RECENT CHANGES AND GROWTH OF ALENTEJAN FARMING SYSTEMS

Pedro Damião de Sousa Henriques (*)
António Afonso Cipriano Pinheiro (*)

1 — Introduction

The Alentejo is one of the seven Portuguese mainland regions, is located in the mid-south of Portugal, has an area of around one third of Portugal and has around 6 per cent of the Portuguese population. Economic activity is modest in national terms with a national share of 5.3 per cent in terms of value added and 5.6 per cent in terms of national employment. During the last decades, agriculture has been losing its share in economic activity, although in 1986 it still represented 28 percent of the value added and 47.4 per cent of employment.

Alentejan agriculture is mainly of dryland type, although irrigated agricultural systems are present, mostly confined to zones where public dams have been built. With the exception of the irrigated areas, annual crops are of the Winter-Spring type (cereals and forages), while permanent crops are adapted to the Mediterranean conditions (olive trees and vineyards). In irrigated areas, rice, maize, tomatoes and vegetables have been the dominant crops. Although irrigated activities only accounts for around 4.2 per cent of total agricultural land, irrigated crops have an important contribution for total product and for stabilization of income of smaller farms (less than 200 ha). The principal livestock activities are cattle, sheep and pigs, in general associated with dryland farming systems either as a principal or a complementary activity. Farms have on average a reasonable dimension, farmers are elderly with low levels of education and professional training, and agricultural products are mainly sold for the market.

The Mediterranean forest represented by cork-oak and holm-oak trees has an important role in the natural equilibrium of the agricultural ecosystems: its fruits are an important source of livestock feed during Autumn, the dispersion of the trees allows farmers to cultivate the land under and between them, and the cork from the oak tree is an important source of farm revenue.

The Alentejo shows a diversity in ecological conditions basically due to differences in topography, soil types, climate and natural vegetation. Based on these characteristics, Sobral and Marado (1987) divided the region into nineteen agro-ecological zones. The farming systems practised in each agro-ecological zone show differences and similarities essentially in the potential of soil for agricultural production. Taking into consideration the similarities among farming systems practised in each agro-ecological zone and their soil potential, Silva

(*) Universidade de Évora.

(1990) aggregated the nineteen agro-ecological zones into ten larger homogeneous zones.

Table 1 summarizes the main land use types observed in each agricultural system, which could be divided into two groups: 1) the first group is composed of those systems in which annual crops have a major role in production activities, and 2) the second group aggregates the systems in which permanent crops and forestry account for a significant proportion of land use. The agricultural systems of the first group are composed of production systems based on dryland and irrigated cereal rotations, while the agricultural systems included in the second group are based on permanent crops and forestry systems associated with traditional rotations based on cereals. The agricultural systems of the first group are: cereal intensive system (IS), cereal-livestock semi intensive system (SIS), cereal livestock extensive system (ES), cereal poor land system (PLS), rice system (RS) and mixed forestry system (MFS). For the second group the agricultural systems are: mediterranean forestry system on poor lands (MSPL), mediterranean forestry system(MS), permanent crop system (PC) and mountain forestry system (MF).

TABLE 1

Alentejo agricultural systems — Land use patterns

Agricultural system	Total area		Cropped land (%)	Permanent crops (%)	Mediterranean forest (%)	Mixed forest (%)	Uncultivated land (%)
	Ha	%					
Intensive (IS)	137 950	5.1	72.2	15	12.2	1.1	0.0
Semi intensive (SIS)	578 100	21.4	40.6	10.5	46.9	1.5	0.6
Extensive (ES)	390 250	14.5	45.0	7.6	38.3	2.6	6.5
Poor land (PLS)	584 900	21.7	42.2	4.7	37.8	1.9	13.9
Mediterranean forest on poor land (MSPL)	304 800	11.3	25.0	3.3	60.9	1.9	8.9
Mediterranean forest (MS)	296 000	11.0	10.9	6.8	67.7	13.5	1.2
Permanent crop (PC)	197 800	7.3	22.5	48.7	26	0.5	2.2
Mixed forest (MFS)	102 750	3.8	54.3	6.0	8.0	27.0	4.7
Mountain (MF)	93 300	3.5	5.8	15.4	52.0	20.8	6.0
Rice (RS)	10 900	0.4	88.0	0	0	0	12.0

Source: Sobral and Marado, 1987, and Silva, 1990.

