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Early exit from business, performance and neighbours' influence: a study of farmers in France

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Abstract

The sustained decreasing trend in the number of farmers in industrial countries raises concerns about the future of farming in these countries. However, the economic literature on farm exits is surprisingly scarce on one driver which may appear essential though, farm economic performance. The aim of this paper is twofold. First, we assess the effect of a farmer's economic performance on his/her own exit decision, depending on his/her characteristics such as age and farm size. Second, we estimate the spillovers of the performance and size of neighbouring farmers on a farmer's exit decision. Our application to France in 2004-2017 shows that neighbours provide both positive and negative spillovers to farmers in the sense that their performance increases the survival probability of farmers, suggesting agglomeration effects or information flows, as well as competition on the land market. Our estimates reveal that younger farmers are more sensitive to positive spillovers. We also show asymmetric effects for farmers below or above the average of the neighbourhood in terms of performance and size.

Keywords: exit; farms; performance; profit; neighbours; France

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1. Introduction

The sustained decreasing trend in the number of farmers in industrial countries raises concerns about the future of farming in these countries. In Europe, this translates into Common Agricultural Policy (CAP) objectives such as maintaining a vital agricultural sector, protecting rural communities, fostering employment and tackling rural depopulation (European Commission, 2010, 2017). The efficiency of this policy depends on how well farmers at risk of exiting the business earlier than retirement can be identified, and thus on our overall understanding of the reasons why farmers quit early.

Several factors driving the structural change in the farming sector and farmers' decision to exit have received much attention in the economic literature, such as farm size (Weiss, 1999; Sumner, 2014), public policies (Foltz, 2004; Ahearn et al., 2005; Key and Roberts, 2006) or cohort effects (Katchova and Ahearn, 2017). However, the economic literature on farm exits is surprisingly scarce on one driver which may appear essential though, farm economic performance.

Classically, individuals choose the occupation that maximizes their expected utility. Although it is usually difficult to observe the utility of alternatives to farming, we expect farmers with higher farm economic performance to have more incentives to remain in the agricultural sector. This is consistent with the literature on firms. In general, empirical studies show evidence of a negative link between firm performance and firm exit. In agriculture, a few case studies confirm this hypothesis (Dimara et al., 2008; Dong et al., 2016; Peel et al., 2016) but none has been applied to France so far. Identifying the farmers for which the decision to quit is the most sensitive to economic performance could help targeting public support where it is most needed.

More recently, a new stream of literature on farm exits highlights the influence of neighbours on farms' survival. Storm et al. (2015) find that, in Norway, farmers surrounded by larger farms in terms of area and labour have a higher survival probability. They also find that the level of direct payments delivered to a farmer's neighbours decreases the farmer's own probability of survival. Taking agents' unobserved heterogeneity into account, Saint-Cyr et al. (2018) find that the influence of neighbours' size on a farmer's probability to exit may be either positive or negative and that, in their particular case of Brittany (France), exiting is overall positively correlated with the size of neighbouring farms. The main lesson of this new stream of literature is that farmers' decision to quit is, to some extent, also based on their neighbours' characteristics. However, no studies have tackled so far the role of neighbours' performance, which is where our paper contributes.

The aim of this paper is therefore twofold. First, we assess the effect of a farmer's economic performance on his/her own exit decision, depending on his/her characteristics such as age and farm size. The focus here is on the probability to exit early, that is, earlier than retirement. Second, we estimate the spillovers of the performance, size and density of neighbouring farms on a farmer's exit decision. To do so, we use data provided by the French authority for farmer healthcare and social security ('Mutalité Sociale Agricole' or MSA) for years 2004 to 2017. Contrary to most past studies based on survey or census data[1], our data set is both exhaustive and annual, in the sense that it contains the yearly records of all French self-employed farmers who contribute to the healthcare and social security system. One strength of this panel dataset is thus that it allows identifying all exits of the farming sector, the year in which they occur, and the characteristics of the farm and farmer prior to exit.

The remaining of the paper is structured as follows. Section 2 presents the model and the data used, and section 3 reports our results. Section 4 concludes.

2. Methodology

2.1. Basic model

We use a probit framework to model the exit decision. In each period farmers face two alternatives for the next period: (1) staying in business (i.e. survival) or (2) getting out of

[1] Pietola et al. (2003) also resort to social security data in Finland, but they include only elder farmers (between 55 and 64 years old) that is to say close to retirement, while we consider only those who are not in retirement age.

business (i.e. exit). The binary decision depends on the difference in expected utility between both alternatives:

$$\begin{cases} exit_{i,t+1} = 0 \; if \; \Delta EU_{i,t} = EU_{j=1,i,t} - EU_{j=2,i,t} > 0 \\ exit_{i,t+1} = 1 \; if \; \Delta EU_{i,t} = EU_{j=1,i,t} - EU_{j=2,i,t} \leq 0 \end{cases} \quad (1)$$

where *i* denotes farmers, *t* denotes time periods and *j* denotes the alternatives with $j = 1$ being survival and $j = 2$ being exit; $exit$ is a binary variable indicating that the farmer exits the sector when the variable is equal to 1, and remains in the sector if the variable is equal to 0; EU is the expected utility and ΔEU is the difference in expected utility.

