demand-driven

> Supply constraints are addressed by non-affected suppliers

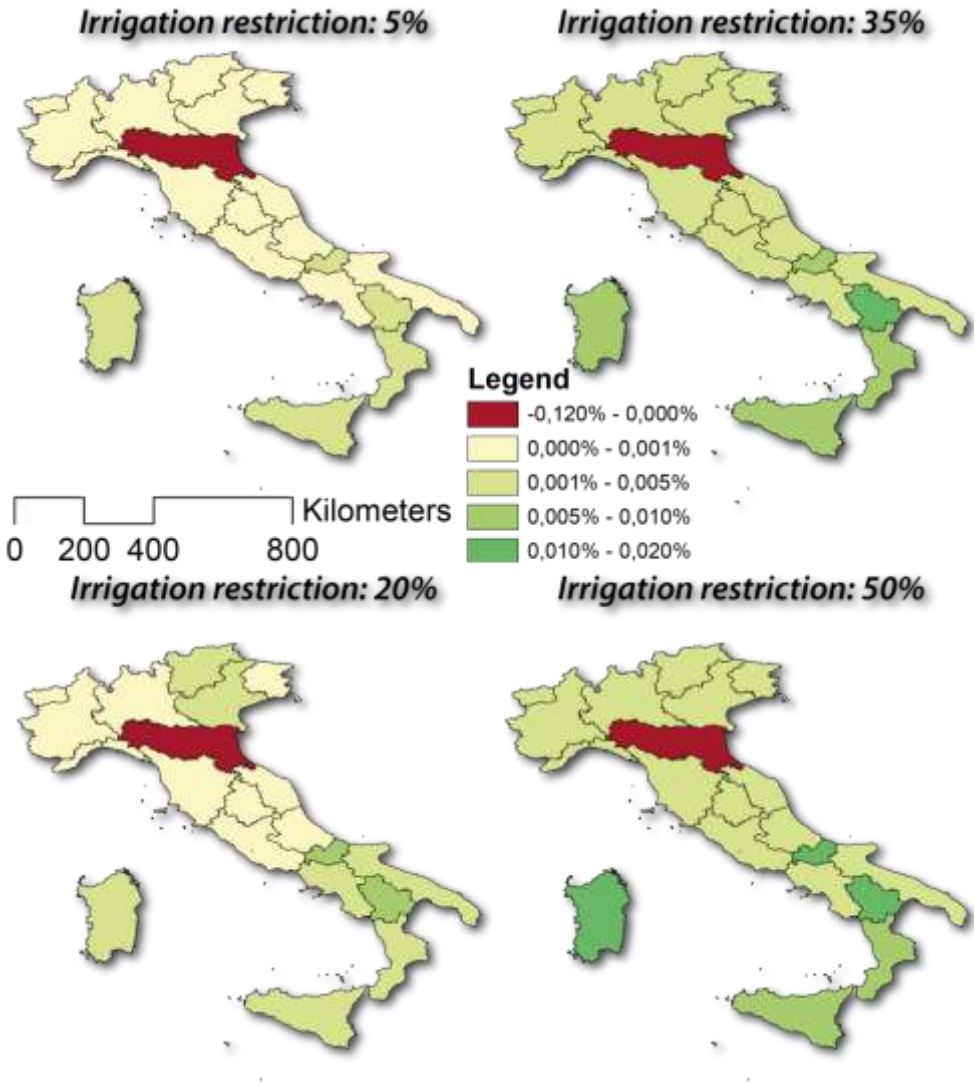
Simulation results: LPRB



Simulation results: RER



Simulation results: Italy



Conclusions

> Proportional allotment is neither cost-effective (productive uses can be affected), nor equitable (asymmetric impacts) within LPRB

> Negative and positive impacts at a national level

> Solidarity mechanisms *partially* address agricultural losses…

> …But not indirect impacts

> Economic and environmental impacts will aggravate under CC

> Enhance cooperation and use of economic instruments

- > Irrigation restrictions based on a basin-wide economic assessment could avoid or reduce impacts on areas with higher water productivity
- > A more flexible setting could also improve economic outcomes (e.g. incremental charges, decoupled subsidies, insurance)

Thanks for your attention

The research leading to these results has received funding from Climate KIC through the AGRO ADAPT Project and from the AXA Research Fund through the project BOOSTER BLUE