Four of these agricultural systems were selected for analysis: intensive (IS), semi-intensive (SIS), extensive (ES) and poor land (PLS). These systems account for 62.7 per cent of the total area of the region, 77.2 per cent of the cropped and 48.5 per cent of permanent crop area, and are believed to represent a significant percentage of the region's agricultural output. The IS farming system occupies the best soils of the region, rotations are short (two to three years) and based on cereals, where forages and fallow are almost entirely absent, and livestock activities, when present, are mostly restricted to sheep as a complementary activity to cereal production. The SIS, ES and PLS systems have a decreasing soil potential, rotations are longer, and forages and fallow have an important role in feeding livestock (mainly cattle and sheep activities).

Total product is dominated by crop activities for the IS and PLS farming systems, by livestock activities for the ES farming system, while, for the SIS farming system, crop and livestock activities make similar contributions to total product. The characteristics of each farming system vary with farm size, with smaller farms showing a higher production intensity than larger farms. As a result, area cropped, irrigated activities, livestock density, capital and labour use, intermediate input consumption and productivity levels decrease with farm size.

In general, the study of farm firm growth has departed from the Gibrat law of proportionate effect that states that the proportional change in firm size is independent of its absolute size. This suggests that firms show constant returns to size meaning that larger firms grow as fast as smaller firms (Clark, Fulton and Brown, 1992). The Gibrat law also suggests three economic implications: 1) there is no optimum size of firms; 2) there is no relation between the rate of growth of a firm in subsequent and preceding periods; and 3) there is an increase in industry concentration as time passes (Haworth, 1992).

Haworth (1992) tested some of the hypotheses arising from the Gibrat law such, such as, firms in different size categories have the same average proportionate growth rate, firms in different size categories have the same dispersion of proportionate growth rates about the mean, distribution of proportionate growth rates is lognormal, and relative dispersion of firm sizes increases over time. The author concluded that there was considerable evidence to question the hypothesis that the process of farm firm growth could be explained by the Gibrat law of proportionate effect, and to assume that differences in growth rates are not due to random forces but to the presence of consistent individual growth rates. Deviations from the Gibrat law were also observed in other studies about individual firm growth such as those by Shapiro, Bollman and Ehrensaft (1987), Hall (1987), and Evans (1987), while Clark, Fulton and Brown (1992) using regional aggregate data for Canadian agriculture did not find strong evidence to reject the Gibrat law.

The objectives of this paper are: 1) to identify the recent changes of Alentejan farming systems during the period 1987-1991; and 2) to analyze the growth of some farm variables responsible for farm size and to infer about the general process of growth of Alentejan farms, testing the hypothesis that growth or decline rates are specific to individual farms and farming systems and that growth rates are independent of farm size.

2 — Methods

The methods proposed to test the Gibrat law depend on the data available. If cross-section data is available the procedures proposed by Shapiro, Bollman and Ehrensaft (1987) and Upton and Haworth (1987) can be used, while if times series data is available, the unit roots tests suggested by Clark, Fulton, Derrick and Brown (1992) are an alternative. Considering that the data set available for this study is cross-sectional, only the first two methods were used to test the Gibrat law.

The method developed by Shapiro, Bollman and Ehrensaft (1987), departs from the suggestion of Gibrat law, that farm growth rates are all drawn from the same distribution and growth rates follow a random walk, which can be expressed by the following expression:

$$\ln S_{it} = \alpha + \beta \ln S_{it-1} + e_{it}, \qquad \textbf{(1)}$$

where S_i is the size of firm i in year t, α is the drift and e_{it} is the lognormal distributed random effect, where the Gibrat law requires $\beta = 1$. The Gibrat law also requires that the growth process has firms of all sizes and extends over all time periods, that is the variance of the growth rates are the same and the growth rates must be serially uncorrelated respectively. This corresponds to test homoscedasticity:

$$e_{it} = a + b \ln S_{it-1}, \qquad \textbf{(2)}$$

and if a and b are different from zero there is generalized heteroscedasticity. To test serial correlation, the growth rates in one period are tested against the growth rates in the previous period through the following equation:

$$g_{it} = c + d\, g_{it-1}, \qquad \textbf{(3)}$$

where $g_{it} = S_{it} - S_{it-1}$, $g_{it-1} = S_{it-1} - S_{it-2}$, and c, d are parameters to be estimated. If $d = 0$ the growth rates are unrelated over time. However, if serial correlation exists, the estimate of β in **(1)** is not consistent. This can be corrected by estimating the following model:

$$\ln S_{it} = \alpha + \beta_1 \ln S_{it-1} + \beta_2 S_{it-2} + e_{it}, \qquad \textbf{(4)}$$

where $(\beta_1, \beta_2) = (1,0)$ to verify the Gibrat law.

Another procedure to test the Gibrat law is the covariance model used to measure, test and compare the growth of some farm variables over time developed by Upton and Haworth (1987), which hypothesized that the growth of a farm firm variable is exponential and incorporates year, farm, and group effects.

The model is expressed in the following form:

$$Y_{ij}(t) = \alpha_t \beta_i \gamma_j e^{(\delta i T + \eta j T)} U_{it}, \qquad \textbf{(5)}$$

where:

- $Y_i(t)$ = variable being analyzed;
- α_t = year effect;
- β_i = farm effect;
- γ_j = farming system effect;
- δ_i = component of growth rate specific to farm;
- η_j = component of growth rate specific to farming system;
- T = time trend;

where t represents the year, i the farm and j the farming system indexes.

This formulation allows one to identify in a cross-section time series data set those effects that are considered important in the evolution of a farm firm variable, such as the ones that are year, farm and/or farming system. This is to test if the evolution of a variable is significantly dependent on the year, the farm or the farming system, and if its growth rate is also farm and/or farming system specific. The year effect is intended to capture the differences among years due to weather, inflation and other random factors specific to individual years. The farm effect is expected to introduce a farm individual effect for the variable in consideration which measures the relative magnitude of the farm for the variable being analyzed. The farming system effect is expected to take into account the variation observed for each farm as a result of observations belonging to a specific farming system. Once the farming system effect is embodied in the farm effect, the combination of the farm and farming systems effect is a measure of the relative size of the farms.

The cross effects of farm and/or farming system with time allows us to test if the growth rate is group and or farm specific. Because the year effect was taken into account, it implies that the average growth rate is not constant over time, and mean size in a particular year is the mean size in the base year multiplied by the year effect. The model considers the error term as multiplicative, thus assuming that the error term varies proportionally to the size of the variable in consideration, and has a normal distribution with mean zero and constant variance.

The model above can be written in its logged form and becomes equal to:

$$\log Y_{ij}(t) = \log \alpha_t + \log \beta_i + \log \gamma_j + (\delta_i + \eta_j)\, T + \log U_{it}, \qquad \textbf{(6)}$$

which was solved using dummy variables to represent different t years, j farming systems and i farms. This is an analysis of covariance model that allows us to test the effect of the different independent variables included in the evolution of a specific variable over time. In order to test the Gibrat law, that farm growth rates are unrelated to farm size, the individual farm size and growth rates measures estimated through equation **(6)** were correlated.

3 — Data

The data used to analyze the recent changes in Alentejan agricultural systems and the growth of some farm variables was based on individual farm account records collected by the Ministry of Agriculture in RICA. The 1988 RICA data was used to identify the farms with each farming system. Since the farming system delimitations do not coincide with the Municipality identification of the RICA farms, this mapping of RICA farms to farming systems was undertaken with the help of the Municipal RICA technicians. For the Alentejo, there were 335 farms in the 1988 RICA data set, of which 217 were classified into the four farming systems analyzed. Based on the above sample, a balanced panel for the period 1987-1991 was compiled with those farms that remained in the RICA service for the period considered (table 2).

