DISSERTATION

INVESTIGATING AGRICULTURAL LAND PROTECTION: A THEORETICAL CASE STUDY ON CONSERVATION EASEMENT VALUATION AND TENURE

Submitted by

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ABSTRACT OF DISSERTATION

INVESTIGATING AGRICULTURAL LAND PROTECTION: A THEORETICAL CASE STUDY ON CONSERVATION EASEMENT VALUATION AND TENURE

This research explores agricultural land valuation as related to conservation easement agreements. Conventional approaches and previous studies have relied on agricultural land's market price urban residual growth value to represent both landowner and land agent conservation easement reservation prices for permanent conservation easement valuation. This dissertation shows that each accounting stance's valuation is driven by differing market and non-market factors. Further, by recognizing that convertible agricultural land holds differing social, market and individual landowner prices, unique *WTA* and *WTP* valuation models are developed that enhance appraisal and understanding of the motivation to accept and pay for placement of voluntary land-use restriction agreements.

Central to understanding agricultural land's valuation is the recognition of a future date of conversion for both the landowner and land agent. Conventional permanent conservation easement placement holds a land agent's conversion date at infinity. While permanent specification may be optimal for certain unique socially desired *PIVs*, without allowance for temporary agreements, land-use flexibility and choice are lost with these unique dual-interest agreements. Permanent specification may not always be optimal when faced with physical and economic constraints. Allowances for less than permanent conservation easement agreements are introduced through a portfolio investment approach to land-use protection policy that enhances optimal public interest value (*PIVs*) acquisitions and ultimately social welfare.

The results of this analysis provide for enhanced land use policy recommendations that actively include term specified conservation easement agreements. Since conservation easements are unique in their recognition of dual public and private interests, their functions are best served by recognizing the goals of both accounting stances. Thus, conservation easements by themselves may best serve to influence a landscape's land-uses rather than used strictly for impeding development. Both accounting stances have something to gain with a fair agreement and more to lose with an overly restrictive imposition.

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CHAPTER 1 INTRODUCTION

The conversion of agricultural land to urban uses is a significant public issue across many areas of our national landscape and a concern to a widening audience in the United States. This concern stems from the significant correlation between and direct loss of high amenity public interest values (*PIVs*) such as open-space or wildlife habitat, associated with converted agricultural land to more intensive uses. While this type of land-use issue has extensive eastern U.S. history, agricultural land protection efforts have become equally important for much of private agricultural and open-space landscapes in urbanizing areas of the west. Protecting productive agricultural landscapes from encroaching and scattered urbanization or "sprawl" has lead to diverse but concerted local, state and national agricultural land-use protection policy efforts and initiatives. This is especially true in Colorado with estimates of annual public expenditures now approaching $100 million for open-space acquisition (Carlson, 1999).

Conversion of agricultural land to a more intensive use involves shifts in resources away from an agrarian landscape to a market-driven, more privately profitable urbanized setting. Historically, agrarian land-use conversion has led to societal gains through an improved standard of living, yet unfettered growth or unwarranted conversion of agricultural land at the margin may be sub-optimal. Of typical concern is resulting increased land costs, lost agricultural production potential, diminished threshold of a local farming/ranching economy and loss of traditional rural community landscape. But an additional and greater issue may be site-specific losses of cultural and open space amenities associated with agricultural land-uses on the urban fringe and critically intense development across rural landscapes. Throughout the western United States, rural agricultural landscapes have faced significant developmental growth and concentration of a highly urbanized population. In the Rocky Mountain States, *PIVs* such as open-space and environmental amenities have traditionally been attained from the presence of federal and state public lands, yet a critical locational supply of *PIVs* has accrued on strategic and convertible agricultural lands where nearly all development occurs.

With an open market economy, productive land-uses such as agriculture have normally exchanged in well-organized, largely competitive markets with the ability to provide efficient quantities of private goods. Many public interest values associated with and produced on agricultural lands, however, are unpriced public or collective goods. As such, these externality benefits are characterized by non-exclusion and non-rivalry in consumption. Land markets fail to accurately signal and allocate resources toward the production of these goods. With that, agricultural landowners cannot appropriate the *PIVs* rents accruing on their property, which transfer instead to third parties. These features inhibit any tendency of unfettered market transactions to systematically result in socially efficient patterns of resource use (Mishan, 1969 and Beasley *et al* 1996). This result leads to the failure of private agricultural land markets to compensate a landowner for the production of society's corresponding agricultural land amenity values, which in turn mitigates excessive conversion of agricultural land, effectively driving a wedge between desired (optimal) levels and actual quantities of convertible agricultural land (Lopez *et al*, 1994).

By recognizing that urbanized conversion of agricultural land involves some net loss of public interest values to society, public agricultural land-use policy has advanced to counter this market failure. Under this focus, land-use legislation has attempted to subsidize and stabilize preferred agrarian activities while prohibiting undue conversion in certain landscapes. Conventional public policy efforts have utilized both regulatory and voluntary land-use control measures to influence agrarian conversion. However, both political and legal challenges to these efforts as well as outright limitations to compete with more lucrative non-agricultural uses has forced public land-use policy to enter directly and more actively into land markets for partial interests in agricultural land via conservation easement contracts. Conservation easement agreements transfer certain property rights from a landowner to a conservator or land agent to the benefit of society or other beneficiaries (typically public). Land agents are conservation organizations or government agencies that hold a non-possessory right to enforce land-use restrictions with the objective to extinguish non-agricultural land-use activities that diminish the production of positive agricultural land's *PIVs*.

