Agricultural Supply Model for Microeconomic policy Analysis (ASMMA) :

First application to assess the impact of the CAP Health Check on the French Arable Sector

K. Louhichi, L. Guindé

INRA – AgroParisTech, France

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

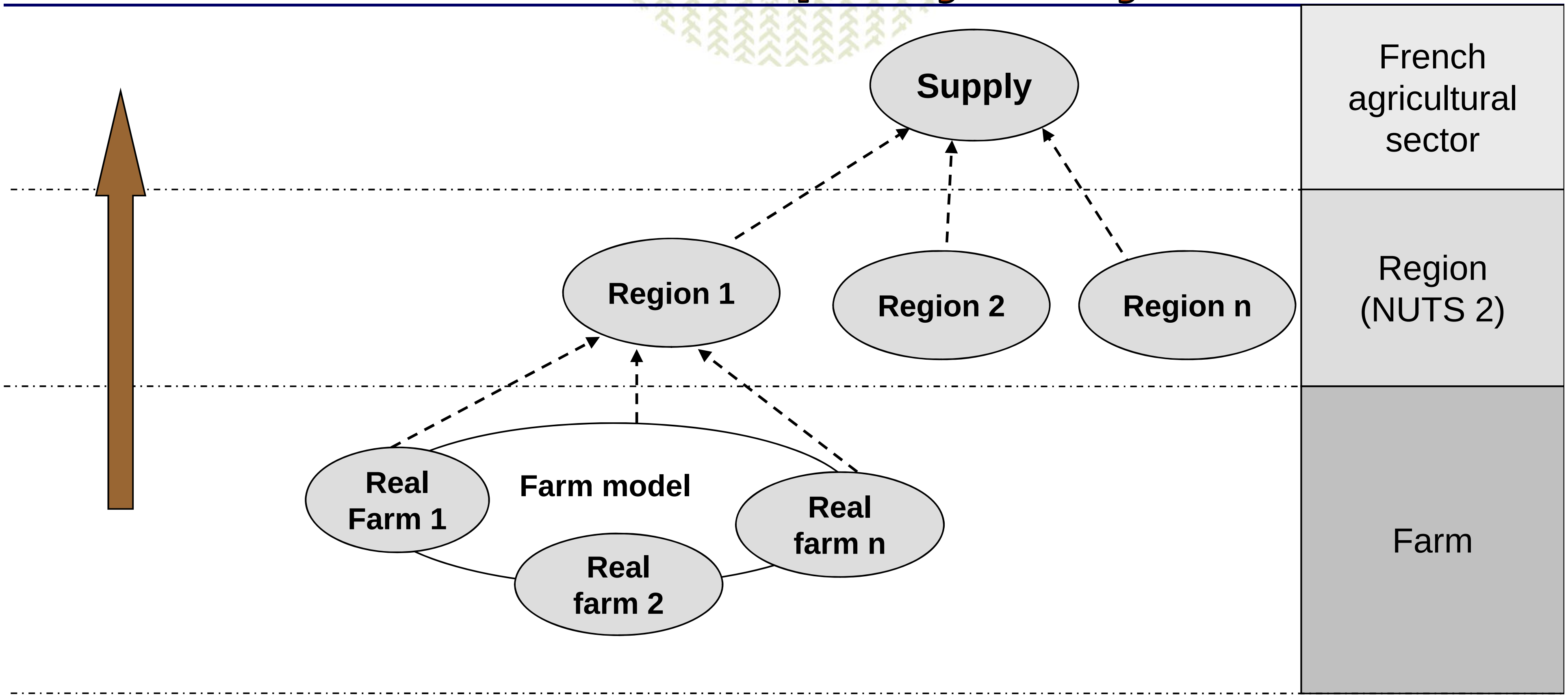
OUTLINE

1. Aims and background
2. Materials and methods
3. Simulated policy scenarios
4. Results and discussion
5. Conclusion and future improvement