We only observe the farmers' exit decision ($exit$) while the difference in utilities is a latent variable (denoted with * below) that is not observed, and is assumed to be generated as follows in period *t*:

$$\Delta EU_{i,t}{}^{*} = \alpha_1 + \alpha_2 X_{i,t} + \alpha_3 PERF_{i,t-s} + \alpha_4 WXS_{i,t} + \alpha_5 WPERF_{i,t-s} + \varepsilon_{i,t} \quad (2)$$

where $PERF_{i,t-s}$ is the economic performance proxy in past periods *t-s*; $X_{i,t}$ is a vector of other explanatory variables; $WXS_{i,t}$ is a vector of specific spatially lagged explanatory variables over neighbouring farms; $WPERF_{i,t-s}$ is the spatially lagged performance proxy in past periods; $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ are parameters to be estimated and; $\varepsilon_{i,t}$ is an i.i.d. error term which is assumed to follow a normal law with unit variance.

We thus have the following probability model, which we estimate with maximum likelihood:

$$Prob(exit_{i,t+1}) = \phi(\alpha_1 + \alpha_2 X_{i,t} + \alpha_3 PERF_{i,t-s} + \alpha_4 WZ_{i,t} + \alpha_5 WPERF_{i,t-s}) \quad (3)$$

where ϕ is the distribution of the centred unit normal law.

2.2. Data

As explained above the database used here is the French authority for farmer healthcare and social security (MSA) database that includes all individuals registered as self-employed farmers in France on January 1st for each year over the period 2004-2017. For each farmer registered in the database, the available data consists of various characteristics of him/herself and of the farm that he/she operates.

To exclude exits due to legal retirement from the data and to focus on farmers exiting for other reasons, we only work on the sub-sample of farmers under 50. In other words, we investigate the factors explaining the probability to exit early, that is, earlier than retirement. Furthermore, we exclude farmers paying a flat-rate social security tax (27.6% of farmers in the full database) as this implies that their agricultural profit, which we will use as the indicator of economic performance, is not reported in the database[2]. This leaves us with a large sample of 2,379,059 observations over 14 years, relative to 325,771 famers and 275,277 farms. We define exit in year *t*+1 when both the farmer and the farm that he/she operates are not present in the database in *t*+1 and subsequent years, meaning that the farmer is no longer a self-employed farmer and that his/her farm stops being operated as such. The farm may however be dismantled and integrated in pieces into other farms, or taken over by another farmer with a new record number. These cases are however not investigated here as we focus on farmers' exits and not on farm exits per se.

[2] For the farmers that we keep in the database, the social security tax amount is based on the annual profit and is thus reported in the data.

In the database the farmer's agricultural profit is defined as the difference between the total output and the total input generated by the farm during the tax year. The total output consists of agricultural market sales and public support, stock variations and gains or losses derived from asset sales. As for total input, it consists of variable costs (including paid salaries and the corresponding social contributions), overheads, taxes and depreciation costs. Though not exactly the same, this agricultural profit in the MSA database used here is close to the 'farm net income' as defined by the Farm Accountancy Data Network (FADN). In the MSA database, each farmer is attributed an agricultural profit: in case the farmer operates a farm with associates, his/her agricultural profit is adjusted with his/her capital shares in the farm.

Based on the existing literature on farm exit and on data availability in the MSA database, the explanatory variables *X* (equation (3)) for the probability to exit include farmer's age, operated area (recorded in the databased as the fraction of the total farm area that the farmer is attributed based on his/her capital shares, production specialization of the farm, legal status of the farm, farmer's marital status, and number of associates on the farm. Table 1 provides descriptive statistics of the data.

Table 1: Descriptive statistics

Quantitative variables (for each farmer)					
	Mean	Median	Min.	Max.	Sd. Dev.
Agricultural profit (k€)	16.7	12.4	-1,979.9	2,023.3	26.0
Operated area (ha)	64.1	53.5	0	1,549.4	51.8
Number of associates	1.7	1.0	1.0	76.0	1.1

Categorical variables (share of farmers)			
Farmer's exit		Importance of farming activity for the farmer	
Yes	1.0%	Exclusive activity	88.5%
No	99.0%	Main activity	6.3%
Farmer's age		Secondary activity	5.2%
45-49	32.1%	Importance of farming activity for the spouse	
40-44	27.6%	Exclusive or main activity	5.5%
35-39	19.5%	Secondary activity	1.3%
30-34	12.6%	No farming activity	93.2%
25-29	6.7%	Farm main production specialization	
under 24	1.5%	Fruits and vegetables	3.3%
Marital status		Field crops	19.0%
Single	41.7%	Vineyards	9.4%
Married	54.7%	Other permanent crops	2.2%
Widowed	0.5%	Dairy cattle	25.0%
Separated	3.1%	Beef cattle	15.1%
Farm legal status		Sheep and goats	3.0%
Individual farm	29.4%	Pigs and poultry	6.2%
Partnership farm	24.6%	Other livestock	1.9%
Limited liability company as a sole holder	30.9%	Mixed crops and mixed livestock	14.9%
Other legal status	15.0%		

As shown in Table 1, 1% of the sample farmers exit early, that is to say before retirement age, during the period considered (2004-2017). The farmers in our sample operate on average 64.1 ha, which is slightly more than the 2010 Agricultural Census average of 55 ha (Agreste, 2011). This is due to the fact that farmers paying a flat-rate rate social security tax, who are excluded from our sample, are generally smaller farms. The annual agricultural profit for each farmer is 16,740 Euros on average but note that average profits are negative for 13.0% of the observations and null for 3.3% of the observations. Almost one third of the farmers are aged 45-49 and 8.2% are under 25. Farming is the exclusive activity for 88.5% of the sample farmers. The majority of farmers are individual farmers or operate a limited liability company as the sole holder. A closer examination of the number of associates shows that, whatever the legal status, about half of the farmers (50.6%) work with no associate.

