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Policy implementations for organic agriculture: A real options approach

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SUMMARY

Organic farming has experienced a vast increase within the EU, despite the fact that it implies greater risk and uncertainty than that of conventional farming. This is the result of the increased environmental concern and the rising demand for quality food, which led to the implementation of the organic policy scheme. Nevertheless, the production of organic fruits, including cherries, is still limited in the EU. Farmers will adopt this alternative farming system only if the support provided by the existing policy regime out weights the increased risk and uncertainty. This study explores the effectiveness of the current policy measures for the production of organic cherries in Greece, using the real options methodology. The framework of real options analysis is an appropriate form of analysis so as to examine the investment's profitability under risk and uncertainty and assess the economic incentives offered to organic farmers. The results indicate that the economic incentives provided by the existing policy regime, compensate for the risk and the uncertainty that farmers are undertaking. Furthermore, this study reveals that the profitability of the economic activity explored, lies mainly on the subsidies organic farmers receive.

Keywords: organic agriculture, real options, agriculture policy, uncertainty

JEL codes: D81, Q14, Q18

Introduction

During the 90s organic farming has experienced a vast increase in European countries. This can be regarded as the result of the introduction and implementation of the relevant policy scheme (which started with Regulation EC 2092/91) as an answer to the increased environmental concern and the rising demand for quality food of EU citizens and customers. Indicative of the rapid development of organic crops is the fact that from 1,200ha in 1994, the European organically cultivated land rose to 63,000ha in 2005 (Abando and Rohnerthielen, 2007) which accounts for 7.5% of the total cultivated land (Allen and Abando, 2007).

In Greece, the organic sector has had a rapid growth. The cultivated organic area in Greece fully converted and under conversion, increased from 591 ha in 1993 to 152,117 ha in 2007 and corresponds to 4.7% of the total utilized agricultural area. According to the relevant data, in 2007 the main organic crops were olive trees, cereals, vineyards and vine grapes, and citrus fruits, while other fresh fruits accounted only for a mere 1.7 percent of the total (Hellenic Ministry of Rural Development and Food, 2009). The organic cherries production is very limited and covers only an area of 112ha. The interest of organic farmers for the production of cherries has significantly increased during the last years. The production of cherries can be found mainly in North Greece, in the region of Central Macedonia, where the 77.9 per cent of the total cherries' cultivated land is located and the 64.24 percent of the production comes from. More specifically, 2/3 of the total cultivated land (67.0%) where almost half (48.6%) of total production of cherries can be found in two prefectures of the region, i.e. the Prefecture of Pella and that of Imathia (NSSG, 2005).

In recent years, the Greek cherries have started to reach new markets and have gradually managed to build their links and strengthen their presence in the European markets. Earlier research showed that this is the outcome of a carefully designed and systematically implemented approach that occurred in the areas of standardization, promotion and post-harvest physiology solutions that were offered to producers who have proceeded to modernise their farms and farm practices and introduced new cherry varieties (NAGREF, 2007).

Equally strong appears to be the interest of Greek farmers in the organic production of cherries in spite of the increased risk and uncertainty involved. This last remark is related not only to the volume of the production but to the quality of the harvested product as well, as extreme weather conditions and/or enemies and diseases may severely affect the organically cultivated cherry tree.

This study has set to examine whether the production of organic cherries could generate satisfactory results to farmers and, hence, could be regarded as a promising alternative productive activity. It employs the framework of real options analysis which is regarded as the appropriate form of analysis in order to account for the uncertainty, irreversibility and flexibility of such investment choices. Therefore the evaluation of farmers' option to turn to organic cultivation under risk and uncertainty and under the current policy support scheme elevates the true dimensions of such an attempt and allows for suggestions which could facilitate farmers' decision on one hand and the policy implementation appraisal and/or its revision on the other.

Methodology

Recent developments in investment analysis point out that Net Present Value (NPV) results appeared to be limited (Dixit and Pindyck, 1994, Collins and Hanf, 1998, Arman and Kutalika, 1999). The real options approach considers all elements of a traditional cost benefit analysis plus temporal flexibility. More specific real options analysis offers a range of possibilities to examine: investing today, or waiting and perhaps investing later on when the conditions are more favourable (Dixit and Pindyck, 1994). The real options approach to organic agriculture assumes that an investor has the opportunity to invest in organic agriculture and that the investor prefers to reduce income variability. The effect of the uncertainty associated with organic agriculture can be valued using real option evaluation procedure, which is a form of a European call option, even though the value of the project is not clearly recognized at the time of the investment.