Aims and background

- Present the Agricultural Supply Model -**ASMMA**- developed:
  - to assess the microeconomic impacts of bio-energy and agricultural policies on the French agricultural sector.
  - to allow finer and integrated assessment of policy changes and technological innovations at disaggregated levels.
  - to be sufficiently generic and re-usable to achieve different modeling goals.
- Illustrate model use by simulating the response of the French arable farms to the **CAP Health Check** using a set of familiar indicators:
  - *land use, supply, agricultural income and certain environmental externalities such as pesticide use.*

ASMMA - Agricultural Supply Model for Microeconomic policy Analysis



A supply model based on the aggregation of microeconomic farm models reproducing the behavior of real farms

ASMMA: main specification

- **A static non-linear programming model**
  - optimizes at farm level
  - opportunities to simulate exchange of intermediates, production factors and production rights.
- **A Positive Mathematical Programming (PMP) model**
  - observed farm data coming from the French FADN data
  - information on crop costs and inputs use from the Cropping Practices Survey Data (*Enquêtes pratiques Culturales, 2006)*.
- **A farm-based model** reproducing the behavior of all individual farms of the French FADN sample in order to captures the wide heterogeneity among farms and to avoid aggregation errors.
- **Based on discrete production functions** to makes easily the smooth integration of engineering data or results from bio-physical models needed to assess the environmental effects of production**.**

ASMMA: main specification

- **It uses primal approach** which makes technology representation explicit, and allows for switching between current production techniques as well as between current and alternative (i.e. innovate) production systems.
- **Activity based** what means that one product can be produced by different activities, and each activity can produces several products. This specification allows taking into account positive and negative *jointness* associated to production process. *Each activity (i) is defined as a crop rotation (R) with a specific agro-management practice (T) growing in a predefined agri-environmental zone (S).*

$$i = \{ i_1, i_2, \ldots \} = \{ (r_1,s_1,t_1), (r_2,s_1,t_1), \ldots \} \subseteq R \times S \times T$$

- **It uses a model template** to allow an efficient uniform handling of the models and their results. This model template is an extension of the Farming System Simulator's template developed within the SEAMLESS project (Van Ittersum et al., 2008).

ASMMA: main specification

- **A generic model** designed with the aim to be able to assess different policies for various farm orientation, farm size, sub-sector or region.
- **It has a modular setup** to be re-usable, adaptable and easily extendable to achieve different modeling goals (i.e. easily activate/deactivate modules following the needs of the simulation).
- **Automatic and integrated components:** it includes several components, which are linked and integrated automatically. The components considered include model, database and indicators.

Thanks to these technical specifications, ASMMA can be replicated for any EU Member State.

ASMMA: DB User Interface

ASMMA: mathematical structure

$$\pi_x = Max \sum_{f=1}^{F} \left[gm'_f x_f - d'_f x_f - \frac{x'_f Q_f x_f}{2} \right]$$

$$s.t.\ \ A_f x_f \leq B_f\ ;\ \ x_f \geq 0$$

Implicit cost function

π agricultural income
f indexes the individual farm from 1 to F
$\mathbf{gm_f}$ (n×1) vector of gross margin
$\mathbf{x_f}$ (n×1) vector of decision variable
$\mathbf{d_f}$ (n×1) vector of the linear part of the activities' implicit cost function
$\mathbf{Q_f}$ (n×n) matrix of the quadratic part of the activities' implicit cost function
$\mathbf{A_f}$ (m×n) matrix of technical coefficients
$\mathbf{B_f}$ (m×1) vector of resource and policy constraints

