# WILL FARM INCOME RISK CHANGE UNDER THE NEW CAP REFORM?[1]

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**ABSTRACT**

Investments in public goods, price stabilisation schemes, compensatory payments, farm insurance and calamity assistance programs are some examples of public intervention to reduce risk in agriculture. Using discrete stochastic programming associated with a Minimisation of Total Absolute Deviations framework, the impact of the 2003 Common Agricultural Policy Reform on income risk of a typical Mediterranean farm was analysed. The introduction of the single payment scheme leads to increase in total farm income and to a decrease in the total income risk. However, the relative production risk increases.

Key words: Income risk, public policies, mathematical programming

## 1 – INTRODUCTION

Farming is an economic activity subject to several sources of risk such as production risk, market risk, institutional risk, financial risk, technological risk, etc. Both risk sources and farmers' attitudes to risk have been seemed by governments as very important issues. Farm income reduction to avoid risk has a negative multiplier effect on income and on employment in rural areas. Moreover, farmers' strategies to avoid risk tend to reduce efficiency of farm resource use, which diminish income and decrease

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the supply of risky products. Governments have had public intervention in various vectors: investments on public goods, price stabilisation measures, compensatory payments, farm insurance and calamity assistance programs are some of the traditional measures implemented (European Commission, 2001). Direct governmental intervention, particularly the semi-decoupled compensatory payments, has been very important to Mediterranean farmers in reducing their income variability. Farmers in Mediterranean areas face a climate characterised by a considerable variability of both rainfall and temperature levels that can lead to not only crop yield decline but also to total crop destruction by fires or late frosts.

According to the 2003 Common Agricultural Policy (CAP) reform, a system of a progressive reduction of direct payments shall be introduced on a compulsory basis for the years 2005 to 2012. This means that farm subsidies are expected to be completely decoupled from production by 2013. To avoid the abandonment of agricultural land and ensure that good agricultural and environmental conditions will be maintained, each Member State establishes a set of standards. Hence, the single farm payment will be conditional upon cross-compliance with environment, food safety, animal health and welfare as well as the maintenance of the farm in good agricultural and environmental conditions. Therefore, the new reform of the CAP involves some discretion for member states including in respect of how fully to decouple subsidy payments from production (EC Nº1782/2003). Portugal decided to implement the single payment scheme starting from 2005. For instance, arable crops subsidies will be totally decoupled, while the subsidies for extensive livestock production will be partially decoupled. This change is expected to have a major impact on both farm income and income variability. This will be particularly evident in the dry land areas of the Mediterranean region in which cereals and extensive cattle are the principal activities. For farms located in this region, the single payment scheme might increase the total farm income but its variability might decrease since cereals and fodder production are very dependent from climatic conditions, in special rainfall. Thus, the objective of this paper is to study the impact of the new CAP reform on income variability of a Mediterranean farm located in the south of Portugal. The two conflicting farm objectives, farm income maximisation and income variability minimisation, are investigated.

## 2 - ANALYTICAL FRAMEWORK

In order to achieve the objectives of this paper, the base model developed by Carvalho (1994, 2002) was modified, improved and applied to a typical farm in the Alentejo region, located in Évora County.

According to Hazell and Norton (1986), if resources are freely tradable, any stochastic discrepancies between the resource requirements of a farm plan and the resource supplies can be captured in the objective function through buying and selling activities. All the risks in the constrained set can be transferred into the objective function of the model and a single risk decision rule can be applied. Hence, the model is based on discrete stochastic programming (DSP) associated with a Minimisation of Total Absolute Deviations (MOTAD) framework (Hazell, 1971; Hazell and Norton,1986). These techniques take into account the variation of the growing season reflected on crop yields. Several states of nature corresponding to different types of years, associated to a certain probability of occurrence, are modelled. Hence, the model represents rainfall variability and its effects on yields, farmer's decision-making flexibility, and indirect farmer's aversion to risk. While the DSP framework allows for sequential decision making, which characterizes the flexibility of farmers in modifying strategic decisions as the growing season unfolds; the MOTAD framework captures the effects of income risk. This risk results from cash crop yield variability, intermediate products selling variability from adjustments in livestock feed-mix, and animal selling variability from adjustments in marketing strategies for selling meat.

