FARMLAND PORTFOLIO MANAGEMENT. AN APPLICATION TO SPANISH FARMLAND.

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ABSTRACT

In the present paper an application of Spanish farmland portfolio management is been carried out. The farmland returns are composed of two effects, the land appreciation effect and the cash-flow effect. The study is performed for crops and irrigions.

The most certain of financial concepts is that risk and return are related. Systematic differences in returns must relate to differences in risk. The returns and risk for every crop and irrigion have been calculated. From Sharpe's model, the Beta index has been estimated for every crop and irrigion and the efficient Spanish farmland portfolio has been built.

KEY WORDS: farmland portfolio, Sharpe's Beta, risk versus returns

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1. INTRODUCTION

From the development of the works of Markowitz about portfolio selection there have been numerous applications and empirical verification of the working models of the stock markets. The Capital Asset Pricing Model (CAPM) was born in the years 60, Sharpe (1961, 1964) Lintner (1965). The fundamental statement of the CAPM is that the return of an asset is a linear function of its systematic risk, measured by a Beta coefficient.

Applications have also been both the Markowitz's model as the Sharpe's posterior one in other processes of taking decisions in a context of risk. In particular in the scope of farm management we could highlight the works of Romero (1976), Alonso (1977, 1983), Rodríguez-Barrio (1980), Caballer (1983), Rivera (1985)

From a practical point of view, the fundamental application of the models it is to obtain efficient portfolios in stock markets but in the last years we have attended a generalization of the models to the scope of real estate investment. Our objective is to study in depth the last one, applying it to the creation of farmland portfolios in Spain, The analogy is clear: both are able to give gainings for appreciation of the asset and in front of the earnings per share, farmland is able to give cash-flows, this cash-flows are generated by the cultivation of land. Formally it is not correct to assume that the farmland generates these cash-flows rather the cash-flows are generated by the farm. This farm possess the land factor as well as other factors. Independently of the economic theory we will assume that the farmland generates some returns due to its cultivation. In some cases like the cultivation of citrics and in any other fruit trees cultivation, the analogy is total (Caballer and Sure, 1983)

In the same way that we evaluate the returns of the stock market we should evaluate the annual returns of the crops in the different irrigions. However, in stock markets the information for closing prices and earnings per share is very extensive and there are full chronological series. In the farmland market the series of available values are much

smaller and the estimate of the agricultural yields for each crop, irrigion and year is very costly.

2. DATA

To be able to evaluate the full returns of the farmland we do need data refered to the evolution of the prices of farmland, to estimate the gainings for the appreciation of the land and on the other hand data of the cash-flows that are generated by the different crops.

The farmland prices data come from the farmland prices in Spain survey carried out by the Ministry of Agriculture (MAPA) every year. The series starts in 1983 and ends in 1999. The series comprise the price of the hectare of every crop in every irrigion. Seven crops are considered in this source : dry farming, irrigated land, nuts and dried fruits trees, citric, vineyard in unirrigated land, olive grove in unirrigated land and natural grasslands in unirrigated land.

The cash-flow data come from the National Farm Accountancy Network (RECAN). The return is an own and specific variable of each farm so we are making a conceptual error when assigning farm returns to the land. However from an investor point of view the returns obtained by the sale of the crop will be considered like one part of the returns provided by the land asset

The observation field of the R.E.C.A.N. includes those Spanish farms with an economic dimension of, at least, 2 ESU (European Size Unit). Irrigarding the total population of farms it comprises the 36,6% of the number of farms and it represents 90,5% of the standard gross margin over the national standard gross margin. The available series goes until 1998.

For our study we use two variables mainly. The variable vegetal gross output / Total utilised agricultural area is quantified in thousands of pesetas per hectare and the family farm income. The vegetable gross output or vegetable total production includes the vegetable products reutilized in the farm. The work is refered to farms dedicated exclusively to vegetable crops (no cattle) for what the concept of reutilization is not

relevant. The meaning of "Total utilised agricultural area" is clear. The family farm income measures the level of gainings for the owner.

The figure of the lease of lands it is not very important in many zones and crops, however in irrigions like Castilla-León in cereal crops this concept it is quantitatively important. We have decided to add the rent of lease in order to obtain a family farm income more adjusted to the figure of the proprietor-manager.

Once obtained the family farm income, its weight on the vegetable gross output is calculated. The achieved value is multiplied later on for the "vegetal gross output / Total utilised agricultural area" and this way we have obtained the family farm income per hectare of crop.

The RECAN uses a typology of farms that is not completely coincident with the data provided by the yearly survey of farmland prices in Spain published by the Ministry of Agriculture. For that reason it has been necessary to carry out a work of filtrate, calculation and weighing of the orientations of the RECAN to adapt them to the typology of the survey of famland prices.

The RECAN data are classified in several intervals according to the ESU of the farm. We have worked with the total data (they include all the interviewed farms)

The adaptation between sources is, schematically, as follows :

?? Dry farming : cereals in unirrigated land ; roots and tubers in unirrigated land ; cereals, roots and tubers in unirrigated land ; oleaginous and textile crops in unirrigated land.

?? Irrigated land: cereals in irrigated land ; roots and tubers in irrigated land ; cereals, roots and tubers in irrigated land ; oleaginous and textile crops in irrigated lands ; horticulture.

?? Vineyard: D.O. viticulture and another viticulture.

?? Olive grove : oliviculture

In those cases that a typology of the survey of farmland prices includes several RECAN orientations, we have calculated the weighted average, weighing with the area of each orientation.

The RECAN series began to differ among farms of unirrigated land and irrigated land in the year 1994. Therefore, the data of unirrigated and irrigated land previous to that year, especially in the cases of Castilla-León, Castilla-La Mancha, Aragón, Andalucía and Extremadura, have been calculated from the data of the RECAN, according with the ratio between of gross outputs of the year 1994.

The interannual variations observed in the RECAN data has forced to use national average values when individual data were not available.

3. CALCULATION OF RETURNS

The dual character of the land, as investment and as factor of production, determines the two components of the returns: the appreciation of the farmland and the family farm income. The family farm income is not really a cash-flow, but it is the nearest available concept in the RECAN.