Template for farm model

$$\pi_x = Max \sum_i \left[(p_i y_i + s_i - \sum_j a_{ij} w_j) x_i - d_i x_i - 0.5 \sum_k Q_{ik} x_i x_k \right]$$

$$s.t.\ \sum_i A_{il} x_i \leq B_l\ ;\ \ x_i \geq 0$$

Implicit cost function

Input coefficients

π farm income
i indexes agricultural activities
j indexes input types
p (n×1) vector of output prices
y (n×1) vector of yield
s (n×1) vector of subsidies
a (n×1) vector of input uses
w (n×1) vector of input prices
x (n×1) vector of decision variable
d (n×1) vector of the linear part of the activities' implicit cost function
Q (n×n) matrix of the quadratic part of the activities' implicit cost function
A (m×n) matrix of technical coefficients
B (m×1) vector of resource and policy constraints (land, set-aside and quota)

ASMMA: main specification

- **Input coefficients** (i.e. Input use and unit costs of crops in each farm)
  - Literature: derived from aggregated farm data using ad-hoc or statistic methodologies prior to the specification of PMP parameters (Léon et al.,1999)
  - ASMMA: derived from "Enquêtes Pratiques Culturales" assuming a common commodity technology per agri-environmental zone and considering a correction for heterogeneity resulting from the size effect in production
- **Implicit cost function:**
  - risk aversion
  - unspecified constraints
  - non-observed costs due to heterogeneous land quality, limited management, machinery capacity …
  - But also heterogeneity resulting from the size effect in production since we assume similar accounted cost per crop and technology for all farms belonging to the same agri-environmental zone.

ASMMA: first prototype

The first prototype of ASMMA is already operational for **arable farms**

- **Representativeness:**
  - covers **most of the arable crops** for both food and energy purposes
  - runs for **2527 arable farms** covering around 109500 farms nation-wide.
- **Data:** it uses
  - **French FADN database**: farm resources, farm representativeness coefficients, output coefficient of the observed crops (e.g. price, yield and observed area) …
  - **Cropping Practices Survey Data (SSP, 2006)**: detailed information on input use and agro-management required to calculate accounting unit costs.
  - **Expert knowledge**: list of rotations growing in each region (in total 57 rotations of 20 different crops were identified).

