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European Review of Agricultural Economics Vol **48 (5)** (2021) pp. 1132–1161
doi:https://doi.org/10.1093/erae/jbab008
Advance Access Publication 26 February 2021

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

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Received March 2020; final version accepted January 2021

Abstract

This article investigates the effects of economic performance and neighbours' characteristics on farmers' exit behaviour before retirement age. Using a unique set of social security data describing all French farmers under 50 over the years 2004–2017, we explore how these effects depend on farmers' characteristics and how they stand relative to their neighbours. Our probit estimations reveal that younger farmers and farmers operating smaller farms are more sensitive to their own and neighbours' performance than other farmers. Allowing for an asymmetric comparison effect between farmers and their neighbours, we uncover a nonlinear influence of own and neighbours' profit and size.

Keywords: exit, farms, performance, neighbours, heterogeneity

JEL classification: D22, L25, Q12

1. Introduction

The sustained downward trend in the number of farmers in industrial countries raises concerns about the future of farming in these countries, and demands improved understanding of the reasons why farmers quit. In the European Union, these concerns were translated into common agricultural policy (CAP) objectives such as maintaining a vital agricultural sector, protecting rural communities, fostering employment and addressing rural depopulation (European Commission, 2010). With CAP expenditures representing approximately 40 per cent of its total budget, the European Union devotes considerable financial efforts to pursuing these goals. Hence, a better understanding of farmers' exit behaviour could go a long way in optimally managing public funds.

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Classical microeconomic theory represents a business' exit decision process with a comparison between the expected utility of current business activity and that of switching to other activities. A business exits if and only if the difference between the second and the first, which we refer to as the expected utility of exit, is positive. In this broad framework, many factors may contribute to determine this expected utility of exit for farmers. First, monetary returns typically play a key role in the decision to exit. They also represent the main policy lever to maintain rural employment. Second, the decision to exit usually implies selling land to neighbouring farmers, and is therefore partly determined by neighbours' wealth and willingness to pay for land (Storm *et al.*, 2015). Third, neighbours represent a social reference point, so that individuals who cannot 'keep up with the Joneses' may experience lower life satisfaction (Luttmer, 2005) and, in turn, be more tempted to exit the business. In particular, farmers may compare their profits to the overall performance in the neighbourhood, and lower relative profits may generate incentives to exit. A farmer's expected utility of exit combines all these determinants, in a way that may vary widely across farmers (Saint-Cyr *et al.*, 2019). Understanding this heterogeneity in farmers' behaviours, especially in their response to financial incentives, is essential to design optimal agricultural policies. However, the importance and the reasons for these behavioural differences remain virtually unexplored in the empirical literature.

In this article, we analyse the exit behaviour of self-employed farmers before retirement age, which we refer to as early exits for simplicity. These early exits are not merely caused by age but rather by switching to another professional occupation,[1] and therefore are more likely to be caused by financial trade-offs and comparison effects with neighbours. Besides, in the objective of saving jobs in rural areas, policy makers have more leverage on exits prior to retirement age, which makes it one policy-relevant variable of interest. Our analysis provides empirical evidence that farmers' heterogeneous responses to financial incentives and to neighbours' characteristics can be explained by observable characteristics such as age, size and relative performance compared to their neighbours. Consistent with the empirical literature on life satisfaction (Ferrer-i Carbonell, 2005; Vendrik and Woltjer, 2007; Senik, 2009), we find an asymmetric effect of relative profit and size. Farmers below the neighbourhood average are more sensitive to their relative profit and size than farmers above the average. Accounting for the heterogeneity of farmers' response to financial incentives and neighbourhood effects could improve the evaluation of the distributional effects of agricultural profit-supporting policies.

To do so, we exploit a unique data set at the farmer-level produced by the French authority for farmer health care and social security ('Mutalité Sociale Agricole' or MSA). Contrary to most past studies resorting to farm-level census data available only for certain years (Weiss, 1999; Kimhi, 2000; Goetz and Debertin, 2001; Foltz, 2004; Key and Roberts, 2006; Storm *et al.*, 2015)

1 After an early exit, a farm manager may stay in the farm sector as an employee or move to another sector.

or survey data on a sample of farmers (Dong *et al.*, 2010; Dong *et al.*, 2016), 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 health care and social security system between 2004 and 2017. In the data, both the farmer and the farm they operate are identified by a unique code, respectively. We consider a restrictive definition of exits, where both identification code of the farmer and the one of the farm they operate exit the data base the same year, and do not reappear in subsequent years. Since we focus on early exits , we remove farmers close to retirement age from the data.[2] For each exit, we identify the year in which they occur and the characteristics of the farm and farmer prior to exit. The richness of the data allows us to investigate various kinds of heterogeneity in the effects of the characteristics of farmers and their neighbours on the expected utility of exit. In each year, we observe the accounting profit of all farmers over the past five years, which we use as a proxy for the profitability of farming.

We first estimate the influence of agricultural profits on the probability of early exit using a probit model. We find a significant heterogeneity in the negative effect, which is stronger for younger farmers with smaller farms than for other farmers. This result contributes to fill the gap in the literature on the influence of economic performance on farmers exit from business,[3] where empirical studies typically assume a homogeneous effect (Dimara *et al.*, 2008; Dong *et al.*, 2016; Peel *et al.*, 2016; Storm *et al.*, 2015). Using a subset of the data we use, Saint-Cyr *et al.* (2019) also estimate heterogeneous effects of agricultural profit on exit, but consider this heterogeneity as unobserved.

Second, we estimate the influence of the density of farmers in the neighbourhood and of the neighbours' characteristics, including their average profit and size, on a farmer's early exit decision. Interacting the neighbours' average profits with farmers' characteristics, we find that neighbours' profits may generate positive or negative spillovers depending on farmers' characteristics. Using several definitions of the neighbourhood, we consistently show that neighbours' average profits have a stronger influence on the exit decision of younger farmers. We also find evidence that smaller farmers are significantly more sensitive to neighbours' average profits when deciding whether to remain in or exit early from the business. These results are in line with several articles showing that neighbours' have a stronger influence on 'vulnerable' populations than on other populations in various fields of economics, including labour (Weinberg *et al.*, 2004; Falk and Ichino, 2006), psychology (Santiago *et al.*, 2011), industrial organisation (Neffke *et al.*, 2012) and education (Carrell *et al.*, 2013), which gives credence to our finding.

2 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, those close to retirement, while we consider only those who are not of retirement age.

3 The literature is however dense on other factors driving structural change in the farming sector, 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). Quite surprisingly, the influence of economic performance has received less attention.

Lastly, we uncover a nonlinearity in the effect of neighbours' profits and size, depending on whether the farmer is below or above the neighbours' average. To do so, we consider an asymmetric influence of the respective differences between own and neighbours' profit and size, which we hereafter refer to as the relative profit and size. We estimate whether these relative profits and size have more influence on farmers' probability of exit after controlling for farmers' performance and neighbourhood characteristics capturing the level of competition for land. We find that farmers below the neighbourhood average are more sensitive to relative profit and size than farmers above the average. This nonlinearity explains most of the heterogeneity in the effects of own and neighbours' profit on exit. Farmers below the average suffer more severe adverse competition effects from their neighbours, while farmers above the average tend to benefit from having more competitive neighbours. These last findings relate to the literature on the effect of relative income on subjective well-being; see, for instance, Luttmer (2005) and Clark *et al.* (2008) for a review. In our framework, the effects of relative profit and size on the expected utility of exit are nonlinear and larger among farmers who are below the average of their neighbours. This is in line with a repeatedly established result in the life satisfaction literature. Among other papers, Ferrer-i Carbonell (2005), Vendrik and Woltjer (2007) and Senik (2009) provide strong evidence that the marginal effect of relative income on life satisfaction is larger among individuals below their reference point. These results and ours are consistent with the nonlinear value function implying loss aversion in prospect theory, as described by Tversky and Kahneman (1991). In the words of the authors (*ibid*, p.1045):

> Loss aversion implies that the same difference between two options will be given greater weight if it is viewed as a difference between two disadvantages (relative to a reference state) than if it is viewed as a difference between two advantages.

The remainder of the article is structured as follows. Section 2 presents some background. Section 3 presents the data set and how we construct the variables controlling for neighbours' characteristics. Section 4 explains our empirical strategy and how we progressively introduce more heterogeneity in the estimated effects. Section 5 presents the results of our estimations. We first comment on the heterogeneity in the effect of own performance and that in neighbours' influence, then we describe the asymmetric effect of relative profit and size, and finally, we show the distribution of the total effect of a shock on all profits. Section 6 concludes the article.

2. Theoretical background

Our study focuses on self-employed farmers in France who are not of retirement age. Although the legal retirement age is 62 in France in the period considered here (2004–2017), some farmers can retire earlier depending on the number of children they have raised, or for health reasons. We consider a low cutoff age at 50 years old, under which we are confident no farmers can retire. For the farmers under 50 in our panel, the decision to exit early involves considering alternative professional occupations and their respective economic returns. The remainder of this section describes how the determinants of early exits operate, gives rationales for heterogeneous effects and provides a broad review of the related empirical literature.

2.1. Financial returns

Classically, the market returns from farming are a key determinant of survival, although relatively few articles study this channel empirically. In contrast, much of the literature on farm exits has focused on the influence of size and age in the probability of exit. Following Weiss (1999), several papers have shown that smaller farms and younger farmers are more likely to fail, contributing to explain farm structural change (e.g. Sumner (2014)). One key underlying mechanism is that entrants progressively learn about their performance, quit if they discover they are not efficient enough or grow if they can outperform their competitors (Jovanovic, 1982). New farmers, who are more likely to be young and to operate small farms, might thus pay more attention to their financial returns as they evaluate their chances to last long in the business.[4] This suggests that financial returns have a heterogeneous effect across age and size, although empirical studies typically consider a homogeneous effect (Dimara *et al.*, 2008; Dong *et al.*, 2016; Peel *et al.*, 2016). A notable exception is Key and Roberts (2006), where the effect of government payments (which contribute to the financial returns) on farms' survival is allowed to vary across size.[5] In our data, we observe the farmers' accounting profits, which include both the subsidies they receive and their market returns from farming.

