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Group farming in France: Why are some regions more conducive to cooperation than others?

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Abstract

The global debate on food security and the kinds of farming systems that could prove economically and ecologically sustainable has focused overwhelmingly on small family farms versus large commercial farms, with little attention to alternative models based on farmer cooperation. France offers a significant but internationally little recognised (and under-researched) model of group farming—the GAEC (Groupement Agricoles d'Exploitation en Commun)—based on farmers pooling land, labour and capital. This model is of considerable contemporary interest for both France and other countries. Catalysed by a 1962 law, GAECs accounted for 7.6% of farms and 15% of agricultural adult work units in 2010, but their incidence varied greatly across regions. Using data from the French agricultural census and other sources, this paper identifies the factors (economic, ecological, social and demographic) underlying this regional variation of GAECs (and comparatively of EARLs—Exploitations Agricoles à Responsabilité Limitée—another type of group farm introduced in 1985). Regions with a higher incidence of group farms are found to be those with greater economic equality, local ecology favouring labour-intensive animal breeding, social institutions that promote community cohesion, and higher proportions of agricultural graduates, among other factors. The paper not only illuminates the contexts favourable to the emergence of group farming in France, but also points to the conditions under which farmer cooperation could take root elsewhere, thus breaking new ground on an issue of substantial policy relevance.

Keywords

Group farming; Cooperation; France; GAEC; Institutional innovation; Regional variations

JEL Codes

D02, Q12, Q13, R11, N94

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1. Introduction

There is a global debate today on what kinds of farm enterprises could ensure food security, socio-ecological sustainability, and equitable economic development. But the debate focuses mainly on two types of farms: family farms (often small-scale) which still characterise agriculture globally, and large-scale commercial farms. Some see family farms (which constitute 98% of all farms and cover at least 53% of agricultural land globally: Graeub et al, 2016) as the most appropriate vehicle for food security and sustainable development (Imai et al, 2014; HLPE 2013), while others favour large commercial farms (Collier and Dercon, 2014). However, for millions of small farmers—especially, but not only, in developing countries—who face serious resource constraints, family farming provides inadequate returns for subsistence, while large commercial farms fail to provide work to the vast numbers still dependent on agriculture and lacking other options (Dorin et al, 2013; Dorin and Aubron, 2016). Clearly, we need to examine alternative models of farming. Yet current policy debates and existing research have paid virtually no attention to an important third model, namely group farming, wherein farmers voluntarily pool their land, labour and capital (without forfeiting private property rights), and share costs, risks and profits. This model contrasts sharply with the collective farms created under socialist regimes, based on forced collectivisation and a forfeiture of individual property rights.

The lack of attention to voluntary group farming is surprising, given its many existing examples globally. For instance, in France, group farming has existed at least since the 1960s. It also emerged as a notable form in many post-socialist countries after de-collectivisation of agriculture in the 1990s, including in East Germany, Kyrgyzstan, Romania and Nicaragua.[1] And since the early 2000s, it has been initiated in several parts of India (Agarwal, 2010a; Agarwal, in press). Reasons for the neglect of this alternative model are likely to lie in the adverse experience of collectivisation under socialist regimes;[2] the poorly designed and hence largely unsuccessful efforts to promote cooperative farming in the 1950s and 1960s in the post-colonial, newly independent developing countries of Asia, Africa and Latin America;[3] and, most of all, in the pessimism embedded in economic theory on the possibility of people cooperating. For instance, Olsen's (1965) highly influential work, *The Logic of Collective Action*, and the numerous papers on prisoner dilemma games which dominated collective action theory among economists in the 1970s and 1980s,[4] entrenched the idea that people driven by self-interest will tend to free ride and expect others to do the same, and so undermine efforts to cooperate, notwithstanding the potential gains from cooperation.

[1] See, Sabates-Wheeler (2002) and Sabates-Wheeler and Childress (2004) for Romania and Kyrgyzstan; Mathijs and Swinnen (2009) for East Germany; Ruben and Lerman (2005) for Nicaragua; and Agarwal (2010a) for additional examples.
[2] See, especially, Robinson (1967) and Nove (1969) for the USSR; Lin (1990) and Putterman (1997) for China; and Goyal (1966) and Agarwal (2010a) for an overview of several countries.
[3] See, especially, Agarwal (2010a) for a detailed discussion on both socialist collectivization and the 1950s/1960s experiments in cooperative farming in developing countries.
[4] In the 1970s there were already over 2,000 such papers (Ostrom 1990: 5).

In recent decades, however, there has been a growing recognition in economic theory that enabling conditions—such as frequent interaction, trust and reciprocity, favourable social norms, and peer pressure within small groups—can curb free riding and propel cooperation (Ostrom, 1990; Baland and Platteau, 1996; Elster, 1989). Evolutionary theories also highlight people's ability to cooperate (Axelrod 1984). Moreover, beyond developments within theory itself, a growing body of empirical work has demonstrated that communities are successfully cooperating for governing common pool resources, leading to improved conservation outcomes (Ostrom, 1990; Agarwal, 2010b).

Cooperation around natural resource *governance*, however, differs from cooperation for agricultural *production*. Farm production involves distinct, dense and complex forms of everyday interaction. And although service cooperatives, especially for marketing, sharing machines or procuring inputs, are widespread globally,[5] these do not require everyday cooperation in the production process itself. For instance, family farms can produce milk, meat, or crops individually, while using cooperatives only for selling these items. Cooperation in agricultural production by pooling land, labour and capital—what Agarwal (2014) terms 'multipurpose comprehensive cooperation'—is much less common, and even less researched.

A study of group farming, based on such multipurpose cooperation, acquires particular relevance today, given that people in many countries are seeking diverse pathways to carve out viable livelihoods within agriculture. This includes not only existing farmers seeking more lucrative and sustainable options, but also new entrants to the labour force who need outlets in farming due to limited non-farm jobs, or those who want to make agriculture a lifestyle choice. Climatic changes also require cooperative solutions for conserving soil and water over wider geographies than covered by individual farms. In other words, there is a growing imperative to examine the potential of farming models based on cooperation.

Here the experience of France is especially relevant. It has perhaps the oldest and certainly the most significant examples of voluntarily constituted group farms, as embodied in GAECs (*Groupements Agricoles d'Exploitation en Commun*) and to some extent in EARLs *(Exploitations Agricoles à Responsabilité Limitée*), and can thus provide particular insights on the characteristic features of these farming models and the contexts in which they emerge. This is not only because of their long existence and numerical strength, but also because of their regional clustering: GAECs are much more concentrated in north-western and central-eastern France, than elsewhere (see Figures 1 and 2). This begs the question: Do regions with more GAECs have features especially conducive to cooperation such as the local ecology, economy, demography, culture, or a mix of these and other factors? An analysis of these factors is of interest not only in itself, but also to help us understand which contexts are more conducive to the formation and endurance of this form of farming. In turn, the underlying factors could provide lessons for the potential adaptability of such models beyond France.

[5] See, eg, Deininger (1993), Inayatullah (1972), Mascarenhas (1988), Hariss and Fulton (1999), Fischer and Qaim (2014).