Once we have defined the way of measuring the appreciation and the family farm income, we define returns in the traditional way in finances.

$$r_n = \frac{V_n - DE - V_{n-1}}{V_{n-1}}$$

where:

rn: return of the asset farmland

Vn: farmland value at end of the year n

DE: family farm income for the year n

Vn-1: farmland value at end of the year n-1 (begining of the year n)

4. APPLICATIONS OF THE MODEL TO THE FARMLAND MARKET IN SPAIN

According to Sharpe's model the returns of a specific dryurity is:

$$R_{it} = a_i + ß_i - R_{Mt} + e_{it}$$

where:

Rit: rate of return of the dryurity i during the year t.

RMt: rate of return of the market, it is estimated in base on a general index during the year t..

?i: parameter that gives information about the return of the dryurity i independently of the fluctuations of the market (it is the intercept with the y-axis)

?i: parameter specific each dryurity i, it means the relationship among the fluctuations of the returns of the market and the fluctuation of the returns the dryurity. It is called Beta coefficient, it corresponds to the slope of the straight line.

?it: error term, it means the variations of the returns of the dryurity that depend on the own characteristics of the dryurity. These varitions are independent of the behaviour of the market.

From this model we will be able to build a stock portfolio whose expectancy of returns will be:

$$E_p = \sum_{i=1}^{N} X_i \cdot (a_i + \beta_i \cdot E(R_{Mt}))$$

and their variance: $\sigma_p^2 = \sum_{i=1}^{N} X_i \cdot \beta_i \cdot \sigma_M^2 + \sum_{i=1}^{N} X_i^2 \cdot \sigma_{ei}^2$

Minimising the variance of the portfolio for a fixed level of returns we could obtain by means of quadratic programming the efficient composition of each portfolio (the portfolio that minimises the risk, the variance) for a level of returns.

In the same way that there are stock portfolios we can think about to create a farmland portfolio.

We have carried out two applications of the model the farmland market in Spain, in all of them the efficient portfolio for several levels of returns has been calculated. Previously the Beta coefficients were estimated by means of ordinary least squares.

The different matrixes have been created by means of Microsoft's Excel spreadsheet and then the estimate of the different portfolios has been calculated by means of the application of optimisation Solver integrated in the spreadsheet.

The first application only picks up the returns for appreciation of the land, using as index, the general index of prices of the farmland in Spain, published in the survey of farmland market prices carried out by the MAPA. This application includes data from 1983 up to 1999, with 61 assets. Two models have been built, the first one without restrictions in the percentage of each type of farmland that constitutes the portfolio and a dryond one with a restriction of 10% as maximum for every farmland that constitutes the portfolio.

The dryond application picks up both components of the returns of the farmlands (appreciation and family farm income). The series only picks up the years from 1990 up to 1998 and the number of available farmlands ads up to 45.

5. APPLICATION FOR RETURNS BY APPRECIATION OF FARMLAND

As it has said, the Beta coefficients, see table 1, have been calculated by ordinary least squares. Using the obtained linear equation we have estimate the returns in order to calculate the residuals and from this residuals we have obtained the residual variance for every kind of crop and irrigion. Once we have realised these estimates we are able to build the portfolios by means of minimising the variance for each level of return. As market index, the general farmland market index has been used.

Table nº 1. Beta coefficients from the returns by appreciation of farmland

Farmland	Beta	Farmland	Beta	Farmland	Beta
Citr-Andalucía	1,749	Irrig-Cataluña	1,176	Dry land-C-LM	0,718
Vineyard-Cas-León	1,650	Citr-C.Val	1,155	Olive-Cataluña	0,715
Vineyard-La Rioja	1,627	Vineyard-Aragón	1,144	Dry fruit trees--Andalucía	0,705
Grassland-Cataluña	1,551	Irrig-Cas-León	1,104	Dry land-Cataluña	0,692
Dry land-Andalucía	1,455	Dry fruit trees--C.Val	1,099	Vineyard-Cataluña	0,650
Irrig-Andalucía	1,438	Dry fruit trees--Aragón	1,087	Olive-Extremadura	0,646
Irrig-Extremadura	1,407	Irrig-Aragón	1,058	Grassland-C-LM	0,610
Dry land-Murcia	1,392	Dry land-Madrid	1,051	Vineyard-Navarra	0,595
Dry land-La Rioja	1,375	Olive-Andalucía	1,049	Vineyard-Murcia	0,592

Vineyard-C-LM	1,286	Irrig-Murcia	1,033	Dry fruit trees--Baleares	0,576
Dry land-C.Val	1,285	Dry land-Navarra	0,909	Vineyard-País Vasco	0,527
Dry land-Extremadura	1,266	Grassland-Asturias	0,887	Grassland-Aragón	0,461
Irrig-C-LM	1,247	Grassland-Navarra	0,866	Dry land-Baleares	0,367
Vineyard-C.Val	1,247	Irrig-Navarra	0,841	Irrig-Galicia	0,314
Dry land-Aragón	1,242	Dry fruit trees--Cataluña	0,828	Dry land-Galicia	0,297
Dry fruit trees--Murcia	1,238	Vineyard-Andalucía	0,820	Irrig-Madrid	0,234
Dry fruit trees--C-LM	1,236	Irrig-La Rioja	0,767	Vineyard-Galicia	0,227
Dry land-Cas-León	1,232	Irrig-Baleares	0,749	Grassland-Galicia	0,139
Olive-C-LM	1,217	Grassland-Cas-León	0,742	Grassland-Cantabria	0,102
Irrig-C.Val	1,190	Vineyard-Extremadura	0,741	Vineyard-Madrid	-0,078
				Grassland-Madrid	-0,459

The higher Beta coefficients belong to lands with citrics in Andalucia, and vineyard in Castilla-León -León and in The Rioja. Among the ten highest Betas, there are 3 farmlands from Andalucia. In all those farmlands with a Beta coefficient bigger than 1, an increase of the average return of the market will suppose a bigger increase of the value of the land.

