



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

The Welfare Impacts of a Conservation Easement*

May, 2014

James Vercammen[†]

Sauder School of Business & Food and Resource Economics

University of British Columbia

Selected Paper Presentation

Agriculture and Applied Economics Association 2014 Annual Meeting

Minneapolis, July 27 - 29 (2014)

Abstract

The welfare impacts of a conservation easement are examined in a real options model. The size of the easement payment to the landowner largely determines the efficiency of the easement outcome. An inefficiently small payment results in states where rejection of the easement by the landowner reduces welfare. In contrast, an inefficiently large payment results in states where acceptance of the easement reduces welfare. This latter outcome emerges because the easement reduces the flow of municipal property tax payments, and the corresponding reduction in the provision of public goods is large relative to the environmental externality. A higher level of development value uncertainty raises the value of the real option to defer the land development decision, which in turn decreases the range of states for which acceptance of the easement by the landowner is socially desirable.

Keywords: Conservation Easement, Real Option, Externality, Community Welfare.

JEL classification: Q24, R14, H23, L14.

*Helpful comments were supplied by workshop participants in the Department of Resource Economics and Environmental Sociology, University of Alberta, January 26, 2012.

[†]Contact information: See www.vercammen.ca

1 Introduction

Public concern over land development continues to grow due to a shrinking supply of land for food production, wildlife habitat, biodiversity and green space. In North America private land trusts have formed to conserve land through a combination of outright purchases and conservation easements. A conservation easement is a perpetual legal contract that allows land to remain in private hands, but which requires current and future owners of the land to preserve specific land attributes and to forego certain types of activities. Easements vary from simple restrictions on land modification such as water drainage to major restrictions that prohibit all commercial activity. Conservation easements are a popular instrument for the land trust because the cost of purchasing the development rights through the easement procedure is typically much less than the cost of purchasing the land outright, and the cost of monitoring and enforcing the conditions of the easement is typically much less than the cost of managing owned properties.

Conservation easements can serve the dual role of preserving the flow of environmental amenities that flow from the undeveloped land and preventing an assortment of public annoyances such as noise and congestion that flow from the developed land [Anderson and King, 2004]. Largely due to these environment-preserving attributes, land trusts and conservation agreements are currently in a rapid growth phase in North America, and are also increasingly being used in other regions such as Latin America, Australia and the Pacific [Fishburn, Kareiva, Gaston, and Armsworth, 2009]. Between 2000 and 2005 the number of local, state and national land trusts operating in the U.S. grew 32 percent to 1,667, and the total acres conserved by these trusts grew 54 percent to 37 million acres [Alderich and Wyerman, Alderich and Wyerman]. The Nature Conservancy in the U.S., which is the world's largest land trust, had protected 17.2 million acres by 2008 at an up-front cost of USD\$7.5 billion [Fishburn et al., 2009].

Land trusts generally encourage landowners to donate conservation easements in exchange for various types of tax credits. According to McLaughlin [2004], a landowner is entitled to a charitable federal income tax deduction and an estate tax deduction for qualifying conservation easements provided that the easement is donated to an eligible agency and the easement is perpetual. Many U.S. states also provide landowners with state income tax deductions. For exam-

ple, subject to certain restrictions, the State of Virginia allows a landowner to deduct 50 percent of the value of a donated easement against state taxes McLaughlin [2004]. If a landowner receives a cash payment from the land trust then the donated value of the easement is deemed to be the market value of land if sold to the highest bidder minus the value of the cash settlement minus the market value of the land with the easement in place. Signing an easement also ensures that the land is assessed at its use value in an undeveloped state rather than at its market value in an developed state. This reduced assessment ensures that landowners who assign an easement pay lower property taxes relative to developed land.

Conservation easements appear to be an attractive private market alternative to command and control land use regulations and public land management schemes. Nevertheless Raymond and Fairfax [2002], Merenlender, Huntsinger, Guthey, and Fairfax [2004] and Fishburn et al. [2009] raise a number of concerns about conservation easements. These concerns include foregone development benefits that exceed the environmental benefits of the land, spotty monitoring and enforcement of the terms of the easement by small-scale land trusts, generous income and estate tax deductions and either higher tax rates for neighboring properties or fewer public goods for the community in order to offset the reduced flow of property taxes from the land protected by the easement [Anderson and King, 2004].¹ McLaughlin [2004] shows how tax incentives favour high income land owners, which goes against the principle of helping cash poor land owners resist the temptation to sell their land for development for purely financial considerations.

