The high cost of noncompliance with pest control policy

Jean-Sauveur Ay
Estelle Gozlan
Emmanuel Paroissien

Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

5 – Robustness checks

6 – Conclusion

Context

Performing a benefit-cost analysis of pesticide use is challenging

- Experimental data suffers from a lack of external validity because of context-dependence and lack of representativeness
- Observational data suffers from simultaneity issues, because pesticide use is both cause and consequence of pest levels

The litterature is mixed about the good intensity of pesticide use

Contribution

Flavescence dorée in French vineyard is a favorable case study

- Specific grapevine disease, without alternative control than insecticide application from a restricted set of products

- In 2013, a specific policy is implemented with compulsory treatments within municipalities (without much controls)

AOC are pre-determinated instruments for causal identification and vineyard prices are proxies for the private costs of noncompliance

Results

- Average compliance rates:

  50% for organic producers and $\sim$ 75% for regular ones

- Causal impact of compliance:

  $$+10\% \;\Rightarrow\; -4.5\% \text{ of FD presence}$$

- High cost of noncompliance:

  $$-10\% \;\Rightarrow\; + \text{€}\, 7 \text{ millions by year nationally}$$

- Social desirability of increasing insecticides use depends on their hidden costs with an average threshold of €70/ha/year

Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

5 – Robustness checks

6 – Conclusion

The case study

Flavescence dorée is an incurable epidemic grapevine disease observed in France since the 80's but with a recent outbreak (2010)

In 2013, France implemented a new control policy with:

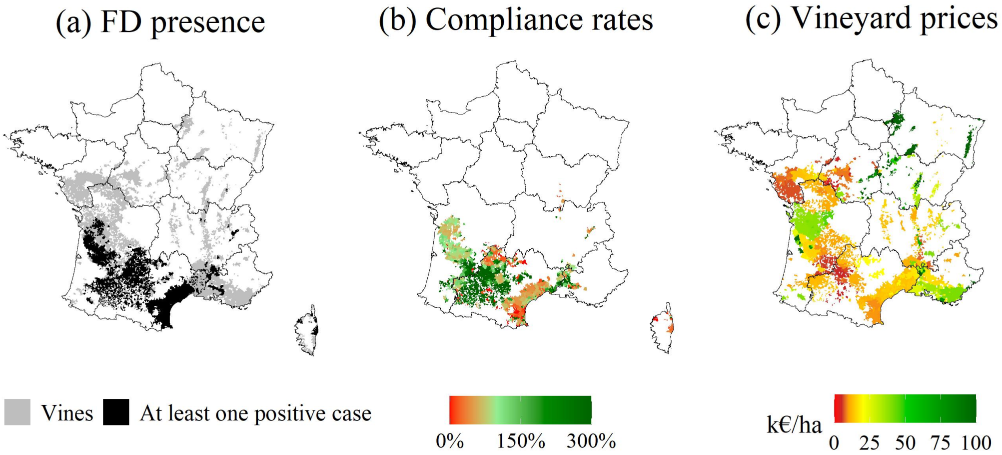
- Designation of control areas (MTP)
- Compulsory vineyard monitoring
- Compulsory insecticide application

In 2018, 75% of vineyard acreages within control areas (568,507 ha)

Data (in a nutchell)

- FD presence and MTP at the municipal level 2016-2017
- AMM and insecticide sales at the postal code level 2016-2017
- Municipal vineyard acreages from FranceAgriMer in 2016
- Vineyard prices at the AOC level 1997-2019 spatialized at the municipal level with the distribution of AOC from INAO

Spatial distribution



Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

5 – Robustness checks

6 – Conclusion

Empirical framework

System of simultaneous equations

$$\begin{cases} I = \beta_0 + \beta_1 \, C^* + \epsilon \\ C^* = \alpha_0 + \alpha_1 \, I + \alpha_2 \, V + \eta \end{cases}$$

With measurement errors on compliance

$$C = C^* + \mu \quad \text{with} \quad \mu = X^\top \gamma + \xi$$

$\Rightarrow$ OLS underestimate β_1 if $\alpha_1 > 0$ or $\mathbb{V}(\mu) > 0$ (or both)

Identification restrictions

- Instrument relevance: $H_{IV1} : |\alpha_2| >> 0$
- Exclusion restriction: $H_{IV2} : \mathbb{C}(V, \epsilon \mid X) = 0$
- Classical measurement errors: $H_{ME} : \mathbb{C}(V, \xi \mid X) = 0$