2.2. Opportunity cost of farming

Beyond the strictly financial returns to farming, other nonmonetary factors may affect the expected utility of exit. The difference in expected utility between farming and nonfarm work is often referred to as the opportunity cost of farming. Although generally not available in observational data, the opportunity cost of farming is partly reflected by the extent of off-farm work. This variable is therefore often included in models explaining farm exit, although the direction of the effect is ambiguous: working another job off-farm may either represent a first step towards full exit, or a way to support and consolidate the on-farm business (Weiss, 1999; Kimhi, 2000; Goetz and Debertin, 2001;

4 As suggested by an anonymous reviewer, younger farmers may also expect growing returns with experience so that they may be less likely to exit than older farmers given lower profits. The sunk cost fallacy might also lead older farmers to maintain an unprofitable business (Rosenbaum and Lamort, 1992).

5 In contrast with the learning mechanism, they find that the effect is increasing with size. This may stem from the fact that they do not include an interaction between payments and age, and include farmers of retirement age who might be both operating a smaller farm and less affected by payments in their decision to exit. Overall, the empirical literature on the effect of payments on farm exit is mixed (Ahearn *et al.*, 2005; Kazukauskas *et al.*, 2013). See Anderson *et al.* (2013) and Sumner *et al.* (2010) for reviews of the evolution of the agricultural policies and their economic analysis.

Breustedt and Glauben, 2007). Structurally, the opportunity cost of farming varies across farmers depending on their nonpecuniary benefits from farming (Key and Roberts, 2009), and their ability to obtain nonfarm jobs which is partly linked to their level of education (Weiss, 1999; Key and Roberts, 2009). Because the self-employed farmers exiting early in our database may remain in the farming sector as employees, we refer to the term expected utility of exit thereafter.

2.3. Associates and succession

For farmers close to retirement age, the timing of exit sometimes hinges on whether or not there is a candidate for succession (Pietola *et al.*, 2003). But even earlier, forward-looking farmers may undertake new investments to keep a fragile business afloat if they can entertain the prospect of passing their farm on to a known successor, but they may prefer to sell otherwise. Therefore, married farmers may be less likely to exit than single ones, as found by Weiss (1999). Similarly, sharing the management of a farm with one or more new associates, who are anticipated to be future successors, may delay exit to organise succession, and thus reduce the probability of exit. Beside securing succession, associates provide support during episodes of financial difficulties, and thus help farmers' ability to survive bad years. Working with partners may thus work as a security net against failure (Bonin *et al.*, 1993), and hence reduce the influence of own performance on exit. By contrast, having associates may complicate coordination, generate inter-personal conflicts and therefore increase the probability of exit (Zhengfei and Lansink, 2006; Minviel and De Witte, 2017). The direction of the overall effect is thus an empirical question and may depend on the context.

2.4. Competition and agglomeration

Apart from their own characteristics, the many channels through which farmers are locally interdependent may affect their exit decision. Because farmers compete for a fixed amount of land, neighbours are natural buyers for those willing to sell. The probability of exit is thus related to the difference in willingness to pay for land between a farmer and their neighbours (Storm *et al.*, 2015). In particular, neighbours with larger and more productive farms may have a higher reservation price *ceteris paribus*, and hence a larger influence. On the other hand, neighbours generate positive agglomerations economies, such as better access to suppliers and workforce, and faster technological transfer (Krugman, 1991). These positive spillovers may be positively related to the density of farmers, but also to their overall size and performance. The emerging empirical literature studying these effects in agriculture suggests both important knowledge spillovers (Alston *et al.*, 2011) and competition effects (Storm *et al.*, 2015). One empirical conundrum is that neighbours' observable characteristics (e.g. size, performance and density) may capture both the adverse effects of the competition for land and the positive agglomeration externalities. This challenges the identification of specific channels through observable characteristics of the neighbours, and suggests that the sign of net effect of each neighbours' characteristic may depend on the context.

2.5. Heterogeneous neighbourhood effects

Although generally considered homogeneous, these neighbourhood effects may have heterogeneous impacts across farmers for several reasons. In the first empirical analysis of this heterogeneity, Saint-Cyr *et al.* (2019) argue that more business-oriented and competitive farmers are more sensitive to the performance of their neighbours than farmers enjoying nonpecuniary benefits from farming. Although their intrinsic motivations are usually unobserved, farmers' observable characteristics may also partly explain their sensitivity to their neighbours' performance. For example, Neffke *et al.* (2012) show that younger firms are more likely to adopt new technologies, so that they benefit more from positive agglomeration externalities. In related fields, several empirical studies find evidence that social interactions with neighbours have a stronger influence on more 'vulnerable' populations, whether the latter are workers with fewer years of formal education (Weinberg *et al.*, 2004), younger individuals living in disadvantaged neighbourhoods (Santiago *et al.*, 2011), or students with lower school test scores (Carrell *et al.*, 2013). In our context, this 'vulnerable' subpopulation may be the younger farmers operating smaller areas with no associates.

2.6. Keeping up with the Joneses

Finally, as exhibited in the happiness literature, neighbours may represent a benchmark for comparison of standard of living or broad economic performance. Luttmer (2005) provides early empirical evidence of this comparison effect, and Clark *et al.* (2008) review the related literature. In our context, comparison with neighbours may influence farmers professional well-being, so that their relative performance to their neighbours may affect their decision to exit the business or not.[6] A stream of the empirical literature on life satisfaction also shows that relative income has a nonlinear effect on well-being, and matters more to individuals who stand below their social reference point (Ferrer-i Carbonell, 2005; Vendrik and Woltjer, 2007; Senik, 2009). This asymmetry is interpreted as the result of an aversion for economic disadvantage, which could be the static counterpart of the concept of loss aversion in prospect theory.[7] Interestingly, this interpretation was already stated in Tversky and Kahneman (1991), as quoted in the introduction. It suggests that the farmers might be all the more sensitive to their relative performance when they are outperformed by their neighbours, and cannot 'keep up with the Joneses'.

6 Seither (2018) provides recent experimental evidence of the effect of the comparison with competitors on performance.

7 See Liu (2013), Bocquého *et al.* (2014), Liebenehm and Waibel (2014) and Bougherara *et al.* (2017) for empirical evidence of loss aversion among farmers.

3. Presentation of the MSA data

The French authority for farmer health care and social security (MSA) provided access to its database that includes all individuals registered as self-employed farmers in France on 1 January of each year over the period 2004-2017. For each farmer registered in the database, the available data consist of various characteristics of him/herself and of the farm that he/she operates, including the accounting profit and the operated area. To exclude from the data exits due to legal retirement and to focus on farmers exiting for other reasons, we only work on the sub-sample of farmers under 50. Early exits of farmers under 50 account for 19.6 per cent of all exits over our period. Furthermore, we exclude farmers paying a flat-rate social security tax (27.6 per cent of farmers in the full database), as this implies that their agricultural profit, which we use as the indicator of economic performance, is not reported in the database.[8] Figure A1 (Appendix in supplementary data at *ERAE* online) reports the spatial distribution of the farmers paying a real rate, the ones we study in this paper. The Table A1 (Appendix in supplementary data at *ERAE* online) compares the summary statistics over the whole population of farmers and those on the subpopulation we consider in the paper (i.e. under 50 and paying a real-rate social security tax), showing the representativeness of our data. Our data set focusing on this subpopulation is large, including 2,272,158 observations over 14 years (37 per cent of the total), related to 308,854 farmers and 261,587 farms.

3.1. Definitions of exit and profit

3.1.1. Exit

The data lists every self-employed farmers in activity each year, and all these individuals are identified by a unique code. If a code listed in year t is absent in year $t+1$, the corresponding individual has stopped working as a self-employed farmer during year t. Either he/she has become an employee or has quit the sector. Furthermore, each farmer is associated with a code relative to the farm he/she operates. If a given farm code disappears in a given year, it implies that this farm stopped being operated as such. It may have been dismantled and integrated in pieces into other farms or taken over by another farmer with a new identification code.[9] We consider a restrictive definition of exit requiring not only the farmer's code to be absent of the data in subsequent years, but also the corresponding farm code. This implies that (i) the farmer either has quit the farming sector or now works as an employee, and (ii) the structure of the farm he/she used to operate has changed.[10] Our definition of exit thus encompasses all situations where a farmer stops operating a given

8 For the farmers that we retain in the database, the social security tax amount is based on the annual profit and is thus reported in the data.

9 These cases are, however, not investigated here because we focus on farmers' exits and not on farm exits per se.

10 This restrictive definition makes it less likely to observe an exit among farmers working with associates, since the latter may take over the farm without any structural change. This does not

farm, does not take over any other farm, and triggers a structural change for the farm, be it a dismantlement or a merger with another farm.

3.1.2. Profit

All farmers compute and report their profits each year according to the French accounting definition of agricultural profit. It is defined as the difference between the total output and the total input of 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. Total input consists of variable costs (including paid salaries and the corresponding social contributions), overhead, taxes and capital depreciation costs. In the MSA database, each farmer is attributed an agricultural profit: if the farmer operates a farm with associates, his/her agricultural profit is adjusted by his/her capital shares in the farm. For each year t and each farmer i, we observe the agricultural profit in each consecutive five years in the past, t to $t-4$. We define $\overline{PROFIT}_{i,t}$ as the average of the agricultural profit over these five years. Partly because the accounting profit includes depreciation expenses, we expect it to be typically lower than what the farmers actually earn.[11] However, it does quantify the profitability of the farming occupation for each individual. The variable $\overline{PROFIT}$ thus represents a meaningful proxy of farmers' recent performance.