The purpose of this paper is to use a real option model of land development to identify the conditions for which a conservation easement is welfare improving. Key to the model is the development value of the land, the level of development value uncertainty and the flow of external benefits from the undeveloped land, which include green space, recreational area and local food. The main result of this paper is that an easement outcome is inefficient if the easement payment which is received by the landowner does not fully reflect the environmental externality and the extent that public good provision is impacted when the easement is accepted. The flow

¹See http://www.agecon.purdue.edu/crd/localgov/topics/essays/Prop_Tax_FarmLand_Asmt.htm for a detailed discussion about use value calculations for farmland in the State of Indiana.

of public goods are reduced when the easement is accepted because the easement provides the landowner with a perpetual tax credit. A reduction in the flow of public goods reduces welfare because society's valuation of those goods is assumed to exceed the monetary value of the tax savings for the landowner.² Higher development value uncertainty raises the easement's social opportunity cost because the real option to defer the land development decision becomes more valuable. The higher opportunity cost decreases the range of outcomes for which the easement is socially desirable.

The number of papers which formally examine the economic impacts of a conservation easement is comparatively small. Tenge, Wiebe, and Kuhn [1999] build on the work of Capozza and Sick [1994] by modeling the minimum level of compensation that is required to induce a landowner to voluntarily sign an easement when development value is uncertain. The real option approach that is used by Tenge et al. [1999] to value the land is similar to the approach used in this paper, but here the analysis includes community welfare in addition to the private market outcome. Anderson and King [2004] use a simple game theoretic framework and laboratory experiments to describe how a private market easement decision is expected to result in non-optimal levels of community welfare because of a property tax externality. Finally, there is a small empirical literature on conservation easements. King and Anderson [2004] and Anderson and Weinhold [2008] argue that the tax-based social cost of the easement may be overstated in the literature because easements generally increase the market value of non-easement properties. Sundberg and Dye [2006] find that the tax advantages of an easement usually more than compensates the landowner for the reduced market value of the land. Moreover, it is those landowners who enjoy the highest tax savings that tend to most frequently self select into an easement agreement.

The welfare analysis that is pursued in this paper combines two separate strands of the real options literature. The first literature, which includes a key paper by Capozza and Sick [1994] and which builds on earlier work by McDonald and Seigel [1986] and Dixit and Pindyck [1994],

²The easement also eliminates development co-benefits (e.g., more jobs and business expansion), but these co-benefits are not included in the formal model. Relaxing this assumption will have the predictable outcome of reducing the number of scenarios for which the easement is welfare improving.

focuses on privately optimal land development and the associated pricing of land. The second literature focuses on optimal timing of natural resource exploitation when the decision to exploit is irreversible and when the future environmental benefits from the resource are uncertain. This literature started with a seminal paper by Arrow and Fisher [1974], who argue that because development is irreversible and conservation is not, the opportunity cost of development must include the *quasi-option* value of becoming more informed if the resource is preserved. Since then a variety of other papers have examined environmental decision making in a real options framework. For example, Reed [1993] examines the decision to conserve or harvest an old-growth forest when both the timber value of the trees and the amenity value of the forest are uncertain. Conrad [2000] models conservation versus exploitation where exploitation is comprised of either straight development or resource extraction followed by development. Pindyck [2002] separates uncertainty into that associated with environmental change and that associated with the social cost of environmental damage. Leroux, Martin, and Goesch [2009] assume that the path to a post-development equilibrium is gradual and stochastic versus instantaneous. The model developed in this paper is most closely related to Reed [1993].

In the next section the landowner's incentives to accept an easement versus wait for the optimal time to sell the land to a developer are examined. In Section 3 the welfare impacts of the easement are identified by determining when the landowner will accept a socially undesirable easement and when the landowner will reject a socially desirable easement. Concluding comments are provided in Section 4.

2 Landowner's Problem with One-Time Easement Offer

This section examines how the landowner chooses between selling the land to a developer and accepting a conservation easement. The analysis initially assumes that the easement option is available to the landowner on a one-time basis. This assumption is later relaxed by assuming that the landowner can accept the easement either immediately or at any date in the future.

2.1 Real Option Valuation

A risk-neutral owner of agricultural land with an infinitely long time horizon earns a fixed and continuous flow of pre-tax profits, $\hat{\pi}$.³ The landowner continuously pays property taxes at rate τ per dollar of assessed value of the land.⁴ Regional regulations stipulate that because the land is used in agricultural production it must be assessed at its pre-tax use value rather than its market value. The pre-tax use value of the land, which is equal to the capitalized value of the pre-tax profit stream, can be expressed as $\hat{\pi}/\rho$ where ρ is the discount rate for the landowner and all other agents in the model. The net profit flow for the landowner can therefore be expressed as $\pi = (1 - \tau/\rho)\hat{\pi}$.

The landowner has a perpetual option to sell the land to a developer for price V which evolves stochastically over time according to changes in the market supply and demand fundamentals for developed real estate. Let $L^D(V) \geq V$ denote the implicit value of the land to the landowner, which includes the option to sell the land immediately or to wait and sell the land to the developer at some point in the future. The landowner also has a one-time option to register a non-reversible and perpetual conservation easement against the title of the land. The easement restricts activities on the land to status quo activities. The easement ensures that the land's after tax profit flow remains permanently fixed at level π , and also causes the market value of the land to permanently drop to level π/ρ . Let $N^E(V)$ denote the value of the land inclusive of easement payments and tax credits if the easement is immediately accepted. Later in the paper the implicit value of the land with the option to accept the easement either immediately or at some point in the future is incorporated into the analysis.

