Concentration of the agricultural production in the EU: the two sides of a coin

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Abstract

Over the last decades, the number of farms has been decreasing and their size increasing all over the European Union. This paper aims at studying the development of agricultural production concentration across EU Member States over the 2004-2013 period. Using an adapted version of the Herfindahl-Hirschman Index (HHI), it shows that a variety of situations exists across Europe as regards the distribution of commercial farm sizes measured in Euros of standard output. Results document how the overall tendency to concentration may originate either from the reduction in farm numbers, or from farm sizes becoming more unequal, or both.

Keywords: Farm size distribution, concentration, parametric Lorenz curve, Herfindahl-Hirschman index, European Union

JEL Classification: Q12, Q24, D33, L11

1 Introduction

Agricultural statistics for the European Union (EU) show that, over the last decades, the number of farms has been decreasing and the average operated area has been increasing (Eurostat 2016). This double trend has had repercussions on the distribution of agricultural land across farms, with the main result being a concentration of land into the hands of fewer operators (Martins and Tosstorff 2011). This raises concerns about the distribution of farm sizes, a standing issue for agricultural researchers, stakeholders and policy makers.

Recently, Piet et al. (2012) investigated the issue for France, analysing the role of several drivers in the relative stability of farm-size inequality over the period 1970-2007. Even more recently, Loughrey et al. (2016) studied the distribution of agricultural land in Western Europe, focusing on identifying spatial clusters of homogeneous farm-size inequality for the year 2010. In the mean time, the OECD tackled the subject for a set of 14 countries observed at several dates, two in Asia (Korea, Japan), two in America (Canada, the USA), and ten EU Member states (Bokusheva and Kimura 2016).

This paper adds to this literature on three grounds. Firstly, it studies the distribution of farm sizes for 27 Members States of the EU, thus extending Loughrey et al. (2016)'s study to Central and Eastern European countries. Secondly, rather than dealing with the physical size of farms as measured in hectares, it focuses on the distribution of the economic size of farms as measured in Euros of standard output (SO). Indeed, investigating the distribution of the operated area for the whole population of farms leads to mixing types of farming which in essence operate on different physical scales such as, on the one hand, horticulture, vineyards or off-land granivore producers and, on the other hand, field crops growers or extensive grazing livestock rearing. While some authors have therefore considered several farm size definitions (see Yee and Ahearn (2005) in the USA case), considering the economic size as we do here allows alleviating this pitfall. Thirdly, while most previous works considered the relative Gini coefficient as a measure of farm-size distribution inequality, this paper proposes an alternate indicator by adapting the Herfindahl-Hirschman Index (HHI), which has been so far mainly used in the industrial organisation literature (Herfindahl 1959, Hirschman 1964, Rhoades 1995). This allows considering not only size inequality but, more generally, production concentration, adding the issue of farm number reduction to that of farm size distribution.

Basically, the method employed has been widely used in the economic literature to investigate distributional issues. It is based on the analysis of 'grouped' data on the number of holdings and economic production potential by farm size categories. In the field of agricultural economics, it has been used to study the distribution of subsidies, income, wealth, operated land or land ownership across farms (*e.g.*, Wunderlich 1958, El-Osta and Morehart 2002, Allanson and Rocchi 2008, Mishra et al. 2009, Sinabell et al. 2013).

The rest of the paper is structured as follows. Section 2 details the implemented method. Section 3 then describes the data used while section 4 reports the obtained results. Finally, Section 5 raises some concluding remarks.

2 Method

Consider we want to study the size distribution of a population of N holdings whose total aggregate size is S but whose individual sizes are not known. Only 'grouped' data are available, that is, the N farms are arranged into K mutually exclusive and exhaustive size categories (Abounoori and McCloughan 2003). For each size category k ($k = 1, .., K$) we only observe the number of holdings, N_k, and their aggregate size, S_k, with $\sum_{k=1}^{K} N_k = N$ and $\sum_{k=1}^{K} S_k = S$. The cornerstone of our method consists in building the so-called Lorenz curves from these data, from which a number of inequality measures can be derived (Cowell and Van Kerm 2015).