3.2. Farmers' characteristics

Based on the existing literature on farm exit explained in Section 2 and on data availability in the MSA database, the explanatory variables for the probability of exit include the farmer's age (*AGE*), the farmer's operated area (*SIZE*), the farmer's agricultural profits ($\overline{PROFIT}$), the production specialisation of the farmer (*SPE*), the farmer's marital status (*MARITAL*), the importance of farming relative to off-farm work (*IMPFARMING*) and the number of self-employed associates operating on the farm (*ASSOCIATES*). We consider categorical variables for age (*AGECAT*) and the number of associates (*ASSOCIATESCAT*) to allow for a nonlinear effect of those variables on the probability of exit. We do not observe farmers' education levels because the MSA does not collect this information. Table 1 provides the summary statistics of these variables.

Between 2004 and 2017, 0.9 per cent of the farmers in our data set exit early, that is, before retirement age. Given our large sample size, we observe 20,381 early exits in the data, a number large enough to safely neglect the small sample bias in discrete choice models applied to rare events[12]. The annual agricultural profit for each farmer is 14.5 k€ on average, but note that average profits are negative for 8.9 per cent of the observations. As for profits, if the farmer has

affect our findings. First, all our results hold when estimations are conducted on the subpopulation of the farmers with no associates. Second, we also obtain the same results with a broader definition of exit only requiring the farmer's code to be absent of the subsequent years.

11 Tax optimisation strategies might also contribute to make accounting profits lower than farmers' earnings.

12 See King and Zeng (2001) for an analysis of this bias in the case of the logit model.

Table 1. Summary statistics for the subpopulation of farmers below 50 over the whole period

Quantitative variables (for each farmer)

Variable (unit)	Mean	Median	Min.	Max.	Q10	Q90	S.d.
$\overline{PROFIT}$ (k€)	14.5	11.1	−433.8	1,123.0	0.0	31.5	18.6
SIZE (ha)	65.2	54.4	0.0	1,549.4	10.9	128.6	52.0
AGE (years)	40.4	42.0	18.0	49.0	31.0	48.0	6.4
ASSOCIATES	0.7	0.0	0.0	48.0	0.0	2.0	0.9

Categorical variables (share of farmers)

Farmer's exit		Farmer's age	
EXIT		*AGECAT*	
Yes	0.9%	18–24	1.0%
No	99.1%	25–29	6.2%
Number of associates		30–34	12.5%
ASSOCIATESCAT		35–39	19.6%
0	50.3%	40–44	27.8%
1	35.2%	45–49	32.8%
2+	14.5 %	Farmer's specialisation	
Marital status		*SPE*	
MARITAL		Beef cattle	15.6%
Single	41.7%	Dairy cattle	25.5%
Married	54.7%	Field crops	19.2%
Separated	3.1%	Fruits and vegetables	3.1%
Widowed	0.4%	Mixed crops and mixed livestocks	15.2%
Importance of farming		Pigs and poultry	5.6%
IMPFARMING		Sheep and goats	3.0%
Exclusive activity	89.1%	Vineyards	9.6%
Main activity	6.3%	Other livestocks	1.0%
Secondary activity	4.6%	Other permanent crops	2.1%

associates, the operated area recorded in the data is the fraction of the total farm area corresponding to the farmer's capital shares. Almost one-third of the farmers are aged 45–49, and 7.2 per cent are under 30. Approximately half of the farmers (50.3 per cent) work with no associate.

We build the *IMPFARMING* variable from the farmers' social security schemes, which reflects the importance of off-farm labour. The vast majority of individuals are enrolled in the social security scheme of self-employed farm managers, and farming is their exclusive professional activity (89.1 per cent). The farmers in the 'Main activity' category have another activity, but farming is their main activity, in the sense that it generates more than half of their income. The last category 'Secondary activity' pools together all the other social security schemes, including farmers enrolled in non-agricultural social security services. Finally, we consider 10 categories for farmers' specialisations. The most frequent categories are 'Dairy cattle' (25.5 per cent) and 'Field crops' (19.2 per cent). The less frequent productions are pooled in broader categories such as 'Other livestocks' (1.0 per cent).

3.3. Neighbours' characteristics

The municipality where the farmer's farm is located enables the identification of the farmers' neighbours. For each farmer, we compute several neighbour variables, namely, the average agricultural profit of the farmer's neighbours over the past five years ($\overline{NPROFIT}$), the average annual operated area (*NSIZE*) of the farmer's neighbours and the annual density of the farmer's neighbours (*NDENSITY*). The latter is defined as the ratio of the number of neighbours (*NNUMBER*) to the total area in the neighbourhood, including non-agricultural areas.

We use two definitions of neighbourhood. In the first definition, we only consider farmers located in the same municipality as the farmer under consideration. In the second definition, following Latruffe and Piet (2014), we also consider farmers located in municipalities adjacent to the farmer's municipality. In both definitions, we exclude the farmer and his/her associates from the set of neighbours, and all neighbours are assigned an equal weight. For each specification presented in Section 5, we test whether our estimates are robust to the use of either of these two definitions of neighbours.

Table 2 displays descriptive statistics on the neighbours. The means and medians are similar when considering only neighbours in farmers' own municipalities and when including adjacent municipalities. For further robustness checks, we also consider a stricter definition of neighbours whereby only farmers with the same specialisation are included in the neighbourhood. The corresponding summary statistics are provided in Table A2 (Appendix in supplementary data at *ERAE* online).

4. Empirical strategy

We begin with a general formulation of the model we use to explain exits. We then state the behavioural questions we investigate using this framework.

Table 2. Summary statistics of the variables controlling for neighbours' characteristics

Variable (unit)	Mean	Median	Min.	Max.	Q10	Q90	S.d.
			Neigbours' in farmers' own municipality				
$\overline{NPROFIT}$ (k€)	14.4	12.1	−8,022.4	606.8	5.4	26.1	13.2
NSIZE (ha)	57.6	51.1	0.0	994.9	24.2	98.9	32.1
NNUMBER	36.3	20.0	0.0	706.0	5.0	78.0	56.4
NAREA (ha)	3,011.3	1,929.4	54.2	75,740.9	669.3	5,844.1	3,971.2
NDENSITY (ha^{-1})	0.013	0.010	0.000	0.201	0.004	0.022	0.012
			Neigbours' in farmers' own and adjacent municipalities				
$\overline{NPROFIT}$ (k€)	14.4	12.3	−566.0	238.7	7.1	24.2	8.7
NSIZE (ha)	57.4	52.0	0.1	256.2	27.6	95.4	26.7
NNUMBER	217.3	146.0	0.0	3,064.0	46.0	446.0	254.5
NAREA (ha)	18,815.3	14,608.2	138.9	192,119.1	6,052.5	34,205.4	16,635.1
NDENSITY (ha^{-1})	0.011	0.010	0.000	0.091	0.005	0.019	0.007

Note: $\overline{NPROFIT}$ and *NSIZE* are computed over all farmers in the neighbourhood, including farmers over 50 years old, and *NSIZE* also accounts for all farmers paying a flat-rate social security tax located in the neighbourhood. This explains why the minimum of $\overline{NPROFIT}$ over neighbours in farmers' own municipality is smaller than the minimum of farmers' own profit shown in Table 1.

4.1. General model

In each period, farmers face two alternatives for the next period, remain in business (i.e. survival) or close the business (i.e. exit). The binary decision depends on the difference in expected utility between the two alternatives, but we only observe the farmers' resulting decision, while the difference in utilities is a latent variable that is not observed. We consider the following general Probit model for the probability of exit:

$$\text{Prob}(EXIT_{i,t+1}) = \Phi(\beta_0 + \beta_1 X_{i,t} + \beta_2 NZ_{i,t} + \alpha_t + \alpha_{d_i}) \tag{1}$$

where i denotes farmers; t denotes time periods; $EXIT_{i,t+1}$ is a binary variable indicating that the farmer exits the sector in period $t+1$ when the variable is equal to 1 and remains in the sector when the variable is equal to 0; Φ is the standard normal cumulative distribution; $X_{i,t}$ and $NZ_{i,t}$ are vectors of explanatory variables relative to farmer i and her/his neighbours, respectively; α_t and α_{d_i} are dummies depending respectively on year t and the region d_i where farmer i operates;[13] and β_0, β_1 and β_2 are vectors of parameters to be estimated. The α_{d_i} dummies control for local time-invariant determinants within each of the regions, including soil quality and systematic spatial differences in urban pressure. The α_t dummies control for determinants that are uniform spatially but vary across time such as macroeconomic shocks affecting wage levels in the nonfarm sector. The argument of function Φ is the expected utility of exit $\mathbb{E}U_{i,t}$ of farmer i at time t, so that β_1 and β_2 respectively represent the marginal effects of $X_{i,t}$ and $NZ_{i,t}$ on $\mathbb{E}U_{i,t}$. Using the spatial econometrics terminology, our general framework belongs to the class of spatially lagged explanatory variables models (usually noted SLX).[14]

In Section 5, we consider various specifications for the vectors X and NZ and run a simulation of a shock to all profits to assess the economic significance of our estimates.[15] In all these specifications, the vector X contains the control variables *ASSOCIATESCAT*, *AGECAT*, *MARITAL*, *IMPFARMING*, *SPE*, an interaction term $SPE \times SIZE$ allowing the influence of area to differ across specialisations, our main variable of interest $\overline{PROFIT}$, and cross-effects between $\overline{PROFIT}$ and *AGE*, *SIZE* and/or *ASSOCIATES* depending on the specification. In our data, the cross-sectional dimension is large compared to the time dimension (more than 300,000 farmers for only 14 years), so we cannot include individual fixed effects.[16] Therefore, we do not control for unobserved

13 These regions are the 95 French administrative counties ('départements').

14 Hence, our empirical strategy is free from the identification problems associated with the use of a lagged dependent variable, such as the reflection problem.