Before deriving expressions for $L^D(V)$ and $N^E(V)$ it is necessary to provide more details about the easement. Assume that when the easement is accepted the landowner receives a one time non-negative payment $P(V)$ from the land trust. The size of the payment reflects both the environmental value of the land and the level of development pressure facing the landowner.

³The assumption of an infinitely long time horizon is not unreasonable because land is assumed to trade in a competitive market and the market value of land is the capitalized value of an infinite profit stream.

⁴The assessed value of the land is proportional to the flow of income. Hence, τ can also be viewed as a composite of the tax rate on property and the tax rate on income.

In the real world the land trust is likely to use a combination of payment according to a schedule and direct negotiation. For this analysis assume that the land trust relies exclusively on a payment schedule when offering the easement contract to the landowner. Further assume that the schedule calls for payments equal to a base payment, P_0 , plus a value-dependent payment, $\theta(V - V^{min})$, for $V \geq V^{min}$. The base parameter, P_0 , and the value parameter, $\theta \in [0, 1]$, are expected to take on larger values the higher the environmental value of the land. Real world payment schedules may not have this specific structure, but nevertheless are likely to be equally simplistic in functional form.

The landowner who signs an easement also receives a perpetual tax credit, the flow value of which is equal to τ multiplied by the value of the landowner's "gift". Taxation authorities recognize a gift of size $G(V) = \text{MAX}\{V - P(V) - \pi/\rho, 0\}$ and therefore allow the tax credit because the landowner forfeits value by agreeing to the easement rather than selling the land for development.⁵ The one-time easement payment and tax credit together imply that the value of the land if the easement is signed can be expressed as

$$N^E(V) = \begin{cases} \pi/\rho & \text{for } V < \pi/\rho \\ \frac{\pi}{\rho} + \frac{\tau}{\rho} \left(V - \frac{\pi}{\rho} \right) & \text{for } \pi/\rho \leq V < V^{min} \\ \frac{\pi}{\rho} + [P_0 + \theta(V - V^{min})](1 - \tau/\rho) + \frac{\tau}{\rho} \left(V - \frac{\pi}{\rho} \right) & \text{for } V^{min} \leq V \end{cases} \quad (1)$$

To derive an expression for $L^D(V)$ it is first necessary to be specific about how the developed land is valued. The developed land's pre-tax profit flow, $X(t)$, is assumed to evolve continuously over time as geometric Brownian motion with drift parameter $0 < \alpha_V < \rho$ and standard deviation parameter σ_V . Specifically, assume that $dX = \alpha_V X dt + \sigma_V X dz$ where $dz = \epsilon_t \sqrt{dt}$ is the increment of a Wiener process. When the land is developed the pre-tax profit flow remains permanently fixed at the prevailing value of X . For the purpose of taxation the assessed value of the land is therefore also permanently fixed at level, X/ρ . This assumption implies that the owner of the developed land pays a fixed stream of property taxes equal to

⁵In reality the tax credit for a gifted easement generally applies to federal income tax and not local property tax. In this analysis there is no meaningful distinction between a property tax and an income tax. To keep things simple the tax rate for the easement gift rebate is assumed to equal the property tax rate.

$(\tau/\rho)X$. The land developer's offer price is assumed to equal the capitalized value of the after-tax income flow, which implies $V = (1 - \tau_d/\rho)X/\rho$.⁶ It is straight forward to show that V , has the same Brownian motion specification as X . That is, $dV = \alpha_V V dt + \sigma_V V dz$.

Following Dixit and Pindyck [1994], an expression for $L^D(V)$ is obtained by constructing a Bellman equation for the dynamic programming problem.

$$L^D(V) = \max \{V, \pi + (1 + \rho dt)^{-1} E [L^D(V + dV)|V]\} \quad (2)$$

Equation (2) shows that the option-inclusive value of the land is equal to the maximum of the current development value, V , which results if the land is immediately sold to the developer, and the discounted value of the land inclusive of the expected capital gain and accompanying profit flow over the next small time interval, which results if the land owner delays the development decision. The solution to the differential equation that is implied by equation (2) has the general form $L^D(V) = AV^\beta + \pi/\rho$ where β is the solution to the fundamental quadratic:

$$\beta = \frac{1}{2} - \frac{\alpha_V}{\sigma_V^2} + \sqrt{\left(\frac{\alpha_V}{\sigma_V^2} - \frac{1}{2}\right)^2 + 2\frac{\rho}{\sigma_V^2}}. \quad (3)$$

Accompanying the solution is a critical development value, V^D , where $V < V^D$ implies it is optimal for the landowner to wait and $V \geq V^D$ implies that the land should be sold to the developer. The solution value for V^D requires simultaneously solving the value matching condition, $AV^\beta + \pi/\rho = V$, and the smooth pasting condition, $d(AV^\beta)/dV = 1$. This pair of equations can be solved to give

$$A^D = (V^D - \pi/\rho) (V^D)^{-\beta} \quad (4)$$

and

$$V^D = \frac{\beta}{\beta - 1} \frac{\pi}{\rho} \quad (5)$$

⁶Continuous time models of land development such as Capozza and Sick [1994] generally make the cost of developing the land explicit. In such models the competitive developer's offer price is equal to the capitalized after-tax returns to the land minus the cost of development. The cost of development is not important for the main results of this analysis and so is omitted.