To construct the Lorenz curve, the grouped data are transformed into a set of K points which map the cumulative shares of holdings, $\sum_{i=1}^{k} N_i/N$ for $k = 1, .., K$, to the cumulative shares of hectares, $\sum_{i=1}^{k} S_i/S$ for $k = 1, .., K$. From these points we can estimate the corresponding Lorenz curve by fitting a parametric function to the observed data, using, for example, the functional specification proposed by Rasche et al. (1980):[1]

$$L(F; q) = \Big(1 - \big(1 - F(q)\big)^{\alpha}\Big)^{1/\beta} \tag{1}$$

where $L(F; q)$ is the cumulative distribution of sizes, $F(q)$ is the cumulative distribution of holdings numbers ordered by size, and α and β are the parameters to be estimated, with $0 < \alpha, \beta \leq 1$. As suggested by Chotikapanich (1993), α and β are estimated through non-linear least squares, parametrising α as $\frac{\exp(a)}{1+\exp(a)}$ and β as $\frac{\exp(b)}{1+\exp(b)}$, where a and b are the parameters to be actually estimated, so as to enforce that α and β lie in the (0,1] interval.

[1] Other functional forms have been proposed in the literature (Kakwani and Podder 1973, Chotikapanich 1993, Rohde 2009) but Rasche et al. (1980)'s function appeared to be more flexible and to better fit the data in our case.

Once the Lorenz curve parameters have been estimated, a number of farm size and farm-size inequality measures may be derived. Among the possible indicators, the Herfindahl-Hirschman index (HHI) has the advantage of allowing to capture both dimensions of concentration.[2] The HHI has been widely used in the industrial economics literature, in particular to study the concentration of market shares and the resulting competitive effects of mergers (Rhoades 1995). Formally, the HHI is defined as the sum of the squared individual size shares (Herfindahl 1959, Hirschman 1964), that is, in our case:

$$\text{HHI} = \sum_{n=1}^{N} \left(\frac{s(n)}{S} \right)^2 \tag{2}$$

where $s(n)$ is the size of holding n. Because in practice size shares are expressed in percent, *i.e.*, they range from 0 to 100, the HHI may take on values from very low above zero up to 10,000, with higher values denoting a higher degree of concentration.

As is obvious from its formal definition above, one needs to know the individual sizes of all agents in the population to exactly compute the HHI. Actually, when used to study mergers and market power issues, the computation of the HHI focuses on a limited set of larger firms in the sector, for which market shares are usually known. Said differently, the true sector HHI is not computed but only a proxy of it focusing on major firms or those of interest.

In the case of the agricultural sector, neither the true HHI nor its 'major players' proxy may be directly computed, for two reasons. First, only grouped data as described above are most often available so that we don't have access to individual sizes, hence size shares. Second, even the size of larger holdings is usually unknown because farming is a highly atomized sector, with no farm holding more than a few percent of the total sector size. To circumvent this issue, we propose to derive a 'simulated' HHI (hereafter SHHI) from the parametric Lorenz curve defined earlier, as follows.

First, generate a set of N observations indexed by $n = 1, \ldots, N$. Each (simulated) individual holding therefore represents $1/N\%$ of the total population. Assuming that these N (simulated) holdings all have a different size $s(n)$, and ordering them according to this criteria, the share of holdings whose sizes are smaller than or equal to a given size $s(n)$ is $F(n) = n/N$. Then, thanks to the Lorenz curve parameters α and β, the cumulated size share $L(F;n)$ held by the n farms whose sizes are smaller than or equal to $s(n)$ can be obtained from equation (1). Finally, the size share held by the n^{th} farm whose size is exactly $s(n)$ is given by $s(n)/S = L(F;n) - L(F;n-1)$, where $L(F;n-1)$ is the cumulated size share of the $n-1$ farms whose sizes are strictly smaller than that of n. The computation of SHHI is then straightforward from equation (2).

The presented method only allows to compute a single SHHI value for a given population of N individuals of aggregated size S and size distribution $L(F;q)$. A Monte-Carlo approach then allows computing the central value and associated standard error for the SHHI estimator. Indeed, the above method can be replicated R times with different values for α and β, randomly drawing these values in the Normal distributions of both estimators, namely $\mathcal{N}(\hat{\alpha}, \sigma_{\hat{\alpha}})$ for α and $\mathcal{N}(\hat{\beta}, \sigma_{\hat{\beta}})$ for β. The central SHHI estimator value, $\widehat{\text{SHHI}}$, and

[2] Other standard farm size farm-size inequality indicators include the average farm size, any decile of farm sizes, the hectare-weighted median, the standard deviation of farm sizes, the inter-quartile or inter-centile ranges, the coefficient of variation, the relative mean deviation, the relative and absolute Gini coefficients, etc.; see for example Lund and Price (1998), Bokusheva and Kimura (2016), Cowell and Van Kerm (2015).

the associated variance, $\sigma^2_{\widehat{\text{SHHI}}}$, are then obtained as, respectively, the mean and variance of SHHI values resulting from the R draws.