While voluntary agricultural land protection agreements such as conservation easements seem to benefit agricultural landowners and society via consideration of complementary production of *PIVs* with ongoing agricultural production, certain economic questions arise with respect to landowner and land agent participation and overall social welfare gained. Of concern is the often-made requirement for permanent conservation easement placement and the valuation approach currently used to determine a conservation easement price. Also of economic concern is the long-term societal implication from perpetually impeding development rather than capturing *PIVs* on convertible agricultural lands within a landscape. These concerns culminate to the issue of optimal agricultural land-use protection policy with a constraint in resources. What exactly should society optimize and capture: acres, *PIVs* or a time period of protection? If society desires to capture *PIVs* such as open-space, public land-use policy may more optimally contain an expanded portfolio of agricultural acres temporally protected rather than fewer perpetual acres given changing and unknown future societal needs.

1.1 Aim and Purpose

This dissertation investigates conservation easement agreements. The research approach involves enhancing the methodological specification for conservation easement valuation and conceptually specifying temporary conservation easement contracts with an associated temporal discount. The research process seeks to evaluate and illustrate potential societal gains via enhanced conservation easement contracts. This involves identifying underlying economic factors of willingness-to-accept and willingness-to-pay by landowners and land agents, respectively, for periods less than or equal to the socially optimal period of protection. If less than socially optimal periods are considered, the associated temporal discount tradeoff is estimated for potential term based agreements. A better understanding of these two accounting stances will improve conservation easement placement and negotiated settlement prices by recognizing and matching a landowner's willingness to accept with a land agent's willingness to pay for *PIVs*. The appeal is for enhanced landowner and land agent participation. Improved understanding and specification of landowner valuation is especially important. Current conservation easement appraisal approaches fail to account for the wide range of considerations (pure donation to purchase-of-development (PDR)). Likewise, consideration of a land agent's valuation approach within a portfolio perspective may yield gains in *PIVs* protected over the restricted choice of either permanent placement or nothing.

From this improved valuation specification for landowner and land agent, social welfare is considered in the face of constraining resources limiting unconstrained optimization of *PIVs* or protected agricultural acres within a landscape. Spatial versus temporal optimization considerations are introduced in recognition of uncertainty and public funding constraints for protection.

1.2 Conventional Attitude Toward Tenure and Valuation

Transactional evidence of conservation easement placement and analysis of legislated land-use policy provides evidence that a statement of permanent tenure is requisite for conservation easement agreements. Most state laws explicitly require (or by default assume) a tenure of perpetuity for a conservation easement.[1] Typical societal support for permanence stems from the desire to protect something "good," thus it should be protected indefinitely. The rationale and justification has been increased public acceptance for permanent capture and protection of unique (scarce) attributes and the perception that any amenity of such value is logically held in perpetuity. The economic justification has been to avoid the real administrative costs of repetitive bargaining with shorter termed agreements.

[1] This is apparent in the eligibility requirement for all federal tax benefits as well as eligibility for Colorado's income tax credits. See Gustanski and Squires (2000) for a current and complete description of all states tenure requirement's for conservation easement placement.

Yet to landowners, permanent loss of control and future land-use allocation decision-making is reflected in a significant market value foregone and thus necessitates real compensation. Predictably, there are good reasons why asset owners do not always desire to restrict their land-use options outright. It follows that maintaining long-term (fee-simple) land-use control of such property interests represents a significant market value component in property ownership. The value of ownership is also enhanced by non-market factors including legacy, heritage, or other personal use that adds greatly to a landowner's value of agricultural land ownership.

From a societal perspective, the unspoken disadvantage of perpetual easements is the sheer difficulty of infinite forecasting of optimal protection levels and spatial developmental growth patterns required for optimal *PIVs* protection and valuation. Korngold (1984) asserts that the best choice of current uses of agricultural land is itself difficult. More difficult still is the decision today regarding speculative future uses. Rigid and permanent land-use choices today defeat the right of future generations to make critical decisions affecting both their land and lives. Also, from an inter-temporal demand perspective, permanent conservation easement acquisition today with a constrained collective conservation budget represents significant outlays for future, unknown and changing generational or societal land-use needs.

The economic theory of a pareto-efficient social outcome suggests there may be net increased social welfare by including temporary conservation easement contracts within a collective land-use policy due to our limited ability to forecast infinite land-use needs, limited knowledge of changing societal values, and constrained public resources to purchase permanent conservation easements. Temporary land-use restriction agreements provide more immediate agricultural land protection. Land agents that seek to capture an optimal level of *PIVs* within a landscape may realize substantial up front expenditure savings. Savings from a portfolio perspective could then be invested in previously unattainable land-use protection. Societal demand for protection within a particular agricultural landscape does not ensure critical *PIVs* become protected with only constrained perpetual conservation placement. For example, a land agent's decision to protect a socially significant agricultural property may financially prohibit the future acquisition of another property that was initially unavailable but socially desired. This type of acquisition uncertainty advocates maintaining a combination of shorter-term agreements to provide investment flexibility as strategic agricultural lands become available. Likewise, a landowner's added appeal may be held in retaining full possessory interests in land-use choices as neighboring communities and rural landscapes evolve.

