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Evaluating the Effects of Decoupled Payments under Output and Price Uncertainty

Christina A. Kotakou

Department of Economics, University of Macedonia, 156 Egnatia Street, P.O. Box 1591, 54006 Thessaloniki, Greece, E-mail: chkotak@uom.gr

Stelios D. Katranidis

Department of Economics, University of Macedonia, 156 Egnatia Street, P.O. Box 1591, 54006 Thessaloniki, Greece, E-mail: katranid@uom.gr

This paper examines the effects of decoupling policies on Greek cotton production under the hypothesis that producers face uncertainty about output price and quantity. Using our estimation results we simulate the effects on cotton production under four alternative policy scenarios: the ‘Old’ CAP regime (i.e. the policy practiced until 2005), the Mid Term Review regime, a fully decoupled policy regime and a free trade-no policy scenario. Our results indicate the decoupled payment will have two contradictious effects on risk aversion. Producers become less risk averse through the wealth effect but more risk averse because of the increased output variance. The overall result of these two effects depends on the degree of risk aversion by farmers. We found that when the degree of risk aversion is high the wealth effect is positive. However, in the case of low risk aversion and a wealth effect equal to zero the decoupled payments become production neutral.

Keywords and JEL codes: Common Agricultural Policy, decoupling, uncertainty,

D21, Q18

1. Introduction

The 2003 reform of the Common Agricultural Policy (CAP) is a major change in the way that farmers receive income support by the European Union. In particular, under the Mid Term Review of CAP all compensatory payments given in the context of the previews reform packages (McSharry Reform in 1992, AGENDA 2000 in 1999) were replaced by a Single Farm Payment (SFP). This payment is based on historical payments while being entirely decoupled from the kind and/or the level of production (OECD, 2004).

As it is well-known from previous studies (Hennessy 1998, Sckokai and Moro 2006, Katranidis and Kotakou, 2008) a fully decoupled policy becomes coupled in the presence of uncertainty and risk. Under the assumption that producers are risk averse, the decoupled payments affect production through the wealth effect. This effect arises when a policy measure affects producers' total wealth: if wealth increases producers become less risk averse and (as a consequence) they produce more. However, this is the case where producers face uncertainty only about output price so the variability of profits i.e. the source of uncertainty, depends on the price variance (Hennessy 1998).

In the present study we examine the effect of decoupled payment on production when producers face uncertainty about output price and quantity. Under the hypothesis that both output and price are uncertain, the variability of profits depends on the price and output variance. Given that prices are determined by the market, the price variance is determined by the market as well so producers' decisions cannot affect it. However, this is not the case for the output variance. Any producers' decision that affects production will also affect the variability of production. In this way, the decoupled payment will have two effects on the degree of risk aversion of producers.

The first effect is the known "wealth effect": the decoupled payment increases the total wealth of producers so if producers are risk averse their degree of risk aversion decreases. The second effect takes place through the relation between the wealth and the output variance: the decoupled payment increases the wealth and since the output variance is a positive function of wealth it will be increased due to payment. The increased output variance will increase the degree of producers' risk aversion. These two effects contradict each other since the first decreases the degree of risk aversion and the second increases the degree of risk aversion. As a result, in order to conclude about the effects of the decoupled payment on production we have to consider both effects.

On the other hand, the degree of risk aversion may be substantially different among the farmers. Particularly, the degree of risk aversion is affected by the farm size (Saha, 1997). Risk aversion is inversely related to the level of wealth, i.e. farms with lower income and wealth tend to be more risk averse than large farms with significantly greater wealth. As we mentioned earlier, decoupled payments will increase the level of wealth and will decrease the level of risk aversion. The drop in risk aversion is expected to be greater for small farms than their "larger" counterparts. In this light, we examine the effect of decoupled payments on production for small, medium and large sized farms.

The objective of this paper is to evaluate the effect of decoupling policies on Greek cotton production. We have chosen cotton, not only because of its great importance for Greek agriculture, but mainly because, especially for cotton, a mix of partial and fully decoupled measures has been adopted after 2005. According to the initial European Commission's regulation, under the MTR regime, 65% of the total amount of subsidies producers' received throughout 2000-2002 (i.e. the reference period), will be paid to producers as a fixed payment independent of the level of production. The rest 35% of the total amount of subsidies will be transferred to producers as an area payment (European Commission, 2007). However, in June 2008 European Commission changed the first regulation for cotton sector. In line with the second regulation, 65% of the total amount of subsidies remains the same (i.e. as it was in the initial regulation) but the rest 35% is subject to national base areas, fixed yields and reference amounts. The national base area for Greece is 250.000 ha, fixed yields are 3.2 tonnes/ha and the reference amount per hectare is 251.75€ (European Commission, 2008). This regulation is applied from 1st January 2009.