3 Data

We used the publicly available Farm Accounting Data Network (FADN), an harmonised accountancy and technico-economic survey carried out by the Member States of the EU over a sample of agricultural holdings.[3]

The analysis was performed with the national-level data from 2004 to 2013. However, Croatia was excluded from the analysis since data for this country were available for 2013 only. Also, data for Bulgaria and Romania were available starting on 2007 only. The remaining 25 Member States were observed during the whole period. As a result, $25 \times 10 + 2 \times 7 = 264$ country×year pairs were observed in the dataset.

A parametric Lorenz curve was estimated for each Member State and each year based on the economic size (ES) of holdings, expressed in thousand Euros of standard output (SO). Indeed, FADN data are broken down into the 13 following ES categories (ES class name in parenthesis):

- 2,000€ of SO or more, but less than 4,000€ of SO (ES2);
- 4,000€ of SO or more, but less than 8,000€ of SO (ES3);
- 8,000€ of SO or more, but less than 15,000€ of SO (ES4);
- 15,000€ of SO or more, but less than 25,000€ of SO (ES5);
- 25,000€ of SO or more, but less than 50,000€ of SO (ES6);
- 50,000€ of SO or more, but less than 100,000€ of SO (ES7);
- 100,000€ of SO or more, but less than 250,000€ of SO (ES8);
- 250,000€ of SO or more, but less than 500,000€ of SO (ES9);
- 500,000€ of SO or more, but less than 750,000€ of SO (ES10);
- 750,000€ of SO or more, but less than 1,000,000€ of SO (ES11);
- 1,000,000€ of SO or more, but less than 1,500,000€ of SO (ES12);
- 1,500,000€ of SO or more, but less than 3,000,000€ of SO (ES13);
- 3,000,000€ of SO or more (ES14).

FADN only covers farms which are large enough to be considered as 'commercial'. To qualify as such, a farm's economic production potential, *i.e.*, its size measured in terms of SO, must exceed a certain threshold, which depends on Member States. For example, this minimum size was 2,000€ of SO (ES2) in Romania and Bulgaria, 4,000€ of SO (ES3) in Spain and Italy, 15,000€ of SO (ES5) in Denmark, 25,000€ of SO (ES6) in Belgium, France, Germany, the Netherlands and the United-Kingdom, etc. Therefore, some of the lower ES categories among the 13 described above were empty for some Member States because such farms are simply out of the scope of the FADN survey in these countries.

Conversely, higher ES categories were sometimes not directly usable either. Indeed, whenever the surveyed sample in some ES category consists of less than 15 farms, the database informs that such farms exist, and records their number, but all other variables are left empty. But since the FADN database also provides information for the population of

[3] For a detailed presentation of the FADN survey, see http://ec.europa.eu/agriculture/rica

commercial farms as a whole, it was possible, by subtraction, to derive the necessary data for an aggregate of the higher blank categories.

As a result, the number of usable observed data points to estimate the 264 parametric Lorenz was not systematically 13 but ranged from 4 (in one country×year case, or less than 0.4%) to 13 (in 14 cases or 5%). The number of usable points was nonetheless sufficient for a robust estimation in most cases: in 95% of the cases 7 points or more were available; in 53% of the cases 9 points or more were available and; in 25% of the cases 11 points or more were available.

Table 1 provides an overview of the corresponding data for 2010, where the original size categories have been aggregated into three to spare space, namely: 2,000€ of SO or more but less than 50,000€ of SO (ES2 to ES6); 50,000€ of SO or more but less than 100,000€ of SO (ES7) and; 100,000€ of SO or more (ES8 to ES14). In this table, farm numbers and production potentials by size categories are not reported as such but rather as category shares, along with the total number of holdings and the total production potential. This allows a more direct cross-country comparison of the distribution of commercial farm sizes.

[Table 1 about here.]

FADN data were also used to identify technico-economic variables potentially linked to the SHHI concentration indicator. These are presented in table 2 along with their summary statistics.

[Table 2 about here.]

In this exploratory work, the chosen set of variables ranges from technical characteristics, such as the ratio of unpaid to total labour or the stocking density of grazing livestock, to economic and financial indicators, such as the farm-level net value added or net investment. Several types of subsidies granted to farms in the framework of the Common Agricultural Policy (CAP), both from the first and second pillars, were also included in the analysis. Variables were also chosen so as to minimize collinearity issues. Finally, in the subsequent analysis, the economic, financial and policy variables were related either to the number of hectares of utilized agricultural area or to the production potential in Euros of SO in order to control for farm size effects.