In those lands with a Beta coefficient smaller than 1, the returns will be smaller than the average returns of the market.

Negative Betas are very strange, however, they appear for the vineyard and the grassland in the irrigion of Madrid. This fact would imply a contrary behaviour in these lands to the global behaviour of the market. When the returns of the market increase the returns of these lands drecrease and vice versa

To estimate the efficient portfolio it is convenient to calculate the coefficients of correlation in order to check the possible causal relationship between two series of data. The Pearson's coefficient of correlation has been used. This coefficient it calculated from the covariance between two series of returns divided by the product of the standard deviations of the series. This calculation is important because the series with positive

correlation of the returns at a significant level should not be included in a stock portfolio, in our case in a farmland portfolio. Significant correlation has been detected through the different crops of unirrigated land. There is significant correlation at different levels in the returns of vineyard

In this application based on the returns by appreciation of farmland, the efficient portfolio have been generated under two suppositions: the first one, unrestricted composition of the portfolio and the second one and with a maximum percentage of the portfolio composition for each farmland of 10%.

In the composition of the unrestricted portfolios, see table nº 2, for several returns it is observed that the extremes of the range of returns present concentration of one of the lands, grassland in Cantabria, with little returns and low variance and olive tree in Andalucía with high returns and low variance. Really in those extremes of the range of returns the diversification is very low.

Table nº 2. Efficient farmland portfolios for several levels of returns (returns by appreciation of farmland)

R = 2,00%		**R = 3,00%**		**R = 4,00%**	
Farmland	%	Farmland	%	Farmland	%
Grassland-Cantabria	76,18%	Grassland-Cantabria	60,49%	Grassland-Cantabria	47,49%
Dry-Galicia	8,34%	Dry-Galicia	12,61%	Dry-Galicia	15,27%
Vineyard-Galicia	5,02%	Vineyard-Galicia	7,80%	Vineyard-Galicia	9,97%
Grassland-Galicia	2,89%	Grassland-Galicia	4,22%	Grassland-Galicia	5,29%
Grassland-Madrid	2,30%	Grassland-Madrid	3,44%	Olive-Andalucía	4,82%
Dry-Baleares	1,57%	Dry-Baleares	2,25%	Grassland-Madrid	4,52%
Irrig-Galicia	1,14%	Irrig-Galicia	1,91%	Dry-Baleares	2,54%
Vineyard-Madrid	1,00%	Dry fruit trees--Baleares	1,57%	Irrig-Galicia	2,48%
Irrig-Madrid	0,70%	Olive-Andalucía	1,47%	Vineyard-Andalucía	1,78%
Grassland-Aragón	0,36%	Vineyard-Madrid	1,40%	Vineyard-Madrid	1,75%
Vineyard-País Vasco	0,28%	Vineyard-Andalucía	0,79%	Dry fruit trees--Baleares	1,75%
Dry fruit trees--Baleares	0,22%	Vineyard-País Vasco	0,76%	Vineyard-País Vasco	1,12%
		Irrig-Madrid	0,42%	Vineyard-Extremadura	0,72%
		Vineyard-Extremadura	0,41%	Olive-Extremadura	0,29%
		Olive-Extremadura	0,26%	Vineyard-Murcia	0,14%
		Vineyard-Murcia	0,19%	Irrig-Madrid	0,05%
R = 6,00%		**R = 7,00%**		**R = 8,00%**	
Farmland	%	Farmland	%	Farmland	%
Grassland-Cantabria	21,78%	Dry-Galicia	23,75%	Dry-Galicia	22,96%
Dry-Galicia	20,79%	Vineyard-Galicia	16,07%	Olive-Andalucía	21,51%

Vineyard-Galicia	13,78%	Olive-Andalucía	15,04%	Vineyard-Galicia	16,81%
Olive-Andalucía	12,09%	Grassland-Galicia	8,52%	Grassland-Madrid	9,05%
Grassland-Galicia	7,35%	Grassland-Cantabria	7,80%	Grassland-Galicia	8,93%
Grassland-Madrid	6,70%	Grassland-Madrid	7,79%	Vineyard-Andalucía	6,11%
Vineyard-Andalucía	3,92%	Vineyard-Andalucía	4,81%	Irrig-Galicia	4,34%
Irrig-Galicia	3,52%	Irrig-Galicia	4,09%	Vineyard-Madrid	3,11%
Dry-Baleares	2,91%	Dry-Baleares	3,29%	Vineyard-País Vasco	2,71%
Vineyard-Madrid	2,50%	Vineyard-Madrid	2,87%	Dry-Baleares	2,33%
Vineyard-País Vasco	1,87%	Vineyard-País Vasco	2,22%	Vineyard-Extremadura	1,95%
Dry fruit trees--Baleares	1,32%	Dry fruit trees--Baleares	1,78%	Dry-Madrid	0,18%
Vineyard-Extremadura	1,31%	Vineyard-Extremadura	1,60%		
Olive-Extremadura	0,15%	Olive-Extremadura	0,26%		
		Dry-Madrid	0,10%		
R = 9,00%		**R = 10,00%**		**R = 11,00%**	
Farmland	%	Farmland	%	Farmland	%
Olive-Andalucía	32,47%	Olive-Andalucía	43,73%	Olive-Andalucía	56,34%
Vineyard-Galicia	15,07%	Vineyard-Galicia	12,63%	Grassland-Madrid	13,73%
Dry-Galicia	13,68%	Grassland-Madrid	12,27%	Vineyard-Andalucía	7,84%
Grassland-Madrid	10,62%	Vineyard-Andalucía	8,08%	Vineyard-Galicia	6,16%
Grassland-Galicia	7,85%	Grassland-Galicia	6,51%	Vineyard-País Vasco	4,73%
Vineyard-Andalucía	7,14%	Vineyard-País Vasco	4,09%	Grassland-Galicia	3,24%
Irrig-Galicia	3,87%	Irrig-Galicia	3,17%	Vineyard-Extremadura	2,64%
Vineyard-País Vasco	3,40%	Dry-Galicia	2,99%	Vineyard-Madrid	2,36%
Vineyard-Madrid	3,04%	Vineyard-Madrid	2,92%	Irrig-Galicia	1,52%
Vineyard-Extremadura	2,29%	Vineyard-Extremadura	2,61%	Olive-C-LM	0,79%
Dry-Madrid	0,31%	Olive-C-LM	0,58%	Dry-Madrid	0,45%
Olive-C-LM	0,26%	Dry-Madrid	0,41%	Vineyard-Cas-León	0,19%
R = 12,00%		**R =13,00%**			
Farmland	%	Farmland	%		
Olive-Andalucía	71,06%	Olive-Andalucía	94,90%		
Grassland-Madrid	14,51%	Vineyard-Cas-León	2,27%		
Vineyard-País Vasco	5,15%	Grassland-Madrid	2,26%		
Vineyard-Andalucía	4,67%	Vineyard-País Vasco	0,58%		
Vineyard-Extremadura	1,98%				
Vineyard-Cas-León	0,92%				
Olive-C-LM	0,72%				
Vineyard-Madrid	0,68%				
Dry-Madrid	0,32%				