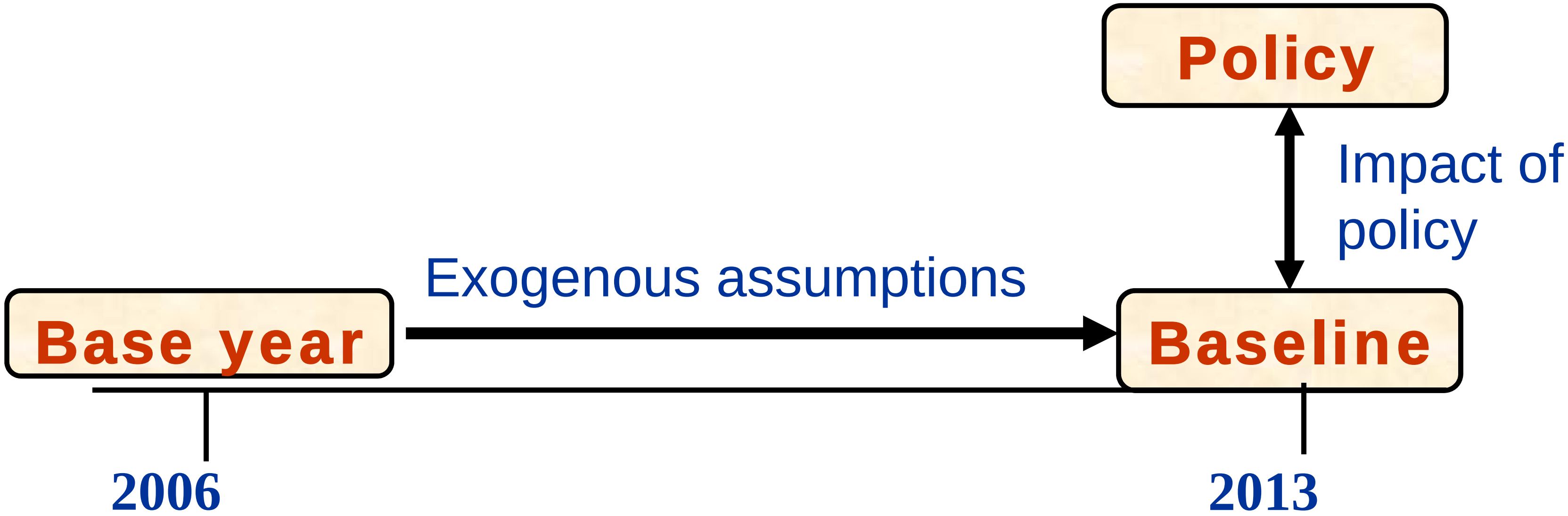
ASMMA: first prototype

- **Model assumptions:**
  - No trade exists between farms
  - Only current activities are considered
  - Only one production technique (i.e. agro-management practice) per crop and only one agri-environmental zone per administrative region are retained.
  - Yield, externalities and inputs coefficients are not rotation dependent.
  - Yield of mono-crop rotations were penalized compared to others rotations using coefficient estimated from regional expert.
  - Sugar beet quota equals to observed sugar beet production
  - A, B and C sugar beet prices were substituted by observed mixed sugar beet price.
  - 2006 sugar reform was not implemented
  - Calibration process guarantee exact reproduction of only observed crop pattern (i.e. not crop rotation)
- **Environmental indicators**: only pesticide use can be computed in this version

ASMMA: first prototype

- **Exogenous assumptions:**
  - Assumed inflation rate of 1.19 % per year

- **Policy representation:**
  - Baseyear: 2003 CAP reform [2006]
  - Baseline (i.e. reference run): continuation of 2003 CAP reform [2013]



ASMMA: first application

Assess the likely impacts of the of the **CAP Health Check** on the French arable sector :

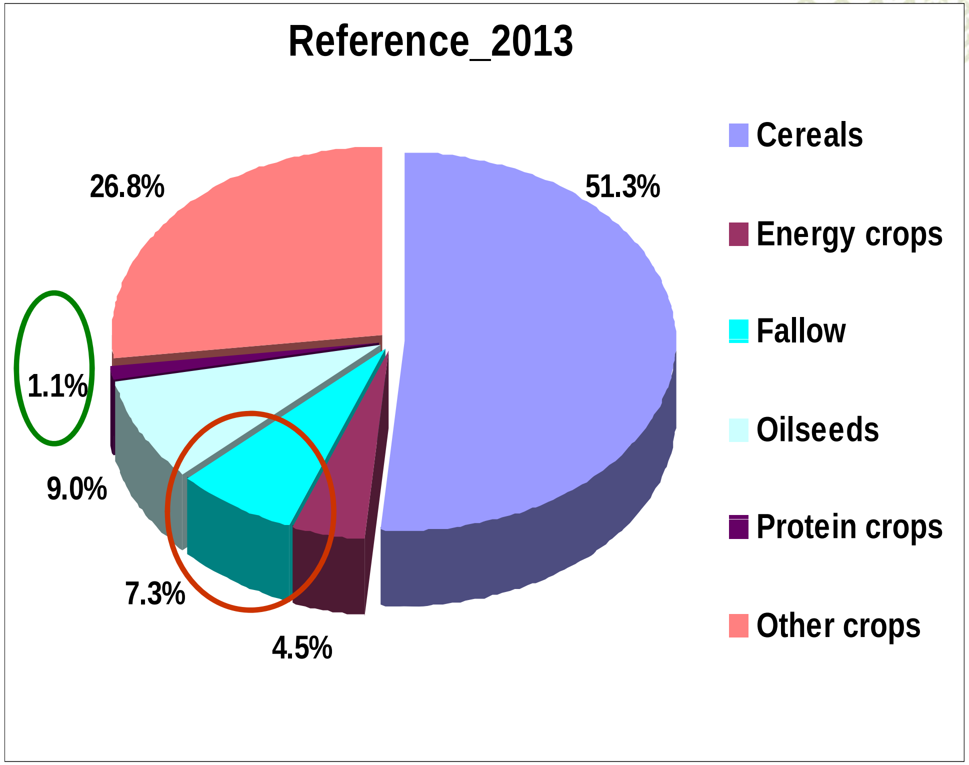
- Agricultural income
- Supply (i.e. production level)
- Land use
- Land competition between food and non-food products
- Cropping system
- Environmental externalities (i.e. pesticide use)