4 Results

4.1 Parametric Lorenz curve estimation

Table 3 reports the results of the estimation of equation (1) for the 27 studied Member States in 2010, along with the derived SHHI concentration indicators.

[Table 3 about here.]

As R^2 figures show, the chosen parametric form for the Lorenz curve fits the data to a highly satisfactory extent: all R^2 values lie above 0.99, three of them even peaking at 1 with 4 decimal places (for Belgium, France and Luxembourg). The estimated parameters are also accurately identified, with standard deviations never exceeding 16% of the coefficient. For Romania, the estimated β hits the upper bound of possible values, so that the standard error cannot be computed in this case; as a result, the SHHI was derived from random draws of α only, β being kept at 1 in this case. In the other 237 country×year cases, the parametric Lorenz curve fitted the data as well as for the reported year, with similar R^2 levels (not reported).

In 2010, the SHHI concentration indicators range from 0.076 for France, to 32.7 for Latvia (table 3). Even if such values are far lower than those generally observed in industrial sectors for the true HHI, the proposed simulated indicator nonetheless allows to rank Member States against each other. Then, overall, with SHHI values well above 5, concentration levels are higher in Central and Eastern Europe Member States, but Poland and Slovenia. In these two latter cases, larger farms are only a few and hold a relatively limited amount of the total production potential (see table 1); moreover, in Poland, the farm population is large, which is consistent with a low SHHI. Among the 15 'old' Member States, Luxembourg and France appear as noticeable exceptions, the former because its SHHI (10.3) compares with that of 'new' Member States, the latter because it appears as an outlier with the lowest SHHI (0.076), by far. This result is particularly interesting because Luxembourg simultaneously exhibits a lower relative Gini coefficient (0.392) than France (0.441).[4] Then, farms in Luxembourg as more equally distributed with respect to the economic size relative to France –as can be deduced from the relative Gini coefficient, but as there are a lot less of them, the production potential is much more concentrated in Luxembourg than in France –as can be deduced from the SHHI. This confirms that the proposed SHHI, even if only a coarse proxy of the true HHI, allows revealing situations that the Gini fails to disentangle.

4.2 Factors related to concentration

Table 4 reports the results of a first attempt to find statistical links between the SHHI and technico-economic variables surveyed in the FADN. Four models were implemented: in models 1 and 2, monetary variables (farm net value added, farm net income, net investment and the four types of subsidies considered) were divided by the utilized agricultural area of the representative farm whereas, in models 3 and 4, these variables were divided by the economic size in SO of the representative farm; moreover, models 2 and 4 depart from models 1 and 3 by the addition of country dummies to the set of considered variables.

The four models were estimated using simple ordinary least squares, with no consideration of potential endogeneity issues. Therefore, the obtained figures should not be viewed as depicting causal relations between the considered covariates and the SHHI, but rather as evidencing significant (or not) statistical, descriptive, relationships.

R^2 values lead to consider that models including national dummies are to be preferred, among which model 4 outperforms model 2 slightly. Marginal effects depicting the absolute SHHI change induced by a 1% variation in each explanatory variable of interest are thus reported for model 4 along with the estimated regression coefficients.

[Table 4 about here.]

It then appears that all the significant considered variables but net investment are negatively linked with SHHI: the higher the share of family labour, output to input ratio, share of crops in total output, coupled area and livestock payments per unit of SO, as well as decoupled payments per unit of SO, the lower the concentration. Conversely, the higher the net investment per unit of SO, the higher the concentration.

[4] Due to space constraints, relative Gini coefficients are not reported here. They are nonetheless easy to parametrically derive from Rasche et al. (1980)'s functional form as $Gini = 1 - \frac{2}{\alpha}B(1/\alpha, 1 + 1/\beta)$, where $B()$ is the Beta distribution.

4.3 Decomposing the evolution of concentration

Finally, one advantage of the SHHI over the relative Gini coefficient is that its evolution may be decomposed into a 'number effect' and a 'distribution effect'. Indeed, it is possible to assess the extent to which concentration has evolved due to, on the one hand, a change in the number of farms and/or, on the other hand, a change in the distribution of farm sizes.

