Evaluating economic performance and antimicrobial consumption in French broiler production: improved healthcare management as a win-win strategy

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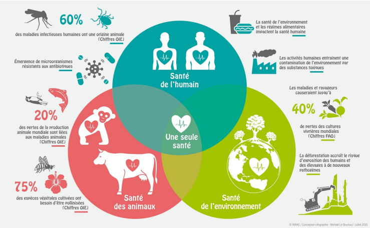
Challenges

- Resurgent public health issues ⇒ Animal production
- Importance of inclusive approach
  - To better promote animal production sector
  - To consolidate and perpetuate the relationship between stakeholders
- For that purpose ⇒ One Health framework



- To emphasize the interconnection between human, veterinary and environmental health;
- To promote the need for more prudent use practices in veterinary medicine (Sanders et al. (2020)).

One of the main features of "One health" notion is related to :

- The management of antimicrobial uses (AMUs).

Useful AMUs

- Accroding to Lhermie et al. (2015), antibiotic treatments allow to respond to :
  - Animal welfare issues ⇒ by optimizing the quality of care;
  - Economic ⇒ since the animals are bred to produce animal products
  - Public health ⇒ in the fight against diseases infectious contagious and particularly zoonoses

In poultry sector

- Antibiotics play a key role with a significant contribution to the intensification of animal husbandry

Harmful AMUs

- the inappropriate use of an antibiotic creates selection pressure in favor of resistant bacteria :

Antimicrobial Resistance (AMR)

- AMR has become a major public health challenge worldwide due to:
  - loss of effectiveness for antibiotics impacts the health of people, the health of animals and the health of ecosystems
- AMR represents a serious public threat, leading policymakers to implement measures to reduce antimicrobial use

In poultry production: AMU contributes to the dissemination, selection, and persistence of AMR in human populations (Hedman et al. (2020)).

Public policies

- World context:
  - Management of AB uses $\Rightarrow$ To the fight against AMR
- European context:
  - Several directives related to Antibiotic uses;
- French context: Ecoantibio plan
  - Phase 1: 25% reduction of antibiotic uses $\Rightarrow$ 2012-2016;
  - Phase 2 with challenges about :
    - (i) sustainable change of antibiotic prescribing practices;
    - (ii) improvement of the living conditions of animals;
    - (iii) access to effective and economical health products, other than antibiotics

To better orient towards sustainable antibiotic prescribing practices ⇒ importance to assess the impact of the antibiotic uses on different aspects (animal health, public health and economic considerations).

Objectives

- This study fits into this register by analyzing:
  - The relationship between AMUs and the profitability of farmers
- Main objective of this study: to analyze the economic performance of farms by highlighting the health care criteria.

Through this study, we attempt to provide an empirical evidence in order to highlight both :

- benefit effects of AMUs
- harmful effects of AMUs

in the context of economic point of view ⇒ Filling the gap to the literature

Data informations: $\Rightarrow$ a large veterinary practices in France, representing 1086 flocks:

- First, technico-economic data;
- Second, veterinary procedures and drugs.

Technical performance data

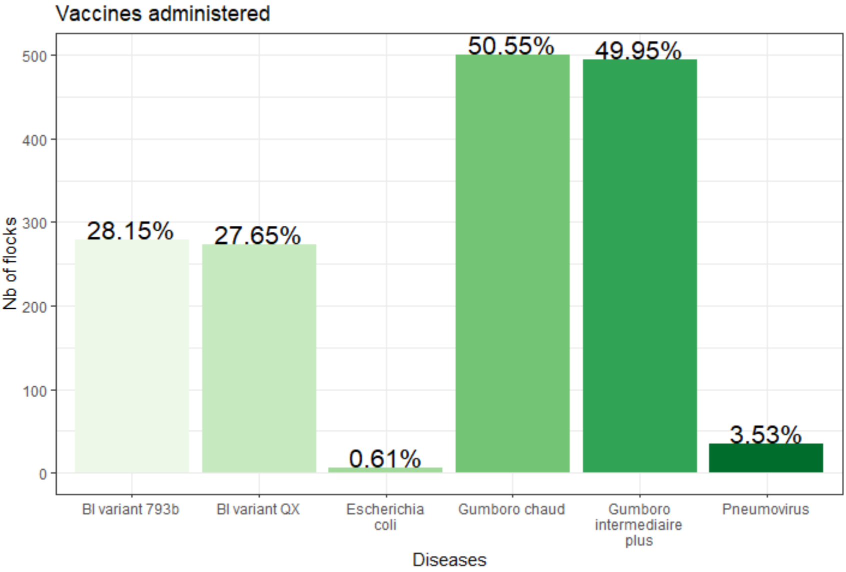
The economic performance of farms measured via the profit per m^2 is used as our dependent variable.

