REAL OPTIONS AND THE ADOPTION OF TRANSGENIC CROPS: AN INTERTEMPORAL PERSPECTIVE

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Abstract

Recently, the impact of irreversibility and uncertainty on the decision of adopting transgenic crops has been assessed using the real option approach. This approach explicitly considers irreversible effects and uncertainties for the valuation of a new technology. This information is important for the risk management of new technologies as it provides a conceptual guideline for decisions makers on whether or not introducing a new technology.

The real option approach pegs the decision making process to a particular point in time. As time passes new information may become available and results from previous real options based ex-ante assessments needs to be updated.

Based on field trials, and data from the Eurostat this study applies a real option approach to quantify, ex-ante, the maximum incremental social tolerable irreversible costs (MISTIC) that would justify immediate adoption of Bt and Ht maize in the European Union at different points in time. The analysis is carried out for different years over the period 1995 to 2004. Preliminary conclusions are drawn about the MISTIC intertemporal development path and the importance of this path in using real option values to model the economic benefits of introducing transgenic crops.

Keywords: GMOs, real option, European Union, field trials, irreversible social costs

JEL: D6, D8, Q1

Introduction

In June 1999 five member states declared they would block new approvals of genetically modified organism (GMOs) until the European Commission proposed additional legislation governing their introduction (Commission of the European Communities, 1999). The decision became to be known as the *quasi moratorium* on GMOs. The long-term human health and environmental effects of transgenic crops were the concerns of decision makers at the EU level. Those effects have to be seen as irreversible effects as otherwise there would be no reason to be concerned.

Previous studies analysing the reversible and irreversible benefits and costs of introducing transgenic maize in the EU did show low maximum incremental social tolerable irreversible costs (MISTICs) on a per household level providing a justification for the *quasi moratorium* but much higher MISTICs at farm level indicating the opposite. Scatasta et al. (2005) did analyse the benefits and costs from the perspective of the year 1996, when transgenic crops were introduced.

Since then ten years have passed.

Over the last ten years the EU common agriculture policy (CAP) has changed from a more crop specific support system to a farm support system. The decoupling of farm support can change the comparative advantage of crops as well as the expected economic benefits from new technologies. Over time other parameters driving the results of the model have changed as well.

In this contribution we present the changes in MISTICs over the period from 1996 to 2004 for Bt-maize and ht-maize and differentiate between the situation with and without the CAP reform.

The results show that by and large comparing the years 1996 and 2004 the MISTICs do increase indicating that the situation for introducing Bt-maize and ht-maize has improved.

In the following the model and the major underlying assumptions will be explained. The results will be presented and discussed.

Real Options and the MISTICs

The MISTICs represent the maximum tolerable amount of social irreversible costs (MISTIC) if not passed would justify immediate introduction adoption of Bt-maize and ht-maize in the European Union (EU). This figure is based on a cost-benefit analysis carried out following a *real option approach*. The *real option approach* considers all elements of a traditional cost benefit analysis plus temporal flexibility, i.e., the value of the option to delay the introduction of Bt-maize and ht-maize. The real option value captures additional opportunity costs that arise because the timing of the decision is flexible, some costs are irreversible (sunk) and the flow of future reversible net-benefits is uncertain. There do exist many different ways of including the real option value (see e.g. Dixit and Pindyck, 1994; Trigeorgis, 1996). Under the assumption that incremental reversible net benefits follow a continuous time continuous state process Bt-maize and ht-maize should be released at the point in time, where the social incremental reversible benefits W^* such as benefits accruing to farmers (the * indicating optimal timing) are greater than the difference between the social irreversible costs (I) and the social irreversible benefits (R), such as benefits from reduced pesticide use, weighted by the size of the uncertainty and flexibility associated to the adoption of a new technology (or hurdle rate). The hurdle rate is commonly expressed in the form $\beta/(\beta-1)$, where $\beta>1$ captures the uncertainty and flexibility effect[1]. As long as $W-\beta/(\beta-1)(I-R)>0$ the EU should delay adoption of Bt maize and ht-maize until more information about the new technology is available.

[1] See e.g. Demont, Wesseler, and Tollens (2004) for more details about the properties of β in the context of releasing ht-sugar beet in the EU.

In the context of transgenic crops where people are more concerned about the not well known irreversible costs of the technology threshold values that indicate the maximum incremental social irreversible costs that an individual or society in general is willing to tolerate for the sake of the benefits of the technology can provide useful information. We have called this value (Scatasta et al., 2005) the *Maximum Incremental Social Tolerable Irreversible Costs, I**, or *MISTICs* for short. Actual incremental irreversible social costs, *I*, are to be no greater than the sum of irreversible social benefits and reversible social net-benefits from Bt maize or ht-maize crops, such that:

$$I < I^* = \frac{W}{\beta/(\beta-1)} + R \tag{1}$$

In the case of transgenic crops incremental net benefits from transgenic crops, reversible and irreversible will depend on the rate of adoption of this new technology, θ, and as these net benefits can be assumed to society over an infinite period of time future values will have to be discounted for calculating the present values:

$$W = \int_0^{\infty} W_{\max}(t)\theta(t)e^{-\mu t}dt \tag{2}$$

and

$$R = \int_0^{\infty} R_{\max}(t)\theta(t)e^{-\mu t}dt \tag{3}$$

where the subscript "*max*" indicates values at complete adoption and *t* represents time and μ the risk-adjusted discount rate.

Thus, the use in practice of the *real option* decision criteria specified in (1) requires quantification of the following factors:

1. Adoption rates, θ;
2. Risk-adjusted discount rates, μ;
3. Reversible social net-benefits from transgenic maize, *W*;

4. Irreversible social benefits from transgenic maize, *R*;

5. Hurdle rate, $\beta/(\beta-1)$;

In the following we show how to quantify reversible social net-benefits and irreversible social benefits for Bt maize and ht maize.

Quantifying Adoption Rates, θ

The transgenic maize adoption curve is assumed to follow a logistic pattern over time. The size and speed of adoption can be estimated with ordinary least squares (OLS) using data from the adoption rates in the United States (James, 2004). Following Demont et al. (2004) the speed of adoption is then assumed half of that of the U.S. This allows us to obtain conservative estimates of the social reversible benefits. Assuming an adoption ceiling of 30% for Bt maize and 40% for ht maize we obtain:

$$\ln\left(\frac{\theta(t)}{0.3-\theta(t)}\right)_{Bt} = 2.41 - 0.335t \text{ Bt maize} \quad (4.a.)$$

$$\ln\left(\frac{\theta(t)}{0.3-\theta(t)}\right)_{Ht} = 2.15 - 0.187t \text{ ht maize} \quad (4.b.)$$

where $\theta(t)$ represents maize adoption rate.

As the speed of transgenic maize adoption is probably important in determining the gains the EU will enjoy from this technology, we take its 95% confidence interval into consideration and allow this parameter to vary between half of the lower bound of this interval (0.14 for Bt and 0 for Ht) and the full upper bound of the confidence interval (1.06 for Bt and 0.40 for Ht), assigning this parameter a pert distribution with mode 0.335 for Bt maize and 0.187 for ht maize. Results for each scenario represent mean results of 5000 iterations on the simulated speed of adoption. The simulation software used is RiskAmp. For a discussion about adoption rate for Bt-maize in Europe depending on European Corn Borer (ECB) pressure consult Nillesen, Wesseler, and Scatasta (2006).