The farmland portfolios of model with the 10% restriction is shown in table nº 3. It presents a wider degree of diversification, as expected.

Table nº 3. Efficient farmland portfolios for several levels of returns (returns by appreciation of farmland) with 10% restriction.

R = 5,00%		**R = 6,00%**		**R = 7,00%**	
Farmland	%	Farmland	%	Farmland	%
Dry-Galicia	10,00%	Dry-Galicia	10,00%	Dry-Galicia	10,00%

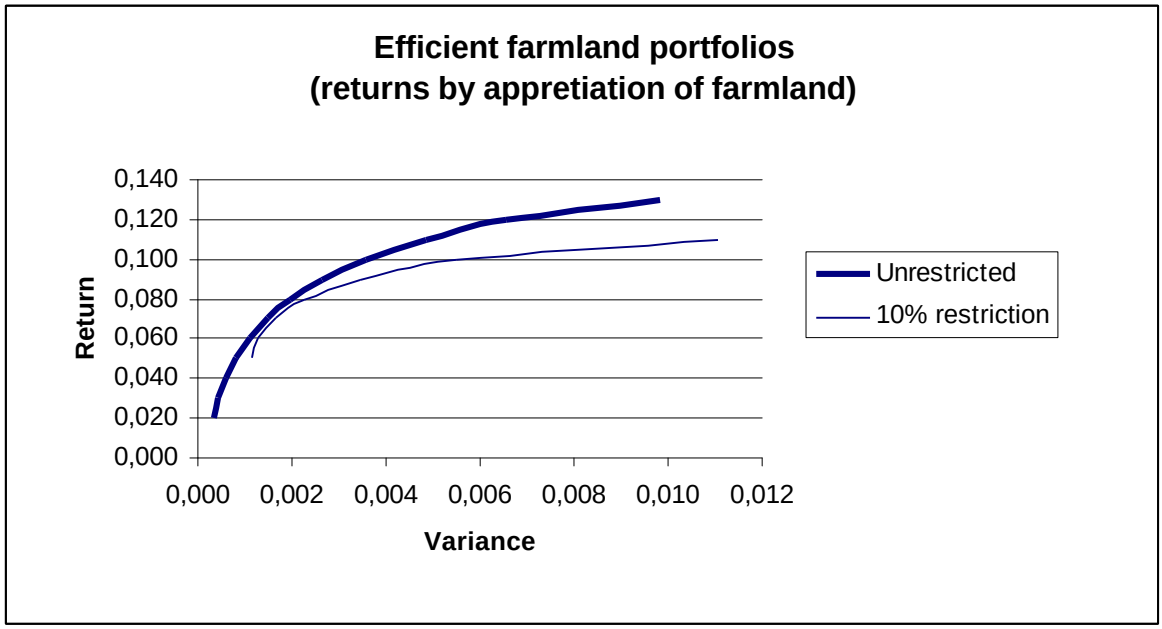
Vineyard-Galicia	10,00%	Vineyard-Galicia	10,00%	Vineyard-Galicia	10,00%
Grassland-Galicia	10,00%	Grassland-Galicia	10,00%	Grassland-Galicia	10,00%
Grassland-Cantabria	10,00%	Grassland-Cantabria	10,00%	Olive-Andalucía	10,00%
Dry fruit trees--Baleares	8,20%	Dry fruit trees--Baleares	7,85%	Vineyard-Andalucía	9,36%
Dry-Baleares	7,65%	Grassland-Madrid	7,59%	Grassland-Madrid	9,16%
Grassland-Madrid	6,48%	Dry-Baleares	6,98%	Grassland-Cantabria	8,08%
Grassland-Aragón	6,12%	Olive-Andalucía	6,17%	Dry fruit trees--Baleares	6,17%
Irrig-Galicia	4,49%	Irrig-Galicia	4,99%	Irrig-Galicia	5,45%
Dry-C-LM	4,29%	Vineyard-Andalucía	3,89%	Dry-Baleares	5,16%
Irrig-Madrid	3,61%	Dry-C-LM	3,74%	Vineyard-Madrid	3,45%
Vineyard-Madrid	3,20%	Vineyard-Madrid	3,34%	Vineyard-País Vasco	3,06%
Olive-Extremadura	2,99%	Olive-Extremadura	3,09%	Olive-Extremadura	2,80%
Vineyard-Cataluña	2,84%	Grassland-Aragón	2,66%	Vineyard-Extremadura	2,69%
Dry-Cataluña	2,19%	Vineyard-Cataluña	2,21%	Dry-C-LM	1,47%
Vineyard-Murcia	2,18%	Irrig-Madrid	1,96%	Vineyard-Murcia	1,09%
Vineyard-Navarra	1,60%	Vineyard-Murcia	1,88%	Olive-C-LM	0,82%
Olive-Cataluña	1,42%	Vineyard-País Vasco	1,88%	Vineyard-Cataluña	0,65%
Vineyard-País Vasco	1,13%	Vineyard-Extremadura	1,37%	Dry-Madrid	0,51%
Vineyard-Extremadura	0,54%	Vineyard-Navarra	0,23%	Grassland-C-LM	0,09%
Dry fruit trees--Andalucía	0,52%	Grassland-C-LM	0,16%		
Vineyard-Andalucía	0,35%				
Grassland-C-LM	0,19%				
R = 8,00%		**R = 9,00%**		**R = 10,00%**	
Farmland	%	Farmland	%	Farmland	%
Dry-Galicia	10,00%	Vineyard-Galicia	10,00%	Olive-Andalucía	10,00%
Vineyard-Galicia	10,00%	Olive-Andalucía	10,00%	Vineyard-Andalucía	10,00%
Grassland-Galicia	10,00%	Vineyard-Andalucía	10,00%	Grassland-Madrid	10,00%
Olive-Andalucía	10,00%	Grassland-Madrid	10,00%	Vineyard-País Vasco	9,32%
Vineyard-Andalucía	10,00%	Dry-Galicia	8,35%	Vineyard-Galicia	9,06%
Grassland-Madrid	10,00%	Grassland-Galicia	8,35%	Vineyard-Cas-León	8,94%
Irrig-Galicia	6,67%	Vineyard-País Vasco	6,90%	Olive-C-LM	8,63%
Dry fruit trees--Baleares	5,13%	Vineyard-Extremadura	6,31%	Vineyard-C-LM	8,38%
Vineyard-País Vasco	4,62%	Olive-C-LM	5,81%	Vineyard-Extremadura	8,05%
Vineyard-Extremadura	4,36%	Vineyard-C-LM	5,67%	Vineyard-La Rioja	4,44%
Vineyard-Madrid	3,91%	Irrig-Galicia	5,39%	Irrig-Galicia	3,26%
Dry-Baleares	3,57%	Vineyard-Cas-León	5,31%	Grassland-Galicia	2,91%
Olive-Extremadura	2,92%	Vineyard-Madrid	3,31%	Dry-Madrid	2,90%
Olive-C-LM	2,81%	Vineyard-La Rioja	2,53%	Vineyard-Madrid	2,39%
Vineyard-C-LM	2,16%	Dry-Madrid	2,07%	Dry-Andalucía	1,72%
Vineyard-Cas-León	1,57%				
Dry-Madrid	1,13%				
Vineyard-La Rioja	0,47%				
Dry-C-LM	0,37%				
Vineyard-Murcia	0,29%				
R = 11,00%					
Farmland	%				