- Main characteristic of flocks:
  - Control variables: number of flocks **(+)**, the weight of flocks**(+)**, the average age of flocks **(+)**, the average daily gain (ADG) **(+)**, the density, the mortality **(-)** and the Condemnation **(-)** and different indexes such as performance index (IP) **(+)** and technical consumption index (ICT) **(-)**.

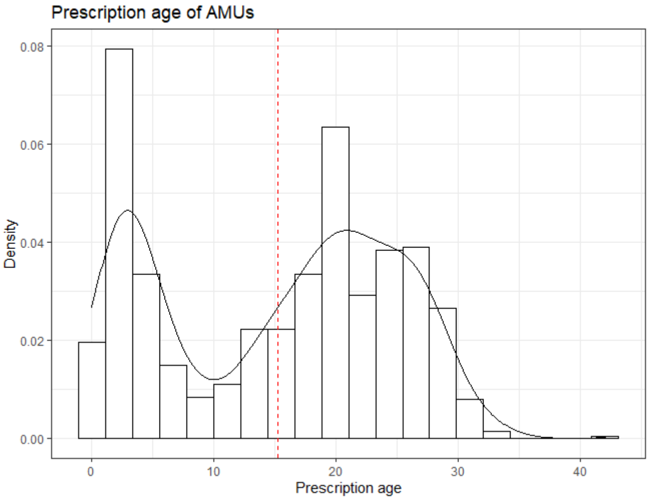
Veterinary prescription data:

- Two metrics for AMUS data: animal course dose (ACD) and the weight of active ingredient (WAI).
- Highest Priority Critically Important Antimicrobials (HP-CIAs) WHO
- Nb of AMUs treaments
- Nb of vaccines administered
- Farmer visits and bacteriological analyzes

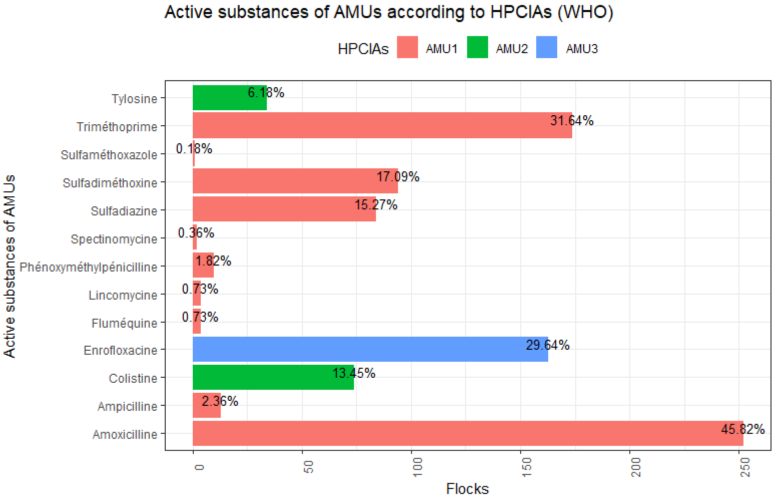
Vaccine characteristics



Antimicrobial uses (AMUs) characteristics: Prescription age distribution



Antimicrobial uses (AMUs) characteristics: Active substance



Statistical analysis

- Aim: to dertermine a typology of flocks according to relative importance of veterinary practices

Econometric approach:

- Objective:
  - to highlight the main determinants of economic performance in the poultry production system.
  - to provide the contributions of veterinary practices in the economic performance of the breeder.
- Specification:

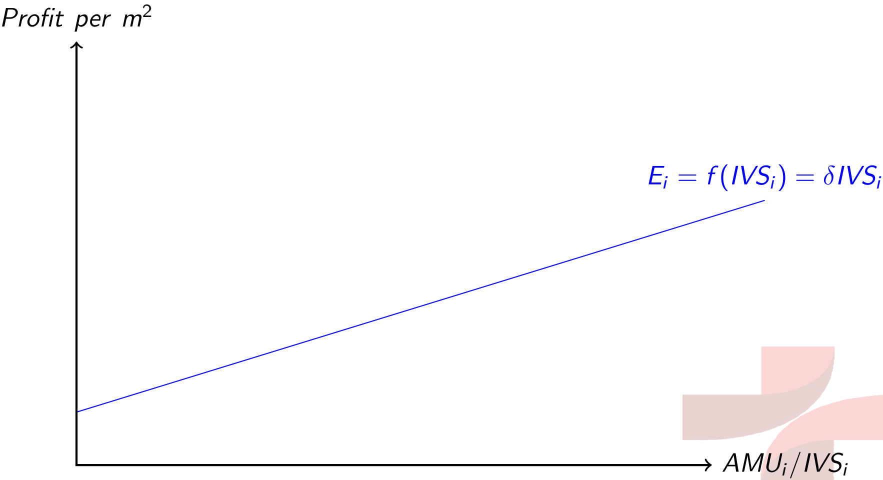
$$lnE_i = \alpha + \beta lnAMU_i + \gamma(lnAMU_i)^2 + \delta lnIVS_i + \theta_k X_{ik} + \epsilon_i \quad (1)$$

Non-linear relationship between AMUs and economic performance

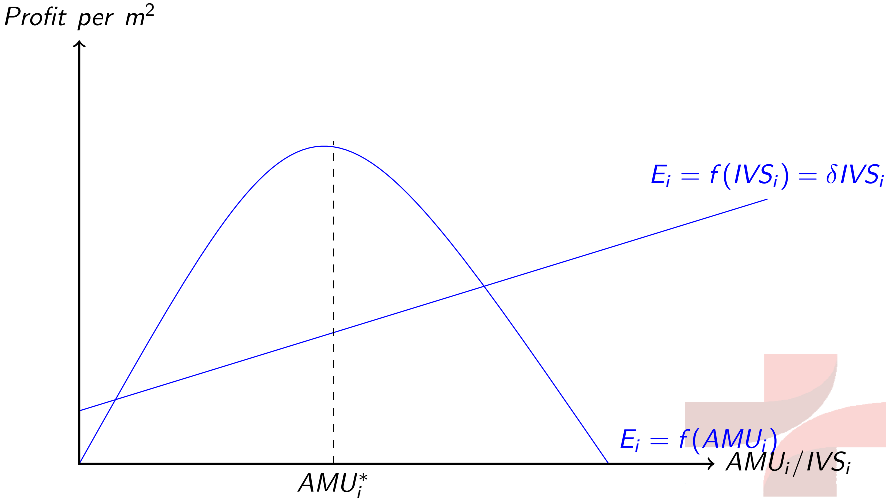
- An inverted-U curve path exists $\Rightarrow$ if $\beta > 0$ and $\gamma < 0$.
- Instrumental Variables (IV) method.