Using equation (4), an expanded version of the value function, $L^D(V) = AV^\beta + \pi/\rho$, can be written as

$$L^D(V) = \left[1 - \left(\frac{V}{V^D} \right)^\beta \right] \frac{\pi}{\rho} + \left(\frac{V}{V^D} \right)^\beta V^D \quad (6)$$

Within equation (6) it is useful to interpret $(V/V^D)^\beta$ as the expected discounted factor. With this interpretation equation (6) shows that the value function can be decomposed into the present value of profits earned before the land is sold (first term) plus the present value of the wealth which is generated when the land is sold at price V^D (second term).

2.2 Easement versus Development

Continue to assume that the easement is available on a one-time basis. Figure 1 shows the optimal action for the landowner as a function of the current value of V . The schedule labeled $N^E(V)$ is the value of the land to the landowner if the easement is signed, as specified in equation (1). If the easement is signed for $V < \pi/\rho$ there is no easement payment and no tax break for the landowner, in which case $N^E(V) = \pi/\rho$. For $\pi/\rho \leq V < V^{min}$ there is no easement payment, but the landowner does receive a tax credit. For $V \geq V^{min}$ the landowner receives both a payment from the land trust and a tax credit.

Also shown in Figure 1 is the $L^D(V)$ schedule, which measures the implicit value of the land inclusive of the option to defer the land development decision. The tangency point of $L^D(V)$ and V defines V^D , which is the development trigger. This tangency point represents the joint solution to the value matching and smooth pasting conditions, which were specified above. Because the easement is available on a one-time basis, the easement option is selected by the landowner if and only if $N^E(V) > L^D(V)$. Figure 1 shows that selecting the easement is optimal for the landowner only for $V^{min} \leq V < V^E$. For $V \leq V^{min}$ the lack of a payment by the land trust makes the easement option unattractive. For $V \geq V^E$ the landowner rejects the easement offer because expected profits are higher with waiting and eventually selling the land for development.

Notice that for $V^E \leq V < V^{E2}$ the easement is rejected by the landowner even though the value of the land with the easement is higher than the current market value of the land. This

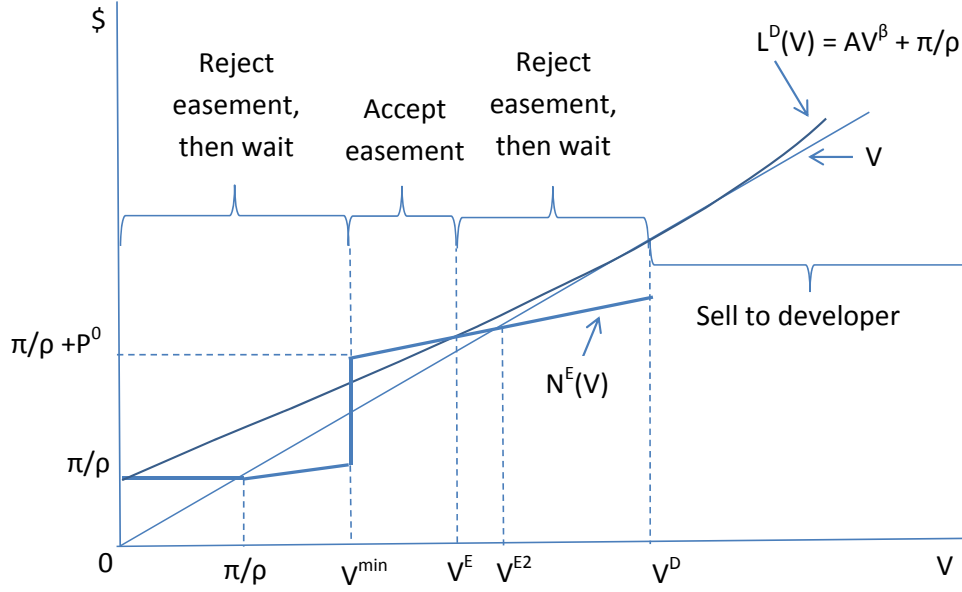


Figure 1: Optimal landowner decision rule with one time easement offer

outcome reflects the value of waiting and preserving the option to eventually sell the land for development. Equation (3) shows that greater development value uncertainty, as measured by σ_V in the Brownian motion equation, $dV = \alpha_V V dt + \sigma_V V dz$, increases the value of β . An increase in β obviously makes the $L^D(V) = AV^\beta + \pi/\rho$ function more convex. It should be evident from Figure 1 that this added convexity will lower the equilibrium value of V^E without changing the value of V^{E2} . Hence, greater development uncertainty decreases the range of V for which easement acceptance is profitable for the landowner, and increases the number of states for which rejection is optimal, even though $N^E(V) > V$.