Figure 1: GAECs number in 2010

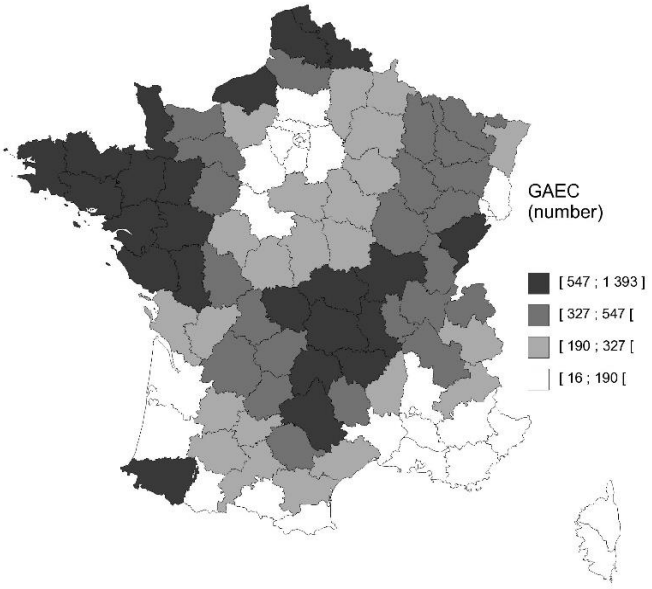
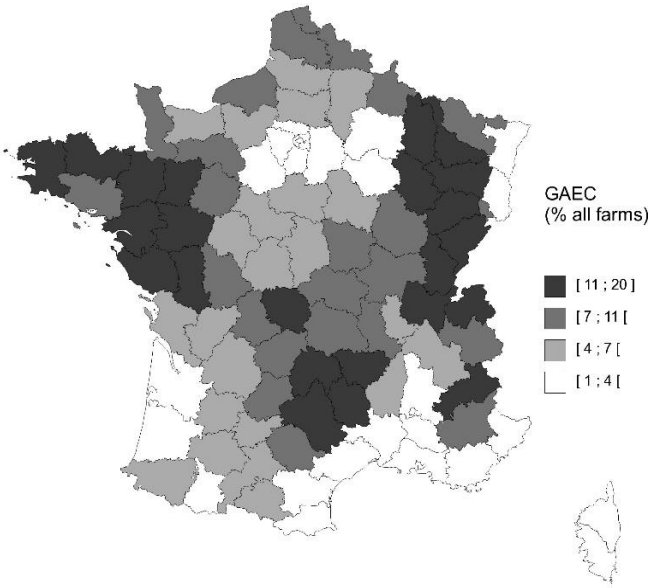


Figure 2: GAECs as a percentage of all farms in 2010



The questions we pose have been little researched, especially the factors underlying the regional clustering of GAECs and EARLs. Our paper will thus break fresh ground. It will also contribute to ongoing academic and policy debates on economically viable agriculture, by its focus on alternative farming models based on cooperation. The paper is divided into six sections. Section 2, which follows, provides a background to GAEC and EARL formation and an overview of existing studies. Section 3 discusses the broad characteristics of GAECs and EARLs based on agricultural censuses from 1988 to 2010. Section 4 presents our model and hypotheses regarding the factors that could explain the greater incidence of GAECs in certain regions over others. A comparison with EARLs is also provided. Section 5 presents our regression results, followed by concluding reflections and policy pointers in Section 6.

2. Background and existing studies

Legally, GAECs were catalysed in France by a law passed in 1962, which became fully effective some years later (Raup, 1975). The law specified a legal minimum of two partners/associates and a maximum of ten, with the requirement that all partners work full time on the farm. The law also incorporated a 'transparency principle' (Article L323-13 of the French Rural Code) under which the State, for its agricultural support programmes, would treat each partner as an individual entity, while also recognising a GAEC's collective identity.

This principle enabled GAEC partners to benefit from public incentives on the same basis as individual farmers, including when the Common Agricultural Policy (CAP) of the European Union (EU) introduced direct income support 'decoupled' from price support.[6] Also in 2013, the EU officially recognised the transparency principle for GAECs.[7]

Socially, however, GAECs were propelled especially by the *Jeunesse Agricole Catholique* (JAC)[8] or Agricultural Catholic Youth association, 'guided by the conviction that a "third road" was needed between what was regarded as the abuses of capitalism and the excesses of Marxian collectivism' (Raup, 1975:3). This was also a period when the French government encouraged the modernisation of family-based agriculture, led by key figures such as Edgard Pisani (Minister of Agriculture, 1961-66).[9] The GAEC was seen as an institutional innovation close in structure to a family farm, in contrast to a corporate farm dependent largely on hired employees.

[6] In 1992 the CAP began to reduce price support for particular products, while introducing 'direct payments' per farm (or per associate in the case of GAEC).

[7] In terms of recognition, for direct subsidies, see EU regulation No. 1307/2013 of 17th December 2013, articles 8.4, 11.5, 41.8 and 52.7; for the European Agricultural Fund for Rural Development (EAFRD), see EU regulation No. 1305/2013 of 17th December 2013, article 31.4. For debates around this in early 2013, see Saget (2014).

[8] The JAC, created in 1929 by youths and priests, became the Rural Christian Youth Movement (MRJC) in 1963, and constituted a vibrant wing of the French Catholic Action.

[9] In 1960, another key institution which impinged on farm structures and growth was introduced, namely *Sociétés d'Aménagement Foncier et d'Etablissement Rural* (SAFER). These non-profit private companies work under government supervision, with a pre-emptive oversight on all transactions in agricultural land (Boinon 2003).

Forming a GAEC was expected to help individual family farms improve their managerial efficiency, productivity, and work conditions (GAEC & Sociétiés, 2010a).[10] For instance, by pooling their land, labour and capital, farmers with limited resources could modernise their farming techniques and organisation; experiment with new technologies which were too risky or needed too much capital for an individual farmer; take advantage of economies of scale; and free children or spouses from agricultural work to seek higher education or non-farm jobs. Moreover, in recognising sons and fathers as equal partners, GAECs enhanced the status of sons within the family, and thus their incentive to work harder and increase productivity. Farmers' wives, however, remained unequal, both economically and socially (Darque, 2008). They could not become associates without the presence of a third associate, until a change in law in 2010 allowed spouses to constitute couple GAECs.

EARLs were instituted legally in 1985, basically as limited liability societies, subject to different laws and procedures than GAECs.[11] For example, unlike GAECs which require at least two associates, EARLs can also be formed by one person (up to a maximum of 10) as well as by married couples. Moreover, in EARLs only shareholders who individually or as a group hold the majority capital are required to work on the farm, while minority shareholders need not. GAEC associates, in contrast, cannot take up any significant income-earning activity outside the GAEC.[12] Notwithstanding these differences, it is important to study EARLs, since those with two or more associates constitute a type of group farm, requiring associates to make capital investments and cooperate. In fact, sometimes EARLs change into GAECs or vice-versa (GAEC & Sociétés, 2010a).

In 2010 (the year of the last French Agricultural Census), GAECs constituted 7.6% of all farming enterprises in France, and accounted for 15% of the total annual work units (AWUs) in agriculture, one AWU being equivalent to one adult working full time for a year on the farm (also termed '*Unité de Travail Agricole*' or UTA).[13] EARLs with two or more associates constituted another 7.3% of farms and provided 12.7% of AWUs. Hence, GAECs—on their own or along with EARLs—accounted for a notable proportion of farms and agricultural employment. Today many GAECs have been operational for long years, and Copex in Taizé, South Burgundy, with six associates, has sustained for over 50 years (Copex, 2012). In the process, they have evolved, innovated, and moved to another generation of associates.

These farming models, based on close cooperation among associates (especially in the case of GAECs), are of considerable contemporary interest for both France and other countries. Apart from the potential advantages of group farming already listed,

[10] *GAEC & Sociétés* is the national association of GAECs founded by several organisations, including FNSEA, the main farmer's union in France. It publishes the journal *Agriculture de Groupe.*

[11] Other French farm enterprises, such as civil companies (SCEA) or commercial companies (SARL), are few in number (Agreste, 2014: 3).

[12] See, https://www.legifrance.gouv.fr/initRechCodeArticle.do and therein "*Code rural et de la pêche maritime*" articles L323-1 to L323-16 and R323-1 to R323-54.