Moreover, it should be pointed out that the total budget which is available for the area payment is fixed and this implies that if the total cultivated land increases then the amount of the area payment per producer will decrease. On this ground, the area payment relates to fluctuations in world prices since the level of production and as a result cultivated land depend on them.

The above policy mix renders the evaluation as well as the comparison of the effects of various alternative policies on cotton production a significant research objective. In this context, we have decided to examine and comparatively review the effects of a) the 'Old' CAP regime (i.e. the policy practiced until 2005), b) the new MTR regime which is a combination of partially and fully decoupled measures, c) a full decoupling system which probably could be applied in the next years and d) a free trade scenario which could also be adopted especially in the period after 2013.

In respect of the paper's structure, the following section presents a literature review on decoupling practices research that has been implemented in Europe or elsewhere. In sections three and four, we present the theoretical framework and the data that are used in the present study. In the ensuing fifth part, we present the estimation and simulation results as well as a rounded discussion of them. Finally, in the sixth section we put forward the main conclusions of our study.

2. Literature Review

Decoupling policies in the farm sector have been thoroughly examined by a significant number of researchers in Europe and elsewhere, especially in the US, over the last 15 years. Although these studies have followed different theoretical approaches and examined different products in several countries and under partly different decoupling regimes they have come to a common conclusion: All different kinds of decoupling policies affect farmers 'production decision.

Although this is an expected result for partly decoupled measures, it is of a special interest in the case of fully decoupled policies, since it contradicts their main property namely their neutrality towards realized production. In the remainder of this section we put forward a short presentation of the main studies on this topic.

A fully decoupled policy becomes coupled in the presence of uncertainty and risk. The first study that analyzed the results of a decoupled policy taking into consideration uncertainty and risk was conducted by Hennessy (1998). He suggested a framework where, under the assumption that producers are risk averse, the decoupled payments affect production through two effects: the wealth effect and the insurance effect. The first effect arises when a policy measure affects producers' total wealth: if wealth increases producers become less risk averse and as a consequence they produce more. The second effect takes place through the stabilization of farm income, when government increases payments so as to compensate producers for price reductions. Additionally, Hennessy checked the validation of the proposed model with a simulation analysis using data for corn production in Iowa. The obtained results confirmed the existence of both effects.

In a highly interesting paper, Serra *et. al.* (2006), analyzed the impact of decoupled payments on production by considering the effect that inputs have on output variability under the hypothesis that both output and output price are uncertain. They estimated production function alongside utility maximization conditions to examine the effect of the lump-sum payments on the mean and variability of output. They found that the elasticity of production with respect to lump-sum payments is positive. However, they came to the conclusion that when producers are risk averse and the inputs are risk increasing the positive effect of the payment on production disappears in practice.

In another paper, Serra *et.al.* (2009) examined the effects of decoupled payments on land allocation and crop mix. In this study, they made the hypothesis that producers face uncertainty on output and produce “program” and “non-program” crops i.e. crops that producers receive a decoupled payment for their production and crops that there is no policy for them. They found that under the hypothesis that producers are risk averse an increase in decoupled payment will increase farmers’ willingness to assume more risk. This way an increase in decoupled payments will motivate farmers to reduce land allocated to program crops in favor of non-program crops.

Féménia *et.al.* (2008), examined the wealth effect of decoupled payments from a different point of view. Under the hypothesis that farmers face uncertainty about prices they distinguished farmers in two categories: a) farmers who do not own land and b) farmers who own part of their land. In the case that farmers do not own land decoupled payments are capitalized in land values and they do not actually obtain the benefits of the payments. Their results indicate that when producers do not own land they reduce production by 1.11% even if they receive the payment.

Maki *et.al.* (2005), analyzed the effects of decoupled payments on farm-level income variability, crop choice and land allocation under the hypothesis that producers face uncertainty about output and prices. Their results indicate that decoupled payment will increase farm income significantly, particularly in the years when prices are low. As for the land allocation, they found that farmers will allocate more land to crops with higher payments rates.

Last but not least, in a very interesting paper, Sckokai and Moro (2006) have simulated the effects of AGENDA 2000 and MTR regime on cultivated land of arable crops in Italy under price uncertainty. Using FADN farm level data, they found that the corn and oilseeds acreage is going to be increased but the opposite holds for durum wheat and other cereals acreage. Yet, the most interesting finding is that decoupled payments are not production neutral since the positive wealth and insurance effects will compensate the negative price effect in all cases. Additionally, according to their estimated coefficients of relative risk aversion, as farm size increases the degree of risk aversion decreases, which means wealthier farms are less risk averse.