The remaining comparative statics of Figure 1 are easy to establish. An increase in the easement payment (e.g., a larger value for P_0 or θ) shifts $N^E(V)$ up. This shift raises the value of V^E and thus increases the range of V for which the landowner's acceptance of the easement is the most profitable. Of course the results are opposite for a decrease in the easement payment. An increase in the profit flow, π , both shifts the $N^E(V)$ schedule up and causes the $L^D(V)$ schedule to shift up and rotate clockwise. The combined effect is a larger easement acceptance zone. To establish comparative static results for the tax rate, τ , Figure 1 can be redrawn with the pre-tax development price, X/ρ , substituting for the after-tax development price, V . In

this new diagram an increase in τ will shift the $N^E(X)$ schedule upward and will cause the $L^D(X)$ schedule to pivot downward.⁷ The net result is a wider range of outcomes for which the easement outcome is optimal. This result is expected because a larger value for τ makes the gift portion of the easement more valuable and at the same time lowers the development value of the land.

3 Welfare Impacts of a One-Time Easement Offer

This section is used to formally examine the welfare impacts of a conservation easement, once again with the assumption that the easement is available on a one-time basis only. This section begins with the derivation of the social welfare functions.

3.1 Social Welfare Functions

Social welfare consists of the capitalized flow of the pre-tax profits from the land before and after development, plus the environmental value of the land, plus the net social value of the public goods which are financed with property taxes. Note that social welfare does not include the easement payment from the land trust to the landowner, $P(V)$, because this payment redistributes welfare but has no effect on net welfare for the system as a whole. The profit flow component of the social welfare function has been fully specified above. Regarding the environmental value of the land, this could be modeled as benefits flowing from the undeveloped land, reduced benefits or damage flowing from the developed land or some combination of the two. The analysis is kept simple by assuming zero environmental benefits or damage for the developed land and a constant flow of environmental benefits at rate ω for the undeveloped land. The assumption that the flow of environmental benefits from the undeveloped land remain constant over time whereas development value is stochastically trending upward limits the generality of the results. Comments about how the main results are likely to change if the flow of

⁷Substitute $\pi = (1 - \tau/\rho)\hat{\pi}$ and $V = (1 - \tau/\rho)X/\rho$ into equation (1) and then differentiate with respect to τ . The resulting expression is $dN^E(V) = (V - E - \pi/\rho)/\rho + (\tau V/(\tau - \rho) - \pi/\rho)$, which can be signed positive.

environmental benefits is allowed to also stochastically trend upward over time are provided in the concluding section of this paper.

Next consider the third component of social welfare, which is the net social value of the flow of public goods that are financed with property tax receipts. Assume that $\lambda \geq 1$ is the social value of each dollar of public good provision. The marginal net gain in welfare from the property tax payment is therefore $\lambda - 1$. The $\lambda \geq 1$ assumption is intended to reflect the stylized fact that cash is scarce for local governments and thus public good projects which are financed with property tax revenue can have a positive net social value.⁸ The $\lambda > 1$ assumption is important in the current analysis because it means that a conservation easement which provides a landowner with property tax relief has a positive social opportunity cost.

Let $Z = [\rho + (\lambda - 1)\tau]/(\rho - \tau)$ denote the scaling factor which converts π and V into welfare flows excluding environmental benefits. Specifically, prior to the land's development the flow of welfare excluding environmental benefits is equal to $Z\pi$ and at the time of development the present value of the future welfare flow is ZV .⁹ With this notation in hand, if $V > V^E$ such that the landowner is either actively selling the land or waiting to sell the land to the developer, then an expression for expected welfare can be constructed using the expected discount factor, similar to equation (6):

$$W^D(V) = \left[1 - \left(\frac{V}{V^D}\right)^\beta\right] \left[Z\frac{\pi}{\rho} + \frac{\omega}{\rho}\right] + \left(\frac{V}{V^D}\right)^\beta ZV^D \quad (7)$$

Noting that A^D is given by equation (4), equation (7) can be written more compactly as

$$W^D(V) = Z \left(A^D V^\beta + \pi/\rho\right) + \left[1 - \left(\frac{V}{V^D}\right)^\beta\right] \frac{\omega}{\rho} \quad (8)$$

Since $Z = [\rho + (\lambda - 1)\tau]/(\rho - \tau) > 1$ and $L^D(V) = A^D V^\beta + \pi/\rho$, equation (8) shows for the case of $V > V^E$ that social welfare is an upward scaled version of expected profits

⁸In standard welfare analysis taxation results in a deadweight loss because it distorts production, investment and labour allocation decisions. These types of losses may be also be present in the current analysis, but they are not formally included in the model and they are assumed to be sufficiently small such that public good provision results in higher rather than lower social welfare.