[13] See National Institute of Statistics and Economic Studies, France: www.insee.fr/en/methodes/default.asp?page=definitions/unite-travail-annuel.htm

there are others, such as the ability of group farms to provide viable livelihoods to those (especially the young) who lack adequate land or capital to farm alone, or who like a rural life and are willing to cooperate on a daily basis for the less strenuous work life possible in a GAEC compared with farming individually. In a GAEC, for example, associates can substitute for each other in labour-intensive or monotonous tasks and take holiday breaks. Resource pooling can also allow associates to invest in larger capital-intensive machines, expand farm size, diversify farm activities or specialise in labour-intensive work such as animal breeding, and enlarge the range of skills and knowledge beyond those found in one farmer or family. The small number of associates (the maximum being 10) who know each other well can also help overcome the classic problems of free riding and work shirking, through peer-vigilance and mechanisms for enforcing accountability, such as weekly meetings and management committees.

Notwithstanding their relevance, long duration, and numerical strength, however, there is rather little systematic and rigorous research on GAECs. On the quantitative side, although the French agricultural census provides periodic data on the numbers, locations, composition and characteristics of GAECs, these data (which are comprehensive from 1988) appear to have been little used analytically, beyond the Ministry of Agriculture's own descriptive briefs.[14] The studies which do use the census, investigating, for instance, farm size inequality across departments (Piet et al, 2012), or preparing a typology of farm size and type of labour used (Bignebat et al, 2015), fail to separate individual and group farms, thus conflating a crucial characteristic of French farms. In fact, most existing research on GAECs is qualitative, and even this is limited in scope. Between 1965 and 1988, for example, the archives of *GAEC & Sociétés* list 29 masters' theses on the subject, but most are sociological studies of single GAECs or writings on GAEC law. In this period, there was, in fact, a fascination with the history of GAEC formation. For instance, a doctoral dissertation by an American anthropologist who researched 42 GAECs (not selected systematically) spread across France in the mid-1970s, provides historical insights on how GAECs emerged and functioned (Murphy, 1977). There are also occasional research papers on the administrative, legal and incentive provisions which encouraged GAEC creation (Raup, 1975), or on how family farms evolved into GAECs (Reboul, 1977; Madec, 1983; Bazille and Viallon, 1985); as well as some specialised monographs, such as on the involvement of GAEC associates in the social movements of the 1970s (Alland and Alland, 2001). Indeed, this preoccupation with the legal, philosophic, historical, or social aspects of GAECs continues, with empirical exploration being limited to a few GAECs, as evidenced by recent journal articles (eg Foyer et al, 2012; Chandellier et al, 2012; Barthez, 2007), as well as two special issues of *Revue de Droit Rural* (2012).

These writings are insightful, but still leave a gap in terms of quantitative analysis based on interdisciplinary explorations and hypothesis testing. Many questions remain unanswered, not only about the characteristics of GAECs and EARLs, and changes therein over time, but particularly about the geographic variations in their incidence across France. Explaining this variation through an empirical analysis, in order to better

[14] See eg various issues of *Agreste Primeur* and also Agreste (2014).

understand the conditions conducive to cooperation, is the central concern of our paper, and one which has not been addressed so far in the existing literature.

3. Characteristics of farm structures and changes over time

To map the range of French farming enterprises over time, we use department-wise data from the French Agricultural Censuses of 2010, 2000 and 1988 (Ministry of Agriculture, 2014). [15] We complement this with data from other sources (as detailed in Appendix A), to quantify the explanatory variables outlined in Section 4. Our analysis is confined to 92 of the 96 departments of metropolitan France: the four excluded departments (Paris, Hauts-de-Seine, Seine-Saint-Denis and Val-de-Marne) are highly urbanised and have few farms.

3.1. Farm types and shifts over time

In 2010, individual farms, GAECs, and EARLs respectively constituted 69.4%, 7.6% and 16.0% of all farms (Table 1). Notably though, almost half the EARLs had one associate, making them effectively similar to individual farms, except for their legal status. Since our interest is in understanding farmer cooperation, we will concentrate on GAECs, with some comparison with EARLs that have two associates or more (herein called 'EARL≥2') as a counterpoint.

In the 22 years between 1988 and 2010, the number of all farm enterprises fell to less than half, mainly due to the dramatic decline in individual farms, both numerically and proportionately (Table 1). In contrast, between 1988 and 2000 GAECs and EARLs increased notably, in both numbers and proportions, after which EARLs continued to increase numerically, but GAECs showed a slight decline. After 2010, however, even GAEC numbers moved upwards.[16]

In proportional terms, both GAECs and EARLs registered a rise from 1988 to 2010. GAECs as a percentage of all farm enterprises doubled from 3.7 to 7.6, and EARLs similarly increased from 0.15 to 16.1. Some argue (GAEC & Sociétés, 2010a:10), that these changes were related to the introduction of new State incentives for young farmers (DJA or *Dotation Jeunes Agriculteurs*),[17] but this does not explain their regional variation, which is the subject of this paper.

[15] Some details available in the 1988, 2000 and 2010 censuses (especially on the GAEC's social composition) are not available in earlier censuses.
[16] We lack comprehensive data after 2010, but according to GAEC & Sociétés, 2,296 new GAECs were registered in 2014 alone (personal communication, Eric Mastorchio, March 2016).
[17] Subsidies were established in 1973 for young farmers under 35 years of age, initially for mountainous and less favoured areas, but extended in 1976 to all of France, the amounts varying by the farm's location (Boinon 2003:168). Subsequently, other types of aid were added (including start-up aid and business development grants), and the age limit raised to 40 (European Commission, 2013). In 2014, further new conditions were set (GAEC & Sociétés, March 2016, and Agreste 2014).

Table 1: Farms by legal status in 1988, 2000, 2010

Type of farm	1988		2000		2010	
	No.	*%*	No.	*%*	No.	*%*
Individual	945,801	*93.05*	537,444	*80.99*	339,836	*69.37*
GAEC	37,708	*3.71*	41,474	*6.25*	37,204	*7.59*
EARL	1,523	*0.15*	55,913	*8.43*	78,594	*16.04*
Other	31,384	*3.09*	28,785	*4.34*	34,252	*6.99*
All farms	1,016,425	100.00	663,616	100.00	489,886	100.00

Source: Calculated from the 1988, 2000 and 2010 agricultural censuses (Ministry of Agriculture, 2014)
Note: In this and subsequent tables, all farms (small and professional) are included.

3.2. Social composition of group farms

Some GAECs are constituted only of relatives, others of both relatives and non-relatives, or only non-relatives. In 2010, the majority were still family GAECs, but after 1988 family GAECs declined and other types increased substantially (Table 2). Among family GAECs, those constituted by father and son fell from 58% in 1988 to 28% in 2010, while same-generation GAECs—typically of brothers or cousins—doubled. This suggests that GAECs are moving towards equality among associates (since father-son GAECs contain an implicit social hierarchy, notwithstanding their equal legal status as associates).

EARLs differ notably from GAECs in their social composition. In 2010, 54% were single member units, 29% were couple EARLs, and only 8% were father-son units, the rest being other family, non-family, or mixed (Agreste, 2014:17). Together, GAECs and EARL≥2 comprised 14.9% of all group farms in 2010.