Quantifying Risk Adjusted Discount Rates, μ

The risk adjusted discount rates can be found based on the capital asset pricing model (CAPM) basic formula:

$$\mu = r + \phi\sigma_m\rho_{xm} \tag{5}$$

where μ is the expected risk adjusted rate of return on asset *x*, r is the risk free rate of return, ϕ is the market price of risk, σ_m is the standard deviation of returns on a market portfolio, *m*, replicating the risk in the dynamics of *x*, and ρ_{xm} is the coefficient of correlation between returns on the particular asset *x* and the whole market portfolio *m*.

With respect to the decision of adopting transgenic maize, the asset *x* is technological change in maize production, the portfolio *m* is technological change in agricultural production activities other than maize production, returns to technological change are approximated with the instantaneous rate of change in the value of production, *V*:

$$r_{i,t} = \ln\left(\frac{V_{i,t+1}/V_{i,t}}{V_{i,t}/V_{i,t-1}}\right) \text{ with } i = x, m \tag{6}$$

where $V_{i,t}$ is asset *i* real value of production per hectare at time *t*. This means that returns on technological change follow a Geometric Brownian motion where $\tilde{V}_{i,t} = \tilde{V}_{i,t-1}e^{r_{i,t}}$ and $\tilde{V}_{i,t} = V_{i,t+1}/V_{i,t}$ (see Demont, Wesseler, and Tollens, 2004 for details). The market price of risk, ϕ, is given by $\phi = \frac{E\left[r_{m,t}\right]-r}{\sigma_m}$ where $E\left[r_{m,t}\right]$ is the expected rate of return on the market portfolio, *m*. The coefficient of correlation between returns on the particular asset *x* and the whole market portfolio *m*, ρ_{xm}, is given by

$\rho_{xm} = corr(r_x, r_m) = \frac{\text{cov}(r_x, r_m)}{\sigma_x \sigma_m} = \frac{E\left[\left(r_{x,t} - E\left[r_{x,t}\right]\right)\left(r_{m,t} - E\left[r_{m,t}\right]\right)\right]}{\sigma_x \sigma_m}$ where σ_x is the standard deviation of returns on a asset *x*, and $\text{cov}(r_x, r_m)$ is the covariance between returns on the market portfolio *m* and returns on asset *x*. Because we assumed that returns on technological change follow a Geometric Brownian motion $E\left[r_{i,t}\right] = E\left[\ln \frac{\tilde{V}_{i,t}}{\tilde{V}_{i,t-1}}\right]$ holds and $\sigma_i = SDV\left[\ln \frac{\tilde{V}_{i,t}}{\tilde{V}_{i,t-1}}\right]$.

The basic assumptions of this approach are that the risk free rate of return and the uncertainty associated to returns on technological change are both given exogenously.

In sum, to quantify the risk adjusted discount rate μ we need:

1. Time series data on the real value per hectare for maize production, $V_{x,t}$;
2. Time series data on the real value of production per hectare for agricultural output other than maize $V_{m,t}$;
3. The risk free rate of return, r .

Data on values of production where obtained from Eurostat Agriculture. The value at basic prices was used, i.e., including subsidies, as the amount of subsidy received may also be influenced by production efficiency and, therefore, technical change. As risk free rate of return we use short term money market interest rates with 3 month maturity (see Appendix B for more information).

Unfortunately risk-adjusted discount rates computed following the procedure described in this section are characterized by negative market prices for risk. This is due to the fact that returns on technological change fall below the risk free interest rate. This result is not uncommon in heavily subsidized sectors such as Agriculture. As noted by Tauer (2000) for American Dairy farms, this could be due to overcapitalization and the fact that the sector is in disequilibrium. We also believe that the Eurostat Data may not be the best source for calculating the risk adjusted rates of return as the heterogeneity among farms that may result in different risk adjusted rate of returns has been averaged out. Mithöfer (2005) has shown that using farm level data for the calculation of the risk adjusted rate of return does provide meaningful results. Detailed farm level data would be more appropriate but they are not available for the EU-15.

Thus we are going to perform our analysis under two sets of values for the risk-adjusted discount rate: 1. CAPM rates; 2. assuming a risk adjusted rate of return of 0.105 (this value has already been used for a similar analysis by Demont, Wesseler, and Tollens, 2004). For clarity Table 1a and Table 1b show the CAPM risk-adjusted rates of interest used within the analysis. The risk adjusted interest rates differ depending on whether or not CAP subsidies have been included. A comparison of the two tables reveals that the risk adjusted interest rates with CAP subsidies are higher than the risk adjusted interest rates excluding the subsidies.

Quantifying Reversible Social Net-Benefits from Bt Maize and ht Maize, *W*

Due to data availability, reversible social net-benefits in this study include only private reversible net-benefits for two market agents: buyers and sellers. We limit the analysis to two types of technologies, transgenic and conventional, without taking organic production into consideration. This is common use in the analysis of welfare impacts of transgenic crops (see Klotz-Ingram et al., 1999; Traxler and Falck-Zepeda, 1999; Pray et al., 2001; Frisvold et al., 2003; Qaim and de Janvry, 2003; Demont and Tollens, 2004; Demont et al., 2004).

Following Moschini et al. (2000), reversible private net-benefits are measured in terms of producer and consumer surplus derived from constant elasticity log-linear demand and supply functions. Supply elasticities were taken from the European Simulation Model (ESIM) where they are derived from behavioural equations. Suggested elasticities of land allocation to maize are 0.77, so we approximate supply elasticities to this value in our base case (see Banse et al., 2004). We consider EU countries to be small open economies with respect to grain maize, and take into consideration a perfectly elastic demand function.

We assume that the adoption of a technological innovation, such as transgenic maize, causes a pivotal shift in the inverse supply function. This shift is calculated as:

$$K = \frac{\left[\frac{VC_c}{y_c}\right]\frac{1}{y_c^{1/\varepsilon}} - \left[\frac{VC_g}{y_g}\right]\frac{1}{y_g^{1/\varepsilon}}}{\left[\frac{VC_c}{y_c}\right]\frac{1}{y_c^{1/\varepsilon}}} \tag{6}$$

where VC_c are variable operating costs (Euro per hectare) associated with the conventional technology; VC_g are variable operational costs (Euro per hectare) associated with the transgenic technology; y_c is production (in metric tons) under conventional technology and y_g is production (in metric tons) under the Bt technology. The expression $\left[VC_i / y_i\right]$ is used to approximate marginal costs of technology *i*. Note that if there is no yield gain from planting the transgenic crop, the K-shift in the supply function reduces to $K = \left[VC_c - VC_g\right]/VC_c$. For Bt maize we used data from field trials carried out in Narbons, France in 2004. comparing average yield and cost advantages of the isogenic variety of MON810 and commercial variety (Paolis) with the Bt variety MON810 and obtain *K*=0.24. For *Ht* maize we follow Gianessi et al. (2003) and find a *K*=0.12.

