Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Department of Economics

WORKING PAPER
04/2016

Passive farming and land development: a real option approach

Luca Di Corato, Mark Brady

Economics

Sveriges lantbruksuniversitet, Institutionen för ekonomi
Swedish University of Agricultural Sciences, Department of Economics

ISSN 1401-4068
ISRN SLU-EKON-WPS-1604-SE

Working Paper Series 2016:04
Uppsala 2016

Corresponding author:
luca.di.corato@slu.se

Passive farming and land development: a real option approach*

Luca Di Corato† Mark Brady‡

April 12, 2016

Abstract

We examine the impact that subsidies paid to passive farmers have on the lease of land and on the speed of land development. First, we find that, even if delaying land development, paying passive farmers increases the value of the land. Second, when bargaining for the lease of land, we show that the agreement between the parties is conditional on an underlying development project passing a threshold level in terms of profitability. Third, we identify the conditions leading to a Pareto improvement. Last, we illustrate our findings by considering the establishment of an energy crop on leased land.

KEYWORDS: Real Options, Land development, Passive Farming, Nash Bargaining.

JEL CLASSIFICATION: C61, Q15, R14.

1 Introduction

As a consequence of the Single Payment Scheme (SPS) reform of 2003, or decoupling, EU farmers are no longer required to produce agricultural commodities to receive direct payments (income support) as long as they keep their farmland in "Good Agricultural and Environmental Condition"

*Luca Di Corato gratefully acknowledges financial support from Swedish Research Council FORMAS through the project TRUSTEE. Mark Brady's time is funded by the Swedish Research Council FORMAS through the project MULTAGRI. The usual disclaimer applies.

†Corresponding author: Department of Economics, Swedish University of Agricultural Sciences, Box 7013, 75007, Uppsala, Sweden. Email: luca.di.corato@slu.se. Telephone: +46(0)18671758. Fax: +46(0)18673502.

‡Corresponding address: AgriFood Economics Centre, Department of Economics, Swedish University of Agricultural Sciences, Box 730, 22007, Lund, Sweden. Email: mark.brady@slu.se. Telephone: +46(0)462220784. Fax: +46(0)462220799.

(GAEC). The reform was driven by the need to reduce the overproduction caused by production-coupled payments (subsidies) as well as escalating environmental degradation associated with modern agriculture. Environmental stewardship has then been promoted and measures introduced to ensure that agricultural land is kept in reserve for potential future use and land abandonment is avoided (Phelps, 2007). This change in the basis for entitlement to support paved the way for the development of passive farming, whereby a landowner manages their entire farm area to meet the GAEC obligation without producing commodities (Brady et al., 2015). Currently, as much as 20-30% of the agricultural area in some EU regions, primarily marginal regions, is managed passively (Trubins, 2013). Within the industry the emergence of passive farming is perceived as a bad thing because it is thought to be hindering agricultural development, since active farmers are presumed to be denied access to land that could be used for farm expansion (LD, 2014, p. 112; Wahlberg, 2014; Vernersson, 2012). In chorus the land managed by passive farmers is referred to as being underutilized or blocked because it could, ostensibly, be used for producing commodities by expansion-willing active farmers (LRF, 2009). Thus from this perspective society is not served by a land management payment: it benefits passive farmers to the detriment of agricultural development.

Indeed the SPS has resulted in more farmers remaining longer in the sector and thus slowing structural change (Brady et al., 2012; Ciaian, Kancs and Swinnen, 2010). However, the extent to which the possibility for landowners to choose passive farming might be hindering agricultural development is unclear. In an initial study Brady et al. (2015) show that passive farming occurs, generally, because active farmers are not willing to meet landowners' minimal rental price, as a result of the inherently poor profitability of commodity production on marginal land. Given the SPS it is therefore rational for the landowner to manage their land passively rather than abandoning it, thereby meeting a Common Agricultural Policy (CAP) goal. Analysis, conducted in a static and fixed rental-price framework, though misses the implications for the decision dynamics of a land management payment such as the SPS. In this paper we aim to evaluate the implications of the SPS for agricultural development in a broader framework by considering the impact on land use over time and under uncertainty about economic returns from land development (farming).

In particular we study the rental bargaining process leading to leasing of land as affected by the SPS and investigate how the optimal timing of development is affected by the payment of subsidies and uncertainty about returns from farming.

The analysis is carried out using a real-options framework[1]. In particular, the model developed in this article should be viewed in the context of the literature investigating the inter-temporal allocation of land under uncertainty (e.g. Capozza and Li, 1994; Geltner et al., 1996; Schatzki, 2003; Isik and Yang, 2004) and the policy impact on agricultural investments in a stochastic and dynamic frame (Feil et al., 2013).

In the model we reproduce the perceived blocking situation by considering the bargaining between a landowner and a potential lessee. The landowner is not willing to take initiatives in terms of land development. However, he is able to meet the GAEC obligation and qualify for the subsidy by undertaking some minimal but costly maintenance practices. This is the situation that we will consider in the following as passive farming. In contrast, the potential lessee is willing to invest and develop land for agricultural activities. If the land is cultivated, the GAEC obligation will be automatically met and the subsidy paid. This is what we will consider as active farming. However, due to uncertainty characterizing the returns from farming, land may, once leased, not necessarily be immediately worth investment. If this is the case, the lessee may, by managing the land passively in the meanwhile, qualify for the subsidy. As one can immediately see, we are basically viewing the SPS as providing a minimal return on land not activated for production. This opportunity enters our bargaining problem in two ways: first, by raising the minimal amount of rent that the landowner must be offered and second, by reducing the cost of waiting before investing in the land for the lessee.

We solve the problem in two steps. We first determine the value and timing of a hypothetical project to be developed on leased land. Then, we proceed to determining the optimal rental payment resulting from a cooperative cake splitting game played by the involved parties. Our main findings are: first, the SPS, as currently designed, accelerates the timing of land development. The intuition is immediate. Paying a periodic subsidy to farmers investing on land lowers the investment threshold, in terms of project value, in that it reduces the burden of the initial investment cost. Second, in line with the current debate, when comparing the SPS with the hypothetical scheme where no subsidy is paid to passive farmers, we show that land development is delayed under the

[1] See Dixit and Pindyck (1994) for a complete treatment of the theory of investment under uncertainty and irreversibility.