Table 2: GAEC and EARL by social composition in 1988, 2000, 2010

Type of GAEC and EARL	1988		2000		2010	
	No.	%	No.	%	No.	%
GAEC						
1. GAEC mixed	460	1.3	1,596	4.1	2,654	7.4
2. GAEC Non-Family	1,152	3.3	2,655	6.9	3,100	8.7
3. GAEC Family	32,891	95.3	34,489	89.0	29,951	83.9
- GAEC Father & Son	*(19,283)*	*(58.6)*	*(11,286)*	*(32.7)*	*(8,285)*	*(27.7)*
- GAEC same generation	*(7,598)*	*(23.1)*	*(15,368)*	*(44.6)*	*(14,799)*	*(49.4)*
- GAEC several generations	*(5,965)*	*(18.1)*	*(7,602)*	*(22.0)*	*(6,434)*	*(21.5)*
- GAEC couple[a]	*(45)*	*(0.1)*	*(233)*	*(0.7)*	*(433)*	*(1.4)*
All GAEC with information[b]	34,503	100.0	38,740	100.0	35,705	100.0
EARL						
1. EARL single person	789	56.0	31,729	56.7	42,747	54.4
2. EARL ≥ 2 associates	619	44.0	24,184	43.3	35,847	45.6
All EARLS with information[c]	1,408	100.0	55,913	100.0	78,594	100.0

Source: Calculated from the 1988, 2000 and 2010 agricultural censuses (Ministry of Agriculture, 2014)
Notes: a Couple GAECs were not legally permitted till 2010. These numbers could thus reflect either misreporting or farms in transition which earlier had >2 associates.
b Excludes cases with missing information on GAEC type
c Excludes cases with missing information on associate numbers

Group farms are also becoming important in terms of annual work units. GAECs and EARL≥2 provided 27.7% of AWUs in 2010 (Table 3), a marked rise from 8% in 1988, while the percentages for individual farms fell from 82.6 to 44.1 during this period. In 2010, the per farm AWU (including salaried and seasonal workers) was 3.04 for GAECs, 2.27 for EARLs, and 0.98 for individual farms. GAECs (and group farms more generally) thus provide adult employment which is proportionately greater than their numeric presence.

Table 3: Annual Work Units by farm type in 2010

Type of farm	Farms		Annual work units (AWUs)		AWUs per farm	Ha of farm land[a] per AWU
	Number	%	Total	%		
GAEC	37,204	7.6	112,963	15.0	3.04	48.5
EARL	78,594	16.0	178,359	23.8	2.27	42.0
EARL ≥2 associates	*(35,847)*	*(7.3)*	*(95,295)*	*(12.7)*	*(2.66)*	*(43.3)*
Individual farm	339,836	69.4	331,179	44.1	0.98	34.8
Other farms	34,252	7.0	128,381	17.1	3.75	19.0
All farms	**489,886**	**100.0**	**750,883**	**100.0**	**1.53**	**35.8**

Source: calculated from the 2010 agricultural censuses (Ministry of Agriculture, 2014)

Notes: a Farm land (SAU) includes both crop land (under seasonal or perennial crops) and permanent pastures.

Another notable difference between group farms and individual farms is average land size, measured here in terms of '*Surface Agricole Utile*' (SAU) or utilised agricultural area.[18] Individual farms are the smallest, EARLs come next, and then GAECs which, on average, were larger than other farms even in 1988, and subsequently grew faster than other farms (Table 4).[19] Moreover, GAECs with non-family associates are larger than those with only family associates; and among family GAECs those constituted of several generations are much larger and equivalent to non-family GAECs. This is not unexpected, since mixed activity GAECs and multi-generational family GAECs can bring together a larger number of associates, who, in turn, are likely to bring in additional land, and also enable the group to expand the area they manage, especially through leasing. In 2010, one AWU on average managed 48.5 ha in a GAEC, against 42 ha in an EARL and 35 ha in an individual farm (see Table 3).

[18] SAU includes arable land (land under crops, vegetables, fallows, and temporary pastures), and land under perennial crops (vines, orchards, etc) and permanent pastures, but excludes woods and forests.

[19] France distinguishes between 'small' farms and 'professional' farms (viz. 'medium' or 'big' farms), based on their annual Standard Gross Production or 'SGP' (www.insee.fr/en/metadonnees/definition/c1354). We based our analysis, however, on all farms, in order to test which farm size categories were more likely to form GAECs. Also, for international comparability, we used agricultural area rather than SGP to define farm size.

Table 4: Average farm size by farm type over time

Type of Farm	Average SAU (ha)			Annual growth rate (%) 1988-2010
	1988	2000	2010	
Individual farms	24.72	29.99	34.01	1.5
GAECs all	83.67	120.11	147.56	2.6
1. GAEC mixed	125.73	149.82	180.20	1.6
2. GAEC non-family	81.21	115.91	148.02	2.8
3. GAEC family	83.17	119.14	144.69	2.6
–GAEC father and son	*(73.93)*	*(90.38)*	*(111.51)*	
–GAEC same generation	*(92.89)*	*(125.70)*	*(143.86)*	
–GAEC several generations	*(96.39)*	*(142.26)*	*(182.42)*	
EARLs all	65.48	85.44	95.15	1.7
1. EARL single associate	63.13	83.39	92.49	1.8
2. EARL ≥ 2 associates	69.97	88.12	98.33	1.6
Other farms	62.51	68.64	71.14	0.6
All farms	28.13	41.97	55.04	3.1

Source: Calculated from the 1988, 2000 and 2010 agricultural censuses (Ministry of Agriculture, 2014).

3.3. Activity specialisation

Most important for our discussion, group and individual farms differ in their activity specialisation. In 2010, almost a quarter of all farms specialised in seasonal crop cultivation (mostly cereals and oilseeds), 42% in cattle or other animals, and 21% in horticulture or gardens, plantations and vineyards, the rest doing mixed farming (Table 5). However, these proportions varied significantly by farm type. Over 65% of GAECs were into animal rearing (with 51% breeding meat and/or milk cattle), and only 10% into seasonal crops. EARL≥2 came in-between, with animal farming again dominating (47%), followed by seasonal crops (22%).[20] In all farm types, some grow crops alongside other activities, and most try and grow at least some of the fodder they need.

This activity pattern suggests a link between GAECs and farm specialisation. Rearing animals tends to be much more labour intensive than growing crops, especially since it needs daily care (feeding, milking, etc), even with some mechanisation. Moreover, this intensity continues throughout the year and, unlike crops, is not limited to seasonal peaks. Hence we would expect farmers who want to rear animals to veer towards group farming. Also, we might surmise that one of the factors underlying the concentration of GAECs in some regions over others could be ecology, which favours a particular type of specialisation. For instance, animal farming is often the best option in many mountainous or semi-mountainous areas (as, say, in parts of central-eastern France) where crop cultivation tends to be less profitable, and where difficult work conditions could also encourage cooperation.[21] Similarly, regions with more permanent pastures would provide fertile ground for forming GAECs, although, technically, intensive livestock breeding is also possible through stall-feeding.

[20] See also Agreste (2014) for a discussion on specialization and farm type.
[21] Within the broad category of 'mountain areas' there can of course be exceptions, but typically, mountain areas tend to be less suitable for crops than flat areas or valleys, in terms of soil, climate, potential for irrigation, mechanization, and market connectivity. The government also recognizes these disadvantages in the special incentives it gives for mountain areas.