Olive-Andalucía	10,00%		
Olive-C-LM	10,00%		
Dry-Andalucía	10,00%		
Dry-Madrid	10,00%		
Vineyard-La Rioja	10,00%		
Vineyard-Cas-León	9,98%		
Vineyard-País Vasco	7,67%		
Vineyard-C-LM	7,58%		
Citr-Andalucía	7,01%		
Vineyard-Andalucía	5,43%		
Vineyard-Extremadura	5,22%		
Vineyard-C.Val	4,17%		
Grassland-Madrid	2,75%		
Dry-Galicia	0,12%		

The composition of the new portfolio is different to the previous one, for low returns the northern crops have greater weight in the composition of the portfolio. As the expected return increases the crops in Andalucía and the vineyard increase their weight too.

In the Figure nº 1 the pairs (variance, return) conform the efficient curves of the two models. It shows that both curves are growing (bigger return, bigger risk or variance) and that the restricted model has less returns. It has been necessary to eliminate the first tract of the restricted model curve, since in that first tract the relationship between variance-return it is decreasing.

Figure nº1.



6. APPLICATION FOR GLOBAL RETURNS (APPRECIATION AND CASH-FLOW)

Once we have quantified the global return (appreciation + family farm income) of each community and crop for the available year, an ordinary least squares adjustment has been carried out. The explanatory variable was the return of a market index. The series of the market index has been calculated using the average prices of Spain and the average family farm income for the whole of crops. With these data an average global returns series has been built. In table nº 4 the returns by appreciation of farmland and the global returns are shown.

Table nº 4.Returns* of Spanish farmland

%	1990	1991	1992	1993	1994	1995	1996	1997	1998
Rent. for appreciation	-2,88	-5,26	-12,15	6,32	5,58	7,75	14,22	16,17	11,45
Global profitability	4,52	2,22	-5,50	16,34	17,88	17,85	25,22	25,63	19,98

*As defined

A change in the tendency of the returns by appreciation of farmland occurs in 1993. That is also manifested in the global returns. From the year 1993 the global returns also grow. These two facts are consequence of the adhesion to the European Union (European Community) and so the integration in the Community Agrarian Politic.

With an ordinary least squares adjustment the Beta coefficients have been obtained, see table nº 5.

Table nº 5. Beta coefficients from the global returns of farmland

Farmland	Beta	Farmland	Beta
Grassland-Cantabria	4,605	Citr-C.Val	0,505
Dry-Galicia	2,583	Irrig-Andalucía	0,477
Irrig-Baleares	1,097	Irrig-Murcia	0,459
Vineyard-Cataluña	0,941	Dry-Navarra	0,452
Dry-Cataluña	0,898	Irrig-Aragón	0,445
Vineyard-Andalucía	0,897	Vineyard-C.Val	0,415
Grassland-Asturias	0,878	Irrig-Extremadura	0,393
Irrig-La Rioja	0,877	Vineyard-Extremadura	0,370
Dry-C-LM	0,861	Dry-La Rioja	0,361
Dry-Extremadura	0,798	Vineyard-Murcia	0,355
Dry fruit trees--Cataluña	0,690	Dry fruit trees--Aragón	0,355
Irrig-Cas-León	0,674	Vineyard-Navarra	0,343
Vineyard-Cas-León	0,664	Irrig-C.Val	0,328
Dry-Andalucía	0,643	Vineyard-C-LM	0,269
Irrig-Cataluña	0,622	Irrig-Navarra	0,259
Olive-Andalucía	0,615	Vineyard-Aragón	0,245
Dry fruit trees--C-LM	0,592	Vineyard-La Rioja	0,210
Dry-Cas-León	0,583	Dry fruit trees--Murcia	0,207
Dry-Aragón	0,577	Vineyard-País Vasco	0,160
Irrig-C-LM	0,564	Vineyard-Madrid	0,070
Dry fruit trees--C.Val	0,527	Vineyard-Galicia	0,057
Dry fruit trees--Andalucía	0,511	Dry-Madrid	-0,022

The Beta coefficients of the grassland in Cantabria, unirrigated land in Galicia and irrigated land in Baleares outstand from the rest because they are greater than the unit. The rest of lands present a smaller Beta coefficient that means that their answers when the market returns vary are smaller than the variations of the market returns. The unirrigated land in Madrid shows a negative Beta, although very close to zero.