SPS. The insight behind this result is straightforward. Counting on the possibility to qualify for the subsidy, even if managing land passively, the cost of waiting before investing is reduced and the lessee may then postpone the initiative and undertake the investment when agricultural returns reach higher levels. This makes the value associated with the land asset unambiguously higher. This result should not be surprising considering that in the presence of a subsidy for passive farming the object over which the parties are bargaining is a package containing two assets, that is, land and the entitlement to receive a subsidy on that land even when managing it passively. Hence, summing up, removing payments to passive farmers if, on the one hand, would definitely accelerate land development it would, on the other hand, reduce the value of land as faster development would preclude the consideration of more valuable future land uses. Third, paying a subsidy to passive farmers introduces, by increasing the minimally acceptable rent, a threshold that rather than deterring the lease of land is simply making it conditional on the possibility of undertaking a development project paying sufficiently high profits to both parties. In the absence of this opportunity, the bargaining fails. Fourth, by setting the rental payment in a cooperative setting, the two parties are able to reach an agreement that makes both better off. This results from sharing the value associated with land according to their respective bargaining powers.

The remainder of the paper is organized as follows. In Section 2, we introduce our model for the analysis of land development and determine the value attached to land and the timing of development. In Section 3, we characterize the bargaining problem and determine the optimal rental payment. We examine the resulting sharing rule and discuss the implications of our results for land values and timing of development. In Section 4, we illustrate our findings by using the establishment of a willow stand as numerical example. Section 5 concludes. All proofs are available in Appendix A.

2 The Basic Model

Consider a landowner (S, hereafter) who owns a specific land parcel (say, 1 hectare) and a farmer (D, hereafter) contemplating the lease of that land.[2] Assume that S is currently keeping his[3] land idle and is not willing to convert it to any other potential alternative use.[4] In contrast, D, once leased land, she will consider its conversion to a profitable land use. Assume that, in order to initiate this project, she incurs the sunk investment cost $K(> 0)$. For simplicity, assume that land development is irreversible and denote by X the value associated with the new use.

Further assumptions are as follows:

Ass 1 A subsidy $n > 0$ is paid to the land manager (i.e., the single farmer payment) if the land is either i) actively managed for production of commodities or ii) passively managed without production, that is, it is kept idle but in *Good Agricultural and Environmental Condition* (GAEC, hereafter). In order to meet this obligation, specific maintenance practices are needed. Hence, accounting for a per-hectare cost of compliance, c, the net cash flow accruing to a passive farmer, i.e., farmer under regime ii), is $m = n - c \geq 0$.[5]

Ass 2 The project value, X, is a random variable evolving over time according to the following diffusion:

$$dX_t/X_t = \alpha dt + \sigma dW_t, \text{ with } X_0 = X \tag{1}$$

where α is the expected growth rate, σ is the volatility parameter, and W_t is the increment of the standard Wiener process satisfying $E\left[dW_t\right] = 0$ and $E\left[dW_t^2\right] = dt$.

Ass 3 S and D are risk-neutral agents and maximize the net present value of their expected future cash flows. Both agents discount future cash flows using the interest rate $r > \alpha$.[6]

[2] For the sake of simplicity we assume that the contract duration is long enough to be reasonably approximated, when discounting future cash flows, by an infinite time horizon. Thus, in the following, considering (long-term) leasing rather than land purchase does not affect the quality of our results.

[3] S is male while D is female.

[4] This may be due to different reasons such as lack of interest in agricultural activities, the presence of a better job option, the lack of the needed skills and abilities, etc.

[5] We implicitly assume that the farmer would never apply for a subsidy paying $n < c$.

[6] Convergence of the model requires the trend in the project value, X_t, not to exceed the discount rate. Note in fact that if $r \leq \alpha$, investing would never be optimal for D. Last, note that in order to use an interest rate incorporating a

2.1 Idle land and potential development: timing and value

We start by considering landowner S. Suppose that he may be willing to lease his land in exchange for a per-period rent p. The present value of the flow of future rental payments is then equal to:[7]

$$P = p/r \tag{2}$$

Farmer D, conditional on having leased the land parcel from S at time $t = 0$, can be viewed as holding the option to invest, by spending the amount K, in a development project worth X_t. At the generic time period $t > 0$ the value of this option is

$$O(X_t; X^i) = \left\{ \begin{array}{ll} E_t[e^{-r(\tau-t)}(X^i - K)] & \text{for } 0 < X_t < X^i \\ X_t - K & \text{for } X^i \leq X_t \end{array} \right| \tag{3}$$

where $\tau = \inf\{t \geq 0 \mid X_t = X^i\}$ is the optimal investment (stopping) time and X^i is the threshold, expressed in terms of the project's value, triggering investment.

Now, consider the initial time $t = 0$ and assume that $X_0 = X$ lies within the continuation region, i.e., $0 < X < X^i$, that is, the range of values where the option to invest is kept open. Hence, the expected net present value attached to holding the right to develop the land is equal to[8]

$$\begin{aligned} V(X; X^i) &= \frac{m[1 - E_0[e^{-r\tau}]] + nE_0[e^{-r\tau}] - p}{r} + O(X; X^i) \\ &= \frac{n - \{c[1 - (X/X^i)^\beta] + p\}}{r} + (X/X^i)^\beta (X^i - K) \end{aligned} \tag{4}$$

where $\beta > 1$ is the positive root of the equation $\Psi(\beta) = 0.5\sigma^2\beta(\beta - 1) + \alpha\beta - r = 0$.

In Eq. (4), the first term is the expected present value of the flow of periodic subsidy payments n net of the maintenance cost c and the rental payment p due to S. Note that c must be deducted only up to time τ since, once the land has been developed, farmer D qualifies for the subsidy on the basis of its productive agricultural activity. In the first term, this is accounted for by using the stochastic annuity term, discount factor $(1 - E_0[e^{-r\tau}])/r = [1 - (X/X^i)^\beta]/r$. The second term

proper risk adjustment, expectations should be taken with respect to a distribution of X_t adjusted for risk neutrality. See Cox and Ross (1976) for further details.

[7] Note that committing to pay p forever is equivalent to a one-shot payment P. This implies that, as mentioned above, our analysis may perfectly apply to a frame where one considers a purchase rather than a lease.