Under $H_{2SLS} = H_{IV1} \cap H_{IV2} \cap H_{ME}$, we have $\hat{\beta}_1^{2SLS} \equiv \frac{\mathbb{C}(I, \hat{\lambda}_1 V)}{\mathbb{V}(\hat{\lambda}_1 V)} \xrightarrow{p} \beta_1$

Estimation procedure

- First stage

$$A = \lambda_0 S + \lambda_1 S \times V + Q^\top \gamma + u$$

- Second stage

$$I = \beta_0 + \beta_1(\hat{\lambda}_0 + \hat{\lambda}_1 V) + v$$

Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

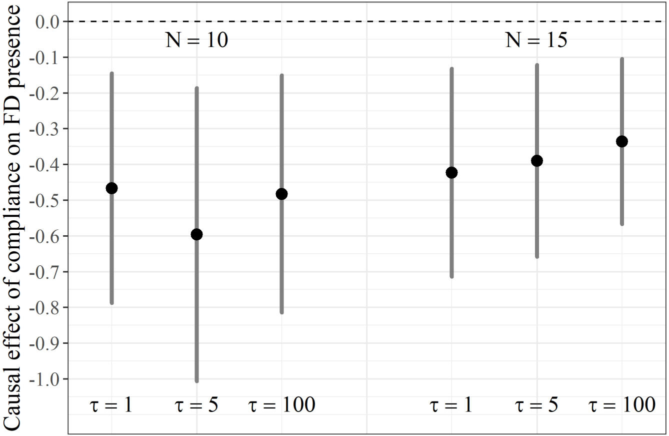
5 – Robustness checks

6 – Conclusion

First stage

	Outcome: acreage actually treated against the FD vector					
		$N=10$			$N=15$	
	$\tau=1$	$\tau=5$	$\tau=100$	$\tau=1$	$\tau=5$	$\tau=100$
Acreage to treat (ATT)	0.573***	0.565***	0.579***	0.677***	0.714***	0.730***
	(0.019)	(0.022)	(0.022)	(0.023)	(0.026)	(0.025)
ATT $\times$ log. price deviation	0.167***	0.130***	0.148***	0.191***	0.198***	0.218***
	(0.028)	(0.033)	(0.032)	(0.034)	(0.039)	(0.037)
Share of permanent crops	1.130***	1.509***	2.269***	1.512***	2.023***	2.751***
	(0.257)	(0.325)	(0.287)	(0.331)	(0.376)	(0.319)
Share of annual crops	0.052***	0.107***	0.105***	0.085***	0.172***	0.169***
	(0.010)	(0.015)	(0.015)	(0.013)	(0.017)	(0.016)
Share of grasslands	-0.029***	-0.045***	-0.030***	-0.041***	-0.056***	-0.045***
	(0.012)	(0.013)	(0.013)	(0.014)	(0.016)	(0.015)
Observations	1,586	1,586	1,586	1,586	1,586	1,586
R-squared	0.804	0.746	0.760	0.804	0.782	0.797
F-stat for weak instrument	35.80	36.08	33.92	42.28	39.82	40.86

Second stage



(bootstrapped confidence intervals)

Cost-benefit analysis with $\hat{\beta}_1 = -0.45$

- MTP about 550 000 ha for an average value of 32 000 €/ha
- Expected benefit of 220 millions for +10% compliance (under the assumption of 5-years loss following a contamination)
- With a private yearly cost of 40 €/ha for insecticide application, the total actualized cost is about 80 millions
- Increasing compliance increases social welfare if the environmental cost of spraying is lower than 70 €/ha

Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

5 – Robustness checks

6 – Conclusion

Landscape controls

We use auxiliary data to compute:

- LSI, Shannon, % of semi-nat., avg. vineyard size (CLC, 2018)
- Topographic and climatic variables (IGN and Météo-France)
- Avg. numbers of wine farms, worked hours (ag. census 2010)

$$\Rightarrow \hat{\beta}_1 \text{ stays between 0.3 and 0.9 at 95\%}$$

Spatial controls

We control for the local average of vineyard price from:

- First and five orders contiguity
- Five and 20 closest neighbors
- Five and 10 km circular buffers

$\Rightarrow \hat{\beta}_1$ stays between 0.3 and 0.9 at 95%

Spatial errors and lags

We allow spatially autocorrelated errors:

$$I = \beta_0 + \beta_1 \hat{C} + Q^\top \gamma + \varepsilon, \text{ with } \varepsilon = \rho W \varepsilon + \upsilon$$

And allow spatially autocorrelated FD presence:

$$I = \beta_0 + \beta_1 \hat{C} + Q^\top \gamma + \rho W \cdot I + \varepsilon$$

$\Rightarrow \beta$ stays between 0.3 and 0.9 at 95%

Imperfect monitoring

We show analytically that, under intuitive assumptions, imperfect monitoring bias downward the compliance effect: $|\hat{\beta}_1| < |\beta_1|$