3. Theoretical Framework

In this section we present the model which specifies farmer's risk preferences. We assume non-linear mean variance risk preferences which mean that absolute risk aversion is non-constant (Coyle (1999), Sckokai and Moro (2006)). Producers' risk preferences are specified through a mean-variance utility function:

$$U = U(\bar{W}, \sigma_w^2) \quad (1)$$

where $\bar{W}$ and σ_w^2 are the mean and variance of final wealth which are uncertain due to price and output uncertainty that producers face. The certainty equivalent of this type of utility function is

$$U = \bar{W} - \frac{a(\bar{W}, \sigma_w^2)\sigma_w^2}{2} \quad (2)$$

where $\bar{W} = W_0 + \bar{\pi}$, expected wealth

$W_0 =$ initial wealth, non-random

$\bar{\pi} =$ market profit, random due to price and output uncertainty

$\sigma_w^2 =$ wealth variance

$a = -\frac{\partial U''(\bar{W})}{\partial U'(\bar{W})}$, Arrow-Pratt measure of absolute risk aversion

Additionally, we assume that the coefficient of risk aversion depends on wealth and wealth variance and preferences are specified as follows:

$$a(\bar{W}, \sigma_w^2) = \frac{\gamma}{\theta}\left(\bar{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\gamma-1} \quad (3)$$

This specification of preferences proposed by Saha (1997) where the risk attitude depends on the value of parameters γ and θ, i.e. the producers will be risk averse, risk neutral or risk lovers for different values of γ and θ[1]. In our case, we assume that preferences are specified as Constant Relative Risk Aversion (CRRA). This is the case where $\gamma = \theta$, and θ>1, so the coefficient of risk aversion becomes:

$$a\left(\bar{W}, \sigma_w^2\right) = \left(\bar{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\theta-1} \quad (4)$$

[1] Saha (1997) provides all the alternative values of γ and θ that specifies risk attitudes.

From the above specification it is clear that as wealth increases the degree of risk aversion decreases and as the wealth variance increases the degree of risk aversion increases. Moreover, it is also clear that as θ increases the coefficient of risk aversion will take larger values i.e. farmers become more risk averse.

The expected profits are equal to:

$$\overline{\pi} = \overline{py} - wx \quad (5)$$

where $\overline{y}$ is the expected output quantity, $\overline{p}$ corresponds to expected output price, w ,x are prices and quantities of variable inputs respectively.

The production follows the Just-Pope (year) technology and is equal to:

$$y = a(x) + b(x)^{1/2}\varepsilon \quad (6)$$

where x are the nonstochastic inputs and ε corresponds to a stochastic weather variable with mean $\overline{\varepsilon}$ and variance σ_{ε}^{2}. The mean and variance of output are $\overline{y} = a(x) + b(x)^{1/2}\overline{\varepsilon}$ and $\sigma_{y}^{2} = b(x)\sigma_{\varepsilon}^{2}$ correspondingly. If we substitute the mean output to expected profits we obtain the expected profit as follows:

$$\overline{\pi} = \overline{py} - wx = \overline{p}a(x) + \overline{p}b(x)^{1/2}\overline{\varepsilon} - wx \quad (7)$$

Additionally, the variance of profits is given by the following equation:

$$\sigma_{\pi}^{2} = \sigma_{w}^{2} = \overline{p}^{2}\sigma_{y}^{2} + \overline{y}^{2}\sigma_{p}^{2} + \sigma_{p}^{2}\sigma_{y}^{2} = \overline{p}^{2}b(x)\sigma_{\varepsilon}^{2} + \overline{y}^{2}\sigma_{p}^{2} + \sigma_{p}^{2}b(x)\sigma_{\varepsilon}^{2} \quad (8)$$

where σ_{p}^{2} is the variance of expected price. According to the foregoing analysis producers will maximize the expected utility function of the form:

$$\begin{aligned}
&U\left(W_0, \overline{p}, w, \sigma_{p}^{2}, \overline{\varepsilon}, \sigma_{\varepsilon}^{2}\right) = W_0 + \overline{py} - wx - \frac{1}{2}a\sigma_{\pi}^{2} = \\
&\quad W_0 + \overline{py} - wx - \frac{1}{2}\left(\overline{W}\right)^{1-\theta}\left(\sigma_{w}^{2}\right)^{\theta-1}\left(\overline{p}^{2}\sigma_{y}^{2} + \overline{y}^{2}\sigma_{p}^{2} + \sigma_{p}^{2}\sigma_{y}^{2}\right) = \\
&\quad W_0 + \overline{p}a(x) + \overline{p}b(x)^{1/2}\overline{\varepsilon} - wx - \frac{1}{2}\left(W_0 - \overline{py} - wx\right)^{1-\theta}\left(\overline{p}^{2}b(x)\sigma_{\varepsilon}^{2} + (b(x)^{1/2}\overline{\varepsilon})^{2}\sigma_{p}^{2} + \sigma_{p}^{2}\sigma_{\varepsilon}^{2}\right)^{\theta-1} \quad (9) \\
&\left(\overline{p}^{2}b(x)\sigma_{\varepsilon}^{2} + (b(x)^{1/2}\overline{\varepsilon})^{2}\sigma_{p}^{2} + \sigma_{p}^{2}\sigma_{\varepsilon}^{2}\right)
\end{aligned}$$