To do so, considering two consecutive observation years $t-1$ and t, four SHHI were estimated:

- $\text{SHHI}(N_{t-1}; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$, the SHHI for $t-1$, derived from the total number of farms observed in $t-1$, N_{t-1}, and the Lorenz curve estimated for $t-1$, defined by the pair $(\hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$;
- $\text{SHHI}(N_t; \hat{\alpha}_t, \hat{\beta}_t)$, the SHHI for t, derived from the total number of farms observed in t, N_t, and the Lorenz curve estimated for t, defined by the pair $(\hat{\alpha}_t, \hat{\beta}_t)$;
- $\text{SHHI}(N_t; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$, the SHHI which would have prevailed in t if only the total number of farms had changed between $t-1$ and t, the distribution of farm sizes remaining unchanged;
- $\text{SHHI}(N_{t-1}; \hat{\alpha}_t, \hat{\beta}_t)$, the SHHI which would have prevailed in t if only the distribution of farm sizes had changed between $t-1$ and t, the total number of farms remaining unchanged.

Note that, as only size shares enter its definition, the SHHI only depends on the total number of farms N_t and not on the total size S_t, for any given year t. Then:

- the ratio $\text{SHHI}(N_t; \hat{\alpha}_t, \hat{\beta}_t)/\text{SHHI}(N_{t-1}; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$ informs on the overall evolution of concentration between $t-1$ and t: if the ratio is below 1 concentration decreased, whereas if it is above 1 concentration increased;
- the ratio $\text{SHHI}(N_{t-1}; \hat{\alpha}_t, \hat{\beta}_t)/\text{SHHI}(N_{t-1}; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$ measures the extent to which the overall evolution is due to a change in the sole distribution of farm sizes (the 'distribution effect');
- the ratio $\text{SHHI}(N_t; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})/\text{SHHI}(N_{t-1}; \hat{\alpha}_{t-1}, \hat{\beta}_{t-1})$ measures the extent to which the overall evolution is due to a change in the sole number of farms (the 'number effect').

Figure 1 summarizes these three ratios for the 237 (264−27) observed annual changes, with the 'distribution effect' appearing on the horizontal axis, the 'number effect' appearing on the vertical axis, and the overall concentration evolution being depicted by two different marker symbols.

[Figure 1 about here.]

Four situations, corresponding to the four quadrants of figure 1, may be identified depending on whether the number of farms increased or decreased and on whether the distribution of farm sizes became more or less unequal. It appears that concentration may have increased not only because there were fewer and more unequally distributed farms ('north-east' quadrant) but also in a large number of cases because the increase in farm size inequality has off-set the increase in farm numbers ('south-east' quadrant) and, in fewer cases, because the reduction in farm number has off-set a change toward more homogeneous sizes ('north-west' quadrant). Similarly concentration may have decreased either because of a consistent farm number and size distribution evolution ('south-west' quadrant) or even though both trends were opposite ('north-west' and 'south-east' quadrants).

5 Concluding remarks

This paper introduced the SHHI indicator, a simulated version of the Herfindahl-Hirschman Index (HHI) to study the concentration of the economic production potential among European commercial farms at the Member States scale. The proposed adaptation of the HHI aims at dealing with the atomized nature of production structures in the farming sector and the grouped nature of the available data where individual size shares, which would be necessary to compute the exact HHI, are not directly observable in practice.

The SHHI allowed comparing the concentration levels of economic sizes across Member States and to investigate the relationships between concentration and a set of technico-economic factors characterising farming structures at the national level. Moreover, a dynamic analysis of the SHHI evolution allowed disentangling the respective contributions of, on the one hand, absolute farm number change and, on the other hand, relative farm size distribution change, in the overall evolution of production potential concentration. Results show that the SHHI may be complementary to the more traditional relative Gini inequality indicator to shed light on the process of farming concentration across EU Member States. They also reveal that there exists a variety of situations that may lead to concentration, resulting from the interplay of farm number reduction and farm size heterogeneity increase.

The present work should be extended in several directions though. Just to mention three of them, the asymptotic properties of the proposed SHHI estimator should first be established. Second, the study could be conducted at a more spatially disaggregated scale (*e.g.*, at the NUTS2 level) and/or by types of farming not only to get a more detailed picture of farming concentration but also to add gainful variability for subsequent econometric analyses. Finally, the econometric analysis of potential concentration drivers should be both widened and strengthened to account for other interesting variables (such as the price of land, the interest rate, land market regulations, etc.) and to tend towards a causal approach which would take potential endogeneity issues into account.