The model assumes that farmer maximise expected returns to management and land, subject to a set of constraints related to farm's limited resources of land, machinery, and labour, livestock feeding requirements and risk, as well as to the no negativity conditions. A simplified formulation of the model is:

$$\text{Max } E(Z) = E(Z_n X_n) - W_g N_g + R_p P_i V_{pi} + W_r P_i N_{r,i} \qquad (1)$$

Subject to

$$A_{mn} X_n \leq T_m \qquad (2)$$

$$Y_i + M_{si} X_s + M_{ir} - M_r + M_{pi} - M_p \geq 0 \quad (3)$$

$$p_i Y_i \leq \lambda \quad (4)$$

Equation (1) states that producer maximise the expected return to land, management, and other fixed factors, and $E(Z_n X_n)$ stays for expected gross margin of $X_n$ crop and livestock activities, $N_g$ represents purchasing activities, and $W_g$ their prices; $V_{pi}$ represents the livestock selling activities for the different marketing strategies by state of nature, $R_p$ their gross margin, and $P_i$ the probability of occurrence of each state of nature; $N_{ri}$ represents the selling activities of intermediate products and $W_r$ their prices.

Equations (2) stay for resources availability and livestock feed requirements in which $A_{mn}$ represents a mxn matrix of technical coefficients for crop and livestock activities; $T_m$ is the vector of the available resources.

Equation (3) computes the sum of absolute deviations from expected returns *per* state of nature. In this equation, $Y_i$ stays for total negative deviation from expected income for each state of nature; $M_{si}$ is the matrix of absolute deviations from expected income of crop activities ($X_s$); ($M_{ir}$ -$M_r$) is the deviation from the mean of the intermediate products selling activities, and ($M_{pi} - M_p$) represents the deviation from the mean for marketing strategies of livestock activities.

Equation (4) sums weighted negative deviations across states of nature according to their probabilities of occurrence. Thus, $\lambda$ is the sum of the expected total negative deviations and will be parameterised from 0 to $\lambda$ max in order to analyse the trade-off between expected income and risk.

The model is applied using data available from a farm survey, for the years 2000, 2001 and 2002, which correspond to the “reference period”, and are used to calculate the reference subsidy amount under the CAP Reform. These data are referred to resources availabilities, technical coefficients and farmer objectives. Other data like product and factor prices, soils and alternative activities were available from official statistics and experts.

Dry land crop activities of this farm, with 366 ha of total area, are based on cereals (wheat, durum wheat, and triticale), on forages (oats*vicia, oats*lupines, oats), and on pastures (fallow, subterranean clover and fertilized fallow). The irrigated crop activities, followed in 65 ha, include corn for grain or for silage, wheat, sunflower, sorghum for hay or silage, tomato and sugar beet.

Livestock activities, which include cattle and sheep, are based on different production technologies, and distinguished by different breeding periods, and crossing used. The composition of livestock unit (the unit of account for livestock) is defined according to the male/female ratio and to the replacement rate of males and females, and includes breeding and replacement animals. The several marketing strategies for selling meat represent independent activities related to the respective production activity through the production rate. Livestock feed requirements are entirely fulfilled from feed supplied from crop activities. Fodder production variability determines the selection of livestock technology and marketing strategies.

## 3 - MODEL RESULTS

The model was applied to three CAP political scenarios. In the first one, named Base Model, the CAP scenario refers to the 1992 CAP reform with the changes introduced by the 2000 Agenda. Under this scenario, the main measures are concerned to arable crops, beef and sheep activities. The compensatory payments are awarded *per* arable hectare, according to the farm productivity class, and *per* livestock head. The producer also receives a monetary compensation due to the set-aside requirements. Related to bovine activities, CAP measures introduced in the model refer to sucker and heifer premiums, special male bovine premium and slaughter premium, and to the extensification payment. Regarding to sheep activities, the subsidies included are the ewe premium and the supplementary premium.

The second scenario (Partial Reform Model) reflects the partial implementation of the new agricultural political agenda, and actually applied to Portugal. Under this scenario, crop compensatory payments awarded in the base scenario are transformed in a single payment and totally decoupled from production. However, livestock subsidies are only semi-decoupled from production. This means that part of the livestock subsidies is still linked to the number of livestock heads and part is included in the single payment. Finally, the third model (Full Reform Model) reflects the full implementation of the 2003 CAP reform in which the total amount of subsidies related to the reference period are transformed into a single payment subsidy and totally decoupled from both crop and livestock production.