The expected utility function satisfies the following properties:

a) It is increasing in output price and initial wealth, decreasing in input prices and variance of expected output price.

b) Under CRRA preferences, it is homogeneous of degree one in expected output price, input prices, initial wealth and variance of expected output price.

c) It is continuous and differentiable so we obtain the supply, derived demands and output variance as follows[2]:

$$y\left(W_0, \overline{p}, w, \sigma_p^2, \overline{\varepsilon}, \sigma_\varepsilon^2\right) = \frac{\partial U / \partial \overline{p}}{\partial U / \partial W_0} = \frac{\left[\frac{\partial U}{\partial \overline{p}} + \left(\overline{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\theta-1}\theta \overline{p}\sigma_y^2\right]}{\partial U / \partial W_0}$$

$$x_i(W_0, \overline{p}, w, \sigma_p^2, \overline{\varepsilon}, \sigma_\varepsilon^2) = -\frac{\partial U / \partial w}{\partial U / \partial W_0}$$

$$\sigma_y^2 = \frac{\left[\frac{-2\sigma_\varepsilon^2}{\theta\left(\overline{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\theta-1}} \frac{\partial U}{\partial \sigma_\varepsilon^2}\right]}{\left(\overline{p}^2 + \sigma_p^2\right)}$$

$$\partial U / \partial W_0 = 1 - \frac{1}{2}(1-\theta)\left(\overline{W}\right)^{-\theta}\left(\sigma_w^2\right)^{\theta}$$

d) Under DARA preferences is quasi-convex in $\left(W_0, \overline{p}, w\right)$.

e) The standard symmetry and reciprocity conditions hold.

In order to estimate the coefficients of the supply and derived demand functions we use the normalized quadratic form of indirect utility function which takes the form:

$$\overline{U} = a_0 + \sum_{i=1}^{m-1} a_i \overline{r}_i + \frac{1}{2}\sum_{i=1}^{m-1}\sum_{j=1}^{m-1} a_{ij}\overline{r}_i\overline{r}_j \quad (10)$$

where $\overline{U} = U / w_m$ and $\overline{r} = (p^e / w_m, w / w_m, \sigma_p^2 / w_m^2, W_0 / w_m, \overline{\varepsilon}, \sigma_\varepsilon^2, z)$

Applying the derivative property in equation (10) supply, derived demands and output variance functions are specified as follows:

$$y = (b_i + \sum_j b_{ij}\overline{r}_j) + \theta\left(\overline{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\theta-1}\overline{p}\sigma_y^2 / (d_i + \sum_j d_{ij}\overline{r}_j) \quad (11)$$

$$x_i = -(c_i + \sum_j c_{ij}\overline{r}_j) / (d_i + \sum_j d_{ij}\overline{r}_j) \quad (12)$$

$$\sigma_y^2 = \left(\frac{-2\sigma_\varepsilon^2}{\theta\left(\overline{W}\right)^{1-\theta}\left(\sigma_w^2\right)^{\theta-1}}\right)\left(e_i + \sum_j e_{ij}\overline{r}_j\right) \Big/ \left(\overline{p}^2 + \sigma_p^2\right) \quad (13)$$

where *b*, *c*, *d*, *e*, are the coefficients to be estimated.

We model price expectations using the hypothesis that each period producers expect that price will be equal to the price that they received the previous period that is:

$$E_t(P_t) = P_{t-1} \quad (14)$$

[2] Proofs of these equations are available from the authors upon request.

Moreover, we generate expected output values by running the following regression:

$$y_t = \gamma + \delta y_{t-1} + e_t \quad (15)$$

where y_t is the output at time t, y_{t-1} is the output at time $t-1$ and e_t is the error term.

As for the computation of expected output price variance, we used the formula that first proposed by Chavas and Holt (1990). According to their formula, variance of expected output price is equal to the weighted sum of squared differences between actual prices and their expected values:

$$Var(P_{i,t}) = \sum_{j=1}^{2} \omega_j \left[P_{i,t-j} - E_{t-j-1}(P_{i,t-j}) \right]^2 \quad (16)$$

where weights ω_j are equal to 0.50 and 0.33 respectively[3].

The same formula is applied to calculate the weather variable variance which follows:

$$Var(\varepsilon_{i,t}) = \sum_{j=1}^{2} \omega_j \left[\varepsilon_{i,t-j} - E_{t-j-1}(\varepsilon_{i,t-j}) \right]^2 \quad (17)$$

We model output variance as follows:

$$\sigma_y^2 = l^2 \operatorname{var} q \quad (18)$$

where l is the cultivated land and *varq* is the variance of yield and is computed by using the formula described above.