According to Dixit and Pindyck (1995) the value of the opportunity to invest is described by the two equations, the value of waiting (BR^{β}) and the value of investing ($\mathrm{R}/\rho - \mathrm{K}$) (Dixit, 1992).

$$V(R) = \begin{cases} BR^{\beta} & \text{if R} \leq \text{H} \\ \mathrm{R}/\rho - \mathrm{K} & \text{if R} \geq \text{H} \end{cases} \tag{1}$$

where, R equals the expected uncertain returns from the investment; B is a parameter equal to $(H - \rho K)/H^{\beta}$ (Pindyck, 1991); K is the sunk cost of initiating the investment project; ρ is the opportunity cost of capital or a risk-adjusted discount rate.

Dixit (1992) described optimal timing of an investment as a tangency between the value of investing and the value of waiting to invest. The optimal investment trigger is at H, where the expected returns from initiating the investment are sufficiently high to make it optimal to proceed. The optimal investment derives from the real options analysis, if the value-matching condition and the smooth-pasting condition are simultaneously satisfied (Dixit, 1992)

$$H = \frac{\beta}{\beta - 1} \rho K \tag{2}$$

where $\beta = \frac{1}{2}\left[1 + \sqrt{1 + \frac{8\rho}{\sigma^2}}\right] \succ 1$; ρK is the Marsallian trigger.

The parameter β is a function of two known or estimable parameters (ρ and σ^2). As uncertainty of returns from investing increases, β gets smaller and the difference between the Marshallian trigger (M) and the optimal trigger increases. Raising the discount rate increases β and reduces the difference between the Marshallian trigger (M) and the optimal investment trigger (H).

A Monte Carlo simulation model is used to estimate the variance of the value of investing in organic cherries technology. The value of the opportunity to invest (V) is modeled as a geometric Brownian motion process

$$\frac{dV}{V} = \mu\, dt + \sigma\, dz \tag{3}$$

where σ is the proportional variance parameter and dz is the increment of Wiener process, $z(t)$. The relationship between dz and dt is given by $dz = \varepsilon_t \sqrt{dt}$ where ε_t has zero mean and unit standard deviation. Therefore, changes in V over time are a function of a known proportional growth rate parameter μ, and σ, which is governed by the increment of Weiner process, dz (Dixit and Pindyck, 1994). It is modeled as the discounted sum of random draws from the distribution of expected returns from investing (R), annualized and projected into perpetuity. More specifically, the opportunity to invest for time t (V_t) is estimated by equation (4) and for a period hence (V_{t+1}) is estimated by equation (5) (Dixit and Pindyck, 1994; Purvis et al., 1995).

$$V_t = \frac{\left[\dfrac{\rho}{1 - \left(\dfrac{1}{(1+\rho)^{n-t}} \right)} PV_t \right]}{\rho} \quad (4) \qquad V_{t+1} = \frac{\left[\dfrac{\rho}{1 - \left(\dfrac{1}{(1+\rho)^{n-t-1}} \right)} PV_{t+1} \right]}{\rho} \quad (5)$$

where, $PV_t = \sum_{t=0}^{n} \frac{R_{t+i}}{(1+\rho)^i}$, $PV_{t+1} = \sum_{t=1}^{n+1} \frac{R_{t+i}}{(1+\rho)^{i-1}}$, R= expected returns from investing, ρ is a discount rate, t is the time period of the investment.

The trend (μ) of the geometric Brownian motion process was estimated by $\mu_v \approx \frac{1}{N} \sum_{j=1}^{N} \left[\Delta \ln V_j \right]$ and the variance of the value of the opportunity to invest was estimated by $\sigma_v \approx \frac{1}{N} \sum_{j=1}^{N} \left[\Delta \ln V_j - \mu_v \right]^2$. To calculate the statistics μ_v and σ_v from simulation data, the mean of N simulated log differences investing in t and t+1 was calculated. The difference between natural logarithms of V_t and of V_{t+1} gives a discrete estimate of the change in the value of the investment opportunity, as occurring over an increment of a geometric Brownian motion process. The estimate of this discrete difference was simulated over 1,000 iterations, in each iteration estimating equations of present value required n and n+1 draws, respectively, with draw representing an observation of annual returns from investing. The evaluation of variance of the opportunity to invest was used to estimate the optimum investment trigger under uncertainty and irreversibility.

Data - Analysis

The data used in this analysis comes from face-to-face interviews with 50 cherry producers located in two specific prefectures of Greece, i.e. Pella and Imathia. 35 of them are conventional cherry producers who were randomly selected, while the other

15 of them constitute the total population of organic producers in the area under study. The detailed collected data was used to estimate the annual production cost of conventional and organic cherry production (Table 1)[1].