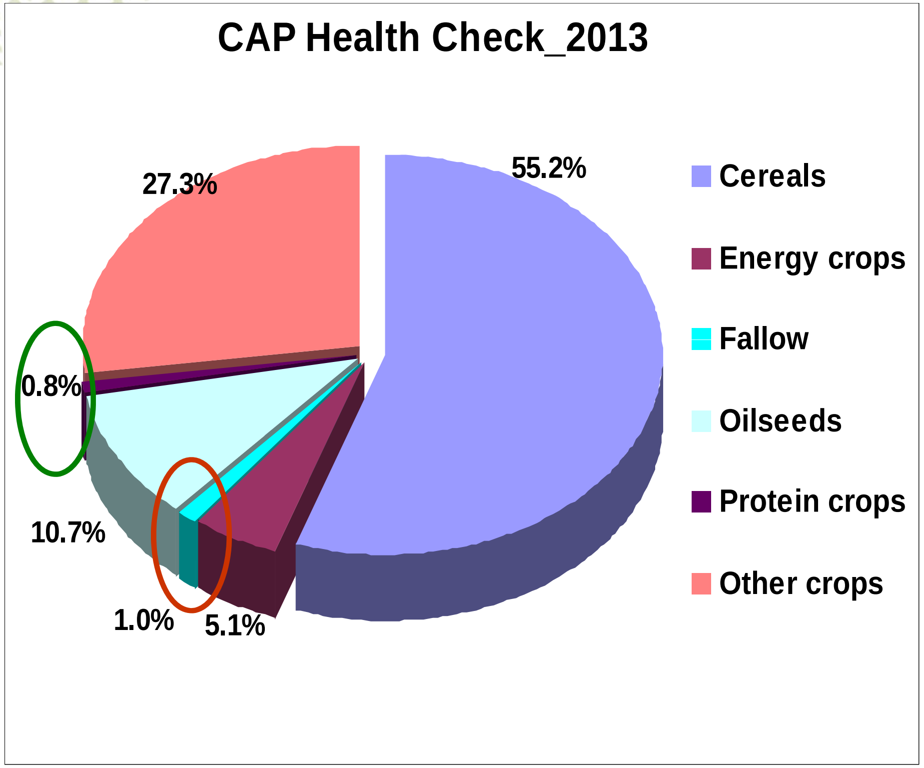
At farm, regional and national levels

Policy scenarios

	Baseyear [2006]	Baseline [2013]	CAP Health Check [2013]
Exogenous assumptions		Inflation rate of 1.19% per year from 2006 to 2013	
EU Compensation payment	- Partial decoupling - Historic Single Payment Scheme		- Full decoupling - Regional Single Payment Scheme - Abolishment of premiums for energy crops
Obligation set-aside	Set-aside is fixed to 10% of total farm area		Abolishment of set-aside obligation
Modulation	5%		10%