Thus the major impetus for allowance of a less than permanent specification is the resulting misallocation of future land-uses and added upfront costs for perpetual conservation easement acquisition. Cheever (1996, pg. 1100) most clearly stated from a legal perspective that "human's capacity to predict the future is spotty at best and limitations on land-use created in perpetuity will inevitability generate problems". By recognizing the added societal costs or burden created with perpetual land-use restrictions, society may improve its resource allocation efficiency via temporary conservation easement agreements.

Regardless of tenure, another economic concern in land-use policy is the continuous struggle for optimal conservation easement valuation. Because conservation easements are land-use restrictions undertaken voluntarily to capture a public good or protect positive non-market externality, these contracts bring to the fore issues involving the valuation of *PIVs* protection to both landowners and land agents. Legally acceptable valuation approaches for taxation assessment of charitable contributions have relied on market-based appraisal methods for estimation of the fair market value (FMV) of the concerned partial interest in real property. In application, both public policy lawmakers and the IRS have defined the explicit price differential between fair market value's highest and best use for agricultural land and pure capitalized agricultural rents as equivalent to a conservation easement value.[2] This legally required appraisal approach assumes any and all capitalized rental value above pure agricultural value is a second best approximation of societal demand for *PIVs* or the minimum amount society must compensate a landowner that would otherwise capture on the open land market for converting agricultural land into an urban use.

Though this value may correctly assess the encumbered financial difference *i.e.* restricted agricultural land's opportunity cost, it fails to accurately identify and value the protection uses a conservation easement is intending to provide. Utilization of this market appraised differential or residual growth value as a conservation easement price explicitly assumes a landowner holds agricultural land as a financial investment reacting only to market signals for agricultural land's highest and best uses. It also assumes that society reacts strictly to developmental rents for *PIVs* protection. A more complete specification would include and recognize any explicit non-market interest values that are lost with conversion and directly measure societal *PIVs* for valuation. This is especially critical given the intensity percentage or meaningful fraction of value above capitalized

[2] This differential value between developed and agricultural uses is considered to be financially equivalent to the amount necessary to make landowners (asset owners) indifferent between choosing urbanized development and voluntary protection for their agricultural lands (input).

agricultural rents of which conservation easement valuation usually consists. Further, there is a substantial range of consideration paid by society against a significant level of donations conceded by landowners in placement.[3] If current methods used for conservation easement valuation were close to actual exchange values, then such a range of landowner's donative capacity within properly specified easement valuation would likely not exist.[4]

Therefore, by allowing the expansion of policy instrument choices in agricultural land protection and with improved valuation specification, improved social outcomes may result through enhanced participation by landowners and increased protection opportunity for land agents. The analysis of and experimentation with land-use policy tools is essential if we are to maximize the amount of protection possible with scarce conservation dollars.

1.3 Goal and Objectives

This dissertation's goal is to improve conservation easement valuation specification for both landowners and society. This involves a theoretical investigation on the *temporal* and *valuation* specification of conservation easement agreements for voluntary exchanges. The specific underlying objectives necessary to achieve this goal include:

[3] Hoag *et al* (2001) found in a survey of Colorado landowners that their conservation easement's value averaged 51 percent of their land's total market value yet respondents captured only 65 percent of the *CE* value. Over half of respondents donated all of their *CE* value away.
[4] Granted there is a real financial incentive for a landowner to donate a conservation easement in Colorado given current state tax credits available. However, this law took effect in year 2000 and significant conservation easement placement has occurred for years before the presence of Great Outdoors Colorado (GOCO) open-space funding.

- Clearly define and investigate what derives the price of agricultural land. This involves incorporating both market and non-market factors relevant to individual, market and social accounting stances influencing agricultural land's value.

- Correctly specify a landowner and a land agent conservation easement valuation model. This involves deriving each stance's respective willingness-to-accept and willingness-to-pay for protection stipulations.

- Define and estimate separate term/perpetual discount ratio or trade off curves for landowners and land agents.

- Identify possible improvements and limitations to social welfare gains from *PIVs* protection via temporary land-use protection agreements and tradeoffs within a constrained portfolio investment.

- Provide land-use policy recommendations for future agricultural land acquisition recognizing both landowner and societal interests.

1.4 Flow of Dissertation

The remaining chapters of this dissertation detail and illustrate the economic research processes utilized to investigate conservation easements. Chapter two provides background on the development of conservation easement agreements and reviews how others have studied conservation easements or agricultural land protection policy. This review focuses on formal literature investigating land-use decision modeling, conservation easement pricing and valuation methods, temporary easement studies and farmland amenity protection literature. Chapter three proposes formal economic methodology of landowner and land agent valuation of conservation easement agreements. Alternative stances for valuation of convertible agricultural lands are introduced that derive landowner *WTA* and land agent *WTP*, respectively. Chapter four focuses on the theoretical discussion of conservation easement models developed in chapter three and defines central economic issues affecting easement valuation and placement. Chapter five introduces a comparative static analysis on the valuation models. Numerical and graphical illustrations are applied to the basic valuation stances under differing scenarios for key variables previously identified. Key spatial and temporal tradeoffs are introduced that recognize social welfare gains from a portfolio perspective. Also derived is a trade-off between *PIVs* captured via permanent protection and a portfolio of less than permanent agreements given a constraining budget and uncertain future demand for *PIVs*. Chapter six extends the theoretical results derived in chapter five into land-use policy recommendations for improving conservation easement placement. This includes a discussion of expanding conservator's protection portfolio mix for improving societal gains and enhancing landowner participation to reach their long-term property goals as well. Chapter seven concludes with a summary of dissertation results and contributions of the research process.