According to Table 1, the production cost of conventional cherries is higher (16.52%), indicating that this production system is more intensive relative to the organic one. The most important element of the conventional cherries production cost is the labour cost (49.74%). The total labour cost in the case of conventional cherries production is 41.66% greater than that of the organic production. This is resulting from the fact that conventional production demands more working hours during the harvesting season (as conventional cherries yield is higher than organic cherries yield). Additionally, conventional cherries production needs more field operations, such as pesticides, fertilizes and more intensive pruning and irrigation, which demand more working hours.

Capital cost is also an important element of the total cost in both activities. The purchasing cost of fertilizers and pesticides constitute more than half of the capital cost. It is worth mentioning that in the case of conventional cherries production, the purchasing cost is high because of the use of large quantity of inputs, while in the case of organic production, the purchasing cost is high because of the price of certified organic pesticides and herbicides.

The technicoeconomical data gathered by face-to-face interviews were also used to assess the establishment cost, the orchard's value and the total investment cost in both activities (Table 2). For the proper estimation of all the above values, the collected information was combined with experts' suggestions as well as local agriculturalists' advice. New cherries trees require about five years to yield the first commercial harvest. The value of the orchard at the end of the fifth year reflects the total investment capital. In the case of organic cherry production, this value is 22.7% lower than that of conventional cherry production, due to the lower organic production cost.

According to the literature, the productive life of a cherry orchard is ranged between 25 and 50 years (Kitsopanides et al. 1999; Pontikis, 1996). In this analysis, the productive life of the cherry orchard was estimated by taking into consideration the cultivation practice in the specific area as well as the experts' advice. Consequently, a

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[1] Depreciation and fixed capital interests are not included in investment appraisal analysis, (see Gittinger, 1982).

productive life of 25 years was adopted, as it was considered to be most appropriate in the area under study.

To construct the price distribution in the case of conventional farming, we used the available data from the Hellenic Ministry of Rural Development and Food (see http://www.minagric.gr/greek/agro_pol/kerasia.htm). The data includes the annual average producer prices for the period 1995-2006 in current prices, which where converted to steady prices according to the agricultural output price indices available by EUROSTAT (base year: 2006) (see: http://epp.eurostat.ec.europa.eu). After removing time trend effects, we found that the data follows the normal distribution[2] with mean value equal to €1.72 and standard deviation equal to 0.2 (CV=11.63%). As each element of the data reflects the average producer price for each year, using the above standard deviation value in individual producer's price distribution would obviously lead to the underestimation of the dispersion. The data collected in the examined area, support the above idea, as the coefficient of variation is much greater (CV=24.39%). In order to correct the underestimated value of the standard deviation, the normal distribution that was finally applied, had a mean value equal to €1.72 and standard deviation equal to 0.3 (30% increase).

In the case of organic cherries production, the individual producer's price distribution was also found to be normal[3]. Although the available data covers just one cultivation period and includes few observations, we apply the distribution which best fits the data, because there are no available time series as in the case of conventional cherries. This distribution has a mean value equal to €2.38 and standard deviation equal to 0.7. Because the above distribution generates negative values, we used the truncated normal distribution with minimum absolute price equal to €0.3 (Simetar, 2006). The mean value and the standard deviation of the organic cherries price distribution, which were estimated after 1000 Monte Carlo iterations, are €2.38 and 0.69 respectively[4]. Monte Carlo iterations were used to estimate the conventional price distribution.

According to Rahim et al. (2007), Mithöfer and Wesseler (2002) and Kitsopanides et. al. (1999) cherry yield is a function of trees' age. In our analysis, we follow Rahim et

[2] The Shapiro-Wilks, Kolmongornov-Smirnoff, Anderson-Darling, Cramer-von Mises and Chi-Squared tests, do not reject the null hypothesis that the distribution is normal, with 95% level of significance.

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[4] The statistical test between the real and simulated data reveals that there is no statistically significant difference between the mean values and the standard deviations (95% confidence level).

al. (2007) and Mithöfer and Wesseler (2002), who suggest that the relationship between the age of trees and yield can be described by the following Hoerl function:

$$u= w*g^{a}*e^{kg} \quad (12)$$

where u, is the yield (kg/0.1ha), g is the tree's age and w, a, k are constants which were estimated through the following regression estimation :

$$\ln(u)=\ln(w)+a*\ln(g)+k*g \quad (13)$$

Using the collected data, we estimate the coefficients of the above regression and thus the resulting equation is:

$$\ln(u)=2.4+2.4*\ln(g)-0.146*g$$

with R^2 equal to 0.693 and adjusted R^2 equal to 0.646 (Figure 1).