[8] See Dixit and Pindyck (1994, pp. 315-316) for the calculation of these expected present values.

in Eq. (4) represents the expected net present value of the development project, that is, the net project payoff, $X^i - K$, discounted by using the stochastic discount factor $E_0[e^{-r\tau}] = (X/X^i)^{\beta}$.[9]

In order to identify the optimal investment timing strategy, we solve the following problem:

$$F(X; X^i) = \max_{X^i} V(X; X^i) \tag{5}$$

We find:[10]

Proposition 1 *Provided that $rK > c$,[11] the optimal investment threshold and value function are:*

$$X^i = (1 + \frac{1}{\beta - 1})(K - \frac{n-m}{r}) = (1 + \frac{1}{\beta - 1})(K - \frac{c}{r}) \tag{6}$$

and

$$F(X; X^i) = \frac{n - (c+p)}{r} + (X/X^i)^{\beta}[X^i - (K - \frac{c}{r})] \tag{7}$$

Studying the threshold X^i we notice that:[12]

i) at the investment time, the project value, X^i, must be higher than the total development cost K net of the present value of maintenance costs, c. Note in fact that, once the land has been developed, production automatically qualifies land as being kept in GAEC. In particular, X^i must cover at least $[1 + 1/(\beta - 1)]$ times the net development cost where the term, $1/(\beta - 1)$, represents the correction needed in order to account for the presence of uncertainty and irreversibility in the investment decision problem;

ii) the higher the volatility of the project value, the higher the threshold set for investing since $\partial X^i / \partial \sigma > 0$, which in expected terms implies that the investment is delayed;

[9] In our frame we abstract from the consideration, once the project has been undertaken, of a potential temporary or permanent suspension of the operations. These opportunities will make even more valuable the possibility of qualifying for a subsidy when managing land passively since the lessee may rely on the subsidy when operations are temporarily or permanently stopped. The simplification comes at minimal cost in terms of generality for our results and these options may, if sensible, be easily incorporated in our frame. In this respect, see Dixit and Pindyck (1994) on the value of the options to mothball, reactivate and abandon an investment project.

[10] These results follow from the first-order condition of the maximization problem (5). See Dixit et al. (1999) for further details.

[11] Note that we will abstract from the consideration of the case where $rK \leq c$. In this case, in fact, the option to invest should be immediately exercised, i.e., $X^i \leq 0$. The assumption is realistic considering, when compared to the rental cost of capital, the usually relatively low cost of compliance.

[12] On the comparative statics relative to the parameters α and σ see Appendix A.1.

iii) the higher the rate at which the project value grows, the higher the threshold set for investing since $\partial X^i/\partial \alpha > 0$, which in expected terms implies that the investment is delayed;

iv) the higher the cost for meeting the GAEC obligation through passive management, the lower the investment threshold since $\partial X^i/\partial c < 0$, which in expected terms implies that the investment is anticipated. In other words, the higher c, the lower the net payment m or, in financial terms, the "dividend" paid for keeping the option to invest open. This in turn makes it less desirable to postpone the exercise of the option. Thus, it is worth stressing it, the timing of land development does not depend on the subsidy n per se but rather on the cost incurred for qualifying for the subsidy when land is managed passively.

v) the investment trigger is not affected by the rental payment, p. This makes sense considering that the rent must be paid irrespective of how the lessee may want to use the leased land, i.e., keeping it idle rather than developing it.

Last, in Eq. (7), the first term represents the value associated with holding the option to develop forever, that is, the present value of the flow of subsidies n net of the compliance cost c and the rental payment p. The second term is the expected present value[13] of the net value attached to the development project, i.e., X^i minus the development cost, K, plus the amount, c/r, which is implicitly saved, as explained above, once land is developed.

3 The optimal rental payment

Let's now focus on the bargaining process leading to the leasing of the land parcel on the basis of a mutually convenient agreement. Denote by t^a the time at which the agreement is reached and assume that $X_{t^a} = X$. At t^a, conditional on having reached an agreement, the parties obtain the following payoffs:

$$W^D(p; X, X^i) = F(X; X^i) \text{ and } W^S(p) = P$$

The agreement must make both parties better off. This implies that the following conditions must hold:

1.

$$W^D(p; X, X^i) = F(X; X^i) \geq 0 \qquad \text{(Condition 1)}$$

[13] The net pay-off $(X^* + \frac{n}{r}) - (K + \frac{m}{r})$ is discounted using the stochastic discount factor $E_0[e^{-r\tau}] = (\frac{X}{X^*})^{\beta}$.

or, once rearranged,

$$(X/X^i)^\beta (X^i - K) \geq P - \frac{n - c[1 - (X/X^i)^\beta]}{r} \tag{7.1}$$

that is, the value of the option to invest must be higher than its actual cost. Such cost is given by the present value of the rent, $P = p/r$, minus the net present value of the benefits associated to the claim on the subsidy n;

2.

$$W^S(p) = P \geq m/r \tag{Condition 2}$$

or

$$p \geq m \tag{7.2}$$

that is, the per-period rent p cannot be lower than the net payment $m = n - c$ that landowner S would receive by not leasing his land parcel and managing it passively.

3.1 Cooperative solution

Assume that D and S are engaged in a cooperative cake-splitting game where the two parties have bargaining power ψ and $1 - \psi$ with $\psi \in (0, 1)$, respectively.[14] As well known, the underlying game can be solved by applying the Nash bargaining solution concept (Nash, 1950; Harsany, 1977).

A feasible Nash bargaining solution, $p^* \geq 0$, solves the following maximization problem:

$$\begin{aligned} \max_{p \geq 0} \Omega &= \psi \ln[W^D(p; X, X^i)] + (1 - \psi) \ln[W^S(p)] \\ \text{s.t. } W^D &\geq 0 \text{ and } W^S \geq m/r \end{aligned} \tag{8}$$

We find:

Proposition 2 *In a cooperative bargaining setting, the optimal rental payment is:*

$$p^* = (1 - \psi)\{m + (X/X^i)^\beta [r(X^i - K) - c)]\} \tag{8.1}$$

[14] Note that our frame may easily apply to the analysis of a Nash bargaining game where the two parties are characterized in terms of aversion to the risk of internal conflict. It would in fact suffice to set the Nash product equal to $(W^D)^p (W^S)^q$, where $0 < p \leq 1$ and $0 < q \leq 1$ measure the level of risk aversion for each of the parties involved.

Proof. See Appendix A.2.1. ■

Note that by setting the rental payment p^* the payoffs accruing to the parties are

$$W^D(p^*; X, X^i) = \psi\{\frac{n-c}{r} + (X/X^i)^\beta[X^i - (K - \frac{c}{r})]\} \geq 0 \tag{8.2}$$
$$W^S(p^*) = (1-\psi)\{\frac{n-c}{r} + (X/X^i)^\beta[X^i - (K - \frac{c}{r})]\} \tag{8.3}$$

that is, D and S are splitting in parts proportional to their bargaining power the total value one may attach to the land asset, i.e.,

$$\begin{aligned} W(X, X^i) &= F(X; X^i) + P = \frac{n-c}{r} + (X/X^i)^\beta[X^i - (K - \frac{c}{r})] \\ &= \frac{m}{r} + (X/X^i)^\beta[(X^i + \frac{n}{r}) - (K + \frac{m}{r})] \end{aligned} \tag{8.4}$$

The first term in Eq. (8.4) represents the value that land would secure if passively farmed while the second stands for the value associated with a potential land development project.