15 Storm *et al.* (2015) run similar regressions and find 'almost identical regression results' for a model accounting for potential spatial autocorrelation in the error term and models which do not. We follow their conclusion that ignoring the spatial autocorrelation in the errors does not lead to a substantial bias and focus our analysis on the economic implications of the size of our estimates.

16 The incidental parameter problem causes the maximum likelihood estimator to be inconsistent in short panels (Greene, 2004). This is because the asymptotic convergence then rests on the time dimension, which is small in our case.

individual characteristics (e.g. management style). Rather, we mitigate the unobserved heterogeneity by controlling factors that broadly capture some individual characteristics: marital status, number of associates and the extent of off-farm labour.

The vector *NZ* contains the variables $N\overline{PROFIT}$, *NSIZE* and *NDENSITY* relative to the neighbours and interaction terms depending on the specification. Although the region-specific dummy variables capture some local time-invariant determinants, we acknowledge that intra-region heterogeneity in natural factors (e.g.: climate or soil quality) may correlate with some of our right-hand side variables. In particular, these factors may influence the local profitability differently across production specialisations, and hence neighbours' average profits. To alleviate this concern, we estimate the model using various definitions of the neighbourhood, including all farmers or only farmers with the same specialisation, with and without farmers in adjacent municipalities. In Section 5, we check that our results hold using all four definitions.

4.2. Model specifications

4.2.1. Heterogeneous influence of own performance

Our first objective is to explain farmers heterogeneous response to their own profit. As explained in Section 2, we expect the marginal effect of farmers' own profit on the probability of exit to depend on their characteristics. We focus on the variables that are key in the study of structural change, and that are measured accurately on an objective scale for replicability. Age is measured in years, size in hectares. These variables are carefully reported in the MSA database because they are key to the computation of farmers' insurance rates.[17] We also precisely identify the number of associates, which may also partly explain the heterogeneity in the marginal effect of own profits. In a first series of specifications, we estimate models with no neighbourhood effect (i.e. where $\beta_2 = 0$) in which we interact $\overline{PROFIT}$ with *AGE*, *SIZE* and *ASSOCIATES*. The results of these estimations are reported in Section 5.1.

4.2.2. Heterogeneous neighbourhood effect

Our second objective is to investigate the heterogeneity of neighbours' influence on a farmer's exit decision. We build on the study of Saint-Cyr *et al.* (2019) who make the case for farmers' heterogeneous response to neighbourhood effects and argue that farmers' unobserved motivation is a key factor driving this heterogeneity. We contend that at least part of this heterogeneity may be captured by observable farmers' characteristics. For the reasons mentioned above, we focus on age, size and the number of associates. In a second series of specifications, we test whether farmers are more influenced by their neighbours by adding neighbourhood variables, including

17 We could have considered off-farm labour, but we only observe three broad categories based on farmers' social security schemes in France. We do not observe the share of off-farm working hours, nor off-farm revenue.

$N\overline{PROFIT}$, *NSIZE*, as well as interaction terms between $\overline{PROFIT}$ and *AGE*, *SIZE* and *ASSOCIATES*. In all estimations we also control for neighbours' density. We concede that unobserved residual differences in farmers' personality (e.g. management style) may correlate with farm size, and partly determine the heterogeneity in farmers' neighbourhood effects. For instance, more competitive farmers may operate larger farms and be less influenced by the performance of their neighbours.[18] In that case, the interaction coefficient between $N\overline{PROFIT}$ and *SIZE* would partly reflect unobserved personality differences. However, the total effect is still relevant for farm size structural change, and in particular, for the analysis of the distributional effects of policies supporting agricultural profits. As we argue using a simulation in Section 5.5, our estimates contribute to identifying which subpopulations in terms of age and size (regardless of their personalities) are the most impacted by a change in overall agricultural profits, so as to assess the effect of policy changes on the structure of farmers' population. The estimations corresponding to these specifications are presented in Section 5.2.

4.2.3. Asymmetric comparison effect

Third, we test for the existence of an asymmetric comparison effect between farmers' own characteristics and those of their neighbours. Following a stream of the empirical literature on life satisfaction showing that relative income matters more to individuals who stand below their social reference point (Ferrer-i Carbonell, 2005; Vendrik and Woltjer, 2007; Senik, 2009), we test whether relative profit and size have more influence on the exit decision of individuals below their neighbours' average profits and size. To do so, we allow for own and neighbours' profit and size to have a different influence depending on whether the farmer is above or below the average of the neighbourhood. We therefore consider a term representing the difference between a farmer's characteristic $Y \in \{\overline{PROFIT}, SIZE\}$ and the average NY among her/his neighbours. Let Δ be the difference operator such that $\Delta Y \equiv Y - NY$ is the relative value of Y. Since ΔY is a linear combination of Y and NY, we cannot separately identify the effects of Y, NY and ΔY. Hence, we do not attempt to test which effect dominates among the respective influences of the absolute value of Y and the relative values of ΔY.[19] We can however test whether the aforementioned result from the life satisfaction literature applies to our case. We use the notation $(\Delta Y)^- \equiv \Delta Y \times \mathbb{1}\{\Delta Y < 0\}$. Without loss of generality,[20] we can test whether the term $(\Delta Y)^-$ influences the probability of exit after controlling for Y and NY. All three variables are correlated but not colinear, so that the large size of our panel allows to precisely estimate their respective effects. Hence, we estimate the effect of $(\Delta Y)^-$ *ceteris paribus*, and in particular, after controlling both farmers' own performance (Y) and the level of local competition

18 We thank an anonymous reviewer for raising that point.

19 Vendrik and Woltjer (2007) find that the effect of relative income on life satisfaction dominates the effect of absolute income.

20 As shown by straightforward algebra provided in the Appendix A, the term $(\Delta Y)^-$ accounts for any asymmetry on Y and ΔY provided that the outcome is continuous in Y.

(as captured by *NY* and *NDENSITY*). Taking $Y = \overline{PROFIT}$, we can therefore interpret the coefficient associated with $(\Delta\overline{PROFIT})^-$ as the additional marginal effect of relative profit for farmers under the average of their neighbours', holding neighbours' characteristics fixed. We report the estimations including the terms $(\Delta\overline{PROFIT})^-$ and $(\Delta SIZE)^-$ in Section 5.3, analyse the distributions of the estimated marginal effect in Section 5.4, and exploit them to simulate a shock to all profits in Section 5.5.

5. Results

5.1. Heterogeneous influence of own profit

We first investigate how the influence of profits on the probability of exit varies across farmers' characteristics. To do so, we interact the average profit with the operated area, the age and the number of associates of each farmer. Table 3 gives the estimated coefficients and standard errors of probit models without (columns 1–2) and with (columns 3–4) these interaction terms.

Figure A2 (Appendix in supplementary data at *ERAE* online) displays the distribution of the fitted probability of exit $\widehat{Prob(EXIT)}$ using the estimates in column (1) conditional on observed exit, and it shows that this distribution is shifted to the right for exiting farmers.[21] To assess how well our model compares to random classifiers, we report the receiver operating characteristic (ROC) curve which provides a thorough evaluation of the model potential classification performance.[22] It has long been a standard tool to evaluate classifiers in various fields, such as medicine, psychology and meteorology, and was only recently introduced in economics to evaluate financial crisis models (Berge and Jordà, 2011; Schularick and Taylor, 2012; Anundsen *et al.*, 2016). The ROC curve corresponding to the specification in column (1) is plotted in Figure A3 (Appendix in supplementary data at *ERAE* online), and the area under the ROC curve (AUROC) is given for each specification in Table 3. An AUROC value of 0.5 corresponds to a random coin toss classifier, whereas we obtain values close to 0.8, indicating significant explanatory power.[23] Our AUROC values lie close to those reported in the recent applications in economics cited above.

The estimated coefficients of the control variables take signs that are overall consistent with the literature. The probability of early exit is lower for farmers with associates and older farmers. Our nonlinear specification of the influence

21 The estimated probabilities of exit are low for all farmers but are significantly higher for exiting farmers. The average among exiting farmers is 0.0288 against 0.0086 among stayers. A t-test rejects the equality of these means at the 0.1 per cent level.

22 The ROC curve synthesises the classifications obtained when using the model with all possible classification thresholds. Let τ be a given classification threshold, all observations with a fitted probability greater than τ are classified as exits. For all τ between 0 and 1, we compute the true-positive rate (share of exiting farmers classified as exiting) and the false-positive rate (share of remaining farmers classified as exiting). The ROC curve plots the first against the second for all τ. See Berge and Jordà (2011) for a complete discussion on the advantages of this tool for the evaluation of classification models.

23 For the specification in column (1), the 95 per cent confidence interval for the value of the AUROC computed with the DeLong *et al.* (1988) algorithm is [0.7956; 0.8018].