**Table 1 –** Impact of 2003 CAP Reform on Expected Income and Risk

| **MODEL** | **BASE** | | **PARTIAL** | | **FULL** | |
|---|---|---|---|---|---|---|
| **λ/λ max** | 0% | 100% | 0% | 100% | 0% | 100% |
| **Total Expected Farm Income *(€)*** | 213 702 | 229 804 | 215 830 | 230 967 | 261 499 | 278 505 |
| **Total Expected Farm Income w/o subsidies *(€)*** | -18 438 | -14 893 | 6 694 | 12 491 | 43 287 | 48 490 |
| **Production Expected Income *(€)*** | 213 702 | 229 804 | 104 175 | 114 987 | 43 287 | 48 490 |
| **Expected Subsidies *(€)*** | 232 140 | 244 697 | 209 136 | 218 476 | 218 212 | 230 015 |
| **Sum of negative deviations ( λ)** | 0 | 12 533 | 0 | 9 293 | 0 | 5708 |

Source: Compiled from model solutions

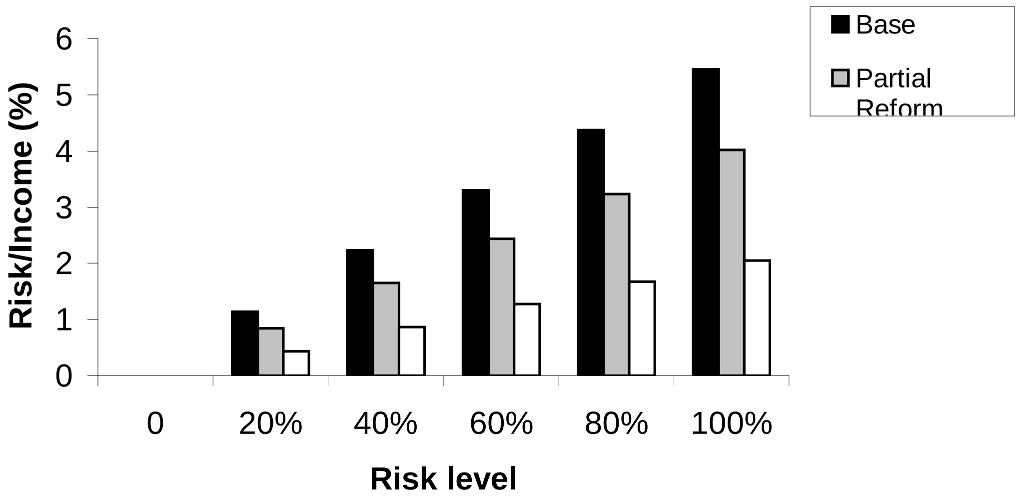
The comparison between the three political scenarios for the two extreme situations of income variability –λ equal to 0% of λ maximum and λ equal to 100% of λ maximum - is shown in Table 1. This λ is the total weighted sum of negative deviations and represents what, in average, the farmer can loose in income. It is related to dry land crop activities and to livestock activities.

The implementation of the 2003 CAP reform leads to an increase in the total expected returns to land and management under full implementation scenario. The income increase for this scenario in relation to the base model, is about 22 % and 21 % for 0 % and 100% of risk, respectively. However, production expected income, that is, the value of the objective function of the model, and hence related to the level of production activities, diminishes with the CAP reform. This decrease is very significant for both scenarios, about 50% under the partial implementation scenario, and about 80% under the full implementation. Under base scenario, many activities have negative gross margins without subsidies, as the total expected farm income without subsidies shows in

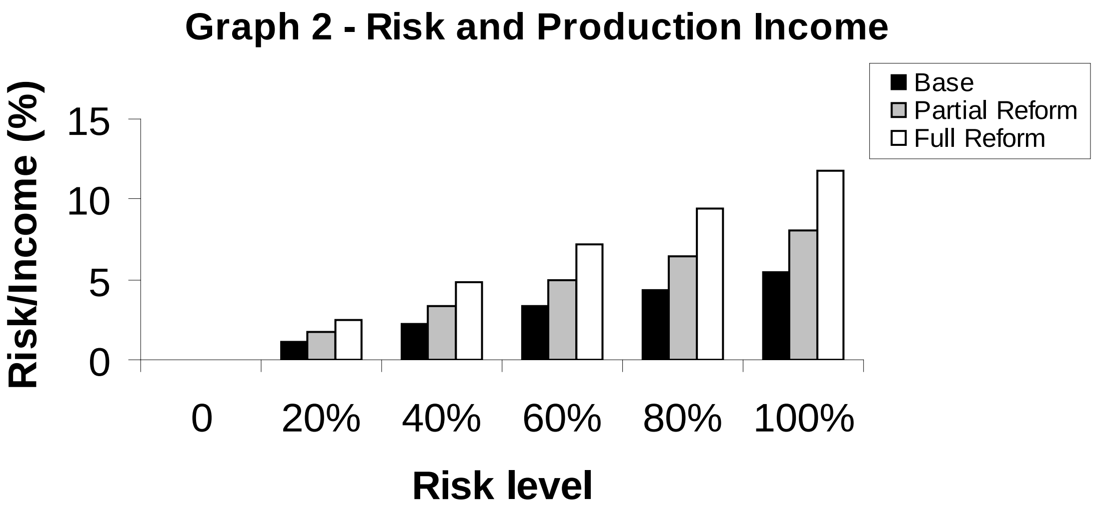
Table 1. However, the farmer continues following those activities since they still have high subsidies coupled (livestock activities) and semi-decoupled to their production level, as it is the case of cereals.