Additionally, since we wanted to measure the risk attitude of farmers according to their farm size we computed the coefficient of relative risk aversion as follows:

$$\theta_c = \theta_1 d_1 + \theta_2 d_2 + \theta_2 d_2 \quad (19)$$

where d_1, d_2 and d_3 are dummy variables that distinguish three types of farm size: small sized farms, medium sized farms and large sized farms. We distinguish farm size by economic farm size that provided by F.A.D.N. data. According to standard F.A.D.N. methodology, there are ten categories of farm size and our sample consists of farms that belong to first nine categories. Details about the way that farms are grouping into nine categories are provided in Appendix. However, due to limitations in the number of observations in each category, we grouped the farms into three size categories. Firstly, the farms that belong to the first three categories are considered as small sized. Secondly, the farms that belong to the next three categories are considered as medium sized and finally the farms of the three last categories as large sized.

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[3] In Chavas and Holt (1990) study variance has three years time horizon but given that the weight in third year is small i.e. equal to 0.17 and because we did not want to lose observations we constructed the variance with two years time horizon.

4. Data

The data we use are from Farm Accountancy Data Network (F.A.D.N.) and the National Statistical Service of Greece. The data are in a farm level during the period 1994-2002 and our dataset consists of 1555 observations which correspond to 485 farms. From the entire sample of farms that are characterized as cotton producers, we use the farms that produce only cotton as well as the farms that the proportion of cotton revenue to total revenue is equal or larger than 95%, so they are considered as pure cotton producers.

Cotton farmers produce cotton using two variable inputs: labor and intermediate inputs[4] and two quasi-fixed inputs: land and capital. Cotton quantity and revenue are available from FADN data so we obtain cotton price by dividing revenue with quantity. As for the variable inputs, the FADN sample contains expenditures and quantity of labor, but only expenditures intermediate inputs. The expenditures of the intermediate inputs are divided by their price index so as to obtain their quantity measure. The quantity of land is available from FADN data and the value of capital is deflated by the capital price index to obtain its quantity measure.

Initial wealth has been computed as the difference between total assets value and total debts value. Total wealth corresponds to the sum of initial wealth and expected revenue minus the variable cost. The F.A.D.N. database provides information for the area that each farm is established. Giving this information we use the temperature of the areas that cotton farmers exist as a weather proxy. Finally, we include a time trend to take into account the effect of technology change in the cotton production. Summary statistics of the variables are provided in Table 2 that follows.

[4] This category includes all intermediate inputs of production like fertilizers, water, pesticides etc.

Table 2. Descriptive Statistics of the Variables

Variable	Mean	Standard Deviation
Initial wealth (€)	93048.73	67904.75
Total wealth (€)	105357.49	74972.29
Expected cotton production (kilos)	36696.76	21410.57
Expected cotton price (€/kilo)	0.81	0.07
Cotton price variance	2.03	4.88
Intermediate inputs (€)	9767.11	6683.79
Intermediate inputs price[a] (Index)	197.48	15.44
Labour (hours)	1738.66	977.49
Labour price (€/hour)	1.97	0.46
Land (ha)	10.47	7.13
Capital (€)	22358.83	18131.87
Temperature	21.57	0.93
Variance of temperature	1.05	0.64

Source: Own Computations
a: Intermediate Inputs Price Index provided by National Statistical Service of Greece

Equations (11) and (12) are very nonlinear in parameters. In the estimation procedure, in order to avoid the high nonlinearity in parameters of supply and derived demands functions, we divide them by the common denominator:

$$\partial U / \partial W_0 = 1 - \frac{1}{2}(1-\theta)\left(\overline{W}\right)^{-\theta}\left(\sigma_w^2\right)^{\theta}$$

Additionally, following Coyle's (1999) suggestion, we substitute equation (13) to supply function.

We estimated a system of two equations: cotton supply and intermediate inputs demand applying the Iterative Nonlinear SURE method in SAS 9.1 econometric software. We imposed homogeneity condition using wage as a numeraire and we also imposed the symmetry restriction. Additionally, in order to maintain the curvature property we impose convexity through Cholesky decomposition[5].

[5] The property d states that utility function is quasi-convex in $(W_0, \overline{p}, w)$. By using Cholesky decomposition we actually impose convexity which is a stronger condition.

5. Estimation and Simulation Results

In this section we present the estimation as well as the simulation results based on them for the evaluation of four alternative cotton policy regimes. As we noted in the introductory comments these regimes refer to: the ‘Old’ CAP regime that had been in action till 2005, the new MTR regime consisting of a combination of partial and fully decoupled measures, another fully decoupled system seen as an alternative to the MTR regime in the coming years and finally, a completely free market-no policy scenario, mainly used as a reference system.