CHAPTER 2 CONSERVATION EASEMENT DEVELOPMENT AND REVIEW OF LITERATURE

This chapter provides a summarization and academic review of conservation easement placement in the west. For this, the chapter is broken into two distinct sections. The first section defines what is a conservation easement and provides a background on conservation easement development and usage. This includes an outline of historical land-use policy and property law that has lead to the widespread placement of conservation easement agreements in the American west. The following section is a formal review of literature concerning land-use policy and the need for market intervention to ensure protection of some quasi or pure public goods occurring on convertible agricultural lands. There are four separate sections to this formal review. First, is a review of market externalities and the need for public intervention. Two sections concerning the financial and economic assessment of permanent and temporary conservation easement models follow this. The final review segment concerns applied non-market valuation studies, which provide estimates of the public or social value for protecting high amenity agricultural lands.

2.1 *Land-Use Policy and Conservation Easement Development*

The struggle between urbanization and land-use protection revolves around the central conflict that private interests must be sacrificed or severely constrained if public land-use policy goals are to be achieved. The challenge for policy design has been to most effectively balance public needs alongside private rights.[5] Conventional approaches continue to evolve from pure regulatory attempts to voluntary measures that improve the weighting of private interests and attach policy costs closer to recipients. These range in spectrum from imminent domain/public trust doctrine to zoning and special land-use tax assessment (Bick and Haney 2001). Mainstream societal efforts have relied on zoning (mandatory land-use regulation by government), preferred land-use tax assessments (voluntary preferential assessment of less than "highest and best" use for property) and "right-to-farm" ordinances stating and assigning certain rights to traditional landowners. This array of policy tools has attempted to balance the need for resource and land-use rights against preservation. Still, political, legal and outright economic land-use policy limitations have led to direct market participation for land-use restrictions.

A conservation easement agreement is one type of incentive based public policy that attempts to directly capture *PIVs* on agricultural land by matching or offsetting private non-agricultural rents that landowners would otherwise capture from conversion. Its advantages stem from that it voluntarily recognizes, weighs, and compensates private interests, while achieving public benefits and tends to be more politically palatable than pure regulatory land-use restrictions.

[5] Boyd *et al* (1999) point out that with the plurality of public laws that impact land-use decisions, land-use policy tends to embody rather than solve conflicts.

2.2 Conservation Easements Defined

Conservation easement agreements represent the legal acquisition of partial interests in private land by government agencies and/or nonprofit land conservation organizations[6] (herein called land agents) for qualified conservation purposes.[7] An easement for conservation purposes involves the voluntary relinquishment of some land-use development rights by a landowner above a mutually accepted reserved level, via the granting and formation of a legal written land-use restriction agreement. This relinquishment of land-use rights in effect extinguishes the non-agricultural development potential and reduces the value on previously convertible agricultural land in exchange for financial consideration and continued agrarian land-use rights. This agreement conversely establishes the production and protection of high-amenity public goods or *PIVs* situated on that agricultural land for the benefit of society. For perpetual agreements, easements are considered "in-gross" and all subsequent landowners of the subject agricultural land become servient to the production and protection of these *PIVs* in the form of lost or restricted private land-uses for the benefit of all society. Yet, the remaining permitted land-uses must retain a certain "alienability" with possessory interest. A landowner is still free to sell or transfer his agricultural land (or remaining possessory interests) to subsequent owners. Agricultural land-uses must also maintain a reasonable degree of "anti-restriction" sovereignty. The underlying possessory must maintain a realistic economic land-use itself, where if not, it becomes a negative externality to the overriding covenant and to surrounding land-uses (Korngold 1984).

[6] A land agent is considered to include qualified not-for-profit entities with legitimate conservation purposes, as well as conservancies, non-profit foundations and all levels of governmental agencies engaged in land-use policy via conservation easement acquisition.
[7] See Appendix I for federal and state statutory authorization and legislative recognition of these covenants.

Conservation easement agreements set affirmative rights to the grantee (land agent), reserved rights of the grantor (landowner), along with restricted rights given up by the grantor and enforced by the grantee. Actual public use or public access of these *PIVs* is a secondary agreement not automatically required with any conservation easement placement. Easement agreements can be as flexible as any other legal contract as long as they conform to pertinent real-property law.

In a real sense, easement contracts model a market exchange for real property interests. These contracts require two parties to engage in land-use protection. The decision choice by an agricultural landowner to voluntarily forgo conversion of its agricultural lands into non-agricultural uses describes their willingness-to-accept land protection restrictions. Likewise, land conservation decisions made by a land agent (reflected by the allocation of public dollars either through direct payment or tax subsidization laws) reflects society's willingness-to-pay for the protection and conservation of agricultural lands within a landscape.