booster

agro adapt

Annex: Microeconomic model calibration

	Alpha Values					Errors			
Agricultural District	a_1	a_2	a_3	a_4	a_5	e_f	e_a	e_d	e
Pianura di Rimini	55.2%	1.0%	0.0%	42.8%	1.0%	13.3%	1.1%	14.6%	6.6%
Pianura di Reggio Emilia	68.3%	6.2%	0.0%	25.4%	0.0%	10.9%	2.6%	10.4%	5.1%
Pianura di Modena	84.5%	15.5%	0.0%	0.0%	0.0%	5.4%	1.2%	5.4%	2.6%
Pianura Forlivese e Cesenate	85.1%	6.6%	0.0%	8.3%	0.0%	3.2%	1.5%	2.9%	1.5%
Pianura di Ferrara	80.7%	2.8%	0.0%	16.5%	0.0%	1.7%	1.3%	1.4%	0.8%
Pianura di Carpi	82.6%	10.6%	0.0%	6.8%	0.0%	7.9%	1.3%	6.6%	3.5%
Pianura del Senio e del Lamone	99.0%	1.0%	0.0%	0.0%	0.0%	14.3%	5.4%	14.3%	7.0%
Pianura dell'Idice e del Santerno	94.9%	5.1%	0.0%	0.0%	0.0%	4.6%	2.7%	2.4%	1.9%
Pianura del Lamone	81.9%	1.5%	0.0%	16.7%	0.0%	4.2%	2.4%	4.3%	2.1%
Pianura di Ravenna	97.6%	2.4%	0.0%	0.0%	0.0%	9.6%	5.7%	9.6%	4.9%
Pianura di Busseto	86.3%	1.0%	0.0%	12.7%	0.0%	3.8%	0.1%	3.8%	1.8%
Pianura a sinistra del Reno	80.8%	7.1%	0.0%	12.1%	0.0%	7.4%	1.1%	7.4%	3.5%
Pianura a destra del Reno	90.4%	5.9%	3.7%	0.0%	0.0%	20.5%	6.4%	19.5%	9.7%
Bonifica Ferrarese Occidentale	82.9%	9.4%	0.0%	7.7%	0.0%	9.1%	2.0%	11.4%	4.9%
Bonifica Ferrarese Orientale	85.8%	3.6%	0.0%	10.6%	0.0%	13.7%	2.7%	14.0%	6.6%
Basso Arda	75.1%	0.7%	0.0%	24.2%	0.0%	3.4%	1.8%	4.7%	2.0%
Bassa Reggiana	76.3%	1.4%	0.0%	22.3%	0.0%	7.6%	2.1%	7.0%	3.5%
Bassa Modenese	80.7%	4.8%	0.0%	14.5%	0.0%	2.6%	0.5%	2.7%	1.3%
Pianura di Parma	86.1%	1.3%	0.0%	12.6%	0.0%	6.3%	0.9%	6.0%	2.9%
Pianura di Piacenza	87.5%	1.9%	0.0%	10.6%	0.0%	2.2%	0.9%	0.0%	0.8%
Colline del Nure e dell'Arda	84.5%	3.7%	0.0%	11.7%	0.0%	2.9%	4.3%	3.9%	2.1%
Colline del Montone e del Bidente	88.6%	0.7%	0.0%	10.7%	0.0%	1.9%	2.1%	1.4%	1.1%
Colline int. Rubicone	89.9%	10.1%	0.0%	0.0%	0.0%	6.6%	2.0%	6.6%	3.2%
Colline Savio	90.2%	0.7%	0.0%	9.1%	0.0%	13.7%	5.2%	13.7%	6.7%
Collina del Senio e del Lamone	85.2%	1.3%	0.0%	13.5%	0.0%	8.4%	4.1%	8.5%	4.2%
Colline del Sillaro e del Santerno	99.7%	0.3%	0.0%	0.0%	0.0%	4.5%	5.7%	4.5%	2.8%
Colline di Bologna	98.9%	1.1%	0.0%	0.0%	0.0%	9.9%	4.2%	9.9%	4.9%
Colline di Salsomaggiore	75.4%	8.7%	0.0%	15.9%	0.0%	7.2%	0.3%	0.1%	2.4%
Colline Modenesi	88.9%	11.1%	0.0%	0.0%	0.0%	8.3%	3.7%	8.3%	4.1%
Colline tra Enza e Secchia	99.5%	0.5%	0.0%	0.0%	0.0%	3.7%	0.2%	0.1%	1.2%
Medio Parma	98.9%	1.1%	0.0%	0.0%	0.0%	4.1%	2.9%	4.0%	2.1%
Colline del Conca	97.3%	1.1%	0.0%	1.6%	0.0%	0.7%	0.4%	0.4%	0.3%
Colline del Trebbia e del Tidone	81.3%	4.9%	0.0%	13.8%	0.0%	0.8%	4.5%	2.0%	1.7%
Colline del Reno	99.0%	1.0%	0.0%	0.0%	0.0%	7.0%	5.7%	7.0%	3.8%
Colline del Montefeltro	98.1%	1.9%	0.0%	0.0%	0.0%	2.3%	1.2%	2.1%	1.1%
Valli del Dragone e del Rossenna	79.6%	0.5%	0.0%	19.9%	0.0%	2.2%	3.6%	2.0%	1.5%
Alto Taro	97.6%	2.4%	0.0%	0.0%	0.0%	4.6%	0.5%	0.1%	1.5%
Alto Reno	83.5%	16.5%	0.0%	0.0%	0.0%	25.0%	2.3%	0.1%	8.4%
Alto Parma	98.8%	0.7%	0.0%	0.5%	0.0%	4.7%	0.6%	0.1%	1.6%
Alto Panaro	86.3%	13.7%	0.0%	0.0%	0.0%	9.6%	3.3%	9.6%	4.7%
Montagna del Medio Trebbia	99.9%	0.1%	0.0%	0.0%	0.0%	20.6%	3.5%	0.1%	7.0%
Montagna del Medio Reno	97.2%	2.8%	0.0%	0.0%	0.0%	8.5%	3.3%	9.0%	4.3%
Montagna del Montefeltro	99.0%	1.0%	0.0%	0.0%	0.0%	2.4%	0.1%	0.3%	0.8%
Montagna tra l'Alto Enza e Alto Dolo	99.2%	0.8%	0.0%	0.0%	0.0%	1.2%	0.1%	0.1%	0.4%
Alto Nure	94.0%	1.0%	0.0%	4.7%	0.0%	10.1%	1.4%	7.0%	4.1%