As some authors note that the decline of family farming and the surge in land grabbing strategies become a topical political issue even in developed countries such as the EU (Kay et al. 2015, van der Ploeg et al. 2015), such a wider and comprehensive analysis would contribute to the political debate on the relevance and efficiency of a public intervention in the agricultural sector to impede the so-called 'financialisation' of farming, and/or to promote a specific model, or a diversity of models, of production structures.

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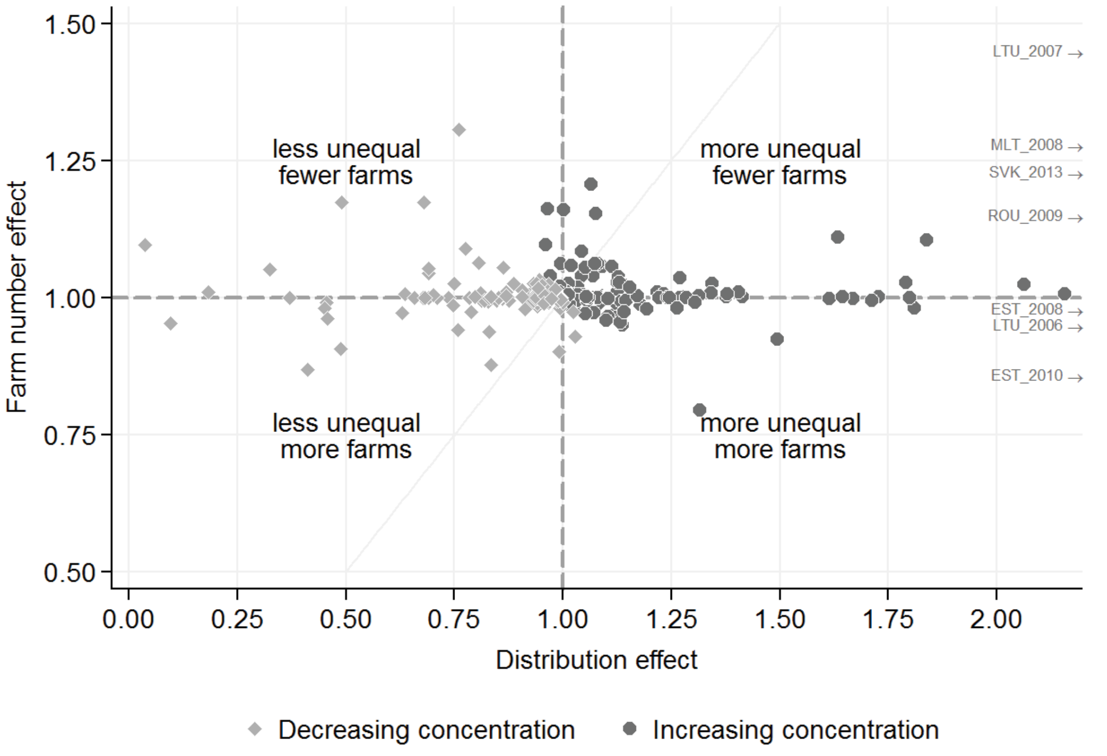
Figure 1. Concentration evolution and the farm number and farm size distribution effects (237 observed annual changes)[a]



[a] On the right hand side of the graph, added texts such as "MLT_2008 →" stand for outlier country×year pairs whose 'distribution effect' lies far beyond 2.

Source: FADN 2013, EU Commission/DGAgri - authors' calculation

Table 1. Distribution of holding numbers and Economic size in 2010 at the national level by size category in Euros of standard output (SO)[a]