TABLE 2

Sample distribution of farms analyzed by the Ministry by agricultural system selected and area class (1988)

Agricultural systems	1988 sample				Balanced panel 87-91
	All farms	Small farms	Medium farms	Large farms	
Intensive system(IS)	41	20	13	8	19
Semi intensive system(SIS)	70	21	26	23	26
Extensive system(ES)	56	10	29	17	28
Poor lands system(PLS)	50	11	24	15	27
Total	217	62	92	63	100

The variables used in the analysis were similar to the ones used by Haworth (1992) and Shapiro, Bollman and Ehrensaft (1987). They comprised total product and capital (machinery and equipment) measured in thousands of escudos.

4 – Results

4.1 — Recent changes in Alentejan farming systems

The objective of this section is to give a brief overview of the changes that have occurred in the production and economic structure of the IS, SIS, ES and PLS farming systems between 1987 and 1991, which includes the first stage of the transition period. To do so, the data panel mentioned in the previous section was used to derive the evolution of a set of production and economic indicators (see Henriques, 1995) and to evaluate the annual growth rates of some farm indicators shown in table 3.

TABLE 3

Average annual growth rates for some indicators by farming system (1987-1991)

Item	ES	IS	PLS	SIS
Average area	0.77	0.93	0.34	– 0.66
Total labour	– 2.96	– 3.58	– 0.32	– 5.35
Livestock herd	1.73	4.65	4.16	– 0.11
Machinery and equipment capital	3.14	4.90	2.95	5.93
Total product	– 0.16	1.22	– 1.45	– 2.67

Source: Henriques (1995).

Regarding land structure, the average farm size of the four farming system was maintained fairly constant, although a tendency for slight increases in the average farm size appears to be present. The land dedicated to irrigated activities increased, especially for the more intensive farming systems (IS and SIS). With respect to land use, the cultivated as well as cereal land increased in average terms, although variations between years was observed. The area of oilseeds, forages and pastures increased for all farming systems, and these results are similar to those obtained using regional aggregated data.

From 1987 the average labour force per farm and per farming system showed a tendency to decrease, and this decrease was essentially due to reductions in hired labour, although a slight decrease in family labour use was also observed. Regarding livestock, the average number of livestock units per farm and per farming system have been increased especially for the IS and PLS farming systems, while the SIS farming system showed a tendency for stagnation. These increases resulted in positive changes in the stocking rate per hectare. The herd composition between sheep and cattle activities remained fairly constant over time for the IS, PLS and ES, while for the SIS the importance of sheep has been decreasing. During the period analyzed, the levels of capital per hectare increased, at a higher rate for the more intensive farming systems (IS and SIS).

The consumption of variable inputs expressed in real terms per hectare increased slightly for all farming systems, while changes in the consumption of fixed inputs per hectare were less evident, with the exception of the PLS farming system in which an increase was observed. The composition of the product among the different farming systems is similar for the PLS and SIS in which crop product accounts for around half of the total product, while for the IS and ES farming systems crop and livestock products are dominant, respectively. The contribution of livestock and principally crop product to total product has been decreasing, while an increase in the level of direct subsidies which reached percentages greater than 20 per cent for the ES, PLS and IS systems in 1991 was observed. Crop and livestock real product decreased and this decrease was not compensated for by the increase in the amount of subsidies received by farmers, which lead to a decrease in total product for SIS, PLS and ES farming systems. With the exception for the IS farming system, the decrease in total product led to a decrease in real value added, while real net income decreased for all farms.

4.2 — Farm growth, farm size and farming system

The results of the statistical tests resulting from equations **(1)** to **(4)**, performed for the product and capital variables, are presented in table 4. The original model expressed by equation **(1)** allows us to conclude that the Gibrat law cannot be rejected. However, the test for serial correlation [equation **(3)**] shows that it exists for product and capital, with exception for capital in the period 87-88-89, implying that the estimates of equation **(1)** are not consistent and equation **(4)** is the correct estimation to test the Gibrat law. From equation **(4)** one can conclude that the Gibrat law cannot be accepted. The test for homoscedasticity [equation **(2)**] is not conclusive, once homoscedasticity is rejected for the period 88-89 and accepted for the period 90-91. The value of the parameter *b* is negative, meaning that the variability of the growth rates declines with farm size.