In the same way as in epigraph nº 5, the efficient unrestricted portfolio has been built, it is shown in table nº 6.

In the portfolios with smallest global returns, dried fruits trees land in Valencia are the most important component. Concretely, the main part of dried fruits trees in the community of Valencia are almond trees. The real agrarian returns (not by appreciation) are very low in almond trees but the CAP subsidies increase it.

It outstands too the irrigated farmland in Murcia, mainly horticulture which is very profitable.

For greater returns the main components of the portfolio are grassland in Asturias and vineyard in Galicia.

Table nº 6. Efficient unrestricted farm portfolio (considering global returns)

R = 8%		R = 9%		R = 10%		R = 11%	
Dry fruit trees--C.Val	19,65%	Dry fruit trees--C.Val	15,22%	Vineyard-Galicia	20,54%	Vineyard-Galicia	25,39%
Irrig-Murcia	18,68%	Irrig-Murcia	13,43%	Irrig-Murcia	11,21%	Irrig-Murcia	8,15%
Vineyard-Cas-León	17,10%	Vineyard-Cas-León	10,69%	Dry fruit trees--C.Val	11,18%	Dry fruit trees--C.Val	7,80%
Dry fruit trees--Andalucía	10,33%	Dry fruit trees--Andalucía	8,92%	Vineyard-Cas-León	10,05%	Vineyard-Cas-León	6,53%
Irrig-C.Val	8,31%	Irrig-C-LM	8,14%	Dry fruit trees--Andalucía	6,74%	Irrig-C-LM	5,43%
Irrig-C-LM	8,11%	Irrig-C.Val	6,73%	Irrig-C-LM	6,74%	Vineyard-Murcia	5,26%
Vineyard-Murcia	5,44%	Olive-Andalucía	6,60%	Vineyard-Murcia	5,64%	Dry fruit trees--Andalucía	5,08%
Irrig-Navarra	3,89%	Vineyard-Murcia	6,58%	Irrig-C.Val	5,21%	Irrig-C.Val	3,98%
Olive-Andalucía	3,74%	Vineyard-Galicia	5,99%	Olive-Andalucía	4,61%	Olive-Andalucía	3,89%
Vineyard-Aragón	2,12%	Irrig-Navarra	5,04%	Irrig-Navarra	3,94%	Vineyard-Extremadura	3,83%
Vineyard-País Vasco	1,23%	Vineyard-Aragón	2,83%	Vineyard-Aragón	2,63%	Irrig-Navarra	3,70%
Vineyard-Madrid	0,76%	Vineyard-Madrid	2,33%	Vineyard-Madrid	2,33%	Vineyard-Madrid	2,67%
Vineyard-Galicia	0,53%	Vineyard-País Vasco	2,12%	Vineyard-País Vasco	2,15%	Vineyard-Aragón	2,58%
Vineyard-C-LM	0,12%	Vineyard-C-LM	1,85%	Vineyard-C-LM	1,95%	Vineyard-Navarra	2,57%
		Vineyard-C.Val	1,69%	Vineyard-C.Val	1,54%	Vineyard-C-LM	2,30%
		Vineyard-Navarra	0,82%	Vineyard-Navarra	1,52%	Vineyard-País Vasco	2,30%
		Vineyard-La Rioja	0,44%	Vineyard-La Rioja	0,89%	Vineyard-C.Val	2,17%
		Irrig-Extremadura	0,26%	Vineyard-Extremadura	0,61%	Irrig-Extremadura	2,01%
		Vineyard-Extremadura	0,23%	Irrig-Extremadura	0,52%	Vineyard-La Rioja	1,49%
		Dry fruit trees--Aragón	0,07%			Dry fruit trees--Aragón	1,11%
						Dry-La Rioja	0,87%
						Dry-Navarra	0,64%
						Dry-Madrid	0,19%
						Dry fruit trees--Murcia	0,07%
R = 12%		**R = 13 %**		**R = 14%**		**R = 15%**	
Vineyard-Galicia	27,15%	Vineyard-Galicia	28,18%	Vineyard-Galicia	28,74%	Vineyard-Galicia	29,10%
Irrig-Murcia	6,01%	Vineyard-Extremadura	6,00%	Vineyard-Extremadura	6,27%	Dry fruit trees--Murcia	7,84%
Dry fruit trees--C.Val	5,45%	Dry fruit trees--Murcia	4,81%	Dry fruit trees--Murcia	6,24%	Vineyard-Extremadura	6,07%
Vineyard-Extremadura	5,15%	Vineyard-Murcia	4,19%	Irrig-Aragón	3,62%	Irrig-Aragón	4,89%
Vineyard-Murcia	4,73%	Irrig-Murcia	4,10%	Vineyard-Murcia	3,57%	Dry fruit trees--C-LM	3,97%
Irrig-C-LM	4,18%	Dry fruit trees--C.Val	3,33%	Vineyard-Navarra	3,19%	Dry-La Rioja	2,98%
Dry fruit trees--Andalucía	3,79%	Vineyard-Navarra	3,19%	Irrig-Extremadura	3,08%	Vineyard-Navarra	2,94%
Vineyard-Cas-León	3,64%	Irrig-Navarra	3,07%	Vineyard-Madrid	2,80%	Irrig-Andalucía	2,86%
Irrig-Navarra	3,37%	Irrig-Extremadura	3,01%	Dry-La Rioja	2,79%	Irrig-Extremadura	2,84%
Irrig-C.Val	3,08%	Irrig-C-LM	2,86%	Irrig-Andalucía	2,79%	Citr-C.Val	2,80%