Graphs 1 and 2 show the trade-off between expected income and risk for the different levels of risk aversion. In this analysis, the different levels of risk aversion, that is, the expected total sum of negative deviations ($\lambda$), was parameterised at the levels of 0%, 20%, 40%, 60%, 80%, and 100% of its maximum value. As expected, the 2003 CAP reform, introducing the single payment scheme, totally decoupled from production, reduces the relative income variability ($\lambda$ divided by expected total income) (Graph 1). This reduction is more effective for higher levels of risk or income variability (100% of $\lambda$ max).

**Graph 1 - Risk and Total Income**




Graph 2 shows that the new CAP reform increases the relative risk (in this case, $\lambda$ is divided by expected production income) for all the levels of risk and under both scenarios. Thus, new CAP situation is more risky than the old one when only the expected production income is taken in account. As the new CAP measures are decoupled or semi-decoupled from production, farmers have no longer the stabilisation effect on production income variability from political intervention. Hence, farmers are expected to respond more to market signals. In summary, the analysis of both graphs allows one to conclude that, under the new CAP reform, the existence of the single payment decreases the variability of total farm income but relative risk increases when only the expected production income is taken in account.




The previous graphs are based on data contained in Table A1 of Appendix. In this table the expected total income and expected production income associated with the total weighted sum of negative deviations (λ) is presented for the three models.

The results of the 2003 CAP reform on cropping areas and on livestock activities for the two levels of risk (0% and 100%) are shown in Table 2. Under the assumption of high risk aversion (λ/λ max equal to 0%), dry land crop activities change for the three models, with cereals being substituted by pastures from Base Model to Partial Model and Full Model. Thus, CAP reform leads to cereals extensification since cereals are risky activities as referred previously. For higher level of risk (λ/λ max equal to 100%) the impact of the CAP reform on dry land cereal production is less relevant. Triticale substitutes for durum wheat under both scenarios.

**Table 2** - Impact of 2003 CAP Reform on Crops and Livestock Activities

| | Base Model | | Partial Model | | Full Model | |
|---|---|---|---|---|---|---|
| **λ/λ max** | 0% | 100% | 0% | 100% | 0% | 100% |
| **Crops** *(ha):* | | | | | | |
| ***Dry land*** | | | | | | |
| Cereals | 56.1 | 56.1 | 45.0 | 56.1 | 17.1 | 45 |
| Hay | 86.7 | 86.7 | 80.5 | 86.7 | 65 | 80.5 |
| Pasture | 152 | 152 | 170.5 | 152 | 217 | 170.5 |
| ***Irrigated land*** | | | | | | |
| Sunflower | 7.3 | 7.3 | 1.9 | 3.9 | 0.9 | 2.2 |
| Cereals | 21.9 | 21.9 | 5.6 | 11.8 | 2.8 | 6.6 |
| Hay | 7.3 | 7.3 | 1.9 | 3.9 | 0.9 | 2.2 |
| Silage | 14.6 | 14.6 | 3.7 | 7.9 | 1.8 | 4.4 |
| Sugar beet | 0 | 0 | 56.0 | 46.9 | 58 | 53 |
| Tomato | 32.5 | 32.5 | 0.7 | 0.6 | 2.9 | 2.7 |
| **Livestock***:* | | | | | | |
| Bovines *(livestock unit)* | 288 | 322 | 213 | 207 | 94 | 146 |
| Stocking rate *(Standard Unit/ha)* | 1.24 | 1.38 | 0.87 | 0.89 | 0.34 | 0.6 |