Table 3. Estimates of the probit model excluding neighbours' variables

	Dependent variable: *EXIT*			
	Estimate (1)	SE (2)	Estimate (3)	SE (4)
ASSOCIATES CAT : 1	−3.95e−01 ***	(7.12e−03)	−3.98e−01 ***	(7.25e−03)
ASSOCIATES CAT : 2 +	−6.57e−01 ***	(1.39e−02)	−6.62e−01 ***	(1.45e−02)
AGECAT : 25–29	1.02e−02	(3.74e−02)	2.19e−02	(3.76e−02)
AGECAT : 30–34	6.38e−02 *	(3.60e−02)	7.76e−02 **	(3.62e−02)
AGECAT : 35–39	1.10e−01 ***	(3.56e−02)	1.16e−01 ***	(3.58e−02)
AGECAT : 40–44	1.21e−01 ***	(3.55e−02)	1.13e−01 ***	(3.57e−02)
AGECAT : 45–49	1.32e−01 ***	(3.55e−02)	1.08e−01 ***	(3.58e−02)
MARITAL : Married	8.65e−03	(6.35e−03)	8.35e−03	(6.37e−03)
MARITAL : Separated	4.11e−01 ***	(2.76e−02)	4.11e−01 ***	(2.76e−02)
MARITAL : Widowed	3.12e−01 ***	(1.23e−02)	3.12e−01 ***	(1.23e−02)
IMPFARMING : Main	4.10e−01 ***	(8.60e−03)	4.06e−01 ***	(8.62e−03)
IMPFARMING : Secondary	3.65e−01 ***	(9.74e−03)	3.48e−01 ***	(9.78e−03)
SPE : Dairycattle	3.84e−02 *	(2.21e−02)	4.12e−02 *	(2.20e−02)
SPE : Fieldcrops	−3.03e−02	(2.10e−02)	−5.07e−04	(2.09e−02)
SPE : Fruits and vegetables	3.65e−01 ***	(2.19e−02)	3.69e−01 ***	(2.18e−02)
SPE : Mixed	6.32e−02 ***	(2.25e−02)	6.74e−02 ***	(2.24e−02)
SPE : Other live stocks	4.98e−01 ***	(2.72e−02)	4.70e−01 ***	(2.72e−02)
SPE : Other permanent crops	3.00e−01 ***	(2.66e−02)	2.89e−01 ***	(2.68e−02)
SPE : Pigs and poultry	2.78e−01 ***	(2.25e−02)	2.81e−01 ***	(2.24e−02)
SPE : Sheeps and goats	2.08e−01 ***	(2.94e−02)	2.03e−01 ***	(2.93e−02)
SPE : Vineyards	7.93e−02 ***	(2.17e−02)	9.21e−02 ***	(2.16e−02)
SIZE	−4.39e−03 ***	(2.31e−04)	−4.67e−03 ***	(2.30e−04)
SIZE × *SPE* : Dairycattle	3.79e−04	(3.30e−04)	3.48e−04	(3.28e−04)

Table 3. (Continued)

	Dependent variable: *EXIT*			
	Estimate (1)	SE (2)	Estimate (3)	SE (4)
$SIZE \times SPE$: Fieldcrops	1.52e−03 ***	(2.68e−04)	9.98e−04 ***	(2.67e−04)
$SIZE \times SPE$: Fruits and vegetables	−4.47e−03 ***	(6.71e−04)	−4.38e−03 ***	(6.64e−04)
$SIZE \times SPE$: Mixed	2.44e−04	(3.03e−04)	1.57e−04	(2.99e−04)
$SIZE \times SPE$: Other live stocks	−5.40e−03 ***	(8.99e−04)	−4.75e−03 ***	(8.92e−04)
$SIZE \times SPE$: Other permanent crops	−6.03e−03 ***	(8.52e−04)	−5.13e−03 ***	(8.71e−04)
$SIZE \times SPE$: Pigs and poultry	−4.50e−03 ***	(4.97e−04)	−4.52e−03 ***	(4.96e−04)
$SIZE \times SPE$: Sheeps and goats	5.07e−04	(4.52e−04)	5.68e−04	(4.49e−04)
$SIZE \times SPE$: Vineyards	−2.03e−03 ***	(5.01e−04)	−2.01e−03 ***	(5.01e−04)
$\overline{PROFIT}$	−7.54e−03 ***	(1.98e−04)	−2.55e−02 ***	(1.47e−03)
$\overline{PROFIT}^2$	4.29e−06 ***	(1.58e−06)	−3.84e−06 ***	(1.16e−06)
$\overline{PROFIT} \times SIZE$			3.32e−05 ***	(1.99e−06)
$\overline{PROFIT} \times AGE$			3.59e−04 ***	(3.39e−05)
$\overline{PROFIT} \times ASSOCIATES$			3.65e−04 ***	(1.41e−04)
Year dummies	Yes		Yes	
Region dummies	Yes		Yes	
Number of observations	2,272,158		2,272,158	
Number of exits	20,260		20,260	
AUROC	0.7976		0.7987	
Log-likelihood	−102,710		−102,538	

Note: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 per cent level.

of age reveals that the probability of early exit increases rapidly until 35 and then continues to increase but at a slower rate. Marriage is associated with neither a lower nor a higher probability of early exit, but separated and widowed farmers have a significantly higher probability of early exit. In contrast with the conclusions of Kimhi (2000), we find that part-time farmers have a higher probability of exit than full-time farmers, a result in line with the conclusions of Goetz and Debertin (2001). The probability of exit depends significantly on the specialisation of the farmer. Consistent with the literature (Weiss, 1999; Dong *et al.*, 2016; Storm *et al.*, 2015), we find that larger farms have a smaller probability of early exit, although the slope of this relationship depends on the specialisation of the farmer.

As expected, our main variable of interest $\overline{PROFIT}$ decreases the probability of early exit. The estimates reported in columns (3) show that the marginal effect of $\overline{PROFIT}$ is negative and increases towards zero when age and size increase.[24] Although the interaction between the average profit and the number of associates is statistically significant, it is less economically significant as *ASSOCIATES* varies little in the data ($ASSOCIATES \in \{0, 1, 2\}$ for 96 per cent of the observations). Overall, the negative marginal effect of profits on the expected utility of exit, hereafter denoted $\frac{\partial \mathbf{E}U}{\partial \overline{PROFIT}}$, is stronger for younger farmers and farmers operating a smaller area and slightly stronger for farmers with no associates *ceteris paribus*. Note that the sign of the quadratic effect of profit changes depending on the specification considered. Although it is statistically significant in all columns, this quadratic term does not quantitatively affect the marginal influence of profit on the expected utility of exit;[25] hence, we do not include this term in the next specifications we consider. We provide a graphical illustration of how the cross-effects between profit and farmers' characteristics affect the distribution of $\frac{\partial \mathbf{E}U}{\partial \overline{PROFIT}}$ in Section 5.4.

5.2. Heterogeneous neighbourhood effects

In this section, we present the estimated coefficients of probit models, including the neighbours' variables, with the two aforementioned definitions of neighbourhood. The estimates for the variables of interest are reported in Table 4, where all specifications include all the control variables shown in Table 3 and dummies for each year and each region.[26]

The signs and significance levels of the estimates for the three spatially lagged variables are the same under both definitions of neighbours.[27] The coefficient on the density of farmers' neighbours is always negative and strongly

24 The specification with interaction terms implies that the marginal effect of $\overline{PROFIT}$ is negative for 99.54 per cent of observations, so that higher profits lower the probability of exit.

25 Considering the estimates given in column (3), the marginal influence of the quadratic profit ($-3.84\text{e-}06 \times 2 \times \overline{PROFIT}$) is equal to 1.9 per cent of the total marginal effect of profit $\frac{\partial \mathbf{E}U}{\partial \overline{PROFIT}}$ on average across all observations. The median of the ratio between these two terms is 1 per cent.

26 The number of observations slightly decreases because these estimations exclude farmers with no neighbours.

27 We now consider specifications without a quadratic term for profit. Including this term does not qualitatively affect our results.

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. In these specifications, the average size of the neighbours is estimated to have a positive effect on the probability of exit, a result in contrast with the estimates of Storm *et al.* (2015) but in line with those of Saint-Cyr *et al.* (2019), who also find a positive effect on average. Neighbours' average profit is found to have a negative effect on a farmer's probability of early exit similar to the effect of farmer's own profit, suggesting positive spillovers. All these effects are robust to both definitions of neighbours, even when considering only neighbours with the same production specialisation as the farmer, that is, ignoring neighbouring farms with different specialisations than the farmer (see Table A3 Appendix in supplementary data at *ERAE* online).

Columns (1) and (3) of Table 4 report the estimated coefficients of the cross-effects between the average profit of the neighbours and a farmer's size, age and number of associates. We find that the cross-effects with size and age are positive and statistically significant under both definitions of neighbourhood, while the cross-effect with the number of associates is statistically significant only when including adjacent municipalities in the neighbourhood. The corresponding estimates ignoring neighbours with different specialisations are reported in Table A3 (Appendix in supplementary data at *ERAE* online), where only the cross-effect with farmer's age is statistically significant at the conventional 5 per cent level. Overall, we find evidence that younger farmers benefit more than older farmers from the profit spillover from neighbours. These cross-effects also imply that the sign of this spillover depends on the farmer's characteristics. Using the estimates of column (3) of Table 4, we find that the marginal profit spillover $\frac{\partial \mathbf{E}U}{\partial \overline{NPROFIT}}$ is positive for 16.0 per cent of observations. Section 5.4 describes the distribution of this effect using the model presented in the next section.

5.3. Asymmetric comparison effects

In a last series of estimations, we relax the linearity assumption of the neighbourhood effects and allow the effect of neighbours' profit and size to depend on whether the farmer is below or above the average of the neighbourhood. As presented in Section 4, we test whether the asymmetric deviations $(\Delta\overline{PROFIT})^-$ and $(\Delta SIZE)^-$ significantly influence the probability of exit. We obtain nonlinear and heterogeneous marginal effects of own and neighbours' profit and size.