We use data about reported monitoring to show that the effect of imperfect monitoring is rather small $|\hat{\beta}_1 - \beta_1| < .1$

Other potential problems

We perform jackknife and bootstrap analysis by dropping some influencing observations without that changes our main result

We perform Monte-Carlo simulation about measurement errors from pesticide sale data without that changes our main result

Outline

1 – Introduction

2 – Data

3 – Model

4 – Results

5 – Robustness checks

6 – Conclusion

Synthesis

We provide evidence about:

- Differentiated compliance wrt economic incentives
- Significant economic impact of insectide application

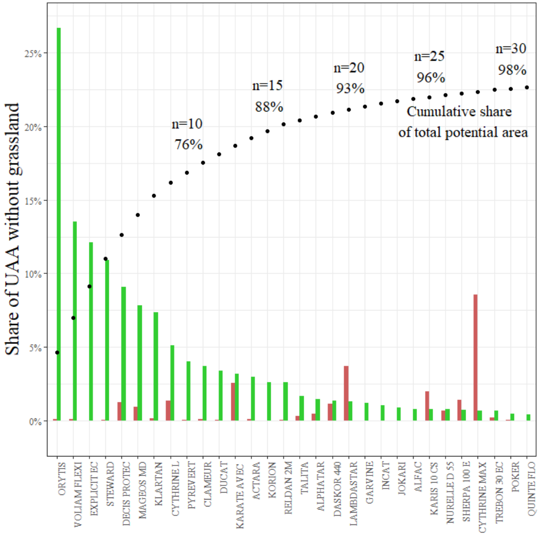
Our results do not imply that:

- The control policy is optimal
- Insecticide application is a panacea

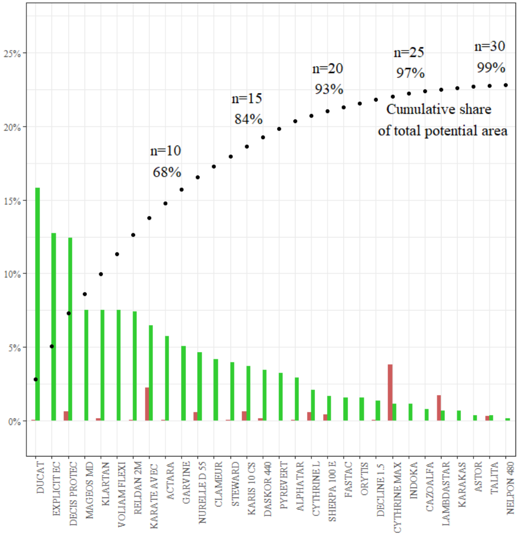
Thank you for your attention

Additional figures

(a): Aquitaine



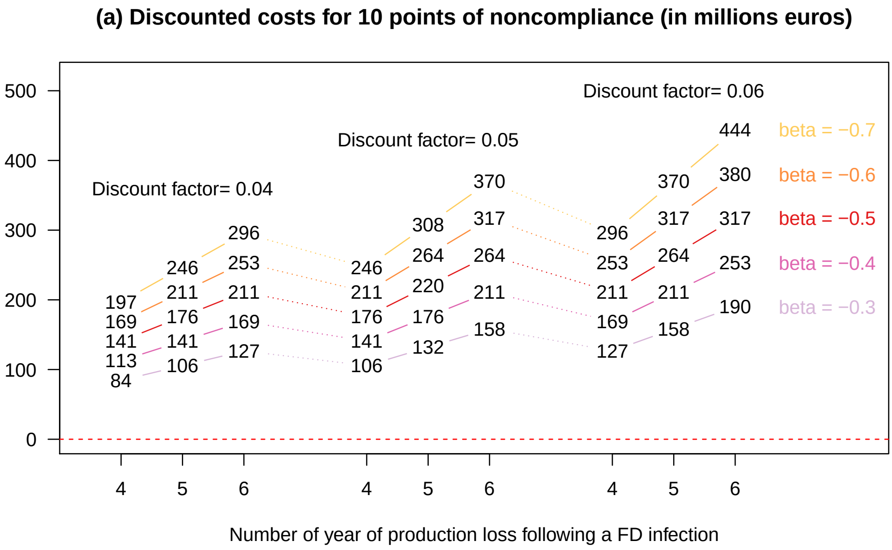
(b): Occitanie



(c): Bourgogne-Auvergne

(d): PACA-Corse

Additional figures



Additional figures