The total shift in the aggregate supply function is proportional to the technology adoption rate. We assume that the introduction of transgenic maize does not cause shifts in the demand function, and it should be taken into consideration that problems of consumer acceptance of GM foods could change the results of our analysis. Under our assumptions the reversible net-benefits from transgenic crops are represented by changes in producer surplus (see Appendix A for a mathematical derivation of changes in producer surplus). These changes are calculated over an infinite time horizon and then expressed in annuities multiplying their total present value by the risk-adjusted discount rate. All values are in 2004 Euro.

Irreversible Social Net-Benefits from Bt Maize and ht Maize, *R*

Irreversible social benefits for Bt maize were calculated on the base of changes in pesticide use and fuel use. Narbons field trials suggest for Bt maize a reduction of 0.035 kilogram Active Ingredient (kgAI) insecticide use per hectare; Gianessi et al (2003) suggest a reduction in herbicide use for Ht maize in the order of 1.719 kgAI per hectare. Changes in fuel use are derived from a comparative technology (soybean), which suggests a reduction of 0.01 tonnes of CO^2 emissions per hectare. (Demont et al., 2004). Following Pretty et al. (2000) we considered 0.69 Euro of social irreversible benefits per kgAI reduction and 77.4 Euro of social irreversible benefits per tonnes of CO^2 emissions (1995 values, the real value in 2004 changes for each county depending on the deflator).

Irreversible benefits are then found summing the value of benefits from reduced insecticide and herbicide use per hectare and then multiplying this value by the adopted number of hectares. These benefits are calculated over an infinite time horizon and then expressed in annuities multiplying their total present value by a risk-adjusted discount rate. All values are in 2004 Euro.

Maximum Incremental Social Tolerable Irreversible Costs (MISTICs), *I**

The MISTICs were computed as in equation (1) for the period 1996 to 2004. Following expert opinions on (ECB) infestation levels we considered for Bt maize five countries: France, Italy, Spain, Portugal and Greece. Based on data availability we considered for Ht maize nine countries: France, Italy, Spain, Portugal, Greece, Austria, Belgium, Netherlands and Germany.

We performed the analysis under two different risk-adjusted discount rates: one fixed at 0.105 for all countries and all years; one varying over countries and years computed with the capital asset pricing model. We also performed the analysis with and without CAP subsidies. In the latter case we allowed the value of production at basic prices, i.e., including subsidies, to be equal to the value of production at producer prices, i.e., without subsidies.

Considering that we analyze Bt maize and ht maize we obtain four sets of results, with and without CAP subsidies and with discount rates based on the CAPM and constant discount rates of 10.5%.

Results and Discussion

The results of the analysis are shown in Table 2a to Table 9b. The tables present the MISTICs in absolute values per year, per hectare and year, per capita and year and per farm holding and year. The annual values are annuities derived form the different net present values and expressed in constant prices of the year 2004.

For some countries in some specific years in the case of the CAPM derived risk adjusted discount rates do the hurdle rates approach infinity as the growth rate for technical change is larger than the discount rate. In those specific cases it always pays to wait. Please note that this is an artefact of the poor results from estimating the risk adjusted rate of return.

Please also note that the results for Greece have to be taken with care as the data reported by EUROSTAT do seem to be incorrect.

The problems with the results using the CAPM risk adjusted discount rate have been mentioned earlier. Nevertheless, the results are reported but have to be interpreted with care.

Taking the caveats mentioned into consideration, an observation common to all the results presented in the tables is an increase in the MISTICs whether on a per hectare, per capita or per farm holding level. This holds for both crops and for all countries considered except for Greece, which can be explained by the poor quality of the data and for Portugal. In some cases the changes are substantial. For the case of Germany the MISTICSs for ht maize in absolute values more than doubled from about 3.24 million Euros per year in 1996 to 8.20 million Euros per year in 2004.

A comparison of the scenario with and without subsidies paid under the CAP shows lower MISTICs for the scenario without subsidies, which can simply be explained by the effects of the subsidies. Comparing the results for Bt maize and ht maize of the year 1996 with subsidies with the year 2004 without subsidies per farm holding indicates higher MISTICs for Bt maize and ht maize except for Portugal and for Greece in the case of Bt maize, and for Portugal, Greece and Belgium in the case of ht maize. This indicates that in most of the countries considered in this study, incentives for farmers to gain access to the technology have increased since 1996. The increase in incentives may be reduced in the short run by the reform of the CAP. In the long-run the effect of technical change on subsidies, the tendency to reduce agriculture subsidies if agriculture income does increase, needs to be considered. The increase in MISTICs by farm holding can be explained by the structural change in the agriculture sector. The number of farm holdings has decreased over the period 1996 to 2004. A comparison of the MISTICs on a hectare basis shows different results. The MISTICs for Bt maize have decreased for all countries except for Spain while for ht maize they have decreased for all countries except for The Netherlands, and Spain.

The MISTICs at the per capital level remain very small. This is not unexpected. But here again we observe lower values without CAP subsides compared to the situation with CAP subsidies.

The total amount of MISTICs per country and year are of considerable amount even so they decrease when comparing the situation in 1996 with CAP subsidies and the situation in 2004 without CAP subsidies.

Conclusions

Comparing the situation in 1996 with the situation in 2004 reveals that not much has changed. The MISTICs per capita are still very small while the MISTICs per farm holding or per hectare are still much higher. The dilemma for decision makers still remains. On the one hand, the results per capita provide good arguments for further delaying the introduction of Bt maize and ht maize. On the other hand, the amount of MISTICs per farm holding suggest that further delaying the introduction of Bt maize and ht maize may be associated to high opportunity costs for farmers.

Our analysis also shows that the MISTICs per country and year do not vary considerably over time. This might suggest that uncertainty associated to technological change does not really resolve over time and it cast doubts on the advantages of waiting. Yet these results are sensitive to the risk-adjusted discount rate chosen for the analysis. Our analysis shows that with a different set of risk-adjusted discount rates uncertainty seems to resolve partially over time and the MISTICs exhibit an increasing trend.

Finally we note that the real option approach offers an additional perspective to CAP analysis. The presence of CAP subsidies may have an effect on both, the size of the MISTICs and on how the MISTICs vary over time affecting farmer incentives for early or delayed technology adoption.

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Appendix A

Partial equilibrium model for grain maize in a small open economy.

Country *j*'s supply of grain maize, Q^s, is given below:

(A1) $Q^s = A^s\left[P^s\right]^{\varepsilon}$

where the subscript *j* is dropped for ease of notation; P^s is the producer (or output) price received by maize sellers; A^s is a technology specific constant term for the associated product and function; ε is the supply elasticity.

The aggregate demand for grain maize, Q^d, is modeled as linear and parallel to the horizontal axes such that the demand elasticity tends to infinity and

(A2) $P^d = P^w$

where P^d is the buyers' price paid for grain maize; and P^w is the world price for grain maize.

The market clears with the following requirements:

(A3) $Q^d = Q^s$

(A4) $P^d\left[1+\tau\right] = P^w\left[1+\tau\right] = P^s$

where $\tau = \left[P^s - P^d\right]\big/P^d$ represents the proportional CAP price support coefficient identifying the relative difference between the output and the input price of maize due to the CAP maize price support regime.

Based on EUROSTAT data on the value of production calculated at the seller's price and the value of production calculated at the buyer's price, we observe that the variation in support received by maize sellers per unit of the product does not vary with the quantity produced. The price support system, therefore, reduces marginal production costs for maize sellers causing a parallel downwards shift in the supply function.