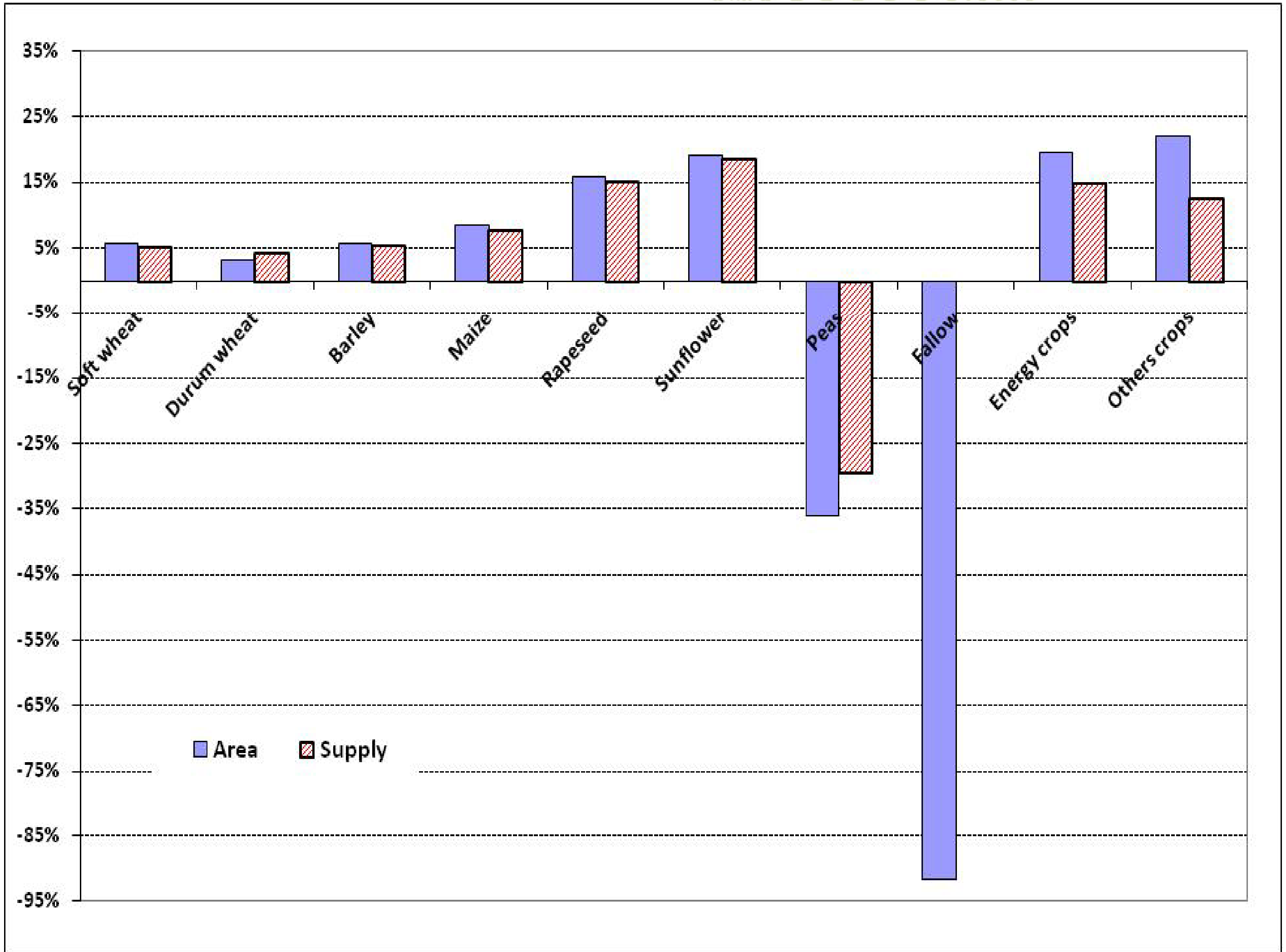
CAP Health Check - impacts at national level





- a fall in fallow land due mainly to the ending of set-aside obligation
- a slight decrease of protein crops area as the supplement premiums given to these crops were decoupled and integrated in the single payment
- an increase in the area of cereals, oilseeds and energy crops