Table 5 gives the estimates of specifications including the asymmetric terms $(\Delta\overline{PROFIT})^-$ and $(\Delta SIZE)^-$. These coefficients are negative and strongly significant in all cases, even when considering only neighbours with the same specialisation (see Table A4 Appendix in supplementary data at *ERAE* online). They imply that the negative marginal effects of profit and size, reflecting comparison effects, are nonlinear and stronger for farmers below the respective averages of their neighbours. It corroborates a result repeatedly reported in the empirical economic literature on happiness, according to which the function

Table 4. Estimates of the probit model accounting for neighbours' influence

	Dependent variable: *EXIT*			
	Same municipality only		Same and adjacent municipalities	
Neighbourhood definition:	Estimate (1)	SE (2)	Estimate (3)	SE (4)
$\overline{PROFIT}$	−2.26e−02 ***	(1.52e−03)	−2.27e−02 ***	(1.53e−03)
$\overline{PROFIT} \times SIZE$	2.66e−05 ***	(1.28e−06)	2.66e−05 ***	(1.26e−06)
$\overline{PROFIT} \times AGE$	3.12e−04 ***	(3.47e−05)	3.08e−04 ***	(3.48e−05)
$\overline{PROFIT} \times ASSOCIATES$	1.22e−04	(2.00e−04)	4.09e−04 **	(2.05e−04)
NDENSITY	−9.42e−01 ***	(3.23e−01)	−1.74e+00 ***	(6.34e−01)
NSIZE	9.55e−04 ***	(1.46e−04)	1.50e−03 ***	(2.36e−04)
$N\overline{PROFIT}$	−6.04e−03 ***	(1.57e−03)	−8.54e−03 ***	(2.40e−03)
$N\overline{PROFIT} \times SIZE$	9.61e−05 ***	(3.48e−05)	1.19e−04 **	(5.32e−05)
$N\overline{PROFIT} \times AGE$	1.63e−05 ***	(3.79e−06)	3.50e−05 ***	(8.17e−06)
$N\overline{PROFIT} \times ASSOCIATES$	3.72e−04 **	(1.47e−04)	−1.55e−04	(3.68e−04)
All control variables	Yes		Yes	
Year dummies	Yes		Yes	
Region dummies	Yes		Yes	
Number of observations	2,233,371		2,271,539	
Number of exits	19,863		20,239	
AUROC	0.7984		0.7992	
Log-likelihood	−100,598		−102,377	

Note: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 per cent level.

mapping relative income to life satisfaction is significantly steeper for negative than for positive values of relative income (Ferrer-i Carbonell, 2005; Vendrik and Woltjer, 2007; Senik, 2009). This asymmetric effect is consistent with the broader view in prospect theory according to which individuals pay more attention to their position relative to their social reference point when they are below it than above it, hence being more sensitive to losses and disadvantages than to gains and advantages (Tversky and Kahneman, 1991).

Both cross-effects with the number of associates are statistically insignificant in Table 5, suggesting that the significance of these interactions indicated in the previous tables may be spurious. Interestingly, when accounting for the asymmetric influence of relative size, the effect of the absolute neighbours' size (*NSIZE*) on exit becomes negative and hence takes the same sign as that of the absolute neighbours' profit. Our estimates imply that the net marginal effect of neighbours' size is positive for farmers operating a larger area than their neighbours, and negative for those operating smaller farms. This qualifies the finding of Saint-Cyr *et al.* (2019) that neighbours' size conveys both a negative spillover caused by accrued competition for land, and a positive spillover due to agglomeration benefits. Our estimations suggest that the net effect is detrimental for smaller farmers and beneficial for larger farmers.

5.4. Distribution of the heterogeneous effects of own and neighbours' profit

In this section, we comment on the respective distributions of the net effects of own and neighbours' profit among the farmers in the sample. We hereafter consider the full model corresponding to column (3) of Table 5. Figure 1 displays the respective scaled densities of the net marginal effect of own (left panels) and neighbours' profit (right panels) on a farmer's expected utility of exit, denoted $\frac{\partial \mathbf{E}U}{\partial PROFIT}$ and $\frac{\partial \mathbf{E}U}{\partial NPROFIT}$.

The two top panels show these densities for two groups of farmers, those above and below their neighbours' average profit. In the top-left panel, we can see a clear difference between the two densities, with the average marginal effect of own profit being more than twice as large for the farmers below their neighbours' average profit (−0.010 against −0.004).[28] The sign of the relative profit also significantly shifts the marginal effect of neighbours' profits, although the two densities in the top-right panel largely overlap. As mentioned above, for the vast majority (91 per cent) of farmers above the average profit of their neighbours, $\frac{\partial \mathbf{E}U}{\partial NPROFIT}$ is negative, whereas it is positive for a large share (43 per cent) of farmers under their neighbours' average profit. Overall, we find that 28 per cent of farmers suffer from a net adverse spillover (increased expected utility of exit) from their neighbours' profits. Of these farmers, 85 per cent have lower profits than their neighbours average.

We then further disaggregate the sample to illustrate how age also significantly contributes to explaining the heterogeneity of the estimated marginal effects. In the middle panels, we subdivide the sample into four groups depending on both the sign of the relative profit and whether the age category is below or above 40, a value close to the median age in our sample. We obtain four distinct densities of $\frac{\partial \mathbf{E}U}{\partial PROFIT}$, while the densities of $\frac{\partial \mathbf{E}U}{\partial NPROFIT}$ overlap more across the four groups. The explanatory power of age is substantial, as the four densities are spread in a balanced way, although the sign of the relative profit has more explanatory power for the heterogeneity of the marginal effects. For instance, the average marginal effect of own profit is smaller in absolute value for farmers under 40 and above their neighbours' average profit than for older farmers with lower profits than their neighbours (0.0060 against 0.0087)[28]. The

28 These means are significantly different at the 0.1 per cent level.

Table 5. Estimates of the probit model with asymmetric neighbours' influence

	Dependent variable: *EXIT*			
	Same municipality only		Same and adjacent municipalities	
Neighbourhood definition:	Estimate (1)	SE (2)	Estimate (3)	SE (4)
$\overline{PROFIT}$	−1.91e−02 ***	(1.55e−03)	−1.72e−02 ***	(1.54e−03)
$\overline{PROFIT} \times SIZE$	1.96e−05 ***	(1.28e−06)	1.54e−05 ***	(1.33e−06)
$\overline{PROFIT} \times AGE$	2.84e−04 ***	(3.39e−05)	2.74e−04 ***	(3.32e−05)
$\overline{PROFIT} \times ASSOCIATES$	−1.58e−04	(2.27e−04)	2.67e−04	(2.16e−04)
NDENSITY	−9.77e−01 ***	(3.22e−01)	−1.21e+00 *	(6.33e−01)
NSIZE	−2.92e−03 ***	(2.37e−04)	−2.52e−03 ***	(2.93e−04)
$N\overline{PROFIT}$	−1.22e−02 ***	(1.65e−03)	−1.70e−02 ***	(2.44e−03)
$N\overline{PROFIT} \times SIZE$	2.04e−04 ***	(3.49e−05)	2.26e−04 ***	(5.34e−05)
$N\overline{PROFIT} \times AGE$	2.25e−05 ***	(3.55e−06)	4.81e−05 ***	(7.37e−06)
$N\overline{PROFIT} \times ASSOCIATES$	6.29e−04 ***	(1.31e−04)	2.95e−06	(3.28e−04)
$(\Delta\overline{PROFIT})^{-}$	−2.54e−03 ***	(3.86e−04)	−5.08e−03 ***	(4.76e−04)
$(\Delta SIZE)^{-}$	−5.09e−03 ***	(2.52e−04)	−6.03e−03 ***	(2.64e−04)
All control variables	Yes		Yes	
Year dummies	Yes		Yes	
Region dummies	Yes		Yes	
Number of observations	2,233,371		2,271,539	
Number of exits	19,863		20,239	
AUROC	0.8001		0.8016	
Log-likelihood	−100,350		−102,040	

Note: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 per cent level.

densities displayed in the middle-right panel show that age also significantly explains the distribution of the net marginal effect of neighbours' profits. Most of the farmers with a positive marginal effect of neighbours' profits (82 per cent) are above 40 years old.

In the bottom panels, we similarly consider groups based on two size categories (more or less than 50 ha, a value close to the median size in our sample) and the sign of relative profits. The densities substantially overlap, especially those of $\frac{\partial \mathbf{EU}}{\partial \overline{PROFIT}}$ in the bottom-left panel. However, size has significant