The term or duration traditionally specified for conservation easement placements has tended to exhibit a *proclivity for permanence*.[8] Society is attempting to protect something worthwhile that current and future citizens will enjoy, therefore it seems logical to protect that amenity forever. While this is not always a requirement, the IRS and most states require permanent agreements to qualify for income and estate tax deductions and/or credits given a bargain sale or donation of a conservation easement's value. In fact, Colorado is only one of four states to legally recognize *only* permanent

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[8] Gustanski and Squires (2000). pg 40.

conservation easement agreements.[9] This permanence tenure requirement has indirectly emphasized or prioritized a societal viewpoint that infinite conservation purpose or social value of agricultural land for protection always outpaces its social developmental value. An immediate economic limitation that runs counter to this societal preservation view has been the much lesser regard or concern about the future and remaining viability of permitted land-use decisions still occurring on the agricultural land or the true long-term societal land-use needs with evolving landscapes. A growing pressure away from the perpetual aspect of conservation easements is the development of a workable *term* easement specification. In other areas of land-use policy, less than permanent land-use restrictions are actually common. The Colorado Division of Wildlife utilizes true temporary leases or management agreements with private landowners for wildlife habitat protection. At the federal level, the USDA has used two prominent temporary land-use retirement programs: the Conservation Reserve Program (CRP) for highly erodible soils and the Wetlands Reserve Program (WRP) for protecting sensitive private wetlands. Both offer some form of public benefits in exchange for compensation and voluntary acceptance of restrictions on the use of private agricultural land.[10]

Similar in nature to a lease agreement between a lessor (grantor) and lessee (grantee), a term conservation easement contains a future date of expiration that in turn yields enhanced land-use future flexibility. The length of the term could be of varied length but it is assumed to be of significant duration. This allows landowners and land

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[9] This is based on the legal necessity of the donative intent for eligibility for both federal and state tax consideration purposes. As of April 2000, the Colorado legislature had considered a bill (HB00-1353), which would recognize conservation easements for terms of at least twenty years, but this bill failed to advance out of the senate finance subcommittee and was postponed indefinitely without any stated justification.

[10] See Weibe *et al* (1996) for a through discussion on USDA's conservation programs and policy tools that emulate term based conservation easement agreements.

agents increased land-use protection options. Formally, a term conservation easement is equivalent to a permanent conservation easement in all aspects except the specified tenure. A term conservation easement is also defined to be identical to a conservation easement lease for the purpose of this dissertation.[11]

Recently in Colorado, some debate and discussion has occurred about term conservation easement placement, yet temporary easement contracts have been opposed by most land trusts as well as the state's umbrella organization. Basis for this opposition has focused on the expanded cost of negotiating and renegotiating term easements and the expansion of competition for limited public funding (Sherrod 2001). Still, contrary to general land trust's desires, a recent Colorado Governor's commissioned report recommends expansion of protection of agricultural land with less than permanent easement type agreements (Commission, 2001). This Governor's report advocates the creation of management agreements with tenure of at least 12 years with landowners in exchange for state income tax credits.

Even with allowance of term specified conservation easements, there still exists some economic contention with optimal valuation of conservation easement contracts. This valuation becomes important in the treatment of financial compensation exchanged for tax implications and subsidization. In exchange for a charitable contribution of a permanent conservation easement, section 170(h) of IRS code provides a landowner that donates a qualified conservation easement to a qualified nonprofit 501(c) and a real conservation purpose is met to utilize that donation value as a federal income tax deduction. Likewise, the state of Colorado has followed suit with passage of a state law

[11] Legally these two terms have very different meanings, but from an economic analysis they are used interchangeably. See Kueter and Watson (2000) for a clear legal definitional difference.

granting state income tax credits in exchange for donation of a qualified conservation easement (Colorado Government 2000 and Appendix I).

Typically, the value of a deduction for a charitable contribution of property is equal to the difference between a property's fair market value (FMV) of the property before the grant of the easement and the FMV of the property after the grant of the easement.[12] The value of the conservation easement is thus equal to its negative effect on the economic uses of the land it encumbers. By this approach, an easement is valued only in relation to the effect it has on other uses of the land. However, this also implicitly assumes landowners treat agricultural land as only a capital investment and react (in their land allocation choices) strictly to market conditions. This valuation approach clearly does not reflect in any way landowners' complete *WTA* for conservation easement agreements nor does a landowner's developmental opportunity cost yield an optimal measure for *WTP* for protection by society. FMV appraisals at best yield the explicit market value differential between "highest and best use" and current agrarian uses.

The empirical valuation of easement acquisition is, thus, problematic. Because there is no conventional market for easements, the usual procedure for valuing an asset cannot be followed. Even where state funded policy initiatives are active and states generate a significant demand for easements acquisition, infrequent land trust or government procurement is not equivalent to a market for easements. Given the lack of homogeneous characteristics and limited transactions within a landscape, perception of value may be subjective and inaccurate at the same time any single protection transaction may significantly influence other future land-uses (RFF, 1999).

[12] Kayser (2000) also points out that "recognizing that markets are generally not well established for easements, and that FMV may be impossible to assess, Congress permits the "before and after" method for valuing easements".