CAP Health Check - impacts at national level



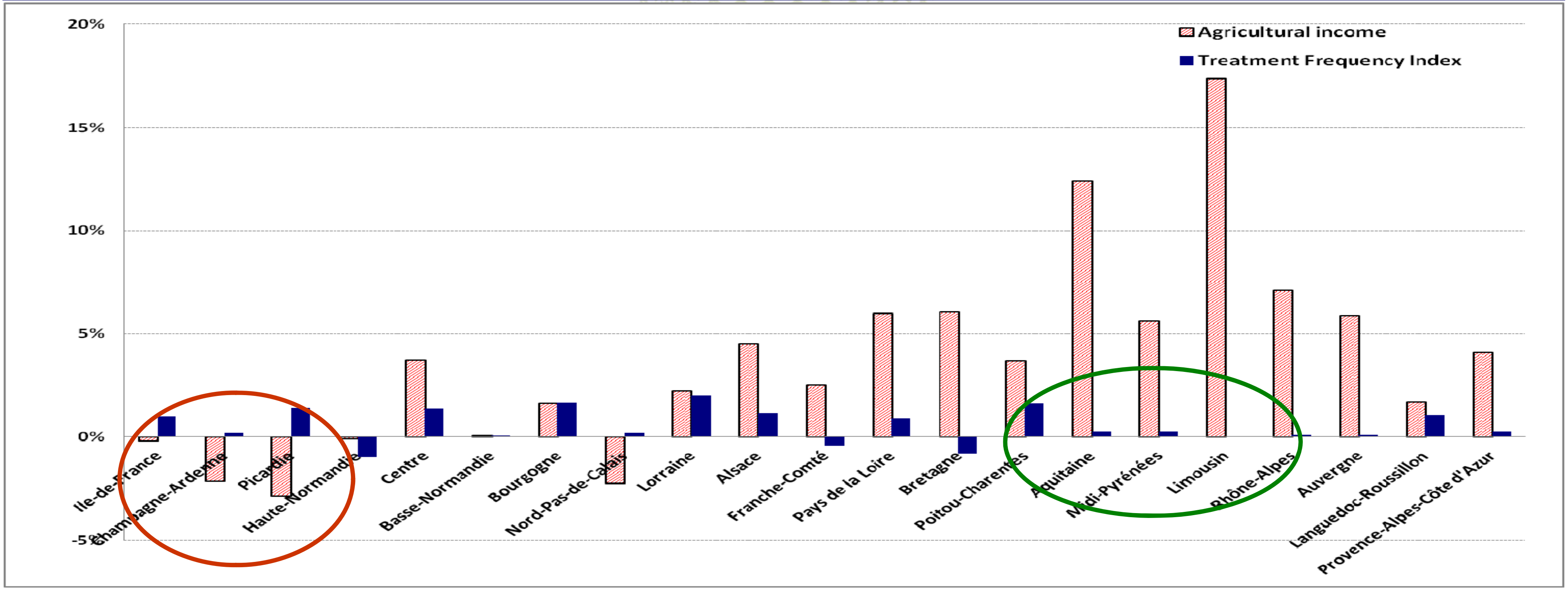
- The impact of the CAP Health check on **supply** (i.e. production level) follows the same trend as land use given that yield is exogenously defined in ASMMA

CAP Health Check - impacts at national level

	Reference [2013]	CAP Health Check [2013]	
	Value	Value	(% change to reference)
National agricultural income (K€)	6 541 951	6 639 025	1.5
Average farm income (€/farm)	59 744	60 630	1.5
Average premiums (€/farm)	23 611	21 560	-8.7
Average pesticide use (IFT/ha)	3.46	3.48	0.6

- A slight increase of agricultural income due mainly to the putting into production of fallow land and the adoption of total decoupling.
- A decrease of EU premiums because of the application of higher modulation rate and the elimination of premiums for energy crops.
- No change in term of pesticide use

CAP Health Check - impacts at regional level



- **Negative economic impacts** in the specialised Grande Cultures regions as these regions have the upper regional premiums and therefore they are hardly affected by the premium reduction and redistribution.
- **Positive economic impacts** in the others regions due to the putting into production of set-aside, the full decoupling and the redistribution of premiums induced by the transition from the basic to the regional rate approach.