As one can immediately see, Condition 1 is always satisfied. In contrast, Condition 2 requires that

$$W(X, X^i) \geq [1/(1-\psi)](m/r) \tag{8.5}$$

That is, the total value of the asset must be higher than $1/(1-\psi)$ times the present value of the flow of net payments, m/r, that one would obtain by not leasing land and managing it passively. If this is the case, a feasible agreement can be reached, otherwise the bargaining fails. In this respect, note that

Proposition 3 *For any finite $W(X, X^i)$, the bargaining fails for any $\psi > \overline{\psi}$ where $\overline{\psi}$ solves the equation $W(X, X^i) = [1/(1-\overline{\psi})](m/r)$.*

Proof. Note that for $\psi \to 1$ the term $[1/(1-\psi)](m/r)$ in inequality (8.5) tends to infinity while it tends to m/r for $\psi \to 0$. This implies that for any finite $W(X, X^i)$ there exist a threshold value $\overline{\psi}$ such that $W(X, X^i) = [1/(1-\overline{\psi})](m/r)$. ■

3.2 Non-cooperative solution

By considering the limit cases $\psi \to 0$ and $\psi \to \overline{\psi}$, we can use Eq. (8.1), together with Proposition 3, to illustrate the outcome of a non-cooperative Stackelberg game. This may serve as a frame for cases where for instance i) intense competition among many potential lessees results in higher bargaining power for the landowner or ii) highly fragmented agricultural land and few active neighboring farmers may give more power to the potential lessee due to lack of competition.

In a vertical relationship where the lessee has no bargaining power, i.e., $\psi \to 0$, we have

$$\lim_{\psi\to 0} p^* = rW(X, X^i), \ \lim_{\psi\to 0} W^D(p^*; X, X^i) = 0, \ \lim_{\psi\to 0} W^S(p^*) = W(X, X^i). \tag{9.1-9.3}$$

In this case, the landowner may actually appropriate the entire value of the potential investment project.

In contrast, inverting the roles in the vertical structure, i.e., $\psi \to \overline{\psi}$, we find

$$\lim_{\psi\to\overline{\psi}} p^* = m, \ \lim_{\psi\to\overline{\psi}} W^D(p^*; X, X^i) = W(X, X^i) - (m/r), \ \lim_{\psi\to\overline{\psi}} W^S(p^*) = (m/r). \tag{9.4-9.6}$$

In this case, the landowner earns exactly the minimal amount that makes him indifferent between signing or not signing the lease contract, i.e., m/r, while the lessee gets the residual value $W(X, X^i) - (m/r)$.

3.3 Timing and value: comparative statics and discussion

In this section we examine the impact that the SPS has on the timing and on the value of land development. Let's first focus on investment timing. We take as the benchmark the investment threshold that one would have in the absence of a subsidy policy, that is

$$\overline{X}^i = (1 + \frac{1}{\beta - 1})K. \tag{10}$$

As can easily be seen, the presence of the SPS speeds up, in expected terms, land development as

$$X^i = \overline{X}^i - (1 + \frac{1}{\beta - 1})\frac{n - m}{r} < \overline{X}^i \text{ for any } c > 0. \tag{10.1}$$

The acceleration depends on the second term, $(1 + \frac{1}{\beta-1})\frac{n-m}{r}$, where, as explained above, the wedge, $(1 + \frac{1}{\beta-1})$, is the correction needed in order to account for the presence of uncertainty and irreversibility in the investment decision to be taken. The term $\frac{n-m}{r}$ is crucial for the magnitude of the acceleration. In this respect we note that

$$\lim_{m\to n} X^i = (1 + \frac{1}{\beta - 1})K = \overline{X}^i, \tag{10.2}$$

$$\lim_{m\to 0} X^i = \overline{X}^i - (1 + \frac{1}{\beta - 1})\frac{n}{r} = X^{i_{m=0}} < X^i. \tag{10.3}$$

The limit result (10.2) may very well approximate the case where compliance costs are very low, i.e., $c \to 0$. In this case, irrespective of the actual regime, i.e., active rather than passive, the farmer obtains the same payment. Hence, not surprisingly, the investment timing is not dependent on the subsidy paid and the SPS has no impact on the speed of land development. The limit (10.3) may instead represent i) the case where compliance cost are high i.e., $c \to n$, or ii) the case where, in line with the current debate, a passive farmer does not qualify for the SPS, i.e., $m = 0$. In these cases, the investment threshold is the lowest possible and the highest degree of potential acceleration is reached. The intuition behind this result is straightforward. The flow of subsidy n paid to an active farmer reduces the burden of the investment cost K and consequently lowers the threshold level at which investment should be undertaken. This effect, however, tends to vanish as m tends to n. This is due to the fact that cashing the periodic net transfer m, as a sort of dividend conditional on holding the option to invest, makes postponing the investment decision less costly.

Last, by changing perspective, one may also view $0 < m < n$ as the partial extent up to which the subsidy is capitalized in the minimal rental payment to which S is entitled. It follows that for $m \to n$ the subsidy is fully internalized and the positive effect of a subsidy n for speeding up the investment is killed. So, at least for what concerns the timing of land development, the payment granted to passive farming has a negative effect. However, in order to draw any conclusion, it is worth examining the impact that the SPS, as currently designed, has on the value associated with future land use.

Studying the impact of m on the value accruing to the parties, i.e., $W^D(p^*)$ and $W^S(p^*)$, and on condition (8.5), we find that

Proposition 4 *i) the total project value $W(X, X^i)$, and consequently the value accruing to the parties, is increasing in the level of m;*

ii) as m increases, the set of potential investment projects supporting an agreement shrinks.

Proof. See Appendix A.3. ∎

Proposition 3 has important implications. First, the value of land is increasing in the level of m, i.e., $\partial W(X, X^i)/\partial m = [1 - (X/X^i)^\beta]/r > 0$. The result can be illustrated on the basis of the following argument: in the presence of a (net) subsidy m paid to passive farmers, the lessee postpones the investment, this in turn allows investing for higher project values X^i. The negative effect of postponing the investment, however, prevails on the higher investment value and the net negative effect is represented by the term $-(X/X^i)^\beta$ in the derivative. This net loss is however balanced by the positive "dividend" m paid when waiting before investment.

Concerning condition (8.5), the presence of a subsidy m paid to passive farmers should not be seen as deterring the possibility of reaching an agreement but rather as imposing a stricter "selection" on the potential projects that could be developed. In other words, only projects paying, in expected terms, a sufficiently high reward may give rise to an agreement. Otherwise, parties are better off keeping land idle. The intuition is straightforward. Consider the extreme case where the value of any investment opportunity is null, then why should the landowner give up the certain amount m/r and getting in exchange, by leasing her land, a share $(1-\psi)$ of the same amount? Obviously it would not make any sense. Hence, the chance of having a deal are strictly dependent on the value attached to the implicit share $(1-\psi)$ of the investment's net value that the landowner may claim through the rent. Thus, summing up, a higher m reduces the chances of having land leased but has a positive effect on the value that the parties may get whenever a deal is reached.