At any time period the equilibrium price, P^* and quantities, Q^*, are given by:

(A5) $$\begin{cases} P^{s*} = P^{d*}\left[1+\tau\right] \\ P^{d*} = P^{W*} \\ Q^* = A^s\left[P^{s*}\right]^{\varepsilon} \end{cases}$$

Producer surplus, PS, at the equilibrium conditions in (A5) is given by:

(A6) $$PS = P^{d*}\left[1+\tau\right]Q^* - \int_0^{Q^*}\left[\frac{Q^s}{A^s}\right]^{\frac{1}{\varepsilon}}\frac{1}{\left[1+\tau\right]}dQ^s = P^{s*}Q^* - P^{d*}Q^*\ \frac{\varepsilon}{\varepsilon+1}$$

With a perfectly elastic demand curve the consumer surplus is zero.

Following Moschini, Lapan, and Sobolevsky we assume that the adoption of a technological innovation, such as transgenic maize, causes a pivotal shift in the inverse supply function by changing the value of the technology specific constant term, A^s. The proportional vertical shift in the inverse supply function is the proportional change in the intercept of the inverse supply function and it is given by:

(A8) $$\frac{\left[\frac{1}{A_0^s}\right]^{1/\varepsilon} - \left[\frac{1}{A_1^s}\right]^{1/\varepsilon}}{\left[\frac{1}{A_0^s}\right]^{1/\varepsilon}} = \theta(t)K$$

where $\theta\,(t)$ is the transgenic maize adoption rate over time, *t*; A_0^s is the direct supply function constant coefficient with conventional technology; A_1^s is the direct supply function constant coefficient with transgenic technology and

(A9) $$K = \frac{\left[\frac{VC_c}{y_c}\right]\frac{1}{y_c^{1/\varepsilon}} - \left[\frac{VC_g}{y_g}\right]\frac{1}{y_g^{1/\varepsilon}}}{\left[\frac{VC_c}{y_c}\right]\frac{1}{y_c^{1/\varepsilon}}}$$

where VC_c are variable operating costs (Euro per hectare) associated with the conventional technology; VC_g are variable operational costs (Euro per hectare) associated with the transgenic technology; y_c is production (in metric tons) under conventional technology and y_g is production (in metric tons) under the Bt technology. The expression $\left[VC_i / y_i\right]$ is used to approximate marginal costs of technology *i*. Note that if there is no yield gain from planting the transgenic crop as for ht-maize, the K-shift in the supply function reduces to $K = \left[VC_c - VC_g\right]/VC_c$.

Given Equations (A5) to (A7) we can compute changes in the equilibrium price and quantities due to adoption of transgenic maize as a function of the vertical shift in the inverse supply function and the CAP price support coefficient:

(A10) $$\begin{cases} \Delta P^{s*} = 0 \\ \Delta P^{d*} = 0 \\ \Delta Q* = Q_1^* - Q_0^* = \left[A_1^s - A_0^s\right]\left[P^{w*}\right]^{\varepsilon} = \frac{A_1^s - A_0^s}{A_0^s}Q_0^* = \left[\left[1-\theta(t)K\right]^{-\varepsilon} - 1\right]Q_0^* \end{cases}$$

The change in producer surplus is then given by:

(A11)

$$\Delta PS = PS_1 - PS_0 = P^W(1+\tau)Q_1^* - P^W Q_1^* \frac{\varepsilon}{\varepsilon+1} - \left[P^W(1+\tau)Q_0^* - P^W Q_0^* \frac{\varepsilon}{\varepsilon+1} \right] =$$

$$\left[P^W(1+\tau) - P^W \frac{\varepsilon}{\varepsilon+1} \right] \left[Q_1^* - Q_0^* \right] = \left[\tau + 1 - \frac{\varepsilon}{\varepsilon+1} \right] \left[\left[1 - \theta(t)K \right]^{-\varepsilon} - 1 \right] P^W Q_0^*$$

Appendix B

B.1. Value of production data

Data on values of production where obtained from Eurostat Agriculture (the value at basic prices was used, i.e., including subsidies, as the amount of subsidy received may also be influenced by production efficiency and, therefore, technical change.)

Time series were available for different countries in different lengths, table 3 describes the data available:

Table B.1. Description of time series on value of production per hectare (Eurostat – basic prices).

Country	Length of time serie
Austria	1990-2004
Belgium	1989-2004
Denmark	No Data
Finland	No Data
France	1973-2004
Germany	1991-2004
Greece	1993-2004
Ireland	No Data
Italy	1980-2004
Luxembourg	1997-2004
Portugal	1980-2004
Spain	1990-2004
Sweden	No Data
United Kingdom	No Data
EU-15	Sum of available data 1973-2004

B.2. Risk free interest rate data

As risk free interest rate we use annual averages for real money market 3-month interest rates from 1996 to 2004.

Money market interest rates are short term interest rates for debt securities such as banker's acceptances, commercial paper, repos, negotiable certificates of deposit, and Treasury Bills with a maturity of one year or less. Money market securities are generally very safe investments which return a relatively low interest rate.

Money market interest rates are available from Eurostat for the following geographic areas: Eurozone, Denmark, Sweden and the U.K.. The Eurozone rates include 11 countries until 2000: Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, and Finland. Greece enters the Eurozone in 2001. In sum interest rates used were as follows:

Table 1. Description Risk free interest rates.

Country	**Risk Free Interest Rate (1996 -2004)**
Austria	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Belgium	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Denmark	CIBOR
Finland	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
France	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Germany	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Greece	3-month ATHIBOR (1996-2000) EURIBOR (2001-2004)
Ireland	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Italy	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Luxembourg	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Portugal	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Spain	3-month LIBOR (1996-1997) EURIBOR (1998-2004)
Sweden	3-month STIBOR
United Kingdom	3-month LIBOR
EU-15	GDP weighted sum of risk free interest rates in the Eurozon11, Greece, Denmark, Sweden and the U.K.

EURIBOR (EURo **I**nter**B**ank **O**ffered **R**ates.) EURIBOR is the benchmark rate of the large euro money market that has emerged since 1999. It is the rate at which euro interbank term deposits are offered by one prime bank to another prime bank and is published at 11.00 a.m. CET for spot value (T+2 days). The rate was first published on 30 December 1998 for value 4 January 1999. From January 1994 to December 1998: 3-month LIBOR.

CIBOR (**C**openhagen **I**nter**B**ank **O**ffered **R**ate): CIBOR is a reference interest rate for liquidity offered in the interbank market in Denmark on an uncollateralized basis. No CIBOR reporting bank is under an obligation to supply liquidity to other CIBOR reporting banks at its offered rate. CIBOR reporting banks should aim to offer CIBOR rates that reflect the interest rate level as realistically as possible.At 10.30 a.m. each banking day, CIBOR reporting banks fix a CIBOR rate to two decimal places. The rates are reported to Danmarks Nationalbank (the Danish central bank). Danmarks Nationalbank calculates CIBOR for the individual maturities by omitting the two highest and the two lowest rates and then calculates a simple average of the remaining rates. The rates offered by the individual CIBOR reporting banks are published on the website of Danish Bankers Association after 11.00 a. m.