As we mentioned before, the above equation was estimated from a single year observations (2007). Thus, it does not reflect the weather conditions' effect, which can drastically alter cherries yield (Vasilakakis, 2007). In order to take under consideration the influence of the weather conditions, we adjusted our data according to information provided by the Hellenic Agricultural Insurance Organization (ELGA) as well as evidences from our survey (year 2007). The information from ELGA involves the damages that occurred due to bad weather conditions during the period 2000-2005 (see http://www.elga.gr/). According to our survey, in year 2007, the average yield reached 70% of the expected yields, as the damage was about 30%. This yield is noticed once in 6 years (period 2000-2005). Similarly, the same frequency applies in the following cases: 100% of the expected yield, 60% of the expected yield, 13% of the expected yield, 42% of the expected yield and 45% of the expected yield. Thus, in order to take under consideration the uncertainty of cherries yield, the yield which had been estimated from the Hoerl function was multiplied by a discrete empirical distribution (Simetar, 2006). This distribution was constructed using the percentage of the damage (100% - the percentage of damage), and the probability for this damage to occur.

In the case of the organic cherries' yield, the estimation of the Hoerl function was not possible due to limited observations. But the survey reveals that the yield is about 50% lower relative to the conventional yield. Consequently, in order to extract the Hoerl function for the organic cherries production, we subtract 50% of the conventional yields at each observation. It is worth noticing that unlike ELGA compensation, both the return of the value-added tax and the subsidies for organic production (90€/stremma) were incorporated in the gross revenue.

Results

In this work, two investment options were evaluated by applying real options, an organic orchard of cherries and a conventional orchard of cherries. First, the traditional Net Present Value criterion was applied without considering the stochastic nature of returns and the flexibility of investment decision. The NPV was applied for a 30 years period (the first 5 years refers to the establishment of the orchard) with an 8% discount rate. Analysis yields a positive NPV equal to 3,455€ for conventional cherries and 2,019€ for organic. Therefore, the establishment of organic or conventional orchard of cherries is an advisable investment.

Then, the real options approach is applied utilizing the same data as above to investigate the role of stochastic factors, taking into account irreversibility and uncertainty. Monte Carlo simulation was used to determine the mean and the variance of equivalent net annual returns of the project. The equivalent net annual returns of a conventional orchard of cherries and of an organic one were determined by 1,000 Monte Carlo iterations though SIMETAR software. The simulated equivalent net annual returns E (R) from investing in an organic orchard of cherries have an expected mean equal to 179€ with a coefficient of variation 35.2%. On the other hand, the simulated equivalent net annual returns from investing in a conventional orchard of cherries have an expected mean equal to 307€ with a coefficient of variation 20.8%.

The sunk cost for investing on orchard of cherries was estimated to 2,147.5€ for the conventional production system and 1,814€ for the organic production system. The annuity is calculated assuming a long run loan of 30 years' duration and a 6.5% rate of interest.

Under the baseline scenario, we assumed a farmer could use a real discount factor of 8% on his investment. Under the real options analysis, the conventional orchard cherries farmer has to use a different discount rate than the organic orchard cherries farmer. To measure the effect of uncertainty and irreversibility on the optimal investment behaviour, the organic cherries farmer has to use the hurdle rate, which is 8,74%, while the conventional cherries farmer has to use a modified hurdle rate at the levels of 8,54%. Therefore, the equivalent net expected annual returns of the investment on organic cherries have to be 1.0926 times greater than the annual sunk cost. For conventional cherries, the equivalent net annual expected returns have to be 1.0671 times greater than the corresponding annual sunk cost.

For the 30 years project life, the optimal investment trigger (H) for organic cherries is equal to 152€ while the sunk cost is equal to 139€. This means that the expected returns from investing in organic cherries are higher than the optimal investment trigger [H<E(R)]. However without organic subsidies, the results are different. More specifically, the expected returns from investing in organic cherries without subsidies are lower than the optimal investment trigger [H>E(R)]. The real options procedure suggests that the investment in organic cherries orchard is advisable only under the condition of the organic subsidies otherwise the investment must be postponed and the option must be kept alive. This means that the potential returns from organic cherries farming are not high enough to compensate for the risk and uncertainty involved.

For a conventional cherries farmer, the establishment of a cherries orchard under the prevailing conditions seems to be viable. The simulated equivalent expected net annual returns E(R) are greater than the optimal investment trigger (H). Therefore, the real options procedure projected that E(R)>H, so the investment is feasible considering the nature of returns., As the cost of inputs has recently increased sharply, we also examined a scenario with the increased input cost. Under this situation, conventional cherries are still an attractive investment while the establishment of an organic cherries orchard isn't an advisable investment if organic subsidies aren't present.