⁹For example, the flow of welfare from the undeveloped land excluding environmental benefits is $\pi + \lambda(\tau/\rho)\hat{\pi}$. Substitute in $\hat{\pi} = \pi/(1 - \tau/\rho)$ and then rearrange to obtain $Z\pi$.

for the landowner who intends to sell the land to a developer either immediately or at a future date. The welfare function is scaled upward because the landowner fails to internalize both the environmental value of the land and the value of the public goods which are financed with property tax payments.

Social welfare which flows from the undeveloped land with an easement in place can be expressed as

$$W^E(V) = Z \frac{\pi}{\rho} + \frac{\omega}{\rho} - (\lambda - 1) \frac{\tau}{\rho} \text{MAX} [V - P(V) - \hat{\pi}/\rho, 0] \quad (9)$$

The first term in equation (9) is the welfare associated with the landowner's profits and the second term is the capitalized environmental benefits. The third term is the net loss in society's valuation of the public goods that result from the provision of the tax credit to the landowner.

3.2 Welfare Results

To conduct the welfare analysis it is necessary to know whether social welfare is higher or lower if the easement is accepted rather than rejected by the landowner. Let $\Delta^W = W^E(V) - W^D(V)$ denote the welfare gain from the easement as a function of the current development value of the land, V . Using equations (8) and (9), the desired expression is

$$\Delta^W = \left(\frac{V}{V^D} \right)^\beta \left[\frac{\omega}{\rho} - \frac{Z}{\beta - 1} \frac{\pi}{\rho} \right] - (\lambda - 1) \frac{\tau}{\rho} \text{MAX} [V - P(V) - \pi/\rho, 0] \quad (10)$$

Within equation (10) keep in mind that $G(V) = V - P(V) - \pi/\rho$ is the landowner's gift and $P(V) = P_0 + \theta(V - V^{\min})$ for $V \geq V^{\min}$.

To analyze the welfare implications of the easement, first assume that $\lambda = 1$, which means that there are no net public good benefits from property tax payments (i.e., $\lambda = 1$). This assumption restricts attention to the environmental externality as the only reason why an easement might have social value. With $\lambda = 1$ it follows that $Z\pi = \hat{\pi}$ since $Z = [\rho + \tau]/(\rho - \tau)$ and $\hat{\pi} = \pi/(1 - \tau/\rho)$. In other words, $Z\pi = \hat{\pi}$ is the pre-tax income flow from the undeveloped land when $\lambda = 1$.

The following result follows directly from equation (10):

Result 1. *If $\lambda = 1$ such that public goods which are financed with property tax revenue have zero net social value, then acceptance of the one-time-offer easement by the landowner raises welfare if and only if $\omega > \hat{\pi}/(\beta - 1)$. This result holds for all feasible development values, V .*

Result 1 emerges because ω/ρ is the capitalized flow of environmental benefits from the undeveloped land and $(\hat{\pi}/\rho)/(\beta - 1)$ is the pre-tax development value of the land in excess of the land's pre-tax use value, $\hat{\pi}/\rho$, when immediate development is the optimal strategy for the landowner.¹⁰ The flow of environmental benefits is an externality from the landowner's perspective, and so the easement has social value only if the size of the externality is larger than the difference between the land's optimal development value and status quo value.

The next result can be established by combining the easement selection outcome, which is illustrated in Figure 1, with the easement welfare outcome, which is described in Result 1. Within this result and all subsequent text "correct" means that social welfare increases with the landowner's specified action and "incorrect" means that social welfare "decreases".

Result 2. *If public goods which are financed with property tax revenue have zero net social value then one of two cases emerges (the "knife edge" case is ignored):*

1. $\omega < \hat{\pi}/(\beta - 1)$, in which case easement acceptance by the landowner when $V^{\min} \leq V < V^E$ is "incorrect" and easement rejection otherwise is "correct"
2. $\omega > \hat{\pi}/(\beta - 1)$, in which case easement acceptance by the landowner when $V^{\min} \leq V < V^E$ is "correct" and easement rejection otherwise is "incorrect"

The first part of Result 2 establishes that overly generous land trusts can reduce social welfare by inducing landowners to permanently remove from the development stream land that has comparatively high development value and/or comparatively low environmental value. The second part of Result 2 establishes that the inability of a land trust to raise the easement signing payment to a level that induces the landowner to accept the easement results in a welfare loss for land that has comparatively low development value and/or comparatively high environmental value. In the first case higher development value uncertainty is "good" for society because it

¹⁰This result emerges because $\hat{\pi}/(\beta - 1)$ can be rewritten as $\hat{V}^D - \hat{\pi}/\rho$.

reduces the range of development values for which a socially undesirable easement is accepted by the landowner. In the second case higher development value uncertainty is "bad" for society because it increases the range of development values for which a socially desirable easement is rejected by the landowner.