LIBOR (London InterBank Offered Rate) average The BBA LIBOR is the most widely used benchmark or reference rate for short-term interest rates. It is compiled by the BBA (British Bankers Association) and released to the market at about 11.00 a. m. each day. LIBOR stands for the London Interbank Offered Rate and is the rate of interest at which banks borrow funds from other banks, in marketable size, in the London interbank market. Series starts in January 1986.

STIBOR (**ST**ockholm **I**nter**B**ank **O**ffered **R**ate) average.

The data is published by Eurostat, Economy and Finance: Exchange rates and Interest rates: Short term interest rates: Money market interest rates annual data.
www.europa.eu.int/comm/eurostat

Until this point the procedure described is the one followed by Eurostat. From this point on the procedure described is our own elaboration.

Greece: From 1996 to 2000 we used the 3-month Athens Inter-bank Offered Rate ATHIBOR. Data were obtained from the annual macro economic database AMECO.

From 2001 to 2004 the EURIBOR. Data were obtained from Eurostat.

EU15: This is a GDP weighted sum of risk free interest rates for : Eurozone 11, Greece, Denmark, Sweden and the U.K. GDP weights were obtained based on GDP data from Eurostat.

Table B.2. Risk free interest rates: Data

	1996	1997	1998	1999	2000	2001	2002	2003	2004
EUROZONE 11*	0.051	0.044	0.040	0.030	0.044	0.043	0.033	0.023	0.021
Denmark	0.040	0.037	0.043	0.034	0.050	0.047	0.035	0.024	0.022
Greece	0.060	0.056	0.083	0.069	0.020	0.043	0.033	0.023	0.021
Sweden	0.060	0.044	0.044	0.033	0.041	0.041	0.043	0.032	0.023
United Kingdom	0.061	0.069	0.074	0.056	0.062	0.050	0.041	0.037	0.046
EU-15	0.053	0.048	0.047	0.035	0.047	0.044	0.035	0.026	0.026

* Eurozone 11 : Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, and Finland.

Source: Eurostat, 2006; Ameco, 2004.

Table 1a. CAPM – Risk adjusted interest rates, including CAP subsidies

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
Austria	0.0688	0.0554	0.0553	0.0416	0.0672	0.0559	0.0503	0.0334	0.0174
Belgium	0.0283	0.0252	0.0226	0.0242	0.0451	0.0384	0.0338	0.0237	0.0223
France	0.0391	0.0334	0.0291	0.0232	0.0349	0.0287	0.0243	0.0136	0.0160
Germany	0.0220	0.0236	0.0116	0.0282	0.0241	0.0193	0.0204	0.0148	0.0212
Greece	-0.0247	0.0577	0.0625	0.0547	0.0141	0.0363	0.0275	0.0200	0.0187
Italy	0.0393	0.0343	0.0300	0.0241	0.0351	0.0301	0.0238	0.0152	0.0169
Portugal	0.0459	0.0460	0.0424	0.0289	0.0326	0.0282	0.0237	0.0153	0.0157
Spain	0.0622	0.0550	0.0506	0.0373	0.0575	0.0501	0.0436	0.0278	0.0283
EU-15	0.0714	0.0611	0.0455	0.0373	0.0597	0.0500	0.0421	0.0277	0.0255

Table 1b. CAPM – Risk adjusted interest rates, without CAP subsidies

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
Austria	0.0624	0.0466	0.0491	0.0383	0.0626	0.0524	0.0468	0.0309	0.0174
Belgium	0.0200	0.0186	0.0169	0.0240	0.0482	0.0404	0.0351	0.0232	0.0204
France	0.0367	0.0314	0.0273	0.0220	0.0331	0.0272	0.0230	0.0130	0.0162
Germany	0.0219	0.0231	0.0146	0.0288	0.0204	0.0175	0.0202	0.0149	0.0215
Greece	0.0010	0.0748	0.0669	0.0582	0.0162	0.0386	0.0293	0.0215	0.0201
Italy	0.0391	0.0342	0.0301	0.0242	0.0351	0.0301	0.0238	0.0152	0.0170
Portugal	0.0457	0.0428	0.0401	0.0273	0.0315	0.0296	0.0253	0.0168	0.0175
Spain	0.0426	0.0290	0.0233	0.0230	0.0323	0.0245	0.0204	0.0156	0.0148
EU-15	0.0611	0.0507	0.0402	0.0328	0.0524	0.0430	0.0367	0.0244	0.0233

Note: for Austria information about CAP subsidies paid are not available.

Table 2a. MISTICs in average million Euro per year and country at a 10.5% discount rate for Bt Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
France	42.57	53.27	43.20	47.95	49.18	52.45	53.43	34.86	54.31
Greece	5.33	1.51	3.85	3.04	4.33	4.75	5.68	6.51	6.60
Italy	37.32	36.76	31.43	39.87	41.43	37.95	43.30	31.16	48.87
Portugal	5.58	6.46	7.09	6.32	4.60	4.90	4.01	4.16	3.73
Spain	7.92	13.02	13.55	11.17	13.31	20.50	17.38	18.47	21.42
					without CAP subsidies				
France	27.74	34.62	26.96	30.53	30.39	30.85	30.89	20.63	31.09
Greece	2.05	aw	1.43	0.60	1.42	1.77	2.38	3.00	2.89
Italy	22.95	20.21	17.63	23.93	22.82	24.06	24.40	17.06	28.55
Portugal	2.37	2.84	3.13	2.84	2.42	2.32	1.80	2.02	1.71
Spain	10.82	14.53	13.72	10.50	12.31	17.76	14.17	14.66	17.47

Note: aw indicates always wait as the MISTICS approach zero.

Table 2b. MISTICs in average million Euro per year and country at CAPM discount rates for Bt Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
France	99.33	143.19	140.89	151.14	127.53	164.62	172.88	190.67	245.73
Greece	14766.61	aw	6.06	aw	aw	8.37	14.23	25.49	aw
Italy	91.64	113.31	92.71	133.71	111.07	128.73	136.43	199.99	116.35
Portugal	11.15	12.37	16.50	13.17	12.08	13.17	11.85	15.28	17.38
Spain	10.97	21.44	24.63	24.82	22.69	39.98	37.96	57.38	63.56
					without CAP subsidies				
France	67.11	94.82	91.75	92.23	80.45	100.11	100.26	108.48	139.26
Greece	49.46	aw	1.96	aw	aw	0.63	1.58	5.56	aw
Italy	57.76	62.63	46.70	68.93	60.58	71.35	83.29	107.23	45.97
Portugal	4.61	5.69	7.76	5.93	6.02	6.94	5.63	6.50	8.25
Spain	21.16	52.44	56.75	46.55	39.25	76.92	71.28	94.13	91.25

Note: aw indicates always wait as the MISTICS approach zero.

Table 3a. MISTICs in average Euro per hectare, year and country at a 10.5% discount rate for Bt Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
France	149.58	175.23	147.18	167.72	167.19	164.21	175.11	124.17	178.81
Greece	150.51	42.65	107.19	86.77	124.57	135.53	151.04	156.30	157.34
Italy	218.21	211.50	193.70	231.93	232.92	204.57	232.86	160.20	244.16
Portugal	179.74	206.95	218.40	229.49	179.04	188.33	170.26	175.02	161.56
Spain	108.48	161.07	177.67	170.68	185.02	240.73	224.97	233.49	268.73
					without CAP subsidies				
France	97.23	113.61	91.63	106.54	103.07	96.35	100.99	73.30	102.11
Greece	57.90	aw	39.91	17.05	40.80	50.41	63.36	71.92	68.75
Italy	134.62	116.65	109.00	139.67	128.71	130.08	131.64	88.01	143.13
Portugal	76.92	91.57	97.28	103.92	95.01	89.76	76.98	85.79	74.48
Spain	147.15	178.57	178.69	159.31	169.83	207.16	182.17	184.05	217.66

Note: aw indicates always wait as the MISTICS approach zero.