The municipality where the farmer's farm is located enables identifying the farmers' neighbours. For each farmer we compute several neighbours' variables ($WXS_{i,t}$ in equation (3)): the average agricultural profit of the farmer's neighbours over the past five years ($\overline{WPERF_{i,t\ldots t-4}}$); the average annual operated area ($WSIZE_{i,t}$) of the farmer's neighbours, excluding the farmer him/herself as well as his/her associates; the annual density of the farmer's neighbours ($WDENSITY_{i,t}$), defined by the ratio of the number of neighbours ($WNUMBER_{i,t}$) to their aggregate operated area ($WAREA_{i,t}$). To compute these variables, we use two definitions of neighbourhood. In the first definition, we restrict the definition of neighbours to those whose farm is located in the same municipality of the farmer under consideration. In the second definition, following Latruffe and Piet (2014), we also consider farmers located in adjacent municipalities to the farmer's municipality. In both definitions, all neighbours have the same weight in the computation of the five above variables. In the empirical application, we test whether our estimates are robust to the definition of the neighbours using both definitions in turn. Table 2 displays descriptive characteristics of the neighbours. The means and median are similar whether considering only neighbours in own municipality or including the adjacent municipalities. As expected, the area of the neighbours and the number of neighbours are much larger when adjacent municipalities' neighbours are included.

Table 2: Descriptive statistics of the variables controlling for neighbours' characteristics

Variable (unit)	Mean	Median	Min	Max	S.d.
Neighbours in farmer's own municipality					
$\overline{WPERF_{i,t\ldots t-4}}$ (k€)	14.4	12.1	-8,022.4	606.8	13.3
$WSIZE_{i,t}$ (ha)	57.6	51.2	0.0	994.9	32.2
$WNUMBER_{i,t}$	36.4	20.0	0.0	706.0	56.6
$WAREA_{i,t}$ (ha)	3,024.8	1,933.3	54.2	7,5740.9	4,002.8
$WDENSITY_{i,t}$ (ha^{-1})	0.013	0.010	0.000	0.201	0.012
Neighbours in farmer's own and adjacent municipalities					
$\overline{WPERF_{i,t\ldots t-4}}$ (k€)	14.4	12.3	-566.0	238.7	8.7
$WSIZE_{i,t}$ (ha)	57.4	52.0	0.0	256.2	26.8
$WNUMBER_{i,t}$	217.5	146.0	0.0	3064.0	255.3
$WAREA_{i,t}$ (ha)	18,879.4	14,646.3	138.9	19,2119.1	16,728.2
$WDENSITY_{i,t}$ (ha^{-1})	0.011	0.010	0.000	0.091	0.007

3. Results: direct (farmer' own) effects and indirect (neighbours') effects on farmer's exit

In a first series of estimation (results presented in sub-section 3.1), we estimate the effect of the farmer's own agricultural profit on his/her probability of exit. We also test whether this effect differs depending on:

- the lag on the farmer's profit (H1);
- the size of the farm, that is to say the farmer's operated area (H2);
- the legal status of the farm (H3);
- the age of the farmer (H4).

In a second series of estimations (results presented in sub-section 3.2), we estimate the influence of neighbours via their average agricultural profit, as well as their annual size (operated area) and density. We also explore potential interaction effects between the neighbours' size and profit, on the one hand, and the farmer's age. Finally, we test whether the effects of neighbours' profit and size are symmetric for farmers below and above their neighbours' averages. All these estimations are conducted for both definitions of neighbours described above. We also run another robustness check where we consider only neighbours who have the same production specialization as the farmer.

3.1. Direct effects of farmers' own profit, depending on size and age, on exit

We first estimate the probit model (3) with no spatially lagged variables that is to say without $WXS_{i,t}$. The model that we estimate includes the *X* explanatory variables and the performance proxy *PERF*, as well as annual and regional fixed effects. We include cross-effects allowing for a differentiated farm size effect for each production specialization. Table 3 reports the coefficient estimates for the four above-mentioned different specifications (H1-4) of farmers' own performance's effect on their probability to exit. The specifications are estimated in separate probit regressions, and only the estimates of the coefficients coefficients relative to the performance' variables are reported. Tables A1 and A2 in the appendix show the coefficients of all control variables and the average marginal effects.

In table 3 the block H1 reports the estimated coefficients for the farmers' own lagged performance up to five years in the past. All five lags are strongly significant and decrease the probability of exiting early (that is to say, before 50 years old). This suggests that a strong performance allows farmers to remain in business, consistent with the literature on firms and farms. The estimates also show a fading effect for further lagged performance. This suggests that not only low performing farms are more likely to exit, but also that exiting farms have seen a deterioration of their performance prior to exit. The latter proposition has been formulated as the 'shadow of death' by Griliches and Ragev (1995) and shown evidence in various firm studies (Almus, 2004; Blanchard et al., 2014).

Considering the average performance over the past five years ($\overline{PERF_{i,t-1\dots t-4}}$) and its cross-effect with the farmer's operated area ($SIZE_{i,t}$) (block H2), results show that the smaller the area, the stronger the negative influence of past performance on exit decision[3]. The estimates in block H3 show that the effect of performance is consistently negative across all farms' legal statuses. Finally, as regard the cross-effect of average performance and farmer's age (block

[3] The estimates reveal however that the effect becomes positive when the area exceeds 353.4 ha, which is the case for only 0.17% of the observations in our sample.

H4), we find that the influence of economic performance on exit decision is stronger for younger farmers.