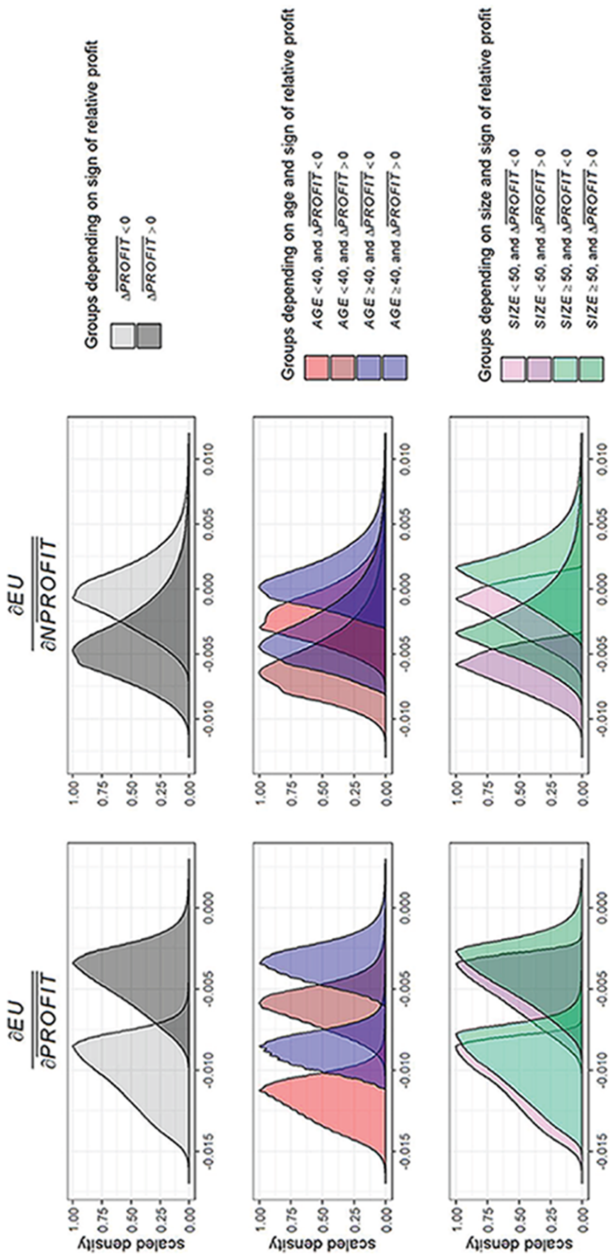

Fig. 1. Distribution of the marginal effects of own and neighbours' profits on the expected utility of exit

explanatory power for the heterogeneity of the marginal effect of neighbours' profit. In our sample, 82 per cent of the farmers receiving an adverse spillover from their neighbours' profit operate an area larger than 50 ha, while the two categories of size are rather balanced among farmers receiving a favourable spillover (56 per cent of farmers under 50 ha and 44 per cent above that figure).

5.5. Simulation of a shock to all profits

Finally, we illustrate how this uncovered heterogeneity translates into early exit decisions. We simulate a shock to all profits where we decrease all profits by a value equal to 10 per cent of the standard deviation of profits (1.86k€). Such a decrease in agricultural profits could be generated by a decrease in payments received from the CAP, which is not an unlikely scenario given the decreasing trend of the CAP budget.

Figure 2 shows the share of expected additional early exits generated by such a shock within age and size groups. We first compute the expected number of additional exits in the simulation using the fitted probabilities after the negative shock on profits. We do this within each category of age and size. The share of additional exits is the ratio between the expected number of additional early exits divided by the number of early exits observed in the data. Figure 2 shows

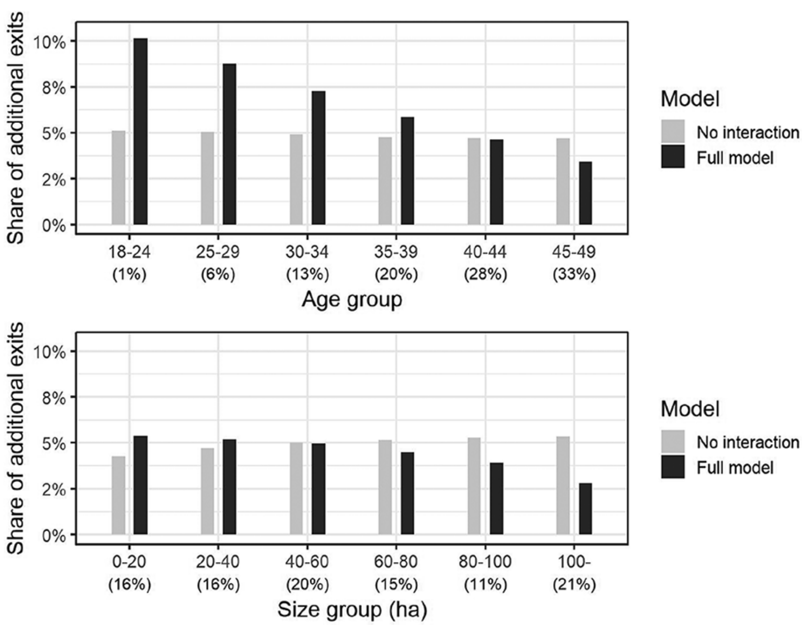

Fig. 2. Distribution of the effect of decreasing profits by 0.1 standard deviation
Note: The *y*-axis gives the ratio between the expected number of additional exits in the simulation and the number of early exits observed in the data. The intervals on the *x*-axis have balanced width in number of years and hectares, but they do not represent the same shares of farmers. These shares are reported between brackets under each interval.

these shares for two different specifications of the model, one with all interactions terms, noted 'Full model', and one without them, noted 'No interaction'. The 'Full model' corresponds to the estimates in column (3) of Table 5. The benchmark 'No interaction' model is a specification that includes own profit and neighbours' profit, size and density but ignores the interactions between profits and farmer characteristics.[29] The benchmark 'No interaction' model does not account for farmers' heterogeneous response to own and neighbours' profit, whereas the 'Full model' does.

The number of expected exits increases in each category and for each specification. But ignoring the interaction terms which control for the heterogeneity in farmers' response to financial incentives leads to substantially underestimate the shares of additional early exits among younger farmers. It also leads to overestimate the share of additional early exits among farmers operating large areas. The results of this simulation suggest that a reduction of agricultural profit-supporting policies, or a negative shock on market prices, would generate more early exits among younger and smaller farmers, hence accelerating the ageing and concentration process already at work in the farming sector in France.

6. Conclusion

This article examines how farmers' exit behaviour before retirement age is influenced by profit, neighbours' characteristics and relative economic performance. We focus our analysis on the subpopulation of French farmers under 50 and paying a real-rate social security tax, for which we observe annual profits and exits cannot be due to retirement. Our contribution is threefold. First, we examine the heterogeneity of the effect of a farmer's own profit on his/her decision to exit early from business. We show that this effect is negative and more important in absolute value for younger farmers and farmers operating smaller areas. Second, we investigate the influence of neighbours' characteristics on early exit. Using a variety of definitions of neighbours, our estimates consistently show that neighbours' average profits have a stronger influence on the exit decision of younger farmers. We also provide evidence that smaller farmers are significantly more sensitive to their neighbours' average profits. Third, we uncover an asymmetry in the influence of relative profit and size on farmers' early exit behaviour. Our estimations reveal that the effects of these relative values depend on whether the farmer is below or above the average of his/her neighbours. For both profit and size, the effects of the relative values are stronger for farmers below the average of their neighbours. This finding is consistent with the implication of prospect theory according to which individuals under their social reference point are more sensitive to their relative position to this point, a postulate supported by the empirical literature on relative income. In our case, the reference point is the average profit and size of the neighbours. Finally, we simulate a shock to profits to illustrate how this heterogeneity influences the distribution of exits. Our results are consistent with

29 This specification corresponds to that displayed in column (1) of Table 4 but without the interaction terms with $\overline{PROFIT}$.

the view that both positive and negative spillovers are channelled through both the profit and the size of the neighbours and in a heterogeneous way among farmers. The direction of the net effect depends on farmers' characteristics.

Our framework opens a promising avenue to disentangle the effect of the absolute performance of farmers and their neighbours from the effect of relative performance on farmers' behaviour, and to explore whether one effect dominates. The identification and the estimation of the various components of these peer effects and spillovers among farmers remains an econometric challenge to be further investigated by economists. Accounting for these heterogeneous comparison effects should allow to improve the evaluation of agricultural policies, especially with respect to their distributional outcome. In this perspective, further research is needed to investigate the heterogeneity in the respective effects of the different components of profit, in particular market returns and public subsidies, on exit.

Acknowledgment

The authors are grateful to the Editor (Jack H.M. Peerlings) and three anonymous referees for helpful remarks and suggestions that improved our article. They also thank Julian Alston, Jean-Sauveur Ay, Kathy Baylis, Valentin Bellassen, Julie Le Gallo, Pierre Mérel, Richard Sexton, Daniel Sumner, Stuart Sweeney, Joakim Weill and seminar participants at University of California Davis, the research unit CESAER in Dijon (France), and the 18th International Workshop on Spatial Econometrics and Statistics for many constructive comments.

Funding

This work was financially supported by the French research agency ('Agence Nationale de la Recherche'-ANR) under the framework of the research project FARM_VALUE 'Farm value and farm transfer: perspectives from economics and sociology' (ANR-15-CE36-0006).

Conflict of Interest

The authors declare that they have no conflict of interest.

Supplementary data

Supplementary data are available at *ERAE* online.

References

Ahearn, M. C., Yee, J. and Korb, P. (2005). Effects of differing farm policies on farm structure and dynamics. *American Journal of Agricultural Economics* 87: 1182–1189.

Alston, J. M., Andersen, M. A., James, J. S. and Pardey, P. G. (2011). The economic returns to U.S. Public agricultural research. *American Journal of Agricultural Economics* 93: 1257–1277.

Anderson, K., Rausser, G. and Swinnen, J. (2013). Political economy of public policies: insights from distortions to agricultural and food markets. *Journal of Economic Literature* 51: 423–477.

Anundsen, A. K., Gerdrup, K., Hansen, F. and Kragh-Sørensen, K. (2016). Bubbles and crises: the role of house prices and credit. *Journal of Applied Econometrics* 31: 1291–1311.

Berge, T. J. and Jordà, O. (2011). Evaluating the classification of economic activity into recessions and expansions. *American Economic Journal: Macroeconomics* 3: 246–277.

Bocquého, G., Jacquet, F. and Reynaud, A. (2014). Expected utility or prospect theory maximisers? Assessing farmers' risk behaviour from field-experiment data. *European Review of Agricultural Economics* 41: 135–172.

Bonin, J. P., Jones, D. C. and Putterman, L. (1993). Theoretical and empirical studies of producer cooperatives: will ever the Twain Meet?. *Journal of Economic Literature* 31: 1290–1320.