Member state	Total holdings	Share within total (%)			Total SO	Share within total (%)		
	(×1000)	ES2-6	ES7	ES8-14	(×1000€)	ES2-6	ES7	ES8-14
Austria (OST)	93.2	65	20	14	5,284.4	28	25	46
Belgium (BEL)	30.8	5	27	68	7,334.4	1	9	91
Bulgaria (BGR)	115.7	94	3	3	2,840.6	29	8	63
Cyprus (CYP)	10.2	84	9	7	364.5	31	18	51
Czech Republic (CZE)	14.9	55	17	28	3,631.0	5	5	90
Denmark (DAN)	28.7	39	16	46	8,438.4	4	4	92
Estonia (EST)	8.1	79	10	11	572.7	16	10	74
Finland (SUO)	39.2	57	22	21	2,974.4	17	22	62
France (FRA)	295.8	18	29	53	46,082.5	5	14	81
Germany (DEU)	193.1	21	25	54	39,472.3	4	9	87
Greece (ELL)	316.6	95	4	1	5,413.2	76	15	9
Hungary (HUN)	105.8	86	8	6	4,999.4	25	12	63
Ireland (IRE)	103.8	80	11	9	3,675.9	36	21	42
Italy (ITA)	787.2	78	11	11	45,942.5	23	14	63
Latvia (LVA)	22.7	90	5	5	762.7	39	11	51
Lithuania (LTU)	53.5	93	4	3	1,325.6	44	12	44
Luxembourg (LUX)	1.6	17	20	63	266.8	4	9	87
Malta (MLT)	3.0	89	5	6	83.9	46	14	40
The Netherlands (NED)	51.7	6	19	75	19,065.7	1	4	96
Poland (POL)	727.7	93	5	3	17,318.3	56	14	30
Portugal (POR)	110.5	86	7	7	3,557.1	43	15	43
Romania (ROU)	1,038.8	99	1	1	9,594.5	68	5	28
Slovakia (SVK)	3.4	18	27	55	1,525.4	1	4	94
Slovenia (SVN)	40.0	89	9	2	876.4	52	29	19
Spain (ESP)	541.4	75	13	12	30,103.5	25	16	59
Sweden (SVE)	27.6	49	20	32	3,357.7	12	12	76
United Kingdom (UKI)	92.6	24	29	47	17,414.3	4	11	84

[a] In the column headings, 'ES2-6' stands for 'less than 50k€ of SO'; 'ES7' stands for '50k€ to less than 100k€ of SO'; 'ES8-14' stands for '100k€ of SO or more'. Shares may not sum to 1 on each row due to rounding.

Source: FADN 2010, EU Commission/DGAgri - authors' calculation

Table 2. Descriptive statistics in 2010 (27 Member States; 4,858,450 extrapolated farms)

Variable name	Description	Unit	Average	Std. dev.	Min.	Max.
UtAgArea	Utilized Agricultural Area (UAA)	ha	32.45	34.91	2.73	508.77
EconSize	Economic size in standard output (SO)	1000€ of SO	58.1	66.5	9.2	369.5
UnpaidShare	Share of unpaid labour in total labour	%	78	13	9	97
RentedShare	Share of rented land in total UAA	%	47	18	18	95
LSDensity	Grazing livestock stocking density	LU/ha	1.46	0.54	0.46	7.39
Output2Input	Ratio of total output to total input		1.27	0.18	0.65	1.53
CropOutSh	Share of crop output to total output	%	57	10	22	71
NetVA	Farm net value added	1000€	27.6	26.2	6.1	145.3
NetIncome	Farm net income	1000€	18.1	13.2	-44.2	65.7
NetInvest	Net investment	1000€	-0.4	4.4	-25.3	31.0
AreaPaym	Compensatory area payments	1000€	0.010	0.019	0.000	0.097
LSPremium	Livestock subsidies	1000€	0.6	1.2	-0.5	10.5
RuralDev	Total support for rural development	1000€	2.0	3.4	0.1	52.9
DecoupPaym	Decoupled payments	1000€	7.3	8.5	0.8	71.5

Source: FADN 2010, EU Commission/DGAgri - authors' calculation

Table 3. Equation (1) estimation results in 2010 (standard errors in parenthesis)