Table 3: Effect of farmer's own performance on probability to exit early in year *t+1*: estimated probit coefficients

H1: Lagged performance		H2: Cross-effect with farm size	
		$\overline{PERF_{i,t\ldots t-4}}$	-9.14e-03 ***
$PERF_{i,t}$	-2.66e-03 ***		(2.20e-04)
	(1.42e-04)	$\overline{PERF_{i,t\ldots t-4}} \times SIZE_{i,t}$	2.76e-05 ***
$PERF_{i,t-1}$	-1.62e-03 ***		(1.20e-06)
	(1.57e-04)	H4: Cross-effect with farmer's age	
$PERF_{i,t-2}$	-1.38e-03 ***	$\overline{PERF_{i,t\ldots t-4}} \times$ *Under 24*	-1.99e-02 ***
	(1.62e-04)		(5.49e-03)
$PERF_{i,t-3}$	-6.17e-04 ***	$\overline{PERF_{i,t\ldots t-4}} \times$*25-29*	-1.87e-02 ***
	(1.73e-04)		(1.40e-03)
$PERF_{i,t-4}$	-8.86e-04 ***	$\overline{PERF_{i,t\ldots t-4}} \times$*30-34*	-9.74e-03 ***
	(1.76e-04)		(6.85e-04)
H3: Cross-effect with farm legal status		$\overline{PERF_{i,t\ldots t-4}} \times$*35-39*	-9.30e-03 ***
$\overline{PERF_{i,t\ldots t-4}} \times$	-9.23e-03 ***		(4.52e-04)
Individual farm	(3.11e-04)	$\overline{PERF_{i,t\ldots t-4}} \times$*40-44*	-7.18e-03 ***
$\overline{PERF_{i,t\ldots t-4}} \times$	-8.31e-03 ***		(3.41e-04)
Partnership farm	(9.21e-04)	$\overline{PERF_{i,t\ldots t-4}} \times$*45-49*	-6.30e-03 ***
$\overline{PERF_{i,t\ldots t-4}} \times$	-8.62e-03 ***		(2.72e-04)
Limited liability company as a sole holder	(3.89e-04)		
$\overline{PERF_{i,t\ldots t-4}} \times$	-5.10e-03 ***		
Other legal status	(3.01e-04)		

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

3.2. Influence of neighbours' size and profit on a farmer's exit

We now discuss the results regarding the effect of spatially lagged variables. We estimate probit regressions including all *X* variables, annual and regional fixed effects, farmer's own average performance ($\overline{PERF_{i,t\ldots t-4}}$) and the neighbours' variables with the above-mentioned two definitions of neighbourhood.

Table 4: Effect of neighbours' performance, size and density on farmer's probability to exit early in t+1: estimated probit coefficients

Variable	Neighbours in farmer's own municipality		Neighbours in farmer's own and adjacent municipalities	
	(1)	(2)	(3)	(4)
$\overline{PERF_{i,t\ldots t-4}}$	-7.38e-03 ***	-7.38e-03 ***	-7.23e-03 ***	-7.24e-03 ***
	(1.97e-04)	(1.97e-04)	(1.97e-04)	(1.97e-04)
$W\overline{PERF_{i,t\ldots t-4}}$	-2.90e-04 **	-1.96e-04	-2.80e-03 ***	-1.12e-03
	(1.28e-04)	(3.27e-04)	(4.69e-04)	(7.53e-04)
$WSIZE_{i,t}$	8.44e-04 ***	8.70e-04 ***	1.25e-03 ***	1.93e-03 ***
	(1.42e-04)	(1.68e-04)	(2.30e-04)	(3.32e-04)
$WDENSITY_{i,t}$	-1.01e+00 ***	-1.02e+00 ***	-2.38e+00 ***	-2.52e+00 ***
	(3.16e-01)	(3.18e-01)	(6.29e-01)	(6.30e-01)
$W\overline{PERF_{i,t\ldots t-4}} \times WSIZE_{i,t}$		-1.13e-06		-3.38e-05 ***
		(3.73e-06)		(1.19e-05)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

Results in Table 4 show that the sign and significance of the estimates for the three spatially lagged variables are the same under both definitions of neighbours (columns 1-2 versus 3-4). Neighbours' performance has a negative effect on the farmer's probability to exit early, similar to the effect of farmer's own performance, suggesting positive spillovers. The coefficient for the density of farmers' neighbours is always negative and strongly significant. This reveals that farmers in areas where the density of farmers is high have a lower probability of early exit and suggests positive agglomeration effects. Those effects are robust to both definitions of neighbours, even when considering only neighbours with the same production specialization as the farmer, that is to say ignoring neighbouring farms with different specializations than the farmer (see Table A3 in appendix). The corresponding average marginal effects on the probability of exit are reported in Table A4 of the appendix.

The cross-effect between neighbours' performance and neighbours' size is negative and significant in the case where adjacent municipalities are accounted for in the neighbours' definition. This indicates that the positive spillover due to neighbours' performance is larger when neighbours' farms are small. However, this is not robust to the specification considering only neighbours with the same production specialization of the farmer (see Table A3 in appendix).