Table 3b. MISTICs in average Euro per hectare, year and country at CAPM discount rates for Bt Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
France	249.44	325.03	322.45	341.85	301.65	345.39	368.99	411.95	499.26
Greece	231827.61	aw	2264.05	aw	aw	2293.45	2377.02	2512.72	aw
Italy	384.25	453.33	386.81	507.41	436.34	470.26	477.39	633.21	360.80
Portugal	267.26	295.14	370.81	321.33	323.48	338.16	326.72	395.04	464.53
Spain	121.82	206.74	245.48	266.45	249.26	356.19	358.66	481.24	530.84
					without CAP subsidies				
France	165.75	212.08	207.04	206.06	187.99	207.36	211.36	231.72	281.96
Greece	801.16	aw	65.74	aw	aw	32.01	46.70	102.93	aw
Italy	241.32	249.80	194.27	260.55	237.43	259.85	290.58	337.51	140.62
Portugal	110.78	133.63	172.54	142.64	159.90	179.78	156.32	167.95	221.77
Spain	209.84	432.92	478.85	456.91	371.51	586.35	582.97	729.99	698.42

Note: aw indicates always wait as the MISTICS approach zero.

Table 4a. MISTICs in average Euro per capita, year and country at a 10.5% discount rate for Bt Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
				with CAP subsidies					
France	0.73	0.92	0.74	0.82	0.84	0.89	0.90	0.58	0.90
Greece	0.50	0.14	0.36	0.28	0.40	0.43	0.52	0.59	0.60
Italy	0.66	0.65	0.55	0.70	0.73	0.67	0.76	0.54	0.84
Portugal	0.56	0.64	0.70	0.62	0.45	0.48	0.39	0.40	0.36
Spain	0.20	0.33	0.34	0.28	0.33	0.51	0.42	0.44	0.51
				without CAP subsidies					
France	0.48	0.60	0.46	0.52	0.52	0.52	0.52	0.34	0.52
Greece	0.19	aw	0.13	0.05	0.13	0.16	0.22	0.27	0.26
Italy	0.40	0.36	0.31	0.42	0.40	0.42	0.43	0.30	0.49
Portugal	0.24	0.28	0.31	0.28	0.24	0.23	0.17	0.19	0.16
Spain	0.27	0.37	0.35	0.26	0.31	0.44	0.35	0.35	0.41

Table 4b. MISTICs in average Euro per capita, year and country at CAPM discount rates for Bt Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
				with CAP subsidies					
France	1.71	2.46	2.42	2.58	2.17	2.78	2.91	3.19	4.08
Greece	1383.46	aw	0.56	aw	aw	0.77	1.30	2.32	aw
Italy	1.61	1.99	1.63	2.35	1.95	2.26	2.39	3.49	2.01
Portugal	1.11	1.23	1.63	1.30	1.18	1.28	1.15	1.47	1.66
Spain	0.28	0.54	0.62	0.62	0.57	0.99	0.93	1.38	1.50
				without CAP subsidies					
France	1.16	1.63	1.57	1.58	1.37	1.69	1.69	1.81	2.31
Greece	4.63	aw	0.18	aw	aw	0.06	0.14	0.51	aw
Italy	1.02	1.10	0.82	1.21	1.06	1.25	1.46	1.87	0.79
Portugal	0.46	0.56	0.77	0.58	0.59	0.68	0.54	0.62	0.79
Spain	0.54	1.33	1.43	1.17	0.98	1.90	1.74	2.26	2.15

Note: aw indicates always wait as the MISTICS approach zero.

Table 5a. MISTICs in average Euro per farm holding, year and country at a 10.5% discount rate for Bt Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
France	258.04	337.49	282.69	326.84	344.61	389.88	416.02	287.36	467.12
Greece	44.97	12.57	34.57	28.23	46.07	47.30	58.67	66.34	73.75
Italy	100.77	103.48	93.88	125.77	140.95	134.86	164.25	125.41	214.27
Portugal	29.74	36.22	41.46	38.85	29.42	33.60	29.14	32.44	30.84
Spain	52.52	91.17	101.20	89.06	114.59	188.93	173.83	200.94	257.86
					without CAP subsidies				
France	168.14	219.32	176.42	208.11	212.95	229.31	240.51	170.04	267.40
Greece	17.31	aw	12.88	5.55	15.10	17.60	24.63	30.55	32.25
Italy	61.97	56.89	52.66	75.50	77.63	85.48	92.55	68.67	125.20
Portugal	12.64	15.91	18.33	17.47	15.50	15.90	13.08	15.79	14.11
Spain	71.74	101.78	102.49	83.71	105.90	163.72	141.74	159.49	210.31

Note: aw indicates always wait as the MISTICS approach zero.

Table 5b. MISTICs in average Euro per farm holding, year and country at CAPM discount rates for Bt Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
France	602.10	907.12	922.03	1030.19	893.73	1223.66	1346.02	1571.80	2113.64
Greece	124532.12	aw	54.44	aw	aw	83.36	147.10	259.68	aw
Italy	247.43	318.98	276.93	421.82	377.88	457.43	517.48	804.81	510.16
Portugal	59.43	69.36	96.50	81.02	77.30	90.25	86.15	119.19	143.78
Spain	72.72	150.19	183.89	197.88	195.32	368.58	379.61	624.26	765.29
					without CAP subsidies				
France	406.77	600.69	600.48	628.65	563.80	744.13	780.59	894.28	1197.80
Greece	417.14	aw	17.63	aw	aw	6.27	16.32	56.67	aw
Italy	155.97	176.33	139.48	217.46	206.12	253.53	315.93	431.53	201.58
Portugal	24.55	31.89	45.41	36.45	38.51	47.57	40.92	50.72	68.24
Spain	140.25	367.27	423.81	371.13	337.83	709.07	712.74	1024.13	1098.73

Note: aw indicates always wait as the MISTICS approach zero.