Theoretical intuitions

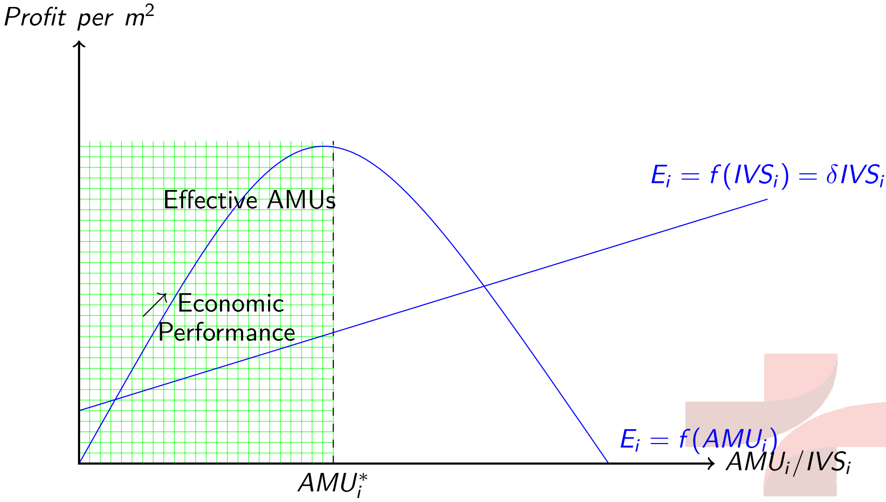
Theoretical intuitions



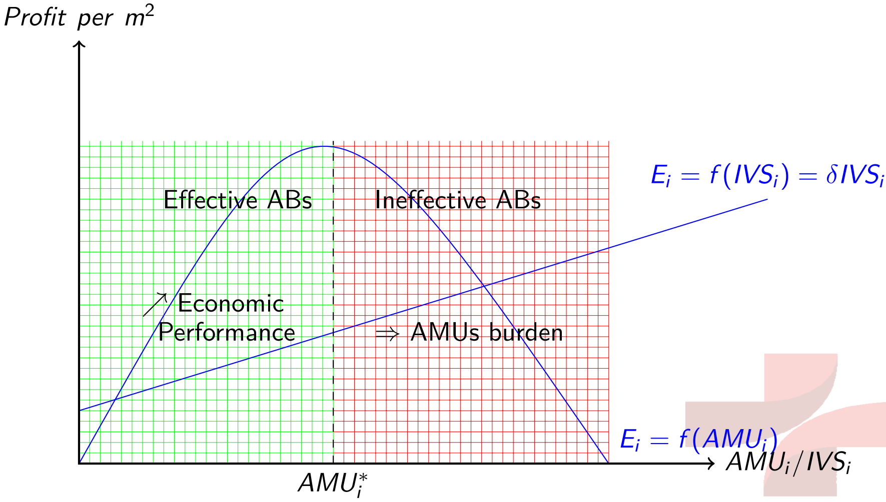
Theoretical intuitions



Theoretical intuitions



Theoretical intuitions



Identification strategies:

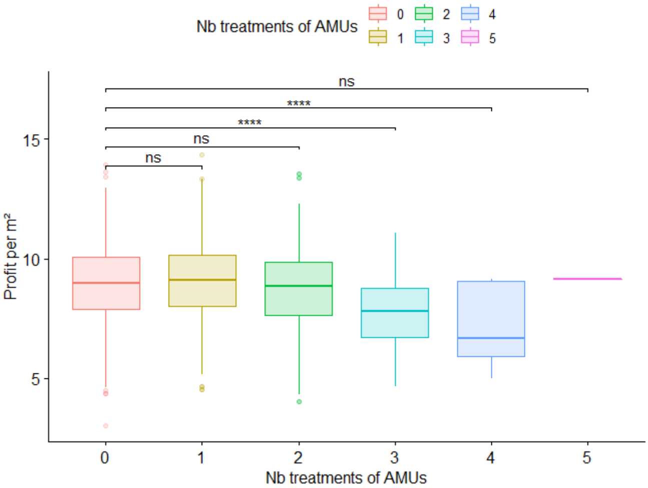
- Analyze the relationship between E_i and ABs_i $\Rightarrow$ confounded by several factors.
  - Some are observed and will be controlled for
  - Others are difficult to capture
- $\Rightarrow$ Occurence of endogeneity bias

Source of endogeneity:

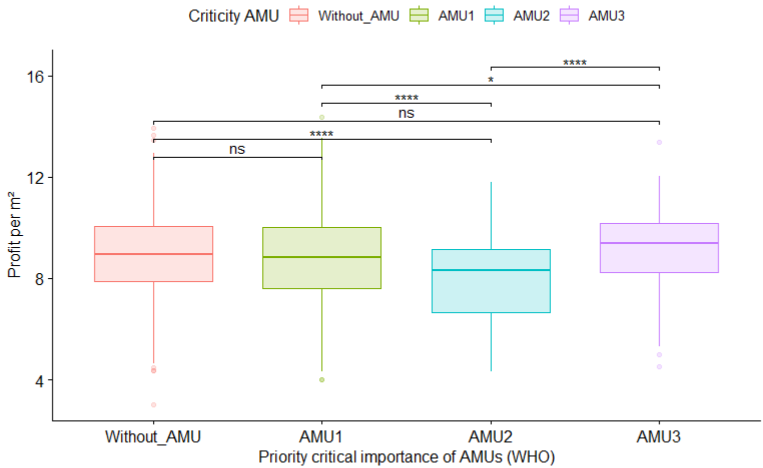
- simultaneity bias
- measurement error bias
- omitted variable bias
- selection bias
- time series autocorrelation
- etc...