TABLE 4

Statistical tests for Gibrat law

Original model (equation 1)

Item — Period	Product					Capital				
	α	β	R^2	$\beta = 0$	$\beta = 1$	α	β	R^2	$\beta = 0$	$\beta = 1$
88-89	0.16	0.99	0.86	*	n. s.	0.59	0.95	0.91	*	n. s.
90-91	0.26	0.99	0.85	*	n. s.	–0.16	1.02	0.99	*	n. s.

Homoscedasticity (equation 2)

Item — Period	Product				Capital			
	a	*b*	R^2	$b = 0$	*a*	*b*	R^2	$b = 0$
88-89	0.83	–0.06	0.06	*	1.05	–0.09	0.18	*
90-91	0.60	–0.03	0.01	n. s	0.22	–0.01	0.01	n. s

Serial correlation (equation 3)

Item — Period	Product				Capital			
	c	*d*	R^2	$d = 0$	*c*	*d*	R^2	$d = 0$
87-88-89	0.04	–0.47	0.22	*	0.20	0.02	0.01	n. s
89-90-91	0.13	–0.56	0.35	*	–0.05	0.38	0.36	*

Model adjusted for serial correlation (equation 4)

Item — Period	Product				Capital			
	β_1	β_2	R^2	$(\beta_1, \beta_2) = (1,0)$	β_1	β_2	R^2	$(\beta_1, \beta_2) = (1,0)$
87-88-89	0.54	0.48	0.89	*	–	–		–
89-90-91	0.44	0.57	0.90	*	1.38	–0.38	0.99	*

* Statistical significance at 95 % confidence level.
n. s. — not significant.

The results obtained from fitting equation **(6)** to total product and capital variables allowed us to test to what extent the rate of growth was farm and/or farming system specific and if there were significant differences among farm firm sizes. The results presented in table 5 of the analysis of covariance, show that during the period 1987-1991 the rate of growth of the total product and capital was farming system and farm specific. The contribution of the individual farm component to the growth rate was much higher than the contribution of the farming system component measured by the sum of squares. The same conclusion was reached for the size component of the equation in which the farm and the farming system effect were both significant at 5 per cent level, and the variance explained by the farm effect was much higher than the one explained by the farming system effect.

The results showed that there were considerable differences in mean farm sizes, and these differences vary across farming systems and within each farming system across farms. This means that farm size is dependent on a farm belonging to a more intensive or extensive farming system and on other specific farm factors. Farm firms grow at different growth rates, which means that each farm has it own individual growth or decline rate and these growth rates vary also across farming systems. The year effect is significant at the 5 per cent level for all variables, which implies that mean farm size and average growth rate has been varying over the years.

TABLE 5

Results of analysis of covariance for total product and capital by different effects

Source of variation	Total product				Capital			
	Sum of squares	d.f. (a)	Variance ratio (*F*)	Signif. level	Sum of squares	d.f. (a)	Variance ratio (*F*)	Signif. level
Total	442.9	459			1441.4	459		
Between years	7.5	4	25.8	(0.001)	15.9	4	43.4	(0.001)
Between farming systems ...	11.9	3	55.1	(0.001)	127.9	3	465.7	(0.001)
Between farm	390.1	88	61.1	(0.001)	1234.4	88	153.2	(0.001)
Between farming systems ...	1.1	3	5.1	(0.002)	2.8	3	10.2	(0.001)
Growth rates	1.1	3	5.1	(0.002)	2.8	3	10.2	(0.001)
Between farm growth rates	12.4	88	1.94	(0.001)	35.4	88	4.4	(0.001)
Residual error	19.7	272			24.9	272		
R square	0.96				0.98			

(*a*) Degrees of freedom.