Studying the impact of β on condition (8.5), we find that

Proposition 5 *As β increase, the set of potential investment projects supporting an agreement shrinks.*

Proof. See Appendix A.4. ■

This result implies that, ceteris paribus, investment projects characterized by a sufficiently low β may more likely meet condition (8.5). Note that since $\partial\beta/\partial\alpha < 0$ and $\partial\beta/\partial\sigma^2 < 0$, these are the projects characterized by a high growth rate and/or a high volatility rate. Back to the considerations relative to the waiting time, these are, however, given a certain X and considering the effect of β on the investment threshold ($\partial X^i/\partial\beta < 0$), projects for which a longer waiting time is expected.

Last, commenting on the possibility of modifying the current SPS in order to exclude passive farming, we can conclude that, on the basis of our findings, this would definitely accelerate land development but at a cost in terms of land value since faster development will preclude the consideration of more valuable future land uses.

4 Numerical Illustration

In the following we illustrate our findings considering a short rotation coppice willow plantation as potential project to be developed on leased land. We calibrate this exercise using as input the data and parameters values used by Di Corato et al. (2013) to examine the establishment of a new willow stand in Central East Sweden.[15] It is worth stressing that the scope here is merely illustrative and that by no means we intend to reach any conclusion concerning the considered investment opportunity.

4.1 Parameters

We consider a 1 hectare willow stand. Annual revenue and operational costs are set equal to SEK 6450.84 and SEK 4432, respectively. The total establishment cost is equal to SEK 12155. The 40% of these costs is however covered by a subsidy granted to farmers investing in energy forestry. Thus, the actual establishment cost paid by the farmer amounts to SEK 7293. Note that, in line with the assumed project infinite horizon, it follows that:[16]

$$X = \frac{SEK\ 6450.84}{r - \alpha} \text{ and } K = SEK\ 7293 + \frac{SEK\ 4432}{r}$$

The single farmer payment, n, is set equal to SEK 2000 per hectare while the cost of compliance, c, is equal to SEK 650 per hectare (HS, 2012). It follows that net cash flow accruing to a passive farmer, m, is equal to SEK 1350. We discount[17] future pay-offs using 4% as risk-free interest rate and, in order to examine the impact of the drift and volatility characterizing the project value, X, we let α and σ take values $\{1\%, 2\%, 3\%\}$ and $\{10\%, 20\%, 30\%\}$, respectively. Last, we will consider,

[15] Note that all figures in Di Corato et al. (2013) consider 2009 as reference year. Note also the periodic revenue and operational costs are set per year computing the equivalent annuity for an assumed project lifetime of 22 years and 8.1 odt/yr/ha as a reference in terms of yield. See Di Corato et al. (2013) for further details.

[16] Note that one may equivalently consider X as the net project value, i.e., the expected present value of the flow of annual revenues minus operational costs, and set K equal to the establishment cost.

[17] We are implicitly assuming that the agents are risk-neutral. Note that, however, one may easily account for a different level of risk aversion by adding a risk premium to the risk-free rate.

as base case, a scenario where the parties have equal bargaining power, i.e., $\psi = 1 - \psi = 50\%$.

Project: willow plantation		
Annual revenue		SEK 6450.84
Operational cost		SEK 4432
Establishment cost		SEK 7293
Single farmer payment (n)		SEK 2000
Cost of compliance (c)		SEK 650
Project value (X)	*Drift rate (α)*	1%, 2%, 3%
	Volatility rate (σ)	10%, 20%, 30%
	Discount rate (r)	4%
Bargaining power (ψ)		50%

Table 1. Development project: parameters values.

4.2 Numerical analysis

Let's now, in line with the figures summarized in Table 1, determine the current value, X, of the considered project (See table 2). This value will then be compared with the investment thresholds in order to determine if investment should be undertaken immediately or if it should be delayed.

Variations in the project's values are due to the positive effect that a higher growth rate α has on the present value of the revenue flow. Hence, a project value which is expected to grow at a 3% annual rate has a present value equal to SEK 645084 while for $\alpha = 1\%$ this value decreases by two-thirds.

Project: current value		*X*
r = 4%	*α = 1%*	215028
	α = 2%	322542
	α = 3%	645084

Table 2. Development project: current values on the basis of different trend levels.

In table 3, in order to examine the impact of paying a subsidy to passive farmers, we include both the investment thresholds X^i and $X^{i_{m=0}}$. We then isolate (in bold), given the current project values, the combinations where investment should be delayed, i.e., $X < X^i$ (or $X^{i_{m=0}}$) . We notice that the investment thresholds are, irrespective of whether a subsidy is paid or not to a passive farmer, increasing in the drift and the volatility characterizing the project value. This effect is in line with findings in the real option literature where the investor responds to higher growth and volatility in the underlying project value by delaying the investment choice. In line with our findings (see inequality (9)), in the presence of a subsidy paid to passive farmers, investment should be, in expected terms, always be postponed if compared to the case where no subsidy is paid. This is due, as explained above, to the lower convenience, in terms of gains in actually cashed subsidies, i.e., $n-m$, of switching from passive farming to active farming. As illustrated in table 3, given the current project values, paying a subsidy to passive farmers does not play a role when the project is characterized by low volatility ($\sigma = 10\%$). Note in fact that for any α the option to invest is always abundantly in the money. This is not the case for higher volatility levels. For $\sigma = 20\%$ and any α, paying passive farmers induces a delay in the investment for projects that would, otherwise, be immediately undertaken. This is also the case for $\sigma = 30\%$ and $\alpha = 3\%$ while for $\sigma = 30\%$ and $\alpha = 1\%$ or $\alpha = 2\%$ the option to invest is, irrespective of whether a subsidy is paid or not to passive farmers, out of the money. A further delay in the exercise is, however, associated to the presence of subsidy to passive farmers.

$X^i(X^{i_{m=0}})$		σ=10%	σ=20%	σ=30%
r = 4%	α = 1%	176057.374 (117713.292)	**250271.749** (167333.584)	**350998.163** **(234680.026)**
	α = 2%	247009.048 (165152.117)	**347713.752** (232484.044)	**492561.200** **(329330.143)**
	α = 3%	472292.697 (315778.469)	**648972.247** (433907.752)	**922536.870** (616815.128)

Table 3. Critical investment thresholds: sensitivity analysis for the impact of α, σ and r.