Conclusions

In the last years a growing interest for the cultivation of organic products has been expressed as a result of the increased demand along with the incentives that the policy support scheme has introduced to fulfil environmental objectives. This paper employs the real options approach in order to examine the efficiency of the current policy measures for the production of conventional and organic cherries in Greece. The real options approach takes into account the uncertainty, the irreversibility and the flexibility of the investments' choices in contrast with the simple net present value

(NPV) rule which, under these considerations, may lead to inaccurate deductions. Thus, the real options approach appears to be more appropriate to answer the inefficiencies of the traditional investment decision appraisal methods and seems to adapt easier to real conditions.

In the case of the conventional cherries production, both NPV and real options approaches concluded that the investment is profitable even under the scenario that tested the 100% increase of the price of fertilizers and pesticides. However this does not seem to be the case for organic cultivation. While the NPV criterion shows that the investment is profitable even without the relevant subsidies, the modified criterion rather resulted to a non-profitable investment. It is suggested, therefore, that farmers should not proceed to the option of growing organic cherries until the future conditions are detected to be more favourable. Consequently, in order to avoid misleading results in investment decisions' appraisal, especially in sectors with uncertainty and irreversibility such as agriculture, the use of the modified NPV criterion seems to be more appropriate.

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Table 1. Annual Operating Cost for conventional and Organic cherries

	Conventional		Organic	
	€/0.1ha	**% of total cost**	**€/0.1ha**	**% of total cost**
Annual operating Cost	**759,36**		**605,42**	
Land	**100**	**13,17%**	**100**	**16,52%**
Labour	**377,71**	**49,74%**	**220,34**	**36,39%**
Family labour	199,62	52,85%	118,56	53,81%
Hired labour	178,09	47,15%	101,78	46,19%
Capital	**281,65**	**37,09%**	**285,08**	**47,09%**
Variable Capital	*229,34*	*81,43%*	*224,63*	*78,80%*
Fertilizers & Pesticides	131,59	57,38%	118,03	52,54%
Diesel & Lubricants	16,06	7,00%	19,44	8,65%
Irrigation	39,41	17,18%	21,57	9,60%
Certification	2,03	0,89%	11,87	5,28%
Other	40,25	17,55%	53,72	23,91%
Fixed Capital	*52,31*	*18,57%*	*60,45*	*21,20%*

Table 2. Establishment Cost for conventional and organic orchard cherries in Greece (€/0.1ha)

	Year 1		Year 2		Year 3		Year 4		Year 5	
	Con	**Org**	**Con**	**Org**	**Con**	**Org**	**Con**	**Org**	**Con**	**Org**
Soil preparation	31	31	-	-	-	-	-	-	-	-
Cherries seedlings	135	135	-	-	-	-	-	-	-	-
Irrigation cost	400	400	-	-	-	-	-	-	-	-
Cost of extra seedlings	-	-	28	28	-	-	-	-	-	-
Labour	51	41	105	185	185	141	222	176	175	129
Land	100	100	100	100	100	100	100	100	100	100
Capital	38	37	63	62	89	84	108	99	119	103
Total	754	744	296	270	375	325	430	375	394	332

Table 3. Net present values and parameters for value of investment opportunity and value of waiting

	Conventional Cherries		Organic Cherries			
	Real cost of inputs	**Increased cost of inputs**	Real cost of inputs		Increased cost of inputs	
			Without subsidy	**With Subsidy**	**Without subsidy**	**With Subsidy**
NPV	3.455€	2.296€	1.313€	2.019€	236€	942€
μ	0,004697172	0,006050513	0.008423894	0.006746362	0.014405904	0,009723665
σ^2	0,000675449	0.001163229	0.002046645	0.001254988	0.010920677	0,00285913
ρ	8%	8%	8%	8%	8%	8%
B	15,8990	12,2387	9,3559	11,8023	4,3602	7,9974
$\beta/(\beta-1)$	1,0671	1,0890	1,1197	1,0926	1,2976	1,1429
ρ'	8,54%	8,71%	8,96%	8.74%	10,38%	9,14%
H	**162**	**165**	**156**	**152**	**180**	**159**
M	152	152	139	139	139	139
E(R)	**307**	**204**	**117**	**179**	**21**	**84**
CV (R)	20,78%	31,26%	35,22%	48,63%	270%	67,76%

Figure 1. Yield for organic and Conventional Cherries