Table 5: Product specialisation by farm type in 2010

	All Farms		GAEC		EARL ≥ 2 associates		Individual farms	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Fieldcrops	118,748	24.3	3,740	10.1	7,846	22.3	82,035	24.3
Cattle	120,526	24.7	18,791	51.0	11,113	31.6	77,806	23.0
- Meat	*(59,519)*	*(49.4)*	*(4,150)*	*(22.1)*	*(2,374)*	*(21.4)*	*(48,404)*	*(62.2)*
- Milk	*(50,219)*	*(41.7)*	*(11,653)*	*(62.0)*	*(7,594)*	*(68.3)*	*(24,056)*	*(30.9)*
- Mixed	*(10,788)*	*(9.0)*	*(2,988)*	*(15.9)*	*(1,145)*	*(10.3)*	*(5,346)*	*(6.9)*
Sheep &/or goats	56,216	11.5	2,549	6.9	1,699	4.8	47,974	14.2
Pigs, cattle (stall-fed) and/or chicken	29,881	6.1	2,721	7.4	3,723	10.6	15,931	4.7
Mixed farms	59,579	12.2	6,782	18.4	5,185	14.8	39,837	11.8
Horticulture or Plantation	32,865	6.7	862	2.3	1,432	4.1	23,934	7.1
Viticulture	69,872	14.3	1,424	3.9	4,122	11.7	50,347	14.9
Total with information	**487,687**	100.0	**36,869**	100.0	**35,120**	100.0	**337,864**	100.0
Unlabelled	1,770	-	0	**-**	0	**-**	1,536	**-**
No info	429	**-**	335	**-**	727	**-**	436	**-**
All farms	489,886		**37,204**		**35847**		**339836**	

Source: Calculated from the 2010 agricultural census (Ministry of Agriculture, 2014)
Note: Percentages exclude farms which were unlabelled or had missing information on specialisation. Figures in brackets are subcategories of cattle breeding.

Later we will statistically test the relationship between ecology and GAEC formation, but we get an inkling of this link from Table 6 which gives the degree of specialisation in animal farming across the newly constituted division of France into 13 regions. These regions club several departments into broader categories. For ease of discussion, we have further clustered these regions broadly into four (without implying full homogeneity within each). As Table 6 shows, the northern region is devoted mainly to crop cultivation, the western and eastern regions mainly to animal farming (with the eastern region having more crops than the west), while the southern region is more mixed, with the extreme (continental) southeast devoted mainly to plantations, horticulture or vineyards. In addition, Figure 3, which gives the regional spread of all farms specialising in animal breeding, reveals an interesting overlap between animal farming regions and the GAEC concentrations noted from Figures 1 and 2: both show concentrations in western and eastern France. Figure 4 also gives us permanent pasture land as a percentage of SAU. Here the overlap with GAEC incidence and animal farming is broadly consistent in the eastern parts but not in the western. In western France, as in Bretagne, there is little pasture land, and here the animals are largely stall-fed, although fodder is often still grown for feed.

Consider now our hypotheses relating to the factors (including permanent pastures) that could explain the regional variations we observe in the incidence of group farming.

4. Explaining regional variability: Hypotheses

We draw on our conceptual and historical understanding of French farming to identify potential explanatory factors for the observed regional variability of GAECs and EARLs. Some factors would be economic, others ecological, social/cultural, or demographic. We use an OLS regression model (specified below) to test for the significance of the identified factors. The dependent variable is the percentage of GAECs (or EARL≥2) to total farm enterprises in a department:

$$\%Farm_{s,i} = \gamma_0 + \sum_l \gamma_l X_{l,i}$$

where *s* represents the legal status of the farm (GAEC or EARL≥2), *i* the region (92 departments), X_l the independent variables (detailed in Appendix A) and $\{\gamma_0, \gamma_l\}$ the parameters to be estimated.

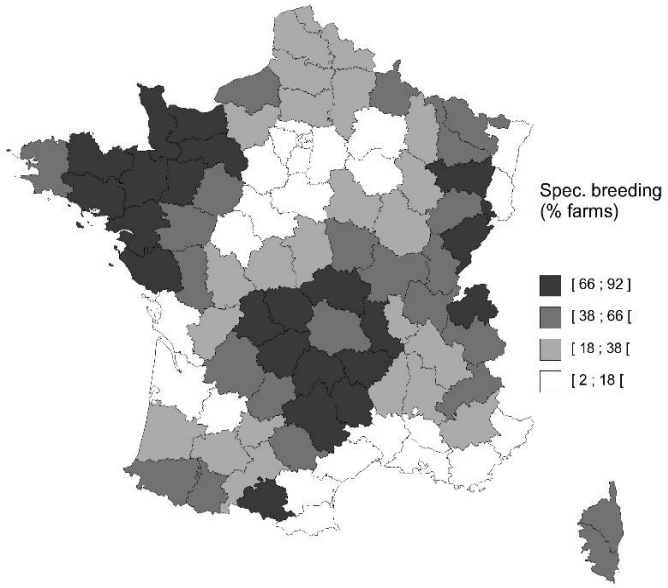
We first outline our hypotheses relating to GAECs, and then discuss briefly how these hypotheses might differ for EARL≥2.

Table 6: Agricultural specialisation by regions in 2010

	Percentage farms in each region with a given specialisation[a]					
Region	Field crops	Animal breeding[b]	Horticulture, Plantation, Viticulture	Mixed farms	Other and Unlabelled	All
NORTH						
Hauts-de-France	50.3	26.3 (22.8)	5.9	17.3	0.3	100.0
Ile-de-France	78.3	7.0 (5.8)	7.0	7.2	0.4	100.0
Centre Val-de-Loire	55.5	20.2 (17.3)	11.0	12.5	0.8	100.0
WEST						
Bretagne	15.9	69.8 (45.8)	3.8	10.3	0.2	100.0
Normandie	20.1	65.1 (61.0)	3.0	11.6	0.3	100.0
Pays de la Loire	13.9	65.3 (49.9)	9.6	11.0	0.3	100.0
Nouvelle Aquitaine	24.5	39.5 (33.4)	21.0	14.4	0.6	100.0
EAST						
Grand-Est	28.8	21.8 (19.6)	35.7	13.6	0.2	100.0
Bourgogne Franche-Comté	20.1	49.9 (46.8)	17.5	12.2	0.3	100.0
Auvergne Rhône-Alpes	15.4	56.0 (51.5)	16.6	11.7	0.3	100.0
SOUTH						
Occitanie	21.4	33.5 (29.8)	34.0	10.4	0.8	100.0
Provence Alpes Côte d'Azur (PACA)	12.6	14.3 (13.2)	64.3	8.5	0.4	100.0
Corse	4.4	53.8 (48.0)	31.7	9.8	0.3	100.0
All France	24.2	42.2 (36.1)	21.0	12.2	0.4	100.0

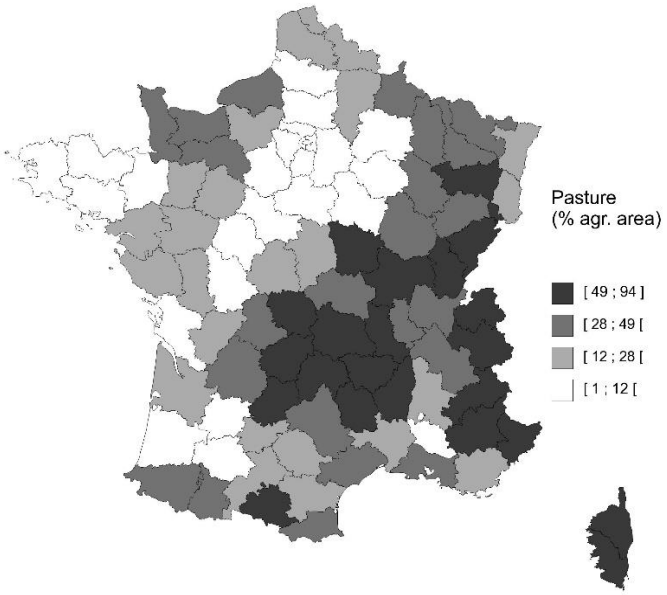
Notes: a Specialisation or Technical-Economic Orientation (TEO, also termed OTEX in France) is based on the proportion of the farm's total Standard Output (SO) attributable of a farm activity. When this proportion exceeds a threshold (usually 2/3), the farm is classified in the corresponding TEO.
b Includes cattle, sheep and goats (and other herbivores) and soilless farming (with 100% stallfed animals). Figures in brackets give the percentage of animals reared on grazing (partly or fully), and exclude soilless farming.