To deal with endogeneity bias, we use an Instrumental Variables (IV) method

Statistic results ⇒Impact of Nb of AMU treatments on the profit



Statistic results ⇒ Impact of HPCIAs criteria on the profit



Statistic results ⇒ Vaccines administered

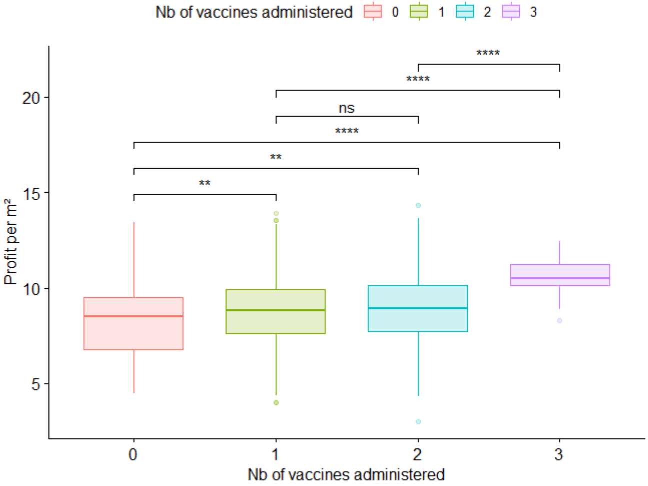


Table: Profit per m^2 estimations

	Dependent variable:			
	'Profit per m^2'			
	(1)	(2)	(3)	(4)
Average_age	0.1571*** (0.0381)	0.1680*** (0.0373)	0.1538*** (0.0512)	0.1645*** (0.0517)
ADG	0.1178*** (0.0137)	0.1143*** (0.0134)	0.1160*** (0.0184)	0.1109*** (0.0187)
Density	0.4779*** (0.0686)	0.4293*** (0.0678)	0.6171*** (0.1018)	0.5665*** (0.1027)
nb_treatments	−2.0287*** (0.3410)	−1.9696*** (0.3311)	4.1260*** (0.9427)	4.2063*** (0.9559)
I(nb_treatments^2)			−2.2914*** (0.4872)	−2.3331*** (0.4941)
Nb_vaccines	0.4233*** (0.1020)	0.4207*** (0.0996)	0.2755** (0.1293)	0.2807** (0.1306)
ID_Farmer		0.00001*** (0.000002)		0.00001*** (0.000003)
Constant	−12.6619*** (2.1449)	−12.0909*** (2.1056)	−16.8374*** (2.9290)	−16.1544*** (2.9583)
Observations	1,086	1,086	1,086	1,086
Note:				*p<0.1; **p<0.05; ***p<0.01

Table: Profit estimation with alternative measures of ABs

	Dependent variable:			
	log('Profit per m^2')			
	(1)	(2)	(3)	(4)
log(Average_age)	0.6976***	0.6804***	0.6727***	0.6123***
	(0.1183)	(0.1181)	(0.1182)	(0.1263)
Mortality (%)	−0.0169***	−0.0163***	−0.0160***	−0.0161***
	(0.0027)	(0.0027)	(0.0028)	(0.0029)
Condemnation (%)	−0.0702***	−0.0699***	−0.0704***	−0.0755***
	(0.0110)	(0.0110)	(0.0110)	(0.0117)
log(Density)	1.0527***	1.0582***	1.0299***	
	(0.1129)	(0.1125)	(0.1151)	
log(ADG)	2.0426***	2.0382***	2.0330***	1.9600***
	(0.0976)	(0.0972)	(0.0973)	(0.1038)
log(WAI)	−0.0216***	0.4010**	0.4022**	0.3766*
	(0.0063)	(0.1830)	(0.1829)	(0.1958)
I(log(WAI)^2)		−0.0136**	−0.0137**	−0.0126**
		(0.0059)	(0.0059)	(0.0063)
log(Nb of vaccines administered)			0.0016	0.0043***
			(0.0014)	(0.0014)
Constant	−11.2583***	−14.4637***	−14.3550***	−10.5442***
	(0.7107)	(1.5573)	(1.5598)	(1.6062)
Observations	550	550	550	550
Log Likelihood	319.2699	321.9658	322.6301	284.6792
Akaike Inf. Crit.	−624.5398	−627.9316	−627.2602	−553.3583
Note:				*p<0.1; **p<0.05; ***p<0.01

Econometric results according to veterinary practice contributions

- Non-rejected of an inverted-U shape curve accroding to AMUs:
  - The best performing flocks are those that use low doses of antibiotics;
  - Existence of a threshold beyond which the consumption of AMUs leads to a reduction in the economic performance
- Variation **(+)** nb of AMUs treatments or HPCIAs criteria $\Rightarrow$ Variation **(-)** of the profit per m^2

- Improving healthcare management and medical prevention positively impact economic performance and health outcome,$\Rightarrow$ reducing antimicrobial use
- Evidence that the economic performance follows an inverse-U pattern according to antimicrobial uses:
  - Marginal profit effect of antimicrobial use was a decreasing function of the antimicrobial input;
  - $\Rightarrow$ Using antimicrobials is profitable for the farmers up to a certain threshold;
- Policies encouraging farmers to work upstream from the occurrence of disease have the potential to perform better than regulations;
- Encouraging adequate infection control practices by subsidizing them would benefit farmers and society.

THANK YOU FOR ATTENTION