With the objective of finding any relationship between the measures of growth and size obtained from the variables studied, a correlation analysis was performed relating farm size and growth parameters obtained from the analysis of the covariance model. The results presented in table 6 show that there is a positive correlation between the measures of size, meaning that the size of output is highly dependent on capital. Regarding the correlation between the measures of growth, one can conclude that the growth rate of output is positively correlated with the growth rate of capital. The cross correlations between the measures of size and growth allow us to conclude that in general there is a weak association between size and growth measures, while the own correlations between size and growth are negative and significant, allowing us to reject the Gibrat law of proportionate effect.

TABLE 6

Correlations between measures of size and measures of growth

Item	Measures of size		Measures of growth	
	Product	Capital	Product	Capital
Measure of size:				
Product	–	–	–	–
Capital	(*a*) 0.55	–	–	–
Measures of Growth:				
Product	(*a*) –0.21	–0.13	–	–
Capital	(*a*) –0.09	(*a*) –0.24	(*a*) 0.28	–

(*a*) Statistical significance at 95 % confidence level.

5 — Concluding remarks

Among the ten farming systems that characterize Alentejan agriculture, four farming systems were selected, the IS, SIS, ES and PLS. The IS and SIS farming systems occupy the better soils of the region and are characterized by a more intensive agriculture than the ES and PLS farming systems, which are located in areas with significant limitations for agriculture. The IS and PLS farming systems show a production pattern in which crop activities are dominant in total product, while, for the SIS farming system, crop and livestock activities make similar contributions to total product, and for the ES farming system, livestock activities are dominant in total product. The characteristics of each farming system vary with farm size, with smaller farms showing a higher production intensity than larger farms.

During the period 1987-1991, the most important changes observed in the farming systems were: 1) positive changes in the irrigated area, principally for the IS and SIS, and in the area cropped, as well as in the area of cereals, oilseeds and forages, were observed; 2) negative changes in labour use, principally hired labour, were observed; 3) the size of the livestock herd increased, principally the number of sheep; 4) in overall terms the use of intermediate inputs per hectare increased for all farming systems; 5) with the exception of the IS farming system, total product decreased, while the contribution to total product of subsidies increased substantially; and 6) the profitability of the Alentejan farming systems decreased, especially for the ES, PLS and SIS.

The analysis of growth of total product and capital variables for the same period, using the covariance model, allows us to conclude that: 1) the growth component of those variables was farm and farming system specific; 2) the size component of those variables was positively correlated between them; and 3) the own size and the growth component of the variables analyzed was negatively and significantly correlated, leading to a rejection of the Gibrat law. This means that growth rates decrease with farm size or small farms grow faster than larger farms. The rejection of the Gibrat law was also confirmed by the Shapiro, Bollman and Ehrensaft (1987) procedure.

If farms show different individual growth rates for the different variables that measure farm size, then there is a set of factors associated with each farm that explains the existence of farm individual growth rates. These factors will be directly related to the production capabilities of farm and farmer as well as other subjective factors that may influence a farmer's decision towards growth. Upton and Haworth (1987) selected a set of variables that could be directly responsible for the different growth rates that their sample of British farmers exhibit, such as managerial ability, propensity to invest, intended expansion of farm, number of dependents, off-farm income and attitude towards risk. The list of farm specific factors can be increased to include years of education, professional training, age, availability of technical assistance, years of experience, etc. They showed through correlation analysis that the different growth rates were partly a result of differences in management ability.

It is widely accepted that all the factors mentioned above will have a relative importance in farmers' attitude towards farm growth, while external factors such as agricultural policy through its structural and price components will have a significant role in determining the magnitude and the path of farm firm growth rate. The period of analysis was coincident with the application of the EC structural policy, while no significant changes occurred in the price policy. Farmers who took advantage of the favourable conditions of the structural policy and expanded their production capabilities are expected to have had higher growth rates for the different measures of farm size. After 1992, with the full application of the price policy, it is expected that significant changes will occur in the magnitude and path of farm firm growth, particularly in farms belonging to farming systems with natural endowment limitations such as the ES and PLS. Considering that the number of years of our sample was relatively small and that additional data on farm and farmer characteristics were not available, no further analysis, with the objective of extending the understanding of the process of farm firm growth was pursued.

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