Table 3. Estimated parameters of supply, derived demand and output variance

Variables	**Cotton Supply**	**Intermediate Inputs Derived Demand**	**Output Variance**
Constant	1.036 (1.75)	1.250 (1.92)	0.093 (0.42)
Price of Cotton	0.368 (4.75)	0.541 (6.80)	-0.247 (-1.50)
Price of Rest Intermediate Inputs	-0.541 (-6.80)	-0.796 (-5.35)	0.162 (2.36)
Cotton Price Variance	-0.001 (-3.42)	-0.001 (-1.64)	0.001 (0.12)
Initial Wealth	0.271 (2.65)	0.421 (4.91)	0.097 (4.72)
Quantity of Capital	0.107 (5.88)	-0.027 (-1.25)	0.018 (1.57)
Quantity of Land	0.120 (10.08)	0.260 (17.95)	0.035 (5.82)
Temperature	-0.090 (-0.17)	-0.230 (-0.39)	-0.136 (0.68)
Variance of temperature	0.247 (1.50)	-0.162 (-2.36)	0.073 (2.68)
Time trend	0.022 (0.66)	-0.006 (-0.16)	-0.021 (-1.34)
θ_1	2.058 (2.41)	2.058 (2.41)	2.058 (2.41)
θ_2	1.476 (3.60)	1.476 (3.60)	1.476 (3.60)
θ_3	0.994 (3.84)	0.994 (3.84)	0.994 (3.84)

Source: Own computations
Note: Numbers in parenthesis are t-values, significant at 0.05 level

The obtained estimation results are presented in Table 3 above. It appears that in their vast majority the estimated coefficients are statistically significant and they have the correct sign. Cotton supply is increasing in cotton price and initial wealth and decreasing in cotton price variance and price of intermediate inputs. The demand of intermediate inputs is decreasing in its own price and cotton price variance and increasing in cotton price and initial wealth. As for the output variance, it is increasing in variance of temperature and initial wealth. Additionally, θ coefficient gradually decreases as farm size increases and this practically means that wealthier farmers are less risk averse than their "smaller" counterparts. Such findings are in line with results obtained in earlier studies (Sckokai and Moro 2006, Saha 1997). The obtained results make clear that small sized farms are more risk averse than medium sized farms and large sized farms are risk lovers.

In Table 4, the elasticities of cotton supply and intermediate inputs demand with respect to cotton price, initial wealth, cotton price variance and price of the intermediate inputs are presented. All computed elasticities are consistent with economic theory, since they exhibit the correct sign. Cotton supply and intermediate inputs demand are inelastic in their own price. Additionally, the elasticities of cotton supply and intermediate inputs with respect to initial wealth are positive which means that as initial wealth increases, cotton farmers produce more and demand more intermediate inputs.

Table 4. Elasticities of cotton supply and intermediate inputs demand

	Cotton	Intermediate Inputs	Initial Wealth	Cotton Price Variance
Cotton	0.336	-0.516	0.245	-0.004
Intermediate Inputs	0.430	-0.659	0.330	-0.003

Source: Own computations
Note: Elasticities are computed at the sample mean values

We now turn to our simulation strategy. Using the estimated cotton supply, FAPRI projections on cotton world prices until 2013 (FAPRI, 2009) and USDA projections on CPI in Greece until 2013[6] (USDA 2009), we have simulated the effects of the four alternative policy scenarios presented earlier on. In order to evaluate the 'Old' CAP regime, we increased the cotton world price by the amount of mean subsidy per kilogram that producers received during the period 2000-2002 (i.e. the reference

[6] We used CPI projections in order to deflate subsidies from 2006 to 2013.

period for MTR reform). Obviously, in this case the wealth effect on cotton production has been zero.

Furthermore, we have assessed the MTR reform (i.e. a combination of fully and partially decoupled policy regime) through changes in prices and initial wealth. We increase initial wealth by 65% of the total subsidies producers received during the reference period (2000-2002). We also, increased world price projections by the remaining 35% of total subsidies per kilogram of production[7]. In the full decoupling policy scenario (3rd scenario) we assume that producers receive the world price and their initial wealth is increased by the full amount of subsidies that they received during the reference period (2000-2002). Moreover, in the free trade scenario we assume that production depends only on world prices. Finally, we recomputed the cotton price variance for all these cases in order to consider its effect on cotton production.

As we noted in the introductory comments, the payment increases the variance of output and consequently increases the degree of risk aversion. In order to take into account the effect of increased initial wealth due to subsidies in output variance and the degree of risk aversion we distinguish two cases. In the first case, under MTR reform and full decoupling scenario, we increase the initial wealth in cotton production and in variance of output. In the second case, under these scenarios, we increase the initial wealth only in cotton production i.e. we consider only the wealth effect on risk attitudes of farmers.