Bougherara, D., Gassmann, X., Piet, L. and Reynaud, A. (2017). Structural estimation of farmers' risk and ambiguity preferences: a field experiment. *European Review of Agricultural Economics* 44: 782–808.

Breustedt, G. and Glauben, T. (2007). Driving forces behind exiting from farming in Western Europe. *Journal of Agricultural Economics* 58: 115–127.

Carrell, S. E., Sacerdote, B. I. and West, J. E. (2013). From natural variation to optimal policy? The importance of endogenous peer group formation. *Econometrica* 81: 855–882.

Clark, A. E., Frijters, P. and Shields, M. A. (2008). Relative income, happiness, and utility: an explanation for the Easterlin paradox and other puzzles. *Journal of Economic Literature* 46: 95–144.

DeLong, E. R., DeLong, D. M. and Clarke-Pearson, D. L. (1988). Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics* 44: 837.

Dimara, E., Skuras, D., Tsekouras, K. and Tzelepis, D. (2008). Productive efficiency and firm exit in the food sector. *Food Policy* 33: 185–196.

Dong, F., Hennessy, D. A. and Jensen, H. H. (2010). Contract and exit decisions in finisher hog Production. *American Journal of Agricultural Economics* 92: 667–684.

Dong, F., Hennessy, D. A., Jensen, H. H. and Volpe, R. J. (2016). Technical efficiency, herd size, and exit intentions in U.S. dairy farms. *Agricultural Economics* 47: 533–545.

European Commission (2010). *Communication on the CAP towards 2020: Meeting the Food, Natural Resources and Territorial Challenges of the Future. Tech. rep.* Brussels: European Commission.

Falk, A. and Ichino, A. (2006). Clean evidence on peer effects. *Journal of Labor Economics* 24: 39–57.

Ferrer-i Carbonell, A. (2005). Income and well-being: an empirical analysis of the comparison income effect. *Journal of Public Economics* 89: 997–1019.

Foltz, J. D. (2004). Entry, exit and farm size: assessing an experiment in dairy price policy. *American Journal of Agricultural Economics* 86: 594–604.

Goetz, S. J. and Debertin, D. L. (2001). Why farmers quit: a county-level analysis. *American Journal of Agricultural Economics* 83: 1010–1023.

Greene, W. (2004). The behaviour of the maximum likelihood estimator of limited dependent variable models in the presence of fixed effects. *The Econometrics Journal* 7: 98–119.

Jovanovic, B. (1982). Selection and the evolution of industry. *Econometrica* 50: 649–670.

Katchova, A. L. and Ahearn, M. C. (2017). Farm entry and exit from US agriculture. *Agricultural Finance Review* 77: 50–63.

Kazukauskas, A., Newman, C., Clancy, D. and Sauer, J. (2013). Disinvestment, farm size, and gradual farm exit: the impact of subsidy decoupling in a European context. *American Journal of Agricultural Economics* 95: 1068–1087.

Key, N. and Roberts, M. J. (2006). Government payments and farm business survival. *American Journal of Agricultural Economics* 88: 382–392.

Key, N. and Roberts, M. J. (2009). Nonpecuniary benefits to farming: implications for supply response to decoupled payments. *American Journal of Agricultural Economics* 91: 1–18.

Kimhi, A. (2000). Is part-time farming really a step in the way out of agriculture?. *American Journal of Agricultural Economics* 82: 38–48.

King, G. and Zeng, L. (2001). Logistic regression in rare events data. *Political Analysis* 9: 137–163.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy* 99: 483–499.

Latruffe, L. and Piet, L. (2014). Does land fragmentation affect farm performance? A case study from Brittany, France. *Agricultural Systems* 129: 68–80.

Liebenehm, S. and Waibel, H. (2014). Simultaneous estimation of risk and time preferences among small-scale cattle farmers in West Africa. *American Journal of Agricultural Economics* 96: 1420–1438.

Liu, E. M. (2013). Time to change what to sow: risk preferences and technology adoption decisions of cotton farmers in China. *Review of Economics and Statistics* 95: 1386–1403.

Luttmer, E. F. P. (2005). Neighbors as negatives: relative earnings and well-being. *Quarterly Journal of Economics* 120: 963–1002.

Minviel, J. J. and De Witte, K. (2017). The influence of public subsidies on farm technical efficiency: a robust conditional nonparametric approach. *European Journal of Operational Research* 259: 1112–1120.

Neffke, F. M. H., Henning, M. and Boschma, R. (2012). The impact of aging and technological relatedness on agglomeration externalities: a survival analysis. *Journal of Economic Geography* 12: 485–517.

Peel, D., Berry, H. L. and Schirmer, J. (2016). Farm exit intention and wellbeing: a study of Australian farmers. *Journal of Rural Studies* 47: 41–51.

Pietola, K., Väre, M. and Lansink, A. O. (2003). Timing and type of exit from farming: farmers' early retirement programmes in Finland. *European Review of Agriculture Economics* 30: 99–116.

Rosenbaum, D. I. and Lamort, F. (1992). Entry, barriers, exit, and sunk costs: an analysis. *Applied Economics* 24: 297–304.

Saint-Cyr, L. D. F., Storm, H., Heckelei, T. and Piet, L. (2019). Heterogeneous impacts of neighbouring farm size on the decision to exit: evidence from Brittany. *European Review of Agricultural Economics* 46: 237–266.

Santiago, C. D., Wadsworth, M. E. and Stump, J. (2011). Socioeconomic status, neighborhood disadvantage, and poverty-related stress: prospective effects on psychological syndromes among diverse low-income families. *Journal of Economic Psychology* 32: 218–230.

Schularick, M. and Taylor, A. M. (2012). Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870–2008. *American Economic Review* 102: 1029–1061.

Seither, J. (2018). Keeping up with the Joneses: ranking effects on effort, cooperation, and firm performance (Working paper).

Senik, C. (2009). Direct evidence on income comparisons and their welfare effects. *Journal of Economic Behavior & Organization* 72: 408–424.
Storm, H., Mittenzwei, K. and Heckelei, T. (2015). Direct payments, spatial competition, and farm survival in Norway. *American Journal of Agricultural Economics* 97: 1192–1205.
Sumner, D. A. (2014). American farms keep growing: size, productivity, and policy. *Journal of Economic Perspectives* 28: 147–166.
Sumner, D. A., Alston, J. M. and Glauber, J. W. (2010). Evolution of the economics of agricultural policy. *American Journal of Agricultural Economics* 92: 403–423.
Tversky, A. and Kahneman, D. (1991). Loss aversion in riskless choice: a reference-dependent model. *Quarterly Journal of Economics* 106: 1039–1061.
Vendrik, M. C. and Woltjer, G. B. (2007). Happiness and loss aversion: is utility concave or convex in relative income?. *Journal of Public Economics* 91: 1423–1448.
Weinberg, B. A., Reagan, P. B., Yankow, J. J., Cosslett, S., Durlauf, S., Gould, E., Hotz, J., Green, R., Ihlanfeldt, K., Lach, S., Levin, D., Haurin, D., Olsen, R. and Yitzhaki, S. (2004). Do neighborhoods affect hours worked? Evidence from longitudinal data. *Journal of Labor Economics* 22: 891–924.
Weiss, C. R. (1999). Farm growth and survival: econometric evidence for individual farms in Upper Austria. *American Journal of Agricultural Economics* 81: 103–116.
Zhengfei, G. and Lansink, A. O. (2006). The source of productivity growth in Dutch agriculture: a perspective from Finance. *American Journal of Agricultural Economics* 88: 644–656.

Appendix A Generality of the expression with an asymmetric term

Let $Y^- = Y \times \mathbb{1}\{\Delta Y < 0\}$ and $NY^- = NY \times \mathbb{1}\{\Delta Y < 0\}$. Consider a function $P(Y)$ continuous and flexibly asymmetric in Y, NY, and ΔY:

$$P(Y) = \alpha_1 Y + \alpha_2 Y^- + \alpha_3 NY + \alpha_4 NY^- + \alpha_5 \Delta Y + \alpha_6 (\Delta Y)^- \tag{A1}$$

Since $\Delta Y = Y - NY$, let $\gamma_1 = \alpha_1 + \alpha_5$, $\gamma_2 = \alpha_2$, $\gamma_3 = \alpha_3 - \alpha_5$, $\gamma_4 = \alpha_4$ and $\gamma_5 = \alpha_6$ and rewrite (A1) as

$$P(Y) = \gamma_1 Y + \gamma_2 Y^- + \gamma_3 NY + \gamma_4 NY^- + \gamma_5 (\Delta Y)^- \tag{A2}$$

For Y approaching NY from above we have:

$$P(Y = NY+) = \gamma_1 Y + \gamma_3 NY = (\gamma_1 + \gamma_3) Y \tag{A3}$$

For Y approaching NY from below we have:

$$P(Y = NY-) = \gamma_1 Y + \gamma_2 Y + \gamma_3 NY + \gamma_4 NY \tag{A4}$$

$$P(Y = NY-) = (\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4) Y \tag{A5}$$

The continuity of P implies $P(Y = NY+) = P(Y = NY-)$. Thus, $\gamma_2 = -\gamma_4$ so that we can rewrite $P(Y)$ using $\beta_1 = \gamma_1$, $\beta_2 = \gamma_3$ and $\beta_3 = \gamma_2 + \gamma_5$:

$$P(Y) = \beta_1 Y + \beta_2 NY + \beta_3 (\Delta Y)^- \tag{A6}$$

Equation (A6), which we estimate in Section 5.3, with $Y \in \{\overline{PROFIT}, SIZE\}$ and additional covariates, is therefore consistent with the general expression (A1) without loss of generality.