Vineyard-Navarra	2,97%	Vineyard-Madrid	2,80%	Citr-C.Val	2,78%	Vineyard-Madrid	2,74%
Olive-Andalucía	2,91%	Dry fruit trees--Andalucía	2,62%	Irrig-Navarra	2,73%	Dry-Aragón	2,66%
Dry fruit trees--Murcia	2,79%	Dry-La Rioja	2,44%	Dry-Navarra	2,60%	Dry-Navarra	2,52%
Vineyard-Madrid	2,76%	Vineyard-C-LM	2,41%	Dry fruit trees--Aragón	2,39%	Vineyard-Murcia	2,45%
Irrig-Extremadura	2,62%	Vineyard-C.Val	2,36%	Vineyard-C-LM	2,34%	Dry fruit trees--Aragón	2,44%
Vineyard-Aragón	2,45%	Dry-Navarra	2,35%	Irrig-Murcia	2,31%	Irrig-Navarra	2,17%
Vineyard-C-LM	2,40%	Irrig-Andalucía	2,34%	Vineyard-C.Val	2,20%	Dry-Andalucía	2,14%
Vineyard-C.Val	2,34%	Irrig-C.Val	2,34%	Vineyard-País Vasco	2,14%	Vineyard-C-LM	2,12%
Vineyard-País Vasco	2,27%	Vineyard-Aragón	2,28%	Vineyard-Aragón	2,09%	Dry-Cas-León	2,09%
Dry-La Rioja	1,80%	Citr-C.Val	2,26%	Vineyard-La Rioja	1,99%	Vineyard-La Rioja	1,99%
Dry fruit trees--Aragón	1,74%	Irrig-Aragón	2,24%	Dry fruit trees--C-LM	1,78%	Vineyard-País Vasco	1,97%
Vineyard-La Rioja	1,73%	Vineyard-País Vasco	2,21%	Dry-Aragón	1,77%	Irrig-Cataluña	1,97%
Dry-Navarra	1,67%	Dry fruit trees--Aragón	2,18%	Irrig-C.Val	1,65%	Dry-Madrid	1,83%
Irrig-Andalucía	1,28%	Vineyard-La Rioja	1,92%	Dry-Cas-León	1,49%	Vineyard-Aragón	1,76%
Citr-C.Val	0,98%	Olive-Andalucía	1,71%	Dry-Madrid	1,45%	Vineyard-C.Val	1,71%
Dry-Madrid	0,72%	Dry-Madrid	1,13%	Dry fruit trees--Andalucía	1,40%	Irrig-C.Val	0,69%
		Vineyard-Cas-León	0,96%	Dry fruit trees--C.Val	1,29%	Grassland-Asturias	0,45%
		Dry-Aragón	0,37%	Irrig-C-LM	1,25%		
		Dry-Cas-León	0,34%	Irrig-Cataluña	0,78%		
				Dry-Andalucía	0,47%		
R = 16%		**R = 17%**		**R = 18%**		**R = 19%**	
Vineyard-Galicia	29,22%	Vineyard-Galicia	29,36%	Vineyard-Galicia	29,04%	Vineyard-Galicia	27,51%
Dry fruit trees--Murcia	9,23%	Grassland-Asturias	13,81%	Grassland-Asturias	20,11%	Grassland-Asturias	26,92%
Grassland-Asturias	7,26%	Dry fruit trees--Murcia	10,61%	Dry fruit trees--Murcia	12,00%	Dry fruit trees--Murcia	13,44%
Irrig-Aragón	5,55%	Irrig-Aragón	6,14%	Irrig-Aragón	6,53%	Irrig-La Rioja	7,73%
Vineyard-Extremadura	5,18%	Dry fruit trees--C-LM	5,72%	Dry fruit trees--C-LM	6,24%	Irrig-Aragón	6,71%
Dry fruit trees--C-LM	4,88%	Vineyard-Extremadura	4,03%	Irrig-La Rioja	5,53%	Dry fruit trees--C-LM	6,34%
Dry-La Rioja	2,90%	Dry-La Rioja	2,72%	Dry-Madrid	3,06%	Dry-Madrid	3,55%
Vineyard-Madrid	2,70%	Dry-Madrid	2,62%	Vineyard-Extremadura	2,66%	Vineyard-Madrid	2,21%
Vineyard-Navarra	2,39%	Vineyard-Madrid	2,61%	Vineyard-Madrid	2,49%	Dry-La Rioja	1,91%
Dry-Aragón	2,38%	Dry fruit trees--Aragón	2,01%	Dry-La Rioja	2,48%	Vineyard-La Rioja	1,52%
Irrig-Andalucía	2,28%	Irrig-La Rioja	1,88%	Vineyard-La Rioja	1,76%	Dry fruit trees--Aragón	1,05%
Dry fruit trees--Aragón	2,25%	Dry-Aragón	1,88%	Dry fruit trees--Aragón	1,67%	Vineyard-País Vasco	0,76%
Dry-Madrid	2,22%	Vineyard-La Rioja	1,88%	Vineyard-País Vasco	1,23%	Vineyard-Extremadura	0,17%
Irrig-Extremadura	2,20%	Vineyard-Navarra	1,75%	Dry-Aragón	0,99%	Grassland-Cantabria	0,11%
Dry-Andalucía	1,97%	Irrig-Andalucía	1,55%	Vineyard-Navarra	0,94%	Vineyard-C-LM	0,06%
Citr-C.Val	1,97%	Vineyard-País Vasco	1,54%	Vineyard-C-LM	0,85%		
Vineyard-La Rioja	1,96%	Irrig-Extremadura	1,46%	Irrig-Cataluña	0,78%		