In table 4, in order to assess the positive impact that the presence of a subsidy for passive farming has on the value of land and consequently on the value shares accruing to the parties involved in the transaction, we compare, evaluating them at the same period, i.e., $t : X = X^{i_{m=0}}$, the expected present value of the leased land in the absence of this subsidy, that is

$$W(X^{i_{m=0}}) = X^{i_{m=0}} + \frac{n}{r} - K$$

with the expected present value of leased land when this subsidy is paid, that is,

$$W(X^{i_{m=0}}, X^i) = \frac{m}{r} + (X^{i_{m=0}}/X^i)^{\beta}[(X^i + \frac{n}{r}) - (K + \frac{m}{r})]$$

This allows isolating the effect of further delay in the investment accompanied by payment of m over the time period before investment. The comparison is based on the ratio $W(X^{i_{m=0}}, X^i)/W(X^{i_{m=0}})$. We note that $W(X^{i_{m=0}}, X^i)$ is higher than $W(X^{i_{m=0}})$ for any α and σ. The interval illustrating the gap indicates, in terms of additional value, a 1.278% (combination $\alpha = 3\%$ and $\sigma = 30\%$) as lowest extreme and a 25.572% as highest one (combination $\alpha = 1\%$ and $\sigma = 10\%$). We also note that the % gap is, unambiguously, decreasing in both α and σ. The intuition is straightforward. Note in fact that, for the parameter values considered, the impact on the value of land of a higher project value X^i (accruing when investing) is lower once discounting for the expected time one needs to wait before investing. This negative effect becomes, as illustrated by the investment thresholds in table 3, higher and higher as α and/or σ increase. This implicit cost of waiting is, however, lowered by the presence of a periodic payment m. Hence, summing up for both effect, we can still associate a higher total value to land when passive farmers are paid a subsidy.

$W(X^{i_{m=0}}; X^i)/W(X^{i_{m=0}})$		$\sigma=10\%$	$\sigma=20\%$	$\sigma=30\%$
$r = 4\%$	$\alpha = 1\%$	1.25572	1.09874	1.05087
	$\alpha = 2\%$	1.10168	1.05172	1.02958
	$\alpha = 3\%$	1.03150	1.02007	1.01278

Table 4. Value functions: sensitivity analysis for the impact of α and σ.

Table 5 presents the rental payment, p^*, which should be offered to S for leasing his land and the ratio between this value and the net payment, m, that is, the amount that S would earn by refusing the proposal. As one can immediately note, a deal set on a cooperative basis will reward S by an amount which is, even in the worst scenario (combination $\alpha = 1\%$ and $\sigma = 10\%$), more than twice the amount that he would receive by not leasing his land and holding on passive farming. The same figure is, irrespective of the volatility level, more than 8 times higher when $\alpha = 3\%$. The absolute rental payments and the wedge are computed considering a deal signed on the basis of the current project values (see table 2). Both measures are increasing in both α and σ. This reflects the higher value of land, i.e., $W(X, X^i)$, resulting from i) a project undertaken when higher threshold values, X^i, are reached and ii) the presence of a payment m, accruing when waiting before investing, which balances the effect of discounting for a delayed investment time. Finally, note that, since $\psi = 50\%$, the parties are equally sharing the value attached with leased land, $W(X, X^i)$, and p^*

represents also the expected annuity corresponding to the position held by D.

$p^*(p^*/m)$		$\sigma=10\%$	$\sigma=20\%$	$\sigma=30\%$
$r=4\%$	$\alpha=1\%$	2938.700 (2.17681)	2973.280 (2.20243)	3173.638 (2.35084)
	$\alpha=2\%$	5088.980 (3.76961)	5096.638 (3.77529)	5257.388 (3.89436)
	$\alpha=3\%$	11539.820 (8.54801)	11539.863 (8.54805)	11654.020 (8.63261)

Table 5. Optimal rental payment and ratio p^*/m: sensitivity analysis for the impact of α and σ.

Last, in order to illustrate the role played by the bargaining power in the set-up of a successful transaction, we provide in table 6 the level for the bargaining power associated with S, i.e., $1-\psi$, to which would correspond a $p^*=m$. It follows that an agreement cannot be reached for any level of $1-\psi$ below the ones indicated in the table. In this respect, we observe that the highest threshold value is 22.96934% (combination $\alpha=1\%$ and $\sigma=10\%$) which is, of course, well below the 50% assumed in our base scenario. Interestingly, this threshold value decreases with both α and/or σ. The effect can be explained on the basis of the same arguments used above for commenting the impact of these two parameters on p^*. Last, it is worth highlighting that the threshold value for the minimal bargaining power needed to sustain a deal between the two parties reaches extremely low levels for $\alpha=3\%$. This in turn implies that even in the presence of a quite unbalanced distribution of the bargaining power a successful deal may be reached.

$1-\psi$		$\sigma=10\%$	$\sigma=20\%$	$\sigma=30\%$
$r=4\%$	$\alpha=1\%$	0.2296934	0.2270220	0.2126897
	$\alpha=2\%$	0.1326395	0.1324403	0.1283907
	$\alpha=3\%$	0.0584931	0.0584929	0.0579199

Table 6. Bargaining power: sensitivity analysis for the impact of α and σ.

5 Conclusion

Passive farming, whereby an agricultural land owner keeps their entire farm area in "good agricultural and environmental condition" without producing any commodities, has emerged in the EU as a consequence of the *decoupling* of agricultural policy payments from production in 2005 in the form of the Single Payment Scheme (SPS). It is feared, particularly by the farming lobby, that passive farming is hindering agricultural development (specifically investments in land to produce food), and thereby denying welfare-enhancing opportunities to development-willing active farmers (potential lessees of passively farmed land). It has been shown that passive farming results from the landowner and potential lessee failing to come to a rental agreement rather than the SPS per se (Brady et al., 2015). This raises the question as to whether the parties, and ultimately society, are made better or worse off as a consequence of the SPS. To answer this broader question we have studied the rental bargaining process using a real-options framework.

We make three major findings. First, we show that the SPS accelerates the timing of land development if compared to the case where this support is not provided. Then, in order to isolate the impact of subsidies paid to passive farmers, we consider a hypothetical scheme where no subsidy is paid to passive farmers. This allows showing that land development accelerates if passive farming does not qualify for support. In fact, including passive farming, by making waiting less costly, encourages postponing the investment decision favouring projects having a higher current value and hence better future prospects than those currently available. This corresponds to part of the intent of the SPS, that is, to keep open the option to use land in the future. This option has a value to society by securing the allocation of land to more valuable development projects. So, if the issue is the speed of development, paying a subsidy to passive farmers induces some delay compared to the case (hypothetical) where they would not receive it. However, the value of the land asset is unambiguously higher. Consequently, even if the sector loses some speed in development it gains in value.

Second, when bargaining for the lease of land, the presence of the SPS makes the agreement between the parties conditional on a development project passing a threshold level in terms of expected profitability. Thus rather than blocking access to land it makes leasing the land for development conditional on a sufficiently good development project being available. That is a project that has a sufficiently high expected payoff to both parties given the underlying project risk.