2.3 Conservation Easements in the Western U.S.

Cumulative and sustained economic growth and prosperity throughout the American West has led to intensive land-use conversion and rapid urbanization of private and strategic agricultural lands. Unfettered urbanized growth or sprawl is the primary factor for loss or conversion of agricultural lands into more developed uses and urban landscapes. Evidence of this growth was clearly shown for Colorado during the 1990's when the state's unemployment declined to historic lows while its population grew at twice the national average and Gross State Domestic Product averaged greater than an eight-percent annual growth.[13] During this decade, estimates of growth in urbanized land area approached 270,000 acres with annualized conversion (USDA, 2001). Population, income, and urban land area growth for eight western states is shown in Table 2.1 for the decade of the 1990's. Economic changes in the west compared with national averages clearly demonstrate common urbanized sprawl factors occurring to a greater extent in the west then the rest of the U.S.

[13] See Colorado Data Book (1999) and Colorado Close-up (2000) for more detail on Colorado's economic expansion.

TABLE 2.1 SIGNS OF ECONOMIC GROWTH IN EIGHT WESTERN STATES

	2000 Population (Millions)	Population % Change (1990-2000)	2000 Real per Capita Income	RPCI % Change (1990-2000)	1997 Acres Urban Land (1,000 Acres)	Urban Land % Change (1990-1997)
Arizona	5.13	40%	14,297	9%	1,746	33%
Colorado	4.30	31%	18,559	24%	1,070	27%
Idaho	1.29	29%	13,524	12%	233	13%
Montana	0.90	13%	12,895	9%	196	24%
Nevada	2.00	66%	16,906	8%	801	33%
New Mexico	1.82	20%	12,519	10%	636	25%
Utah	2.23	30%	13,366	17%	549	19%
Wyoming	0.49	9%	15,696	15%	206	38%
U.S.	281.42	13%	16,848	13%	64,292	17%

Source: Population U.S. Department of Commerce, Census Bureau, 2002.
Income U.S. Department of Commerce, Bureau of Economic Analysis, 2002.
Urban Land Vesterby, M. and Krupa, K. August 2001.

Intensive land development pressure in Colorado is most known for its Front Range urban sprawl, centered around the metropolitan area of Denver. However, like most Rocky Mountain States, urban growth and development is also scattered throughout its mountainous arable valleys and resort communities. Agricultural land conversion is a significant issue in these areas since agricultural lands are usually high in natural amenity attributes and concentrated within the rural landscape's private (developable) lands relative to surrounding public (non-developable) lands.[14]

Conservation easements are the fastest growing public method for protecting agricultural land from direct urban development (Gustanski and Squires, 2000 pg. 14). In fact, the Rocky Mountain States lead the nation in acres under conservation easement

[14] See Rosenberger and Walsh (1997) or Kling and Sparling (2000) for a specific investigation into the significance of Colorado's rural ranching communities and mountainous landscapes.

contracts (Land Trust Alliance 2000). Table 2.2 describes land trust activity in the eight western states and their usage of conservation easements in agricultural land protection.

TABLE 2.2 LAND TRUST ACTIVITY IN EIGHT WESTERN STATES

			Protected Acres		
	# Private Land Trusts	Total Acres Protected (1,000 acres)	Percent Acres Owned	Percent Acres Under Easement	Percent Transferred and/or Other
Arizona	10	38.2	5%	4%	91%
Colorado	37	339.1	2%	87%	12%
Idaho	8	36.5	15%	45%	40%
Montana	9	505.7	1%	89%	10%
Nevada	2	12.2	57%	0%	43%
New Mexico	8	271.6	85%	15%	0%
Utah	4	56.5	2%	50%	48%
Wyoming	3	40.8	3%	26%	70%

Source: Land Trust Alliance, 2000 Cenus

Table 2.2 reflects total land-use policy options that land trusts are engaged in. Given the preferential treatment of Colorado State laws, the proliferation of land trusts in this western state has occurred to a much greater extent then others. Also note that easements are only one of three differing options for agricultural land protection.

2.4 Review of Literature

Research into conservation easements extends into many academic disciplines including appraisal, legal, financial, environmental and economics. With such application into assorted studies, the review is divided into multiple parts.

First is a review of public land-use policy and a market's failure to adequately account for the presence of externalities. The next segment introduces formal economic research of conservation easements and their approaches to theoretical and empirical land protection valuation and pricing models. These studies define land-use decisions in a financial framework for optimal asset investments incorporating both uncertainty (stochastic rents or growth rates) and irreversible (one time conversion) components faced by the landowner and generally assume a permanent nature to all investments (easements) analyses. The third sub-section uncovers all relevant temporary conservation easement research. Also within this section, is a summary of federal conservation programs that are both temporary and voluntary agreements, such as the Conservation Reserve Program (CRP) that in effect proxies as a form of temporary conservation easement placement.

The fourth and final sub-section reviews applied non-market valuation studies. These define the public's value for protecting high amenity agricultural lands and estimate the magnitude and significance for a collective willingness-to-pay through contingent valuation surveys and hedonic approaches to approximate public demand for protecting high amenity public goods or public interest values occurring on agricultural lands.

2.4.1 Public Good, Markets and Land-Use Policy Review

Justification of public policy for agricultural land protection was probably most clearly stated by Gardner (1977). Gardner summed that:

"agricultural land retention legislation is the wrong thing for the wrong reasons... yet the market will not provide the optimal quantities of open space and environmental amenities and more can be justified."