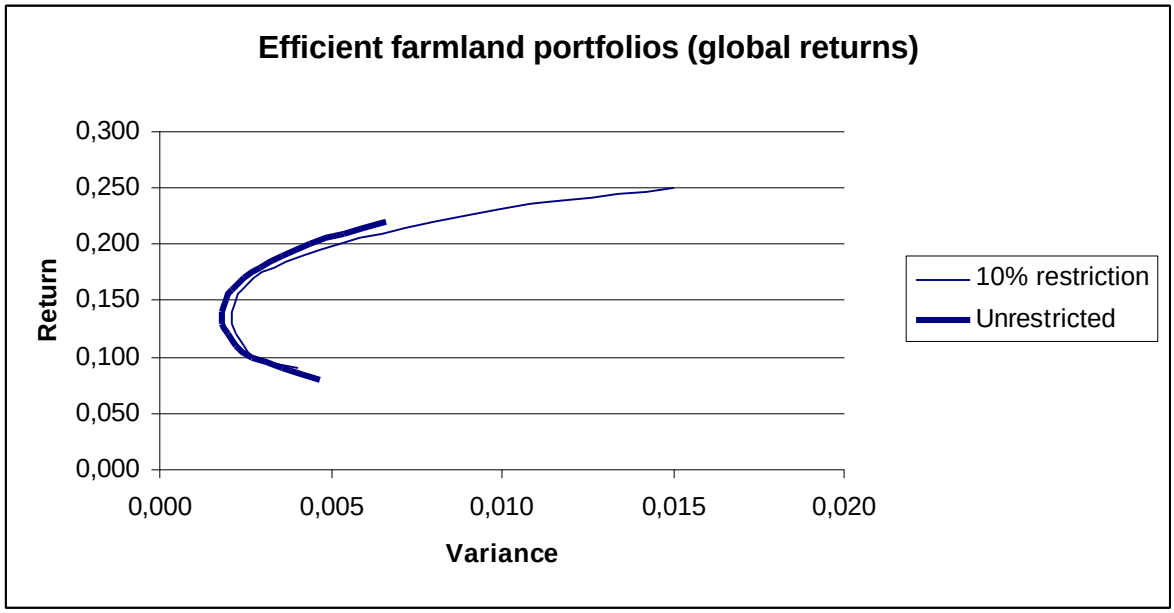
Dry-Navarra	1,92%	Irrig-Cataluña	1,44%	Irrig-Andalucía	0,57%	
Irrig-Cataluña	1,82%	Vineyard-C-LM	1,36%	Irrig-Extremadura	0,48%	
Vineyard-País Vasco	1,78%	Dry-Andalucía	1,27%	Dry-Navarra	0,26%	
Vineyard-C-LM	1,76%	Dry-Navarra	1,20%	Vineyard-Aragón	0,22%	
Dry-Cas-León	1,54%	Citr-C.Val	0,93%	Dry-Andalucía	0,09%	
Irrig-Navarra	1,44%	Vineyard-Aragón	0,82%			
Vineyard-Aragón	1,33%	Dry-Cas-León	0,74%			
Vineyard-Murcia	0,96%	Irrig-Navarra	0,67%			
Vineyard-C.Val	0,88%					
R = 20%		**R = 21%**		**R = 22%**		
Grassland-Asturias	32,11%	Grassland-Asturias	37,38%	Grassland-Asturias	42,73%	
Vineyard-Galicia	25,04%	Vineyard-Galicia	22,13%	Vineyard-Galicia	18,87%	
Dry fruit trees--Murcia	14,72%	Dry fruit trees--Murcia	16,05%	Dry fruit trees--Murcia	17,31%	
Irrig-Aragón	6,50%	Irrig-Aragón	6,14%	Irrig-Aragón	5,72%	
Irrig-La Rioja	6,24%	Dry fruit trees--C-LM	5,14%	Dry-Madrid	5,13%	
Dry fruit trees--C-LM	5,88%	Dry-Madrid	4,60%	Dry fruit trees--C-LM	4,34%	
Dry-Madrid	4,07%	Irrig-La Rioja	4,12%	Grassland-Cantabria	3,16%	
Vineyard-Madrid	1,86%	Grassland-Cantabria	2,07%	Irrig-La Rioja	1,50%	
Vineyard-La Rioja	1,16%	Vineyard-Madrid	1,42%	Vineyard-Madrid	0,96%	
Dry-La Rioja	1,10%	Vineyard-La Rioja	0,74%	Vineyard-La Rioja	0,29%	
Grassland-Cantabria	1,04%	Dry-La Rioja	0,21%			
Dry fruit trees--Aragón	0,15%					
Vineyard-País Vasco	0,12%					

The efficient portfolio with a restriction of 10% in the composition has been built too.

For low global returns the main components of the portfolio are dry fruits trees in Valencia, obviously 10% of the composition, irrigated land in Murcia and Valencia, dry fruits trees in Andalucía.

For higher global returns the main components are irrigated land in La Rioja and Aragón, dry fruis trees in Murcia y Castilla-La Mancha

In the figure nº 2 the graphics of both portfolios are shown, as before, the returns of the restricted model are smaller, as expected.


Efficient farmland portfolios (global returns)
Return
0,300
0,250
0,200
0,150
0,100
0,050
0,000
0,000
0,005
0,010
0,015
0,020
Variance
10% restriction
Unrestricted

CONCLUSIONS:

?? We can establish a clear analogy in the construction of the returns between stock returns and returns of investment in farmland. However, the necessary data to be able to build efficient portfolio are more available in the case of the stock market.

?? The return by farmland can be easily obtained from the farmland prices survey of the Ministry of Agriculture. The returns by cash-flows should be estimate from accountancy information that use a crop classification different to the series of farmland from the survey. That fact force us to assume some hypotheses to establish the relationship between both classifications.

?? Although we include the gainings generated by cultivation like part of farmland return, in strict sense, we should not speak of gainings of a parcel but of gainings of a farm. The gainings depends on the farmlands as well as other assets of the farm.

?? Changes in CAP could cause distortions of the farm results if they affect to the subsidies perceived by the farms and therefore to the cash-flows component of returns.

?? When we build farmland portfolios based on the historical returns and on historical variability we are assuming that the future behaviour of the market will be alike.

?? An important bias could take place if big properties with important forest masses make up the portfolio, since the agrarian productions are refered to total utilised agricultural area.

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