Third, cooperative bargaining results in an agreement that makes both parties better off, which can be seen in contrast to the argument that the SPS is blocking land and thereby reducing opportunities for active farmers. As we show though, the distribution of benefits between the two parties will depend on their relative bargaining power. Intense competition among many potential lessees should result in the land owner extracting most of the rent. On the other hand in regions with fragmented agricultural land and few active farms within practical distance to the land, the potential lessee should have the power to extract most rent due to lack of competition. This result concurs with what is observed in reality, in highly productive arable regions (e.g., the plains of Scania in southern Sweden) rents are high and passive farming is not observed, on the other hand in regions with low productivity and fragmented arable land (e.g., the mixed farming-forestry regions in southern Sweden) rents are low and passive farming frequent.

Consequently rather than reducing welfare the SPS benefits both parties by:

i) maintaining the option to develop land in the future if current market returns are too low given the risk of development,

ii) increasing the value of land,

iii) making both parties better off financially in the event of a realized rental agreement.

Finally, this paper has focused on the impacts of a land management subsidy on land use from a private-economic or development perspective. The EU's management subsidy in the form of the SPS is however motivated in terms of the provisioning of public goods that are assumed to boost social utility. As shown here, paying people to keep land in good agricultural condition allows for a potentially better use of the land in the future. Keeping land in good environmental condition on the other hand is intended to provide conservation of biodiversity and a range of ecosystem services through landscape management, particularly those related to cultural and recreational values (Van Zanten et al., 2014). While good agricultural condition should be fairly straightforward to define and control it is hardly the case for environmental values which will depend on the actual management measures performed in a particular spatial context (Ekroos et al., 2016). That is, it is unlikely that a general land management condition will optimize environmental values across a spatially and socially diverse EU. This is of course a fundamental challenge for the CAP as highlighted by the problem of even evaluating the efficiency of agri-environmental schemes (Kleijn et al., 2006). It is therefore not surprising that the environmental utility of decoupled payments is severely doubted (Pe'er et al., 2014). This raises the crucial question as to whether the environmental value of agricultural land would change if it is managed through passive farming as compared to using the land in commodity production. To inform a broader evaluation of the impacts of the SPS on social welfare in the EU, there is a need for ecological research to empirically investigate the environmental implications of passive management.

A Appendix

A.1 Investment threshold: comparative statics

Let's study the effect of the parameters α and σ on $X^i = (1 + \frac{1}{\beta-1})(K - \frac{c}{r})$. It is easy to show that $\partial\beta/\partial\alpha < 0$ and $\partial\beta/\partial\sigma^2 < 0$. Hence, it immediately follows that:

$$\partial X^i/\partial\alpha = -(\frac{1}{\beta-1})^2 \frac{\partial\beta}{\partial\alpha}(K - \frac{c}{r}) > 0, \tag{A.1.1}$$

$$\partial X^i/\partial\sigma^2 = -(\frac{1}{\beta-1})^2 \frac{\partial\beta}{\partial\sigma^2}(K - \frac{c}{r}) > 0. \tag{A.1.2}$$

A.2 Optimal rental payment

The first-order condition for the maximization problem (8) is:[18]

$$\left.\frac{\partial\Omega}{\partial p}\right|_{p=p^*} = -\frac{1}{r}\frac{\psi}{W^D(p^*; X, X^i)} - \frac{1-\psi}{W^S(p^*)} = 0 \tag{A.2.1}$$

From Eq. (A.2.1) we obtain

$$P^* = \frac{p^*}{r} = (1-\psi)\{\frac{n-c}{r} + (X/X^i)^\beta[X^i - (K - \frac{c}{r})]\} \tag{A.2.2}$$

A.3 Bargaining and project value: comparative statics

Condition (8.3) - Let's now study the impact of m on the condition (8.3). We first define the function

$$\begin{aligned} H(m; X, X^i) &= W(X, X^i) - \frac{1}{1-\psi}\frac{m}{r} \\ &= [\frac{X}{\beta/(\beta-1)}]^\beta \frac{(K + \frac{m-n}{r})^{1-\beta}}{\beta-1} - \frac{\psi}{1-\psi}\frac{m}{r} \end{aligned} \tag{A.3.1}$$

Note that if no transfer is paid to passive farmers, we have

$$H(0; X, X^{i_{m=0}}) = (X/X^{i_{m=0}})^\beta[(X^{i_{m=0}} + \frac{n}{r}) - K] > 0 \tag{A.3.1.1}$$

This implies that an agreement can always be reached if $m = 0$.

Taking the derivative of $H(m, X)$ with respect to m, we obtain

$$H_m(m; X, X^i) = -[(X/X^i)^\beta + \frac{\psi}{1-\psi}](1/r) < 0 \tag{A.3.2}$$

[18] As one can easily check, the second-order condition holds always.

This implies that as m increases, Condition (8.3) becomes, ceteris paribus, stricter and then may not hold.

By taking the derivative of $H(m; X, X^i)$ with respect to β we have

$$dH(m; X, X^i)/d\beta = \ln[X/X^i](X/X^i)^\beta[X^i - (K - \frac{c}{r})] < 0 \tag{A.3.3}$$

This implies that as β increases, Condition (8.3) becomes, ceteris paribus, stricter and then may not hold.

Project value - The first derivative of $W(X, X^i)$ with respect to m is:

$$W_m(X, X^i) = [1 - (X/X^i)^\beta]/r \geq 0 \text{ for } 0 < X \leq X^i \tag{A.3.4}$$

This implies that the higher is m the higher is the total value associated to the asset, $W(X, X^i)$, and then the value accruing to both parties, i.e., W^D and W^S.

Last, from Eq. (A.3.1) follows that

$$dW(X, X^i)/d\beta = dH(m; X, X^i)/d\beta = \ln[X/X^i](X/X^i)^\beta[X^i - (K - \frac{c}{r})] < 0 \tag{A.3.5}$$

This implies that as β increases, the total value associated to the asset, $W(X, X^i)$, lowers.

References

[1] Ander, G., 2012. Inlåsningen drabbar bönder över hela EU. Stockholm, LRF Media. Available from: http://www.lantbruk.com/lantbruk/inlasningen-drabbar-bonder-over-hela-eu (Accessed 20 February, 2016).

[2] Andersson, H., Andersson, Å., Ehde, L., Eskhult, G., Jansson, G., Johansson, E., Nilsson, C., 2011. Passiva lantbrukare - en effekt av EU:s jordbrukspolitik. En studie av ett antal faktorers påverkan på svenska passiva lantbrukares attityder till markanvändning och EU:s jordbrukspolitik. Examensarbete, Inst. för ekonomi, SLU. Available from: http://stud.epsilon.slu.se/3195/4/andersson_h_etal_110907.pdf (Accessed 20 February, 2016).