Table 5: Cross-effects of neighbours' characteristics with farmer's own age on farmer's probability to exit early in *t+1*: estimated probit coefficients

Variable	Neighbours in farmer's own municipality			Neighbours in farmer's own and adjacent municipalities		
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{PERF_{i,t\ldots t-4}}$	-7.34e-03 ***	-7.38e-03 ***	-7.38e-03 ***	-7.27e-03 ***	-7.24e-03 ***	-7.24e-03 ***
	(1.98e-04)	(1.97e-04)	(1.97e-04)	(1.97e-04)	(1.97e-04)	(1.97e-04)
$W\overline{PERF_{i,t\ldots t-4}}$	-8.79e-03 ***	-2.88e-04 **	-2.89e-04 **	-1.55e-02 ***	-2.80e-03 ***	-2.79e-03 ***
	(1.61e-03)	(1.28e-04)	(1.28e-04)	(2.39e-03)	(4.69e-04)	(4.69e-04)
$WSIZE_{i,t}$	9.38e-04 ***	2.29e-04	8.42e-04 ***	1.26e-03 ***	3.64e-04	1.24e-03 ***
	(1.43e-04)	(6.13e-04)	(1.42e-04)	(2.31e-04)	(7.50e-04)	(2.31e-04)
$WDENSITY_{i,t}$	-7.90e-01 **	-1.01e+00 ***	-2.70e+00	-2.29e+00 ***	-2.37e+00 ***	-8.61e+00 ***
	(3.18e-01)	(3.16e-01)	(1.72e+00)	(6.30e-01)	(6.29e-01)	(2.92e+00)
$W\overline{PERF_{i,t\ldots t-4}} \times AGE_{i,t}$	1.81e-04 ***			3.01e-04 ***		
	(3.56e-05)			(5.50e-05)		
$WSIZE_{i,t} \times AGE_{i,t}$		1.51e-05			2.18e-05	
		(1.46e-05)			(1.75e-05)	
$WDENSITY_{i,t} \times AGE_{i,t}$			4.10e-02			1.50e-01 **
			(4.09e-02)			(6.88e-02)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

Table 5 reports the estimated coefficients of the cross-effects between the farmer's neighbours' economic performance, size and density on the one hand, and the farmer's own age (here considered as a continuous variable) on the other hand. Here again, the signs and the significance of the coefficients relative to the spatially lagged variables are stable across neighbours definition (see also Table A5 in the appendix). The coefficient of the cross-effect between neighbours' performance and farmer's age is positive and strongly significant in both specifications (1) and (4) where the only difference between both is the neighbours' definition. This implies that younger farmers benefit more from the positive performance spillover from neighbours than older farmers[4]. The cross-effect between neighbours' size and farmer's age is not significant in these specifications, but becomes significant in the specification where we only consider neighbours with the same specialization as the farmer (see Table A5 in appendix). Finally, the cross-effect between neighbours' density and farmer's age is significant only when distant neighbours are accounted for (specification 6). The positive sign indicates that the positive agglomeration effect from neighbours' density has a stronger effect on younger farmers. Overall, these estimations are consistent with the fact that younger farmers benefit more from the positive spillover of performance. Table A6 in appendix provides corresponding average marginal effects on the probability of exit.

Lastly, we allow the effect of neighbours' performance and size to differ depending on whether the farmer is below or above the average of the neighbourhood. In order to guarantee the continuity of the expected utility $\Delta EU_{i,t}$ around the average of the neighbours, we consider the following differences between the farmers' own value and their neighbours' averages:

[4] The estimates in columns (2) and (5) indicate that the influence of neighbours' performance on the probability of exit is negative for farmers under 50.0 and 55.8 years old respectively, which is the case for all farmers in our sample.

$$\Delta\overline{PERF_{i,t\ldots t-4}} = \overline{PERF_{i,t\ldots t-4}} - W\overline{PERF_{i,t\ldots t-4}}$$

and

$$\Delta SIZE_{i,t} = SIZE_{i,t} - WSIZE_{i,t}$$

In the specifications of Tables 4 and 5, the effect of this difference is given by the difference between the effect of the own variable and the effect of the spatially lagged variables. This effect is symmetric in all previous specifications above. Here we test for an asymmetric effect by including these variables censored to zero above zero:

$$\left(\Delta\overline{PERF_{i,t\ldots t-4}}\right)^{-} = \Delta\overline{PERF_{i,t\ldots t-4}} \times 1\left\{\Delta\overline{PERF_{i,t\ldots t-4}} < 0\right\}$$

and

$$\left(\Delta SIZE_{i,t}\right)^{-} = \Delta SIZE_{i,t} \times 1\left\{\Delta SIZE_{i,t} < 0\right\}$$

Table 6 reports various specifications testing for asymmetries in the effect of own and neighbours' profits and size. The asymmetric terms are strongly significant in all cases: the marginal effect of neighbours' profit and size, respectively, on the expected utility of exit is larger (negatively) when the farmer's own profit and size, respectively, are below the neighbours' average. Interestingly, when accounting for this asymmetric effect, the sign of the coefficient of the neighbours' size ($WSIZE_{i,t}$) is negative while it is positive otherwise. Including such asymmetric effect show that the neighbours' size has two effects. On the one hand, it generates a positive spillover for all farmers, just like the neighbours' profits and density. On the other hand, it generates a negative spillover only for the farmers whose area is under their neighbours' average. These findings are robust to the specification considering only the neighbours with the same production specialization of the farmer. Figures A1 and A2 in appendix provide a graphical illustration of the marginal effect of profit and area (of the farmer and of the farmer's neighbours, respectively) on the farmer's marginal expected utility of exit.

These findings suggest that ignoring asymmetric effects of economic variables relative to locally defined references – here the neighbours' averages – leads to biased estimate of the spillovers. This omitted variable bias may explain the discrepancy between our results and the literature's results in terms of estimates of the neighbours' spillover. For instance, Storm et al. (2015) find that the neighbours' area decreases the farmer's probability of exit, whereas Saint-Cyr et al. (2018) show a positive effect on average (the effect being allowed to vary across farmers).