Figure 3: Farms specialising in animal breeding as percentage of all farms in 2010



Note: Animal breeding includes mainly farms breeding cattle for milk and/or meat (grazed or stall fed), sheep, goats, pigs and poultry

Figure 4: Permanent pastures as a percentage of SAU land in 2010



4.1. Economic factors

We examine two economic variables to explain the regional (departmental) incidence of GAECs: (i) income inequality and (ii) farm size categories dominant in the department in 1970 (that is, fairly soon after the GAEC law became effective).

We would expect GAECs to thrive more in regions of relative economic equality, since GAEC associates need a spirit of cooperation. Indeed, equality among associates is an important principle in GAEC formation and functioning. Hence regions with high inequality are likely to adversely affect GAEC formation. We measure this inequality by using the Gini coefficient of the department's per household taxable income.

Our second explanatory variable is pre-existing farm (land) size categories in a department. Normally we would expect the presence of a large number of small farms in a region to encourage group farming, since resource pooling would help non-viable farms to create a viable economic unit. This trajectory may not play out for GAECs, however, since GAEC associates are legally required not only to pool their resources (each has to bring a share of capital or land), but also to work full time on the farm without seeking outside employment, or running individual farms on the side. This means that the GAEC must provide associates with at least a basic income. Moreover, the idea that all farms (not just GAECs) should be large enough to yield a minimum income for the family was embedded in the French government's 1975 decree, under its Rural Code (article 188), which specified the minimum surface area (*Surface Minimum d'Installation* (SMI)) of the farm.[22] These factors are likely to reduce the chances of very small farms combining to form GAECs. Rather, we would expect departments with a high percentage of small farms in 1970 (the earliest year for which there are data after the GAEC law became effective) to be *less likely* to have formed GAECs.

In addition, departments with a high percentage of very large farms in 1970 are also likely to have a low incidence of GAECs since they would not need to form a GAEC to tap economies of scale, although they may form one for other reasons, such as engaging in multiple economic activities. In short, departments with a high percentage of farms in the very small and very large categories in the early period of GAEC formation may be expected to have lower proportions of GAECs today. It also means that the relationship between farm size categories and GAEC incidence could be non-linear. In this context, Raup's (1975:21) observations for the 1970s are especially notable: he observed that GAECs tended to be concentrated in areas dominated by medium sized farms, and were rarer in areas dominated by either very large or very small farms. He did not, however, statistically test this observation, as we will be doing.

[22] Fixed by ministerial decree (and periodically revised), the SMI varied by departments and zones within departments, according to land quality and activity. However, we could not find historical SMI data for all departments to use this as the threshold level. SMI specifications were discontinued in 2014. See, http://www.terresdeurope.net/SMI.asp

To test the effect of a pre-existing farm size distribution on GAEC formation, we used data from the 1970 agricultural census. Although it does not give the size of each farm, it gives us the proportion of farms in different farm size categories (in SAU units). Our hypothesis is that the higher the proportion of farms in the <20 ha category in a department in 1970, the lower the proportion of GAECs to total farms in 2010 in that department is likely to be (ie, the relationship would be negative). Alternately, the higher the proportion of ≥20 ha farms in 1970, the higher is likely to be the proportion of GAECs to total farms in 2010 (the relationship would be positive), although this relationship may not be linear. We also tested how the relationship pans out at different size categories above 20 ha, by examining the effects of several size categories, viz. 20-49 ha, ≥50 ha, and so on.

4.2. Ecological factors

We expect local ecology to play an important intermediary role in GAEC formation. As noted earlier, some regions of France are less suited to crops, such as ecological zones with poor land quality, marginal pasture areas, and mountain terrains characterised by low crop yields, where animal breeding on pastures often becomes the main livelihood option. In addition, the CAP has regulations regarding the conversion of permanent pastures to crop land.[23] For example, the CAP reform of 2003 (i) linked the maintenance/use of permanent pastures to subsidies, which would be reduced if the pastures were converted to cropland (see eg Beaufoy et al, 2011);[24] and (ii) specified that land under permanent pasture in a given reference year be maintained. In France, the reference year was 2003 and the regulation was enforced from 2005 (Dexjeux et al, 2007:19). In many regions, therefore, ecological and related conditions encourage milk or meat farming over crops or other activity. Livestock breeding, in turn, needs high labour inputs throughout the year, which would encourage GAEC formation, since GAECs can induct more adults to share the work. There would therefore be a greater likelihood of GAEC formation in regions with more permanent pastures (and hence greater potential for livestock farming). We use the percentage of SAU land under permanent meadows and pastures in a department as an explanatory variable, expecting it to be related positively to the incidence of GAECs in the department.

A region's irrigation potential can also affect activity choices. Crop cultivation is more dependent on irrigation than other farm activities, and one crop—maize—alone accounts for half of all surface area irrigated in France (Barraque et al, 2010). Farmers in regions with a higher percentage of irrigable land are thus more likely to cultivate crops, and hence less likely to form GAECs. We use irrigable area as a percentage of

[23] Under the rules in France, permanent pastures are 'areas devoted to grass production or other herbaceous fodder crops, in place for 5 years or more (except fallow lands). These permanent pastures are [so] named whether [they are] permanent grasslands, temporary grassland more than 5 years old, moorland, heath and rangelands' (Beaufoy et al, 2011: 31).
[24] See also European Union (2009), wherein Regulation (EC) No 1782/2003 recognised the environmental benefits of permanent pastures and sought to encourage their maintenance and prevent their mass conversion to cultivated land. This principle still stands (see Regulation No. 1307/2013 of the European Parliament and of the Council of 17 December 2013).

total SAU to test this effect. Notably, only 9.8% of SAU land in France was irrigable in 2007 and only 5.8% was actually irrigated around that time.

4.3. Social factors

The importance of social norms and relations of trust and reciprocity in laying ground conditions conducive to cooperation, is now widely recognised in collective action theory, as noted earlier. In the early years of GAEC formation, catholic priests and religious associations, especially the JAC, played an important role in establishing social norms that emphasised community, cooperation and benefit sharing (Murphy, 1977). René Colson, a French farmer, became the general secretary of JAC in the early 1940s and mooted the idea of small farmers pooling resources to invest in machinery, and practice modern agriculture through cooperation.[25] In 1951, he founded an organisation with his colleagues, which evolved into '*GAEC & Sociétés*' forty years later (GAEC & Sociétiés, 2012:5).

Catholic priests worked in tandem with JAC to encourage young farmers to form GAECs (Raup, 1975; Murray, 1977). To capture these social effects on GAEC formation, we used the number of active (namely, non-retired) Catholic priests in a department as a proxy measure to explain the regional incidence of GAECs.

4.4. Demographic factors

In addition to the variables discussed, we would expect at least two other factors to affect the geographic incidence of GAECs: availability of educated youths specialised in agriculture and the gender composition of the agricultural work force. The first is likely to matter especially due to the link between having an agricultural degree and getting state support. For instance, formal training in agriculture at the secondary level or above has been essential (at least since the early 1990s: Rogers, 1991: 150) for getting the young farmer subsidy that is offered jointly by the French government and the EU. And subsidies to young farmers are noted to be linked to GAEC formation (GAEC & Sociétés, 2010a:10). This effect may be strengthened further by the necessity (barring exceptional circumstances) for farming establishments to have professional agricultural skills in order to receive national and European incentives.[26] Moreover, without an agricultural qualification, farmers face greater restrictions in buying or renting farm land.[27] Overcoming such restrictions matters more to GAECs, since they have a greater need than individual farms to expand farm size, in order to provide for all the associates. Overall, therefore, in regions where a larger percentage of students are specialising in agriculture, the potential for constituting GAECs is likely to be greater.