[3] Brady, M., Hristov, J., Sahrbacher, C., Söderber, T., Willhelmsson, F., 2015. Passive farming in Europe: hindering agricultural development or preserving valuable landscape. 147th Seminar, October 7-8, 2015, Sofia, Bulgaria. No. 212248. European Association of Agricultural Economists.

[4] Brady, M., Sahrbacher, C., Kellermann, K., Happe, K., 2012. An agent-based approach to modeling impacts of agricultural policy on land use, biodiversity and ecosystem services. Landscape Ecology 27(9), 1363-1381.

[5] Capozza, D., Li, Y., 1994. The intensity and timing of investment: The case of land. American Economic Review 84, 889-904.

[6] Ciaian, P., Kancs, d' A., Swinnen, J.F.M., 2010. EU Land Markets and the Common Agricultural Policy. Centre for European Policy Studies (CEPS), Brussels.

[7] Cox, J.C., Ross, S.A., 1976. The valuation of options for alternative stochastic processes. Journal of Financial Economics 3, 145-166.

[8] Di Corato, L., Gazheli, A., Lagerkvist, C.J., 2013. Investing in energy forestry under uncertainty. Forest Policy and Economics 34, 56-64.

[9] Dixit, A.K., 1993. The Art of Smooth Pasting. Chur, CH: Harwood Academic Publishers.

[10] Dixit, A.K., Pindyck, R.S., 1994. Investment under uncertainty, Princeton University Press, Princeton, N.J.

[11] Dixit, A.K., Pindyck, R.S., Sødal, S., 1999. A Markup Interpretation of Optimal Investment Rules. Economic Journal 109, 179-189.

[12] Ekroos, J., Ödman, A.M., Andersson, G.K.S., Birkhofer, K., Herbertsson, L., Klatt, B.K., Olsson, O., Olsson, P.A., Persson, A.S., Prentice, H.C., Rundlöf, M., Smith, H.G., 2016. Sparing land for biodiversity at multiple spatial scales. Frontiers in Ecology and Evolution 3, 145, 1-11.

[13] Feil, J., Musshoff, O., Balmann, A., 2013. Policy impact analysis in competitive agricultural markets: a real options approach. European Review of Agricultural Economics 40(4), 633-658.

[14] Geltner, D., Riddiough, T., Stojanovic, S., 1996. Insights on the effect of land use choice: The perpetual option on the best of two underlying assets. Journal of Urban Economics 39, 20-50.

[15] Harrison, J.M., 1985. Brownian Motion and Stochastic Flow Systems. New York: John Wiley & Sons.

[16] Harsany, J., 1977. Rational Behaviour and Bargaining Equilibrium in Games and Social Situations. Cambridge University Press, Cambridge, England.

[17] HS (Hushållningssällskapen), 2012. Produktionsgrenskalkyler för växtodling: Efterkalkyler för år 2012 Södra Sverige. Hushållningssällskapen, Kristianstad, Sweden.

[18] Isik, M., Yang, W., 2004. An analysis of the effects of uncertainty and irreversibility on farmer participation in the Conservation Reserve Program. Journal of Agricultural and Resource Economics 29(2), 242-259.

[19] Keenleyside, C., Tucker, G., 2010. Farmland abandonment in the EU: an assessment of trends and prospects. Report prepared for WWF. Institute for European Environmental Policy, London, UK.

[20] Kleijn, A.D., Baquero, R.A., Clough, Y., Díaz, M., Esteban, J., Fernández, F., Gabriel, D., Herzog, F., Holzschuh, A., Jöhl, R., Knop, E., Kruess, A., Marshall, E.J.P., Steffan-Dewenter,

I., Tscharntke, T., Verhulst, J., West, T.M., Yela, J.L., 2006. Mixed biodiversity benefits of agri-environment schemes in five European countries. Ecology Letters 9(3), 243-254.

[21] LD (Landsbygdsdepartementet), 2014, Gårdsstödet 2015-2020. Landsbygdsdepartementet, Stockholm, Sweden.

[22] LRF (Lantbrukarnas riksförbund), 2009. Den framtida jordbrukspolitiken. Lantbrukarnas riksförbund, Stockholm.

[23] Nash, J., 1950. The bargaining problem. Econometrica 18, 155-162.

[24] Pe'er, G., Dicks, L.V., Visconti, P., Arlettaz, R., Báldi, A., Benton, T.G., Collins, S., Dieterich,M., Gregory, R.D., Hartig, F., Henle, K., Hobson, P.R., Kleijn, D., Neumann, R.K., Robijns, T., Schmidt, J., Shwartz, A., Sutherland, W.J., Turbé, A., Wulf, F., Scott, A.V., 2014. EU agricultural reform fails on biodiversity. Science 344(6188), 1090-1092.

[25] Phelps, J., 2007. Much ado about decoupling: Evaluating the environmental impact of recent European Union agricultural reform. Harvard Environmental Law Review, 31, 279-320.

[26] Renwick, A., Jansson, T., Verburg, P.H., Revoredo-Giha, C., Britz, W., Gochte, A., McCracken, D., 2013. Policy reform and agricultural land abandonment in the EU. Land Use Policy 30, 446-457.

[27] Schatzki, T., 2003. Options, uncertainty and sunk costs: an empirical analysis of land use change. Journal of Environmental Economics and Management 46, 86-105.

[28] Trubins, R., 2013. Land-use change in southern Sweden: Before and after decoupling. Land Use Policy 33, 161-169.

[29] Wahlberg, C., 2014. Höj kraven för att gynna aktiva lantbrukare." Jordbruksaktuellt, 2014-04-16.

[30] Van Zanten, B.T., Verburg, P.H., Espinosa, M., Gomez-y-Paloma, S., Galimberti, G., Kantelhardt, J., Kapfer, M., Lefebvre, M., Manrique, R., Piorr, A., Raggi, M., Schaller, L., Targetti, S., Zasada, I., Viaggi, D., 2013. European agricultural landscapes, common agricultural policy and ecosystem services: a review. Agronomy for Sustainable Development 34(2), 309-325.

[31] Vernersson, L. (2012), "Gårdsstödet får allvarliga bieffekter." ATL, Landbrukets Affärstidning, 2012-06-18.

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Department of Economics

Department of Economics	Institutionen för ekonomi
Swedish University of Agricultural Sciences (SLU)	Sveriges lantbruksuniversitet
P.O. Box 7013, SE-750 07 Uppsala, Sweden	Box 7013, 750 07 Uppsala
Ph. +46 18 6710 00	Tel. 018-67 10 00
www.slu.se	www.slu.se
www.slu.se/economics	www.slu.se/ekonomi