Part of Gardner's argument is that private agricultural land should not be immobilized to reach public goals. Rather, market allocation of prime agricultural land as a resource input is already in its own highest and best use. McConnell (1989) furthers Gardner's argument, in that with a growing society, the demand for amenities from agrarian land can be expected to grow over time, yet this is not necessarily the same as saying the demand for preserving farmland is growing. That is, as the U.S. demand for open space and natural areas grow, agriculture contributes to some subset of these public goods. Lopez *et al* (1994) notes that in highly urbanizing areas, land is under-allocated to agriculture given existing market condition's omission of the potential level of public interest values derived from agricultural lands on the urban fringe. They estimated a twenty-percent under allocation of agricultural land in the northeastern U.S from an optimal social welfare criterion of natural land allocation. Still, Gardner (1977) and Kline and Wichelns (1994) argue that urbanization does not pose a threat to the nation's supply of prime cropland or its ability to produce food and fiber. Growth-related factors such as increasing population, rising land values and recognition of environmental factors such as the prevalence of resource-sensitive lands, play a more significant role in motivating public sentiment to preserve farmland. Wiebe *et al* (1996) further state that concerns about the effectiveness of land-use planning, environmental quality, lifestyle preservation and the viability of local agricultural economies continue to justify attention to farmland protection at the local, state, and national levels.

Abundant economic research has been conducted citing misallocation of public or collective goods through recognition of market externalities (both positive and negative) in quasi-private competitive markets resulting in typical market failures. Public interest amenity values that are jointly produced with private goods on agricultural lands are under allocated due to the market failure to recognize and distribute optimally agricultural land uses generating those values (Bergstrom 2001, McConnell 1989, Crosson 1985 and Gardner 1977).

It is from this specific type of market failure that conservation easement agreements were first created. Their placement attempts to internalize a positive externality. In a slightly different view, Libby (1997) also defined the economic framework for which conservation policy and farmland protection should operate. The author concludes that no single land-use pattern or policy can be solely identified as economically efficient and there is a need for different and alternative institutional and industrial approaches for social welfare improvement given the irreversible nature of agricultural land conversion and uniqueness of *PIVs* on the urban fringe. That is, conventional conservation easement agreements are not the sole policy tool necessary for effective land-use policy.

2.4.2 Economic and Financial Investigations into Agricultural Land and Conservation Easement Valuations

Bick and Haney (2001), Gustanski and Squires (2000) and Daniels and Bowers (1997) all provide current and complete overviews of conservation easements and their usage throughout the U.S. Each cites conservation easements as the most common and fastest growing agricultural land protection policy tool in the U.S. They all recognize that conservation easement placement by private land trusts (non-governmental organizations) as well as relevant governmental agencies play a central role in offsetting social losses due to excessive urbanized encroachment on agricultural lands.

General economic modeling and investigation of conservation policy tools is most clearly delineated by several USDA-ERS studies. Wiebe *et al* (1997) and Wiebe *et al* (1996) examine land ownership and the evolving public role in influencing land-use and agricultural conservation policy. Both studies focus on the voluntary acquisition and conveyance of conservation easements and other partial interests in land. Their basic hypothesis is that conservation easement contracts involve the acquisition of future development rights and their valuation is determined by standard appraisal methods (income stream approach). They consider improving valuation through real option theory, but even with this approach, for a given parcel under consideration, neither the development rents nor the conversion time are observed and appraisers must make explicit assumptions about these values. Ultimately, they conclude the need for additional consistent research that would facilitate ranking or weighing of multiple easement opportunities within or across landscapes. Buist *et al* (1995) further examine the economic principles, issues and problems underlying farmland protection programs. Purchase of development rights (PDR's) programs are defined for approximating the cost of protecting societal interest values. The authors ultimately conclude that conventional valuation procedures may systematically overprice easements by exaggerating the returns a parcel would generate if converted to urban use today and simultaneously under price easements by failing to recognize the true option value of waiting to convert at a socially optimal future date.

A comparison study by Boyd *et al* (1999) found that incentive based tools such as conservation easements may be preferred to more regulatory traditional methods of property taxation. However, easements maintain inherent problems themselves including difficulties associated with the long-term enforcement and monitoring of land use restrictions, the lack of market prices as indicators of value for appraisal and the way in which incentives of this type target specific properties for protection.

Tegene *et al* (1999) provides one of the first complete economic analysis of perpetual conservation easements from a landowner's perspective. They define a landowner's decision to convert farmland to urban use as an irreversible investment under uncertainty. They attempt to improve on conventional conservation easement valuation by incorporating real-option theory into easement valuation to account for uncertain future urban rents.[15] Following this strategy, they extend modeling convertible agricultural land as an investment opportunity and focus on valuation of the option to convert as equivalent to a conservation easement value and derive a real options premium that is added to conventional valuation. A recent study by Plantinga and Miller (2001) also draws from Tegene *et al* (1999)'s development right valuation model approach and they empirically estimate a simplified and modified linear model for both the price of convertible agricultural land and potential developmental rights value in upstate New York. While their approach overcomes problems associated with standard appraisal methodology, they still hold that conservation easement exchange values are equivalent

[15] Their method comes directly from advancements in financial and economic theory of irreversible investment under uncertainty developed by Dixit and Pindyck (1994).

to the underlying developmental land-use opportunity costs and hold landowners as solely price taking agents in their land allocation decisions, which reflects in agricultural land market prices.