We apply the simulation strategy described above in each farm size category so as to evaluate the effects of aforementioned policies by farm size. Tables 5, 6 and 7 report the percentage changes in cotton production under the three alternative regimes (‘Old’ CAP regime, MTR regime, full decoupling regime) taking as a reference the free trade-no policy scenario for small, medium and large sized farms respectively. Elaborating on the results of each individual scenario, we come to realise that the ‘Old’ CAP regime distorts production more than any other alternative. Under this regime, production is on average, compared to the fourth-no policy scenario, higher by 42.36%, 35.4% and 33.79%, for small, medium and large farms respectively.

[7] In order to evaluate MTR regime we take into account the provisions of the first European Commission’s regulation during the period 2006-2008 as well as the corresponding provisions of the second regulation during the period 2009-2013.

In the case of the MTR regime the production distortion becomes smaller. When we consider the effects of the payment on output variance, the corresponding increases are 9.96%, 9.94% and 10.93% for small, medium and large farms respectively. On the other hand, if we assume that the payment does not affect output variance, the production is higher by 9.48%, 9.32% and 9.88% for small, medium and large farms correspondingly.

However, the most interesting results in terms of our analysis arise when we compare the full decoupling regime with the free trade-no policy scenario. In the case of small farms the production is on average smaller by 2.85% when we consider the effect of payment on output variance and by 3.39% if the payment does not increase variance. Farmers produce less under full decoupling relative to free trade-no policy scenario since their marginal risk premium is smaller because of the payment. Additionally, the difference of 0.55% between the above two results is attributed to the effect of the payment on output variance and as a result on the degree of risk aversion of farmers. If the payment does not affect output variance farmers become less risk averse, their marginal risk premium becomes smaller and they produce less.

In the case of medium farms when we consider the effect of payment on output variance, production under full decoupling is equal to the production under free trade-no policy scenario. This practically means that the decrease of risk aversion due to payment, i.e. the wealth effect, is compensated by the increase of risk aversion due to increasing output variance. However, if the payment does not affect output variance production is smaller by 0.72% since farmers are less risk averse and this result is attributed to wealth effect.

Finally, in the case of large farmers the situation is completely different since they are risk lovers. When the degree of risk aversion is larger i.e. when the payment affects output variance, they produce 2.02% more relative to free trade-no policy scenario. On the other hand, when the degree of risk aversion decreases their production is on average 0.82% more compared with free trade-no policy scenario.

Table 5. Percentage changes in cotton production in relation to free trade-no policy scenario, small sized farms

	Payment affects production variance			Payment does not affect production variance		
Year	Old CAP Regime	MTR Regime	Full Decoupling Regime	Old CAP Regime	MTR Regime	Full Decoupling Regime
2006	48.76%	15.38%	-2.96%	48.76%	14.82%	-3.53%
2007	44.54%	13.81%	-3.06%	44.54%	13.26%	-3.64%
2008	41.14%	12.56%	-3.12%	41.14%	12.02%	-3.72%
2009	46.20%	14.64%	-2.67%	46.20%	14.14%	-3.18%
2010	42.86%	6.46%	-2.73%	42.86%	6.03%	-3.26%
2011	39.97%	5.88%	-2.78%	39.97%	5.45%	-3.31%
2012	38.46%	5.61%	-2.74%	38.46%	5.19%	-3.27%
2013	36.98%	5.34%	-2.72%	36.98%	4.93%	-3.24%

Source: Own computations

Table 6. Percentage changes in cotton production in relation to free trade-no policy scenario, medium sized farms

	Payment affects production variance			Payment does not affect production variance		
Year	Old CAP Regime	MTR Regime	Full Decoupling Regime	Old CAP Regime	MTR Regime	Full Decoupling Regime
2006	40.37%	14.38%	0.03%	40.37%	13.67%	-0.70%
2007	37.50%	13.33%	-0.02%	37.50%	12.61%	-0.78%
2008	35.17%	12.47%	-0.06%	35.17%	11.76%	-0.85%
2009	37.72%	13.43%	0.04%	37.72%	12.81%	-0.60%
2010	35.47%	6.95%	0.00%	35.47%	6.41%	-0.66%
2011	33.48%	6.55%	-0.03%	33.48%	6.00%	-0.71%
2012	32.31%	6.32%	-0.04%	32.31%	5.78%	-0.72%
2013	31.17%	6.08%	-0.05%	31.17%	5.56%	-0.72%

Source: Own computations

Table 7. Percentage changes in cotton production in relation to free trade-no policy scenario, large sized farms

	Payment affects production variance			Payment does not affect production variance		
Year	Old CAP Regime	MTR Regime	Full Decoupling Regime	Old CAP Regime	MTR Regime	Full Decoupling Regime
2006	38.37%	15.24%	2.17%	38.37%	14.03%	0.92%
2007	35.94%	14.37%	2.18%	35.94%	13.15%	0.87%
2008	33.97%	13.65%	2.19%	33.97%	12.42%	0.82%
2009	35.58%	14.07%	1.95%	35.58%	13.01%	0.86%
2010	33.68%	7.96%	1.95%	33.68%	7.04%	0.81%
2011	31.98%	7.62%	1.95%	31.98%	6.69%	0.78%
2012	30.90%	7.38%	1.92%	30.90%	6.47%	0.75%
2013	29.86%	7.15%	1.89%	29.86%	6.26%	0.73%