Table 6: Asymmetric effect of profit and size on farmer's probability to exit early in *t+1* depending on the difference with the neighbours: estimated probit coefficients

Variable	Neighbours in farmers' own municipality			Neighbours in farmers' own and adjacent municipalities		
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{PERF_{i,t\ldots t-4}}$	-6.09e-03 ***	-7.27e-03 ***	-6.25e-03 ***	-2.80e-03 ***	-7.08e-03 ***	-3.21e-03 ***
	(2.89e-04)	(1.95e-04)	(2.89e-04)	(3.34e-04)	(1.95e-04)	(3.38e-04)
$W\overline{PERF_{i,t\ldots t-4}}$	-2.51e-04	-3.06e-04 **	-3.27e-04	-6.82e-03 ***	-3.14e-03 ***	-6.62e-03 ***
	(2.11e-04)	(1.31e-04)	(2.04e-04)	(5.69e-04)	(4.68e-04)	(5.69e-04)
$WSIZE_{i,t}$	**6.84e-04 *** **	**-2.98e-03 *** **	**-3.01e-03 *** **	**1.33e-03 *** **	**-2.82e-03 *** **	**-2.53e-03 *** **
	(1.42e-04)	(2.31e-04)	(2.31e-04)	(2.30e-04)	(2.88e-04)	(2.89e-04)
$WDENSITY_{i,t}$	-1.36e+00 ***	-8.90e-01 ***	-1.16e+00 ***	-2.71e+00 ***	-1.63e+00 ***	-1.97e+00 ***
	(3.20e-01)	(3.14e-01)	(3.18e-01)	(6.30e-01)	(6.27e-01)	(6.28e-01)
$\left(\Delta\overline{PERF_{i,t\ldots t-4}}\right)^{-}$	-2.22e-03 ***		-1.76e-03 ***	-7.11e-03 ***		-6.23e-03 ***
	(3.41e-04)		(3.43e-04)	(4.58e-04)		(4.62e-04)
$\left(\Delta SIZE_{i,t}\right)^{-}$		-5.15e-03 ***	-5.02e-03 ***		-6.07e-03 ***	-5.73e-03 ***
		(2.47e-04)	(2.48e-04)		(2.59e-04)	(2.61e-04)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

4. Conclusion

This paper provides a first empirical confirmation of the existence of the 'shadow of death' in French agriculture, when performance is measured by agricultural profit and exit is not linked to retirement but is 'early retirement'. In addition, the paper shows for the first time in the literature the role of a farmer's neighbours' performance on this farmer's own survival. Our application to France in 2004-2017 shows that neighbours provide positive spillovers to farmers in the sense that their density and their performance increase the survival probability of farmers, suggesting agglomeration effects, technological spillovers or information flows. By contrast, neighbours may also provide negative spillovers to farmers in the sense that neighbours' size decreases the survival probability of farmers, suggesting competition on the land market.

Our analysis is a promising avenue to investigate issues such as the coherence of agricultural policies which may have an impact on farm performance, farm size or both. On the one hand, subsidies which either intend to increase farm performance, such as some second pillar measures of the CAP, or may provide an incentive for farm area enlargement, such as first pillar coupled and decoupled CAP payments, are likely to raise farm survival. But, on the other hand, they may meanwhile foster competition among neighbours, all the more as other measures, such as 2013-2020 CAP top-up subsidies targeted towards farms under a given size, are clearly intended to favour smaller farms. Balancing both the objective of a strong vitality of the agricultural sector and that of family-sized farms then appears to be a narrow path.

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Appendix

Table A1: Coefficients of the control variables in specification H1 of Table 2

Control Variable	Coefficient	Control Variable	Coefficient
Dairy of beef cattle	-1.79e-02	Operated area	-3.84e-03 ***
	(2.15e-02)		(2.26e-04)
Field crops	-3.04e-02	Operated area-Dairy of beef cattle	1.14e-03 ***
	(2.06e-02)		(3.22e-04)
Fruits and vegetables	3.70e-01 ***	Operated area-Field crops	1.50e-03 ***
	(2.15e-02)		(2.62e-04)
Pigs and poultry	2.88e-01 ***	Operated area-Fruits and vegetables	-4.40e-03 ***
	(2.21e-02)		(6.63e-04)
Mixed farms	4.50e-02 **	Operated area-Pigs and poultry	-4.45e-03 ***
	(2.21e-02)		(4.93e-04)
Other livestock	5.10e-01 ***	Operated area-Mixed farms	3.58e-04
	(2.66e-02)		(2.97e-04)
Other permanent crops	3.13e-01 ***	Operated area-Other livestock	-4.82e-03 ***
	(2.61e-02)		(8.54e-04)
Sheep and goats	2.06e-01 ***	Operated area-Other permanent crops	-5.68e-03 ***
	(2.84e-02)		(8.39e-04)
Vineyards	1.04e-01 ***	Operated area-Sheep and goats	6.10e-04
	(2.13e-02)		(4.32e-04)
Age: Under 24	2.14e-02	Operated area-Vineyards	-1.96e-03 ***
	(3.67e-02)		(4.95e-04)
Age: 25-29	9.10e-02 **	Married	-1.01e-02
	(3.53e-02)		(6.36e-03)
Age: 30-34	1.54e-01 ***	Widowed	4.48e-01 ***
	(3.50e-02)		(2.75e-02)
Age: 35-39	1.65e-01 ***	Separated	3.25e-01 ***
	(3.49e-02)		(1.22e-02)
Age: 40-44	1.75e-01 ***	Individual farm	2.74e-01 ***
	(3.49e-02)		(7.09e-03)
Farming: main activity	4.03e-01 ***	Partnership farm	-2.59e-01 ***
	(8.53e-03)		(1.07e-02)
Farming: secondary activity	3.62e-01 ***	Other legal status	1.37e-01 ***
	(9.67e-03)		(8.57e-03)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