CAP Health Check - impacts at farm level

- The economic effects will be very different across farms according to farm resource endowment, farm orientation, historic single payment...
- It seems favourable for the farms having a lower historical value entitlement and unfavourable for the inverse.
- Majority of the farms belonging to the OTEX 14 and 81 are positively affected mostly because they are beneficial of the full decoupling and the premium redistribution process.
- The environmental impact in term of pesticide use will be quite different between farms but in the majority of cases it shows a small rise compared to reference scenario.

Conclusion and future improvement

- CAP Health Check would affects positively but moderately agricultural income due to the ending of set-aside obligation and the adoption of the full decoupling
- Regional flat rate seems favourable for the farms with a lower historical value entitlement and unfavourable for the inverse. However, this impact is not so big since the transfer of funds between sectors or between "old" beneficiaries and newcomers are not considered in this application.
- CAP Health Check seems to be benefic for energy crops even with the abolishment of energy crop’s premiums.
- Environmental impact in term of pesticide use seems negligible especially at national scale .

Conclusion and future improvement

- The need for several interactions with local experts and/or further methodological development to specify a large list of crop rotations and to take into account rotational effects on inputs and outputs coefficients.
- Estimate a more flexible implicit cost function enable to capture all elements of farm behavior (e.g. through Maximum Entropy).
- Extend the work to the others sub-sectors (i.e. livestock and mixed farms).
- Provide the model with a set of alternative (i.e. new) production activities (e.g. Integrated Pest Management) to simulate the switching between current and alternative activities.
- Link ASMMA with a biophysical model or indicator calculators to compute environmental effects associated to production process.
- Link ASMMA with one of the existing market model to have the feedback from the demand side.

Thank you for your attention

klouhichi@grignon.inra.fr

Used PMP approach: first step

Standard PMP approach

(Howitt, 1995)

$$\max_{x_i \geq 0} z = \sum_i (p_i y_i + s_i - c_i) x_i$$

$$s.t. \sum_i a_{ij} x_i \leq b_j \quad [\gamma_j]$$

$$x_i \leq x_i^0 (1+\varepsilon) \quad [\lambda_i]$$

Where: ε: small number

x_0: observed activity level

ASMMA PMP approach

(Kanellopoulos et al, 2009)

$$\max_{x_i \geq 0} z = \sum_i (p_i y_i + s_i - c_i) x_i - \kappa \omega$$

$$s.t. \sum_i a_{ij} x_i \leq b_j \quad [\gamma_j]$$

$$x_i \leq \omega$$

$$x_i \leq x_i^0 (1+\varepsilon) \quad [\lambda 1_i]$$

$$x_i \geq x_i^0 (1-\varepsilon) \quad [\lambda 2_i]$$

Where: ω: total rented land (ha)

κ: average gross margin

Used PMP approach: second step

Standard PMP approach (Howitt, 1995)

$$\begin{cases} d_i = \lambda_i \\ Q_i = \dfrac{\lambda_i}{X_i^0} \end{cases}$$

ASMMA PMP approach (Kanellopoulos et al, 2009)

$$\begin{cases} d_i = (\lambda 1_i + \lambda 2_i) - \alpha_i \left| \lambda 1_i + \lambda 2_i \right| \\ Q_i = \alpha_i \dfrac{\left| \lambda 1_i + \lambda 2_i \right|}{X_i^0} \end{cases}$$

Used PMP approach: third step

Standard PMP approach (Howitt, 1995)

$$\max_{x_i \geq 0} z = \sum_i (p_i y_i + s_i - c_i) x_i + (d_i x_i - Q_i x_i^2)$$

ASMMA PMP approach (Kanellopoulos et al, 2009)

$$\max_{x_i \geq 0} z = \sum_i (p_i y_i + s_i - c_i) x_i - (d_i x_i + 0.5 Q_i x_i^2)$$