[25] See also Flauraut (2006) on JAC, and Hervieu and Purseigle (2008) on the influence of Christian youth movements on young farmers in France, historically.
[26] http://www.terresdeurope.net/en/acquiring-capacity-french-professional-agricultural-skill-qualifications.asp
[27] See articles L331-1 to L331-12 and R331-1 to R331-12 of the French Rural Code. A degree can also help farmers acquire the skills to manage bigger farms, which need more complex accounting procedures.

The gender composition of the agricultural work force is also likely to matter, given the legal restriction until 2010 on wives becoming GAEC associates with husbands, unless there was a third associate. This restriction was much debated over the years. Some argued (unsuccessfully) that excluding spouses was neither pragmatic nor conducive to the efficient organisation of a farm (eg Foyer et al, 2012). Others felt that the restriction would free wives from hard agricultural labour, and allow family holidays which would prove difficult if both spouses worked on the same farm. In any case, since we are using 2010 data we expect that the larger the percentage of farmers who are female in a department, the lower would be the incidence of GAECs.

What about EARLs? We would expect the effects to be similar for EARL≥2 and GAECs, except on two counts. First, since (unlike GAECs) not all EARL associates work on the farm, EARLs are likely to be affected less by the labour intensity of an activity (in particular cattle versus crops), and therefore by whether a department is dominated by permanent pasture or crop land. In fact, EARLs may favour crops since they need less labour than animal upkeep (in other words, the relationship could even be negative). Second, since EARL≥2 could be formed by couples even before 2010, and given that it is not mandatory for wives who are associates to work in the EARL, we do not expect the percentage of women working in agriculture to significantly affect the incidence of EARL≥2.

5. Regression results

We examine the impact of the mentioned factors on the two dependent variables at the department level: (i) the percentage of GAECs to total farm enterprises; and (ii) the percentage of EARL≥2 to total farm enterprises. The analysis is based on 2010 data, unless another year is mentioned. Exact definitions of the explanatory variables are given in Appendix A. The results are presented in Table 7 and the summary statistics in Appendix B.

First consider the results for GAECs (Table 7, equations 1-3). Of the two economic variables, the Gini coefficient of household taxable income is consistently and negatively significant, as hypothesised. Departments with higher levels of income inequality have a significantly lower proportion of GAECs relative to all farms. But it is our farm size variable which gives particularly interesting results. It is regions with a high proportion of farms in the 20-49 ha category in 1970 that are significantly and positively related to the incidence of GAECs in 2010 (equation 2), while regions which had a high proportion of farms in the <20 ha category as well as those in the ≥50 ha category are found to be related negatively (equations 1 and 3), the former being significant just above the 10% level and the latter being insignificant. (Even when we disaggregated the farms above 49 ha into several categories in our regressions, viz. 50-74 ha, 75-100 ha, and so on, the coefficients remained insignificant from 50 ha onwards.) This indicates that departments with a predominance of farms which were neither too small nor too big in 1970 had the greatest likelihood of forming GAECs (as

Table 7: Geographic variations in the incidence of GAECs and EARLs
Regression results

Dependent variable	**% GAEC to total farms in 2010**			**% EARL≥2 to total farms in 2010**		
Explanatory variables	**Eqn 1**	**Eqn 2**	**Eqn 3**	**Eqn 4**	**Eqn 5**	**Eqn 6**
Income gini, 2010	-75.51***	-67.30***	-78.88***	-46.36***	-44.24***	-52.39***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)	(0.000)
% SAU under permanent pastures, 2010	0.06***	0.06***	0.04***	-0.07***	-0.08***	-0.08***
	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)
% SAU 2010 that was irrigable in 2007	-0.09***	-0.08***	-0.10***	-0.03	-0.04*	-0.04*
	(0.001)	(0.000)	(0.000)	(0.165)	(0.066)	(0.085)
No. of active priests, circa 2010-2014	0.02***	0.02***	0.02***	0.01***	0.01**	0.01***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.013)	(0.002)
% students specialised in agriculture, 2010	0.60***	0.42***	0.61***	0.01	-0.09	0.12
	(0.000)	(0.004)	(0.000)	(0.916)	(0.400)	(0.242)
% women among farm workers, 2010	-0.57***	-0.48***	-0.68***	0.04	-0.01	-0.05
	(0.000)	(0.001)	(0.000)	(0.737)	(0.915)	(0.680)
% farms with SAU <20 ha, 1970	-0.04†			-0.07***		
	(0.101)			(0.000)		
% farms with SAU 20-49 ha, 1970		0.14***			0.01***	
		(0.000)			(0.004)	
% farms with SAU ≥50 ha, 1970			-0.02			0.08***
			(0.644)			(0.002)
Constant	47.54***	37.29***	50.95***	27.70***	22.91***	26.65***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	92	92	92	92	92	92
Adjusted R^2	0.66	0.69	0.65	0.63	0.61	0.60

Notes: All regression equations are with robust standard errors. Figures in parenthesis are p values
*Significance: *** at 1%; ** at 5%; * at 10%; † at close to 10%*

also observed by Raup, 1995),[28] and that the relationship between farm size and GAEC formation is non-linear.[29]

The social variable is again significant, as hypothesised. The greater the number of active priests in a department, the greater the percentage of GAECs to other farms. Similarly, both the ecological variables are significant and in the direction expected: the higher the percentage of permanent pasture to total farm land, the greater the proportion of GAECs to other farms, while the higher the proportion of farm land that is irrigable, the lower the percentage of GAECs to other farms in that department.

The demographic variables are again significant in the directions expected. Departments with more female farmers have a lower percentage of GAECs and those with a higher proportion of students specialising in agriculture have a higher percentage of GAECs.

Now consider the EARL≥2 results (Table 7, equations 4-6). Many of the relationships are in the same direction as for GAECs. For instance, lower inequality in taxable income (gini coefficient) matters (negatively), as does the percentage of irrigable SAU (also negatively) and the presence of active priests (positively). But there are also important and interesting differences with GAECs. The percentage of SAU under

[28] We also ran one model for GAECs using the <20 ha and 20-49 ha farm categories in the same equation, with 50 ha and above as the reference category. Here again the 20-49 ha coefficient was positive and significant while the <20 ha category was insignificant.
[29] In addition, we tested the impact of average farm size and farm size square in 1970 on GAEC incidence in 2010: both were significant but with opposite signs (the former positive, the latter negative), again indicating a non-linear effect.

pasture is negatively significant for EARL≥2 (while for GAECs it was positively significant). This would be in keeping with our observation that a fair proportion of EARL≥2 undertake crop cultivation. Animal farming (linked with pastures), with its high labour intensity, is less favoured by EARL≥2, understandably perhaps since (unlike GAECs) they cannot depend on the guaranteed labour of associates. The effect of farm size distribution in 1970 is similar to that for GAECs for the <20 ha category, namely negative but more strongly significant. Also similar to GAECs, the coefficient is positive and significant for the 20-49 ha farm size category**.** However, for 50 ha and beyond, unlike for GAECs the size effect continues to be positive for EARL≥2.

The results between GAECs and EARL≥2 also differ for other variables. The proportion of students specialising in agriculture as well as the proportion of females among farm workers are both insignificant for EARL≥2. That gender is not significant is not surprising since (as noted earlier) married couples could form EARLs, while couple GAECs were banned till 2010.

Overall, therefore, the departments which tend to have a larger percentage of GAECs are those whose economic and social conditions are conducive to cooperation (less economic inequality and a greater presence of institutions which promote community cooperation—religious or other); whose ecological conditions are more favourable to animal farming (such as a higher percentage of permanent pastures) and less favourable to crop cultivation (lower percentage of irrigable land); which have a size distribution of farm holdings that were dominated by lower-middle-sized farms historically (rather than very small or large farms); and which have particular demographic characteristics (a higher percentage of agriculture students and lower percentage of females among farm workers).