Source: Own computations

Taking into consideration the aforementioned results, we first conclude that the closer we move to a more decoupled policy the smaller the distortion to production becomes. Secondly, it becomes apparent that the degree of risk aversion affects farmers' production decisions. Farmers with different risk attitudes for example risk averse and risk lovers' farmers, behave completely different in terms of production decisions even if the same policy is applied to them. Additionally, the wealth effect that arises due to decoupled payment is partly or totally compensated when we consider the effect of the payment on output variance. The degree of compensation depends on the degree of risk aversion. For example, in the case of medium sized farms production under full decoupling is the same with production under free trade no policy scenario. This is the case where the wealth effect disappears in practice and the decoupled payment becomes production neutral. This result does not take place when we consider that producers face uncertainty only about output price (Katranidis and Kotakou, 2008).

Table 8. Mean percentage changes in relation to free trade – no policy scenario by farm size.

	Payment affects production variance			**Payment does not affect production variance**		
Farm Size	Old CAP Regime	MTR Regime	Full Decoupling Regime	Old CAP Regime	MTR Regime	Full Decoupling Regime
Small	42,4%	10.0%	-2.8%	42,4%	9.5%	-3.4%
Medium	35.4%	9.9%	0%	35.4%	9.3%	-0.7%
Large	33.8%	10.9%	2%	33.8%	9.9%	0.8%

Source: Own computations

In the Table 8 above we present the mean percentage changes under the different policy regimes in relation to free trade-no policy scenario by farm size. The reported results make clear that under the 'Old' CAP regime the production gradually decreases as farm size increases. Additionally, under the MTR regime there is no large differentiation among the producers by farm size. However, under the full decoupling regime relative to free trade-no policy scenario small farmers reduce their production. Medium farmers produce the same under both policies i.e. MTR regime and free trade-no policy scenario and large farmers produce more. These results make clear that a full decoupling policy will be harmful for small producers.

6. Concluding Remarks

All in all, in this study we have attempted to evaluate the effects of four alternative policy scenarios on Greek cotton production: the 'Old' CAP regime i.e. the policy in action until 2005, the new MTR regime adopted after 2005, a fully decoupled policy and a free trade-no policy scenario mainly used as a system of reference. In our analysis, we assumed that cotton producers face uncertainty over price and output and we used the mean-variance utility function approach proposed by Coyle (1999) making the hypothesis that risk attitudes depend on the expected wealth and its variance.

Our estimation results indicate that the degree of risk aversion of cotton farmers is greatly influenced by farm size. In particular, we found that as the farm size increases the degree of risk aversion decreases. Small sized farms are more risk averse than medium size farms. As for the large sized farms, we found that they are risk lovers and this is reasonable since they are wealthier than their "smaller" counterparts. This differentiation to the degree of risk aversion among the farmers means that a proportional change of wealth and wealth variance due to decoupled payment has different effects on farmers risk attitudes and as a result on cotton production. A direct consequence of this is that farmers with different risk attitudes behave completely different, in terms of production decisions, even if the same policy is applied to them.

According to the obtained simulation results and in line with our expectations production gradually decreases as farmers' support becomes decoupled to production. However, in order to come to the right conclusions about the effect of decoupled payment on production we have to consider not only its effect on total wealth but also its effect on wealth variance. Our results indicate that the decrease of risk aversion which arises due to decoupled payment, i.e. the wealth effect, is partially or totally compensated by an increase of risk aversion due to the effect of the payment on output variance i.e. wealth variance. The degree of compensation depends on the degree of risk aversion. In the case of small sized farmers, which are more risk averse, this decrease of risk aversion due to decoupled payment is larger than the corresponding increase so the wealth effect is partially compensated. On the other hand, in the case of medium sized farmers, the wealth effect is totally compensated and this practically means that the decoupled payment becomes production neutral. This result does not take place when we consider that the only source of uncertainty is output price.

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Appendix

Each farm in the FADN sample has its own size which is determined by the Standard Gross Margin (SGM) of the output that produces. The SGM is defined as: SGM = value of output from one hectare or animal – cost of variable inputs required producing that output. The SGM is expressed in terms of European Size Units (ESU) which value is expressed as fixed number of euro. One ESU corresponds to 1200 euros. The economic size classes in terms of ESU are presented in the following table:

Table 1 Size class per category

Category	Size Classes
1	<2 ESU
2	2-<4 ESU
3	4-<6 ESU
4	6-<8 ESU
5	8-<12 ESU
6	12-<16 ESU
7	16-<40 ESU
8	40-<100 ESU
9	100 -<250 ESU
10	>=250 ESU

Source: European Commission