Table 6a. MISTICs in average million Euro per year and country at a 10.5% discount rate for ht Maize, with and without CAP subsidies, at different times of release

Countries	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
Austria	1.08	0.99	0.83	1.04	1.25	1.22	1.38	1.39	1.61
Belgium	0.01	0.02	0.02	0.04	0.03	0.04	0.06	0.08	0.12
France	20.03	24.99	20.33	22.51	23.09	24.63	25.07	16.47	25.47
Germany	3.24	3.92	2.91	4.65	4.92	5.36	5.90	6.57	8.20
Greece	2.53	0.76	1.85	1.47	2.07	2.26	2.70	3.09	3.13
Italy	12.56	12.38	10.61	13.39	13.92	12.79	14.54	10.58	16.40
Netherlands	0.01	0.03	0.03	0.03	0.06	0.21	0.19	0.19	0.16
Portugal	2.63	3.03	3.32	2.96	2.16	2.30	1.89	1.96	1.76
Spain	3.80	6.18	6.42	5.30	6.31	9.67	8.21	8.71	10.08
					without CAP subsidies				
Austria	0.43	0.47	0.41	0.56	0.70	0.66	0.73	0.77	0.84
Belgium	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
France	13.27	16.49	12.92	14.57	14.51	14.76	14.76	9.97	14.85
Germany	2.45	2.76	1.95	3.10	2.99	3.14	3.34	3.66	4.64
Greece	1.01	aw	0.73	0.34	0.72	0.88	1.17	1.46	1.41
Italy	7.87	6.98	6.11	8.20	7.84	8.27	8.38	5.98	9.77
Netherlands	0.01	0.03	0.03	0.02	0.04	0.23	0.20	0.20	0.18
Portugal	1.15	1.37	1.51	1.36	1.17	1.12	0.87	0.98	0.83
Spain	5.08	6.79	6.41	4.92	5.76	8.28	6.62	6.85	8.13

Note: aw indicates always wait as the MISTICS approach zero.

Table 6b. MISTICs in average million Euro per year and country at CAPM discount rate for ht Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
Austria	1.55	1.68	1.35	2.27	1.84	2.33	2.53	3.19	8.31
Belgium	0.06	aw	aw	0.22	aw	0.09	0.14	0.15	aw
France	54.84	80.49	80.91	89.57	71.40	94.54	101.55	120.03	150.73
Germany	12.84	14.34	8.07	10.60	20.14	33.01	0.16	40.79	42.92
Greece	10063.09	aw	3.15	aw	aw	4.80	8.40	15.47	aw
Italy	50.23	63.25	53.05	78.36	61.83	73.21	80.26	123.14	72.54
Netherlands	0.02	0.05	0.05	0.06	aw	0.35	0.33	0.41	0.34
Portugal	6.00	6.63	8.92	7.64	6.86	7.65	7.09	9.64	10.83
Spain	5.75	11.28	13.08	13.86	11.78	21.09	20.50	32.98	36.36
					without CAP subsidies				
Austria	0.57	0.92	0.63	1.20	1.07	1.34	1.34	1.63	4.55
Belgium	0.07	aw	aw	0.09	aw	0.05	0.07	0.13	aw
France	38.02	54.61	54.17	56.50	46.17	59.16	60.87	71.36	87.63
Germany	9.96	12.92	6.64	5.64	15.75	22.96	3.16	23.23	25.41
Greece	34.73	aw	1.09	aw	aw	0.60	1.29	3.86	aw
Italy	32.00	35.49	27.42	41.37	34.24	41.26	49.81	67.95	31.04
Netherlands	0.01	0.05	0.04	0.04	aw	0.30	0.28	0.23	0.10
Portugal	2.60	3.21	4.37	3.66	3.57	4.13	3.50	4.35	5.32
Spain	11.55	29.85	33.26	27.36	22.06	44.52	42.28	57.23	55.87

Note: aw indicates always wait as the MISTICS approach zero.

Table 7a. MISTICs in average Euro per hectare, year and country at a 10.5% discount rate for ht Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
Austria	39.05	39.60	37.42	43.97	49.09	46.20	51.88	51.98	58.10
Belgium	3.79	4.63	5.38	7.10	4.59	5.83	7.59	9.84	14.97
France	75.70	88.42	74.51	84.69	84.43	82.96	88.36	63.11	90.19
Germany	56.33	68.92	55.29	81.11	88.25	87.49	95.80	91.78	114.94
Greece	76.58	23.12	55.11	44.99	63.73	69.16	76.84	79.45	79.97
Italy	78.86	76.49	70.22	83.68	84.03	74.05	84.01	58.43	87.99
Netherlands	8.67	15.53	13.00	10.56	18.98	50.85	51.43	49.67	45.82
Portugal	91.16	104.64	110.31	115.81	90.81	95.41	86.46	88.82	82.15
Spain	55.51	81.58	89.81	86.34	93.45	121.07	113.25	117.48	134.95
					without CAP subsidies				
Austria	15.58	18.94	18.34	23.74	27.34	24.95	27.43	28.64	30.39
Belgium	2.67	2.95	3.33	2.24	1.88	2.06	2.18	2.23	2.18
France	49.76	57.88	46.99	54.37	52.66	49.33	51.63	37.90	52.18
Germany	42.33	48.08	36.70	53.65	53.30	50.81	53.82	50.72	64.49
Greece	30.68	aw	21.77	10.43	22.21	26.97	33.39	37.63	36.06
Italy	49.43	43.11	40.41	51.21	47.35	47.84	48.38	33.02	52.43
Netherlands	7.33	14.64	11.73	9.74	12.79	54.32	53.57	51.23	52.00
Portugal	40.21	47.47	50.30	53.59	49.18	46.58	40.24	44.61	39.00
Spain	74.65	90.22	90.28	80.68	85.89	104.39	92.01	92.94	109.59

Note: aw indicates always wait as the MISTICS approach zero.

Table 7b. MISTICs in average Euro per hectare, year and country at CAPM discount rates for ht Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
Austria	44.11	47.31	42.26	58.90	56.52	62.11	63.61	66.56	140.18
Belgium	8.86	aw	aw	21.85	aw	10.03	12.33	8.81	aw
France	127.10	164.38	163.09	172.65	152.85	174.41	186.04	207.28	250.35
Germany	114.74	132.26	64.28	103.18	190.37	267.54	0.80	266.50	306.11
Greece	118700.53	aw	5240.90	aw	aw	5255.31	5296.53	5363.48	aw
Italy	194.43	228.49	195.64	255.13	220.11	236.82	240.32	317.24	182.80
Netherlands	9.21	18.80	14.33	12.15	aw	54.95	54.18	55.17	48.58
Portugal	136.47	150.23	187.56	163.07	164.14	171.37	165.72	199.46	233.74
Spain	63.03	104.96	124.07	134.34	125.99	178.75	179.91	240.30	264.79
					without CAP subsidies				
Austria	86.02	108.88	106.38	105.90	96.99	106.54	108.51	118.58	143.36
Belgium	10.17	aw	aw	10.22	aw	8.87	9.06	9.25	aw
France	25.32	39.87	36.79	60.18	44.32	47.46	57.94	89.16	163.21
Germany	88.66	118.15	56.09	56.07	141.78	181.04	25.23	150.66	181.58
Greece	437.92	aw	74.75	aw	aw	58.07	65.32	93.06	aw
Italy	123.88	128.04	100.63	133.33	121.94	132.99	148.15	171.32	74.17
Netherlands	59.23	70.51	89.70	74.92	aw	93.25	81.67	87.41	113.97
Portugal	107.61	217.63	240.28	229.46	187.35	293.32	291.66	364.23	348.67
Spain	5.99	17.58	9.46	7.57	-24.19	43.70	43.53	28.07	11.29

Note: aw indicates always wait as the MISTICS approach zero.