Now consider the case where $\lambda > 1$, which assumes a positive net public good benefit that is associated with the flow of property taxes. The welfare comparison that is implied by equation (10) must now be adjusted by the loss in net public goods that results from providing the landowner with an easement tax credit. Within equation (10) the expression $MAX[V - P(V) - \pi/\rho, 0]$ is the size of the easement gift, which provides the basis for the tax credit. With $P(V) = MAX\{P_0 + \theta(\theta - V^{min}), 0\}$ equation (10) either monotonically increases in V or first increases and then monotonically decreases in V for $V \in [\pi/\rho, V^D]$.¹¹ This being the case, it is useful to identify the largest value of the public good parameter, λ , which ensures a non-negative value for equation (10) when $\omega > Z\pi/(\beta - 1)$ and V takes on its maximum value of V^D . Letting λ^* denote this critical level of λ , it follows from the above discussion that for $\lambda \leq \lambda^*$ the difference in welfare with and without the easement is non-negative for all $V \in [\pi/\rho, V^D]$ when $\omega > \hat{\pi}/(\beta - 1)$. Noting that $G(V) = V - P(V) - \pi/\rho$ is the level of the easement gift, the desired expression for λ^* is found by setting equation (10) equal to zero and solving for λ :

$$\lambda^* = 1 - \left(\frac{1}{\tau}\right) \frac{\omega - Z\pi(\beta - 1)^{-1}}{(\lambda - 1)G(V^D)} \quad (11)$$

The next result follows from the above discussion.

Result 3. *If public goods which are financed with property tax revenue have a positive net social value then one of three cases emerges:*

1. $\omega < Z\pi/(\beta - 1)$, in which case easement acceptance by the landowner when $V^{min} \leq V < V^E$ is "incorrect" and easement rejection otherwise is "correct"
2. $\omega > Z\pi/(\beta - 1)$ and $\lambda \leq \lambda^*$, in which case easement acceptance by the landowner when $V^{min} \leq V < V^E$ is "correct" and easement rejection otherwise is "incorrect"

¹¹This result holds because equation (10) is a linear function of V^β and V .

3. $\omega > Z\pi/(\beta - 1)$ and $\lambda > \lambda^*$, in which case the range of values for $V \in [\pi/\rho, V^D]$ can potentially be divided into four distinct zones of landowner action regarding the easement: (i) "correct" acceptance; (ii) "incorrect" acceptance; (iii) "correct" rejection; and (iv) "incorrect" rejection

The first pair of cases in Result 3 emerge because the public good effects are not strong enough to reverse the corresponding results in Result 2. The third case in Result 3 is the most interesting because now whether or not the easement is socially desirable depends on the land's development value, V . Figure 2 shows the most interesting version of the third case. This case is interesting because the intersection point of the two welfare functions in the upper portion of the graph coincides with the easement acceptance region (i.e., values of V between V^{min} and V^E). With this outcome the four possibilities that are described in third part of Result 3 emerge. If the easement welfare function was to decrease more rapidly so that the welfare intersection point was to the left of V^{min} , then there would be three zones: (i) incorrect rejection at the left; (ii) incorrect acceptance in the middle; and (iii) correct rejection at the right. Conversely, if the easement welfare function was to decrease less rapidly so that the welfare intersection point was to the right of V^E then the three zones are reorganized: (i) incorrect rejection at the left; (ii) correct acceptance in the middle; and (iii) correct rejection at the right.

The above discussion implies that the speed at which the easement welfare function decreases with an increase in V is an important determinant of the welfare implications of the easement. Equation (10) shows that the speed of decline is proportional to both society's valuation of the public goods which are financed with property tax payments, λ , and the rate of property taxation, τ . Easement welfare declines for land with a higher development value because as discussed above high development value implies a larger easement gift and thus a larger tax credit that is provided to the landowner when the easement is accepted. The higher tax credit reduces the flow of public goods, which reduces welfare.