Table A2: Average marginal effects in specification H1 of Table 2

Variable	(1)	(2)	(3)	(4)
Operated area	-8.51e-05	-9.04e-05	-8.44e-05	-8.36e-05
Operated area-Dairy of beef cattle	2.53e-05	2.49e-05	2.56e-05	2.56e-05
Operated area-Field crops	3.32e-05	2.31e-05	3.33e-05	3.24e-05
Operated area-Fruits and vegetables	-9.75e-05	-9.84e-05	-9.72e-05	-9.91e-05
Operated area-Pigs and poultry	-9.88e-05	-9.80e-05	-9.86e-05	-9.89e-05
Operated area-Mixed farms	7.93e-06	6.21e-06	7.95e-06	7.73e-06
Operated area-Other livestock	-1.07e-04	-1.01e-04	-1.04e-04	-1.10e-04
Operated area-Other permanent crops	-1.26e-04	-1.11e-04	-1.17e-04	-1.16e-04
Operated area-Sheep and goats	1.35e-05	1.45e-05	1.35e-05	1.34e-05
Operated area-Vineyards	-4.35e-05	-4.40e-05	-4.32e-05	-4.44e-05
$PERF_{i,t}$	-5.89e-05			
$PERF_{i,t-1}$	-3.60e-05			
$PERF_{i,t-2}$	-3.06e-05			
$PERF_{i,t-3}$	-1.37e-05			
$PERF_{i,t-4}$	-1.96e-05			
$\overline{PERF_{i,t\ldots t-4}} \times SIZE_{i,t}$		6.12e-07		
$\overline{PERF_{i,t\ldots t-4}}$		-2.03e-04		
$\overline{PERF_{i,t\ldots t-4}}$ ×Under 24			-4.41e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×25-29			-4.16e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×30-34			-2.16e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×35-39			-2.06e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×40-44			-1.59e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×45-49			-1.40e-04	
$\overline{PERF_{i,t\ldots t-4}}$ ×Individual farm				-2.05e-04
$\overline{PERF_{i,t\ldots t-4}}$ ×Partnership farm				-1.84e-04
$\overline{PERF_{i,t\ldots t-4}}$ × Limited liability as a sole holder				-1.91e-04
$\overline{PERF_{i,t\ldots t-4}}$ ×Other legal status				-1.13e-04

Table A3: Estimates of Table 3 only considering neighbours with the same specialization

Variable	(1) Neighbours in own municipality		(2) Neighbours in own and adjacent municipalities	
$\overline{PERF_{i,t\ldots t-4}}$	-7.23e-03 ***	-7.22e-03 ***	-7.15e-03 ***	-7.15e-03 ***
	(2.18e-04)	(2.18e-04)	(2.03e-04)	(2.03e-04)
$W\overline{PERF_{i,t\ldots t-4}}$	-4.09e-05	-3.80e-04	-1.22e-03 ***	-1.05e-03 ***
	(2.71e-04)	(3.64e-04)	(2.67e-04)	(3.94e-04)
$WSIZE_{i,t}$	8.30e-04 ***	7.05e-04 ***	8.47e-04 ***	9.21e-04 ***
	(1.72e-04)	(1.96e-04)	(1.97e-04)	(2.30e-04)
$WDENSITY_{i,t}$	-1.21e+00 ***	-1.16e+00 ***	-3.68e+00 ***	-3.71e+00 ***
	(3.50e-01)	(3.52e-01)	(6.33e-01)	(6.35e-01)
$W\overline{PERF_{i,t\ldots t-4}} \times WSIZE_{i,t}$		6.41e-06		-3.73e-06
		(4.51e-06)		(6.06e-06)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

Table A4: Average marginal effects in the models with neighbours in Table 3

Variable	(1) Neighbours in own municipality		(2) Neighbours in own and adjacent municipalities	
$\overline{PERF_{i,t\ldots t-4}}$	-1.62e-04	-1.62e-04	-5.83e-05	-5.51e-05
$W\overline{PERF_{i,t\ldots t-4}}$	-6.37e-06	-4.32e-06	-1.60e-04	-1.60e-04
$WSIZE_{i,t}$	1.85e-05	1.91e-05	-6.21e-05	-2.48e-05
$WDENSITY_{i,t}$	-2.22e-02	-2.24e-02	-5.27e-02	-5.59e-02
$W\overline{PERF_{i,t\ldots t-4}} \times WSIZE_{i,t}$		-2.48e-08		-7.50e-07

Table A5: Estimates of Table 4 only considering neighbours with the same specialization