Table 8a. MISTICs in average Euro per capita, year and country at a 10.5% discount rate for ht Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
Austria	0.14	0.12	0.10	0.13	0.16	0.15	0.17	0.17	0.20
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
France	0.35	0.43	0.35	0.38	0.39	0.42	0.42	0.28	0.42
Germany	0.04	0.05	0.04	0.06	0.06	0.07	0.07	0.08	0.10
Greece	0.24	0.07	0.17	0.14	0.19	0.21	0.25	0.28	0.28
Italy	0.22	0.22	0.19	0.24	0.24	0.22	0.26	0.18	0.28
Netherlands	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Portugal	0.26	0.30	0.33	0.29	0.21	0.22	0.18	0.19	0.17
Spain	0.10	0.16	0.16	0.13	0.16	0.24	0.20	0.21	0.24
					without CAP subsidies				
Austria	0.05	0.06	0.05	0.07	0.09	0.08	0.09	0.10	0.10
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.23	0.28	0.22	0.25	0.25	0.25	0.25	0.17	0.25
Germany	0.03	0.03	0.02	0.04	0.04	0.04	0.04	0.04	0.06
Greece	0.09	aw	0.07	0.03	0.07	0.08	0.11	0.13	0.13
Italy	0.14	0.12	0.11	0.14	0.14	0.15	0.15	0.10	0.17
Netherlands	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Portugal	0.11	0.14	0.15	0.13	0.11	0.11	0.08	0.09	0.08
Spain	0.13	0.17	0.16	0.12	0.14	0.20	0.16	0.16	0.19

Note: aw indicates always wait as the MISTICS approach zero.

Table 8b. MISTICs in average Euro per capita, year and country at CAPM discount rates for ht Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
Austria	0.20	0.21	0.17	0.28	0.23	0.29	0.31	0.39	1.02
Belgium	0.01	aw	aw	0.02	aw	0.01	0.01	0.01	aw
France	0.95	1.38	1.39	1.53	1.21	1.60	1.71	2.01	2.50
Germany	0.16	0.17	0.10	0.13	0.25	0.40	0.00	0.49	0.52
Greece	942.79	aw	0.29	aw	aw	0.44	0.77	1.41	aw
Italy	0.88	1.11	0.93	1.38	1.09	1.29	1.41	2.15	1.25
Netherlands	0.00	0.00	0.00	0.00	aw	0.02	0.02	0.03	0.02
Portugal	0.60	0.66	0.88	0.75	0.67	0.75	0.69	0.93	1.03
Spain	0.15	0.29	0.33	0.35	0.29	0.52	0.50	0.79	0.86
					without CAP subsidies				
Austria	0.07	0.12	0.08	0.15	0.13	0.17	0.17	0.20	0.56
Belgium	0.01	aw	aw	0.01	aw	0.00	0.01	0.01	aw
France	0.66	0.94	0.93	0.97	0.79	1.00	1.02	1.19	1.46
Germany	0.12	0.16	0.08	0.07	0.19	0.28	0.04	0.28	0.31
Greece	3.25	aw	0.10	aw	aw	0.06	0.12	0.35	aw
Italy	0.56	0.62	0.48	0.73	0.60	0.72	0.87	1.19	0.54
Netherlands	0.00	0.00	0.00	0.00	aw	0.02	0.02	0.01	0.01
Portugal	0.26	0.32	0.43	0.36	0.35	0.40	0.34	0.42	0.51
Spain	0.29	0.76	0.84	0.69	0.55	1.10	1.03	1.37	1.32

Note: aw indicates always wait as the MISTICS approach zero.

Table 9a. MISTICs in average million Euro per farm holding, year and country at a 10.5% discount rate for ht Maize, with and without CAP subsidies, at different times of release

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
					with CAP subsidies				
Austria	26.14	24.58	21.58	27.80	34.79	35.40	41.58	43.59	52.61
Belgium	3.42	3.91	4.68	6.54	3.96	5.34	7.46	10.06	13.94
France	121.42	158.32	133.06	153.45	161.80	183.12	195.17	135.79	219.06
Germany	73.93	88.08	66.85	106.90	118.04	123.97	136.86	149.84	191.10
Greece	21.36	6.36	16.59	13.66	22.00	22.53	27.87	31.48	34.99
Italy	33.90	34.84	31.69	42.25	47.34	45.45	55.17	42.59	71.89
Netherlands	8.21	14.31	12.07	10.33	23.02	70.33	57.26	51.74	41.84
Portugal	13.99	16.99	19.43	18.19	13.84	15.79	13.73	15.27	14.54
Spain	25.20	43.30	47.97	42.25	54.27	89.10	82.06	94.81	121.43
					without CAP subsidies				
Austria	10.47	11.80	10.62	15.08	19.47	19.21	22.08	24.13	27.64
Belgium	2.41	2.49	2.90	2.06	1.62	1.88	2.14	2.28	2.02
France	80.44	104.45	84.56	99.29	101.70	109.73	114.92	82.18	127.73
Germany	55.97	61.90	44.70	71.22	71.82	72.53	77.44	83.41	108.02
Greece	8.53	aw	6.53	3.15	7.64	8.76	12.07	14.86	15.73
Italy	21.26	19.64	18.24	25.86	26.69	29.37	31.78	24.07	42.85
Netherlands	6.98	13.58	10.96	9.59	15.62	75.66	60.06	53.73	47.81
Portugal	6.14	7.67	8.81	8.37	7.46	7.67	6.36	7.63	6.87
Spain	33.66	47.56	47.90	39.21	49.54	76.31	66.21	74.49	97.95

Note: aw indicates always wait as the MISTICS approach zero.

Table 9b. MISTICs in average Euro per farm holding, year and country at CAPM discount rates for ht Maize, with and without CAP subsidies, at different times of release

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
					with CAP subsidies				
Austria	37.52	41.96	34.91	60.88	51.55	67.50	76.20	99.94	272.28
Belgium	14.53	aw	aw	39.89	aw	12.66	19.15	19.37	aw
France	332.38	509.90	529.54	610.55	500.34	702.74	790.64	989.49	1296.49
Germany	293.04	322.12	185.24	243.87	483.14	763.36	3.80	929.90	1000.07
Greece	84865.66	aw	28.32	aw	aw	47.81	86.78	157.58	aw
Italy	135.63	178.05	158.46	247.19	210.36	260.15	304.42	495.53	318.05
Netherlands	10.86	23.85	22.37	23.20	aw	114.40	98.61	112.14	90.23
Portugal	32.00	37.22	52.18	46.97	43.89	52.41	51.53	75.16	89.62
Spain	38.11	79.01	97.67	110.50	101.43	194.43	204.95	358.81	437.82
					without CAP subsidies				
Austria	13.85	22.90	16.28	32.17	29.86	38.76	40.25	51.03	149.01
Belgium	18.24	aw	aw	15.42	aw	6.78	9.04	15.88	aw
France	230.45	345.96	354.55	385.09	323.51	439.76	473.92	588.22	753.72
Germany	227.26	290.05	152.26	129.76	377.78	530.84	73.31	529.53	592.02
Greece	292.86	aw	9.80	aw	aw	6.02	13.30	39.35	aw
Italy	86.39	99.92	81.89	130.52	116.51	146.62	188.94	273.46	136.08
Netherlands	7.58	24.43	16.21	16.75	aw	97.09	83.89	63.13	27.39
Portugal	13.83	17.98	25.55	22.49	22.86	28.33	25.43	33.96	44.04
Spain	76.56	209.05	248.35	218.11	189.84	410.42	422.77	622.64	672.75

Note: aw indicates always wait as the MISTICS approach zero.