Source: Compiled from model solutions

Regarding to irrigated land, the major differences are observed in tomato, cereals and sugar beet activities. Sugar beet production, not produced under the Base scenario, replaces cereals and tomato under both the partial and full models. This can be the result of the strong effects of decouple of the tomato price subsidies and of sugar beet and cereals compensatory payments under the two new scenarios. The costs used to estimate the gross margin of the activities might also explain this result since only the variable costs are taken in account and these costs are heavier for tomato than for sugar beet. Taking in account the total costs (including the fixed costs) this substitution could not occur, as sugar beet has higher fixed costs than tomato. The production of intermediate products for animal feeding in irrigated land decreases under both scenarios but it is more pronounced under the full reform model. Even though the increase in dry land pasture areas, the decrease of fodder production in irrigated land leads to decline in livestock activities (bovines) which is more pronounced under lower level of risk (λ/λ max equal to 0%) and with the full implementation the CAP reform. One should notice that the partial implementation of the reform leads to the production of heavier animals (small number of bovine heads but larger stocking rate) for the maximum level of risk ($\lambda/\lambda$ max equal to 100%) compared with the minimum risk. In summary, the full implementation of CAP reform leads to an increase of extensification of production activities. This is more pronounced for dry land areas in which pastures substitutes for cereals, and in livestock activities which stocking rates decreases to less than half.

**4 – CONCLUSIONS**

Agriculture in dry land Mediterranean areas faces a considerable level of production risk as result of the unpredictable weather. Governmental intervention, such as income stabilisation instruments, has had a major impact on Mediterranean farmers in reducing their income variability and changing income levels. This study also shows that the implementation of the 2003 CAP reform has a strong effect on farmers' income, measured in terms of total expected returns to land and management, and on farmers' production risk. The introduction of the single payment scheme, totally decoupled from production, increases the total farm income but reduces the relative total income variability. The reduction of income risk is more effective for higher levels of risk or income variability (100% of $\lambda$ max).

When only the expected production income is taken in account, this means that the decoupled subsidies are not accounted for the farmers' income, the new CAP situation is more risky than the old one and the production income decreases. Hence, the relative risk increases when only the expected production income is taken in account.

In terms of farming activities, the full implementation of CAP reform leads to an increase of extensification of production activities. This is more pronounced for dry land areas in which pastures substitutes for cereals, and in livestock activities which stocking rates decreases to less than half.

As only a single farming system is analysed, further research should be conducted on other farming systems. In addition, the agri-environmental measures, not modelled in this study, should be included in future research.

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# APPENDIX

**Table A1 –** Trade-off between expected income and risk

| **Base Model** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| λ/λ max | 0% | 20% | 40% | 60% | 80% | 100% |
| Total Expected Farm Income*(€) (TI)* | 213702 | 220387 | 224923 | 227871 | 229325 | 229804 |
| Production Expected Income*(€) (PI)* | 213702 | 220387 | 224923 | 227871 | 229325 | 229804 |
| Total sum of negative deviations *(€) (λ)* | 0 | 2507 | 5013 | 7520 | 10027 | 12533 |
| λ/PI (%) | 0 | 1.14 | 2.23 | 3.30 | 4.37 | 5.45 |
| λ/TI (%) | 0 | 1.14 | 2.23 | 3.30 | 4.37 | 5.45 |
| **Partial Model** | **1** | **2** | **3** | **4** | **5** | **6** |
| λ/λ max | 0% | 20% | 40% | 60% | 80% | 100% |
| Total Expected Farm Income*(€) (TI)* | 215830 | 221164 | 224676 | 228891 | 230346 | 230967 |
| Production Expected Income*(€) (PI)* | 104175 | 107941 | 110779 | 113034 | 114366 | 114987 |
| Total sum of negative deviations *(€) (λ)* | 0 | 1859 | 3717 | 5576 | 7435 | 9293 |
| λ/PI (%) | 0 | 1.72 | 3.36 | 4.93 | 6.5 | 8.08 |
| λ/TI (%) | 0 | 0.84 | 1.65 | 2.44 | 3.23 | 4.02 |
| **Full Model** | **1** | **2** | **3** | **4** | **5** | **6** |
| λ/λ max | 0% | 20% | 40% | 60% | 80% | 100% |
| Total Expected Farm Income*(€) (TI)* | 261499 | 264211 | 266290 | 268028 | 273427 | 278505 |
| Production Expected Income*(€) (PI)* | 43287 | 45690 | 46835 | 47823 | 48325 | 48490 |
| Total sum of negative deviations *(€) (λ)* | 0 | 1142 | 2283 | 3425 | 4566 | 5708 |
| λ/PI (%) | 0 | 2.50 | 4.87 | 7.16 | 9.45 | 11.77 |
| λ/TI (%) | 0 | 0.43 | 0.86 | 1.28 | 1.67 | 2.05 |