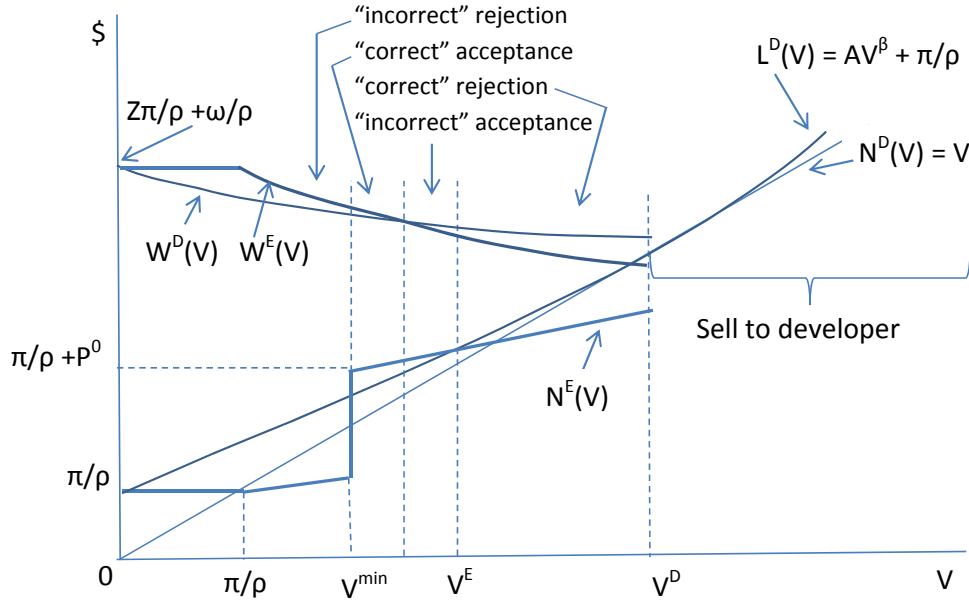


Figure 2: Welfare effects with one time easement offer

4 Conclusions

This analysis has clearly demonstrated that a conservation easement is a second best instrument which has the potential to raise welfare under some but not all market conditions. In the absence of public good considerations, the easement will increase (decrease) welfare if the easement payment is small (large) relative to the environmental value of the land. Development value uncertainty creates a real option associated with deferring the land development decision, and this real option raises the social opportunity cost of easement implementation. If the provision of public goods has a comparatively high social value, then the easement has an additional opportunity cost because of the tax credit that is provided to landowners when the easement is implemented. The size of the easement payment relative to the flow of environmental benefits defines the size of the environmental externality. The size of this externality relative to the public good opportunity cost of the easement determines if the easement increases or decreases welfare.

The main limitation of this analysis is that there exists a bias toward easement rejection by the landowner and toward lower welfare with versus without the easement. This bias exists

because the land's development value is stochastically trending upward, whereas the environmental value of the land is fixed over time. The primary impact of relaxing this assumption on the main result of this paper is fairly obvious. If environmental value was also stochastically trending upward then clearly there would be a wider range of development values for which the landowner would accept the easement, and for which this acceptance is socially desirable. What is less predictable is the how the joint interaction between the option to defer the development decision and the option to defer the easement acceptance decision would be affected by relaxing the assumption of a fixed flow of environmental benefits from the land. Perhaps a stochastically trending upward environmental value would raise the value of both the development option and the easement acceptance option, which in turn may expand the "waiting" zone. Further research in this direction certainly appears warranted.

References

- Alderich, R. and J. Wyerman. National land trust census report. Technical report, Land Trust Alliance. www.lta.org.
- Anderson, C. M. and J. R. King (2004). Equilibrium behavior in the conservation easement game. *Land Economics* 80(3), 355–374.
- Anderson, K. and D. Weinhold (2008). Agricultural land values and the value of rights to future development. *Ecological Economics* 68, 437–466.
- Arrow, K. J. and A. Fisher (1974). Environmental preservation, uncertainty and irreversibility. *Quarterly Journal of Economics* 88(2), 312–319.
- Capozza, D. R. and G. A. Sick (1994). The risk structure of land markets. *Journal of Urban Economics* 35(4), 297–319.
- Conrad, J. (2000). Wilderness: Options to preserve, extract or develop. *Resource and Energy Economics* 22, 205–219.
- Dixit, A. K. and R. S. Pindyck (1994). *Investment Under Uncertainty*. Princeton, NJ: Princeton University Press.
- Fishburn, I., P. Kareiva, K. Gaston, and P. Armsworth (2009, March). The growth of easements as a conservation tool. *PLoS ONE* 4(3), 1–6.
- King, J. R. and C. M. Anderson (2004). Marginal tax effects of conservation easements: A vermont case study. *American Journal of Agricultural Economics* 86(4), 919–932.
- Leroux, A. D., V. L. Martin, and T. Goesch (2009). Optimal conservation, extinction debt, and the augmented quasi-option value. *Journal of Environmental Economics and Management* 58, 43–57.
- McDonald, R. and D. Siegel (1986). The value of waiting to invest. *The Quarterly Journal of Economics* 101, 707–728.

- McLaughlin, N. A. (2004). Increasing the tax incentives for conservation easement donations. *Ecology Law Quarterly* 31, 1–113.
- Merenlender, A., L. Huntsinger, G. Guthey, and S. Fairfax (2004). Land trusts and conservation easements: Who is conserving what for whom? *Conservation Biology* 18, 65–75.
- Pindyck, R. S. (2002). Optimal timing problems in environmental economics. *Journal of Economics, Dynamics and Control* 26(9-10), 1677–1697.
- Raymond, L. and S. K. Fairfax (2002). The shift to privatization in land conservation: A cautionary essay. *Natural Resources Journal* 42, 599–639.
- Reed, W. J. (1993). The shift to privatization in land conservation: A cautionary essay. *Ecological Economics* 8, 45–69.
- Sundberg, J. O. and R. F. Dye (2006). Tax and property value effects of conservation easements. Working paper, Lincoln Institute of Land Policy.
- Tenge, A., K. Wiebe, and B. Kuhn (1999). Irreversible investment under uncertainty: Conservation easements and the option to develop agricultural land. *Journal of Agricultural Economics* 50(2), 203–219.