Variable	(1) Neighbours in own municipality			(2) Neighbours in own and adjacent municipalities		
$\overline{PERF_{i,t\ldots t-4}}$	-7.24e-03 ***	-7.23e-03 ***	-7.24e-03 ***	-7.18e-03 ***	-7.16e-03 ***	-7.16e-03 ***
	(2.18e-04)	(2.18e-04)	(2.18e-04)	(2.03e-04)	(2.03e-04)	(2.03e-04)
$W\overline{PERF_{i,t\ldots t-4}}$	-1.66e-03	-4.19e-05	-3.26e-05	-7.86e-03 ***	-1.23e-03 ***	-1.21e-03 ***
	(1.54e-03)	(2.71e-04)	(2.71e-04)	(1.61e-03)	(2.67e-04)	(2.67e-04)
$WSIZE_{i,t}$	8.30e-04 ***	-2.14e-04	8.28e-04 ***	8.57e-04 ***	-9.43e-04	8.41e-04 ***
	(1.72e-04)	(6.38e-04)	(1.72e-04)	(1.97e-04)	(6.56e-04)	(1.97e-04)
$WDENSITY_{i,t}$	-1.21e+00 ***	-1.20e+00 ***	-3.72e+00 **	-3.62e+00 ***	-3.65e+00 ***	-1.13e+01 ***
	(3.50e-01)	(3.50e-01)	(1.87e+00)	(6.33e-01)	(6.33e-01)	(3.29e+00)
$W\overline{PERF_{i,t\ldots t-4}} \times AGE_{i,t}$	3.95e-05			1.56e-04 ***		
	(3.71e-05)			(3.77e-05)		
$WSIZE_{i,t} \times AGE_{i,t}$		2.56e-05 *			4.38e-05 ***	
		(1.50e-05)			(1.53e-05)	
$WDENSITY_{i,t} \times AGE_{i,t}$			6.09e-02			1.83e-01 **
			(4.44e-02)			(7.76e-02)

Notes: standard errors in brackets. *, **, *** significance at the 10, 5, 1% level.

Table A6: Average marginal effects in the models with neighbours in Table 4

Variable	(1) Neighbours in own municipality			(2) Neighbours in own and adjacent municipalities		
$\overline{PERF_{i,t\ldots t-4}}$	-1.61e-04	-1.62e-04	-1.62e-04	-5.96e-05	-5.79e-05	-5.89e-05
$W\overline{PERF_{i,t\ldots t-4}}$	-1.93e-04	-6.34e-06	-6.35e-06	-1.61e-04	-1.60e-04	-1.61e-04
$WSIZE_{i,t}$	2.06e-05	5.03e-06	1.85e-05	-3.45e-04	-6.21e-05	-6.18e-05
$WDENSITY_{i,t}$	-1.74e-02	-2.22e-02	-5.94e-02	-5.08e-02	-5.24e-02	-1.91e-01
$W\overline{PERF_{i,t\ldots t-4}} \times AGE_{i,t}$	3.98e-06			6.67e-06		
$WSIZE_{i,t} \times AGE_{i,t}$		3.31e-07			4.82e-07	
$WDENSITY_{i,t} \times AGE_{i,t}$			9.02e-04			3.33e-03

Figure A1: Asymmetric marginal effect on farmer's expected utility of exit – the case of farmer's neighbours in own municipality

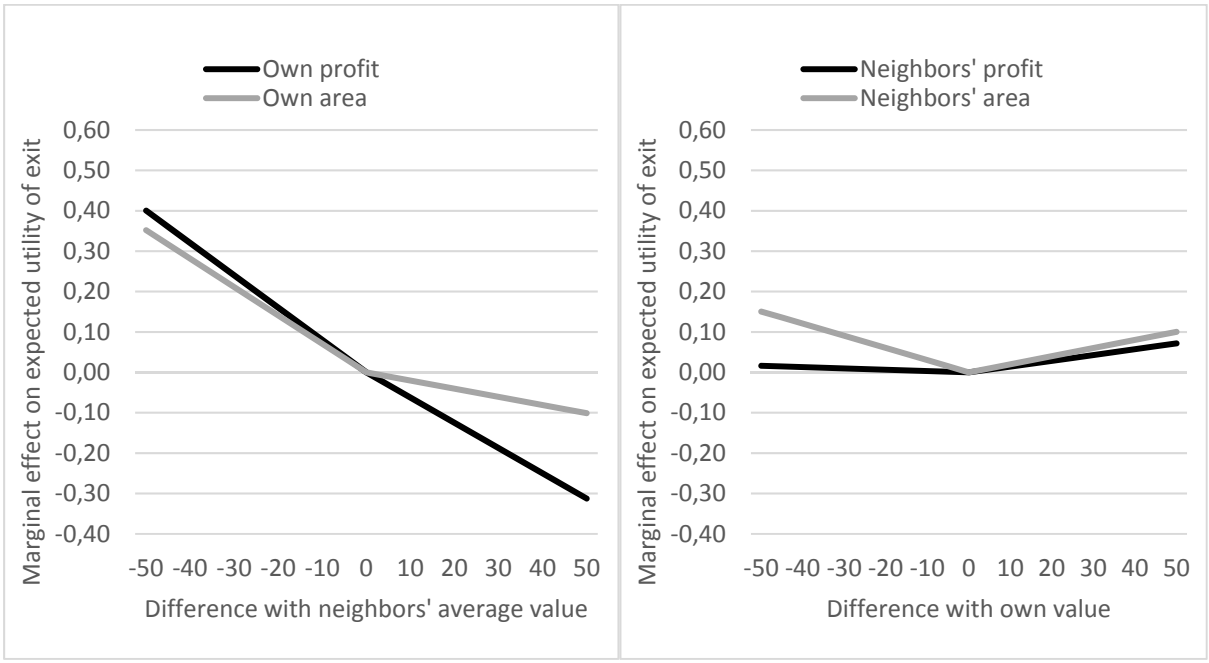


Figure A2: Asymmetric marginal effect on farmer's expected utility of exit – the case of farmer's neighbours in own and adjacent municipalities