Member state	R^2	α	β	SHHI[a]
Austria (OST)	0.9995	0.637(0.029)	0.575(0.031)	0.303(0.034)
Belgium (BEL)	1.0000	0.654(0.010)	0.614(0.015)	0.750(0.014)
Bulgaria (BGR)	0.9961	0.416(0.030)	0.330(0.048)	10.135(3.446)
Cyprus (CYP)	0.9988	0.428(0.016)	0.544(0.029)	21.391(2.886)
Czech Republic (CZE)	0.9955	0.637(0.053)	0.223(0.034)	7.464(1.875)
Denmark (DAN)	0.9996	0.678(0.013)	0.328(0.012)	1.596(0.043)
Estonia (EST)	0.9944	0.494(0.047)	0.315(0.051)	31.699(10.768)
Finland (SUO)	0.9998	0.671(0.017)	0.470(0.018)	0.760(0.036)
France (FRA)	1.0000	0.648(0.007)	0.646(0.010)	0.076(0.002)
Germany (DEU)	0.9999	0.493(0.009)	0.664(0.014)	0.458(0.041)
Greece (ELL)	0.9999	0.556(0.013)	0.709(0.024)	0.121(0.010)
Hungary (HUN)	0.9972	0.320(0.024)	0.549(0.052)	26.365(8.822)
Ireland (IRE)	0.9987	0.633(0.048)	0.456(0.047)	0.400(0.096)
Italy (ITA)	0.9996	0.421(0.010)	0.522(0.020)	0.754(0.105)
Latvia (LVA)	0.9983	0.340(0.023)	0.671(0.059)	32.679(8.435)
Lithuania (LTU)	0.9994	0.319(0.015)	0.721(0.042)	23.259(4.393)
Luxembourg (LUX)	0.9999	0.741(0.015)	0.622(0.018)	10.268(0.181)
Malta (MLT)	0.9964	0.491(0.060)	0.578(0.084)	29.445(13.159)
The Netherlands (NED)	0.9999	0.555(0.014)	0.601(0.021)	0.923(0.077)
Poland (POL)	0.9998	0.403(0.008)	0.751(0.019)	0.582(0.081)
Portugal (POR)	0.9993	0.467(0.027)	0.618(0.048)	1.342(0.406)
Romania (ROU)	0.9917	0.273(0.007)	1.000(na)	6.110(1.133)
Slovakia (SVK)	0.9995	0.679(0.022)	0.331(0.018)	13.185(0.642)
Slovenia (SVN)	0.9995	0.544(0.033)	0.587(0.045)	1.417(0.330)
Spain (ESP)	0.9998	0.482(0.010)	0.516(0.016)	0.332(0.038)
Sweden (SVE)	0.9994	0.619(0.021)	0.479(0.028)	1.435(0.107)
United Kingdom (UKI)	0.9999	0.547(0.006)	0.589(0.013)	0.583(0.017)

[a] For SHHI, central values and standard errors derive from the simulation of 100 Monte Carlo replications (see text).

Source: FADN 2010, EU Commission/DGAgri - authors' calculation

Table 4. Regression results (standard errors in parenthesis)

	Model 1	Model 2	Model 3	Model 4	
	Coefficients	Coefficients	Coefficients	Coefficients	Marginal effects
Dependent var.	SHHI	SHHI	SHHI	SHHI	
Constant	126.8(75.7)	258.4(99.3)***	130.1(61.2)**	290.2(85.6)***	
UnpaidShare	-5.6(14.7)	-256.4(73.5)***	-46.5(24.0)*	-176.5(52.3)***	-122.3(36.2)***
RentedShare	-25.0(26.8)	-67.1(60.0)	-6.7(15.0)	-80.6(52.4)	-42.4(27.6)
LSDensity	2.4(3.2)	2.2(1.9)	2.4(1.3)*	1.3(1.9)	2.1(3.0)
Output2Input	-85.0(46.5)*	26.6(19.4)	-92.7(44.3)**	-62.5(27.5)**	-67.2(29.6)**
CropOutputSh	20.2(19.7)	-67.2(23.9)***	18.6(20.8)	-66.9(26.3)**	-31.7(12.5)**
FarmNetVAHa	-11.8(8.3)	-22.5(9.5)**			
FarmNetIncHa	43.0(25.6)	15.1(8.7)*			
NetInvHa	-3.6(2.6)	0.4(2.0)			
AreaPaymHa	-197.5(90.2)**	35.6(31.2)			
LSPremiumHa	-72.1(34.5)**	14.2(15.3)			
RuralDevHa	-73.2(51.3)	-0.3(17.4)			
DecoupPaymHa	-101.3(45.2)**	28.0(20.1)			
FarmNetVAES			-27.1(33.4)	39.7(42.0)	19.0(20.1)
FarmNetIncES			135.5(56.6)**	40.1(40.9)	12.7(13.0)
NetInvES			42.5(33.0)	35.1(15.0)**	1.6(0.7)**
AreaPaymES			-333.1(184.5)*	-141.6(69.7)**	-0.9(0.4)**
LSPremiumES			-36.5(65.8)	-234.0(76.5)***	-6.3(2.0)***
RuralDevES			-46.0(49.6)	56.6(44.9)	4.2(3.3)
DecoupPaymES			-142.5(81.3)*	-128.9(50.9)**	-15.5(6.1)**
Year dummies	yes	yes	yes	yes	
Country dummies	no	yes	no	yes	
Variance	clustered	robust	clustered	robust	
Observations	264	264	264	264	
Adjusted R^2	0.20	0.73	0.31	0.77	

Note: *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Source: FADN 2004-2013, EU Commission/DGAgri - authors' calculation