For EARL≥2 again, the economic and social conditions conducive to cooperation matter. Economic inequality is negatively related to cooperation and farm size distribution is again important, although the effect is slightly different from GAECs at the higher range. However, there is an important divergence from GAECs in the ecological variables (the proportion of agricultural land under permanent pastures is significant but negative), and the demographic variables (gender, and degree/diploma in agriculture are insignificant). On gender, given the change in GAEC laws, the difference between GAECs and EARL≥2 is likely to disappear in time.

Two additional points need mention. First, the nature of social institutions can change over time. In France, historically, religious ideology and movements played a role in GAEC formation, but in modern-day France religion is a less cohesive force, while other types of institutions have emerged, including political bodies, farmers' unions, and similar groupings which generate social capital, cohesion and support. Secondly, some factors which are difficult to capture statistically could still prove important for GAEC formation. For instance, there can be a snowballing effect. Regions where GAECs have been historically successful would encourage others by demonstration, leading more farmers to see GAECs as alternatives to individual farms, and encourage them to form one themselves. Over time, such regions would also stimulate investment in support services for refrigeration, milk processing and storage, animal slaughter, marketing, etc which newcomers forming GAECs could take advantage of. Similarly, farmers who

have been exposed directly to GAECs formed by their parents or relatives or neighbours are more likely to form or join GAECs themselves, than those totally unexposed to such enterprises. All these factors could intensify a regional clustering of GAECs over time.

6. Concluding reflections and policy pointers

What lessons can we draw from this analysis for France, and for regions beyond France? For France, and for Europe more generally, our analysis suggests, first, that group farming will tend to find more fertile ground in regions which have less overall economic inequality, a larger percentage of farms in the lower-middle size range (rather than very small or very big) historically, and more social institutions which promote community cohesion/cooperation.

Secondly, cooperation is more likely to be sought for those agricultural activities that require intensive labour inputs *on an everyday basis*, such as cattle breeding (for milk or meat), and hence group farms are more likely to emerge (or take root more easily if promoted) in ecological zones that have a high incidence of permanent pastures, or where other types of farming are less profitable or less possible, as in harsher mountain areas and in zones with poor quality land. The reverse is likely in regions which are favourable for crop cultivation due to soil type, access to irrigation, etc. Since crops require less intensive labour inputs on a regular basis than animal breeding, they can also be grown by individual families (or associations like EARLs which have few working associates), with peak requirements being covered by hired labour and machines. Here there would be less incentive to undertake group farming.

Thirdly, demographic factors can matter, such as the incidence of agricultural graduates or of women farm workers in a region, but these factors are subject to legal conditions (as in France), such as whether or not an agricultural degree is needed to access farm subsidies, or whether spouses alone can form an association.

The incidence of farm enterprises needing lower levels of cooperation than a GAEC, such as EARL≥2, are likely to be affected by similar factors on some counts but different ones on other counts. Economic inequality, farm size ranges, and social factors can matter in the same way, but ecological variables such as pastures may not, depending on the choice of farm specialisation and hence intensive labour needs. Demographic factors could also matter less.

These observations stem from our results based on existing models of group farming. Variations on these models may emerge, however, if some of the legal requirements for forming GAECs were relaxed. For instance, GAEC associates need to work full time on the farm and pool all their productive resources. This requirement implicitly dictates a certain minimum farm size. If associates were allowed to undertake supplementary income-earning activities at an individual level, such as cultivating their own plot in addition to the group farm, or allowed to seek part-time non-farm work, then even small farms could pool their resources to farm collectively, while also pursuing other earning opportunities. Of course, in such models, it would be especially important to set in

place mechanisms for monitoring each associate's work contribution, to ensure that the work is equitably shared and the likelihood of free riding is minimised.

Beyond France, say for other parts of the European Union, the factors found significant in our study—especially economic and ecological—are general enough to be relevant. For developing countries, however, it is more difficult to extrapolate directly from our results, since laws governing land use and tenancy and the structure of subsidies would be quite different. Even so, it could be argued that efforts to promote group farming are more likely to be received favourably in regions of lower economic inequality, and where the local ecology and economy favour labour intensive farm activity, such as milk or meat production. Also, models that allow a combination of group farming and individual activity (rather than those, like GAECs, which only allow group activity) may be more relevant for developing countries which are characterised by very small farms (say under two hectares), since farmers here need to diversify their livelihood portfolios to earn a decent income.

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Appendix A: Definitions and data sources for explanatory variables

Variable	Definition
Surface Agricole Utile (SAU)	This is 'utilised agricultural area' which includes arable land, permanent grassland, permanent crops, other agricultural land such as kitchen gardens. It excludes unused agricultural land, woodland and land under buildings, farmyards, tracks, ponds, etc[a]
% SAU under permanent pasture, 2010	Percentage SAU under permanent pastures, census 2010[a]
% SAU 2010 that was irrigable in 2007	Percentage SAU in 2010 that is irrigable using the latest available 2007 data on irrigable area (for the 20 departments that had no data on irrigable area in 2007, the 2000 value was used)[b]
Average SAU per farm, 1970	Average SAU per farm (ha), 1970[c]
% farms with SAU <20 ha, 20-49 ha, and ≥50 ha in 1970	Percentage farms under 20 ha SAU, 20-49 ha SAU, and ≥50 ha SAU (as relevant) in 1970 [c]
Income Gini, 2010	Gini coefficient of taxable income per unit of household consumption in 2010[d]
No. of active priests, c2010-2014	Number of priests per department currently active (ie not yet retired), c.2010-2014. Data is available by dioceses. Adjustments were made when these did not overlap with administrative departments.[e]
% students specialised in agriculture, 2010	Percentage students in secondary education (or doing short term higher education degrees) who specialise in agriculture, September-October 2010[f]
% women among farm workers, 2010	Percentage agricultural workers (other than seasonal workers) who are female in 2010. These include farmer heads, co-heads, and agricultural salaried employees.[a]

Sources of data:
[a] Ministry of Agriculture (2014)
[b] Ministry of Agriculture (http://www.stats.environnement.developpement-durable.gouv.fr/Eider; access date: 10/02/2015)
[c] 'Données en ligne Agreste' (http://agreste.agriculture.gouv.fr; access date: 14/04/2016)
[d] Institut National de la Statistique et des Etudes Economiques (http://www.insee.fr; access date: 19/01/2015)
[e] Eglise catholique de France (http://www.eglise.catholique.fr; access date: 20/01/2015)
[f] Ministry of Agriculture (http://www.chlorofil.fr; access date: 19/01/2015) and Ministry of Education (http://www.education.gouv.fr; access date: 19/01/2015)

Appendix B: Summary statistics

	Obs	Mean	Std. Dev.	Min	Max
GAEC	92	7.73	4.63	0.74	20.48
EARL≥2	92	7.12	3.41	0.90	15.97
Income gini, 2010	92	0.34	0.02	0.30	0.40
% SAU under permanent pasture, 2010	92	32.83	24.23	1.40	94.44
% SAU 2010 irrigable, 2007	92	10.81	12.27	0.03	54.01
No. of active priests, c2010-2014	92	98.50	67.50	24.00	358.00
% students specialised in agriculture, 2010	92	4.71	2.69	0.13	11.65
% women among farm workers, 2010	92	31.26	2.46	23.58	37.00
ha_sau_perfarm_1970	92	21.93	11.81	2.68	64.45
% farms with SAU <20 ha, 1970	92	65.70	16.92	31.07	98.08
% farms with SAU 20-49 ha, 1970	92	23.68	9.86	1.20	52.28
% farms with SAU ≥50 ha, 1970	92	10.61	10.83	0.44	43.85