Research of financial valuation and optimal urban land development decisions has been most clearly put forth by Capozza and Helsley (1989). They developed a dynamic land-use decision model for urban lands where land prices were concluded to contain four additive components: the value of agricultural land rent, the cost of urban conversion, the value of accessibility, and the value of expected future rent increases (growth premium). They deduced that the growth premium easily accounted for half of the average price of land including agricultural lands with possible future conversion. Capozza and Sick (1994) extend this modeling to provide a sophisticated tool for valuing convertible agricultural land-use decisions. They focus on timing and intensity of urban development by integrating spatial and asset pricing theories that characterize the spatial and temporal risk structure of the land market. Capozza and Li (1994) extend even further a land-use decision model of capital investment involving the choice of both the timing of investment and the intensity or level of capital investment.

These financial models theoretically define permanent farmland conversion decisions (land-use decisions) as a financial option from the perspective of the agricultural landowner. In particular, Capozza and Sick (1994) and Capozza and Li (1994) have shown that agricultural land is a real asset with an attached perpetual American option to convert to urban use. They both conclude that real option valuation methodology can be used to value convertible agricultural land.

Modeling the value of convertible agricultural land under these approaches assumes agricultural land is a strict capital investment with two explicit capitalized rent streams: net urban and pure agricultural returns given underlying assumptions about their underlying future uncertainty. No significant non-market public amenity values are incorporated or directly estimated as misallocated in the land market. In addition, no account is made for the presence of private interest values on agricultural lands are held by a landowner.

Economic literature suggests that agricultural land also derives part of its value from an additional non-consumptive use rent. Stewart and Libby (1994) advocate that landowners derive an intrinsic enjoyment from the location or quality of land. This type of value represents a non-market or personal value that landowners claim as attractive for agricultural land ownership. In addition, Rowe *et al* (2001) show that personal motivations ranked much higher than market factors (including non-agricultural rents) for maintaining agricultural land-uses in two rural Colorado counties.

Appraisal valuation literature holds conservation easement valuation as the subject of many legal and economic debates since valuation has focused on protection of public interest values (non-market values) as proxied by the general opportunity cost of agricultural land's net development (market) value. Kayser (2000) and Schwab (1994) point out that the IRS requires landowners that donate conservation easements for tax purposes to estimate the fair market value of the said easement or covenant. Since few contemporary markets exist for public interest value protection, the IRS permits the before and after valuation procedures for estimating a permanent conservation easement value. Therefore from a legal aspect, the value of a conservation easement is thus equal to its negative effect on the economic uses of the land it encumbers. But Mundy and Adams (1991) point out that public interest values tend to grow at a non-linear rate over time due to increasing scarcity of unique amenities combined with a growing (population) demand for high amenity public goods. This rate of growth is independent and separate from urban-use growth rates. They conclude that conventional appraisal methods may not fully incorporate this differential growth rate since it is increasing with time for a non-market amenity good relative to traditional urban growth rates.

2.4.3 Temporary Conservation Easement Valuation

The preceding conservation easement valuation literature (financial, economic, and appraisal) has focused on permanent or fee-simple valuation for a conservation easement contract. This is based on optimal developed land-use valuation model that assumes an "irreversible" aspect from conversion away from agricultural uses into a permanent use more intensive condition. The assumption holds that the expected re-conversion costs always exceed the returns to less developed land values (one-way development). But agricultural land-use policy may necessitate the legal and economic need for less than permanent or temporary agreements. Kueter and Weston (2000), Chever (1996) and Korngold (1984) all advocate that the permanent nature of conservation easement placement has significant legal and financial drawbacks (which in turn become economic concerns) to both landowners and conservators. Stipulation of a single land-use placed "in gross" is likely inter-temporally inefficient with meeting land-use needs of both the relevant future landowner and society. Judicial courts have been concerned with long-term conservation enforcement since they have traditionally favored a tacit legal "anti-restriction" policy disfavoring perpetual covenants. This occurs when the burden of the easement places such restriction on the underlying possessory interest that its alienability is extinguished. Korngold (1984) asserts courts in turn have severely limited legal land-use covenants that stalled basic economic development, hindered marketability and thwarted future land-use needs. Just as developed land-uses are considered irreversible, permanent covenant conservation easement placement is held against all future land-uses and subsequent landowners of the subject agricultural land. Therefore in valuation, just as there is a need to account for uncertainty with irreversible conversion a likewise effort must be made to account for the irreversible decision to permanently protect agricultural land.

Alpe and Mucklow (1997) and Pattison (1986) have suggested alternative temporary conservation easement valuation methods. They describe six and eight approaches, respectively, for estimating temporary restrictions on property. These represent either a modification from an estimated fee-simple easement value or direct market based valuation (bidding) for the period of protection. Neither extends investigation into *WTP* and *WTA* differences but both implicitly assume conservation easement market equilibrium to exist with temporary valuation.

Other explicit market examples exist with respect to quasi-conservation leases and/or temporary restricted land-use easements. Most commonly cited are the USDA's Conservation Reserve Program (CRP) and Wetland Reserve Programs (WRP). These involve finite-term restrictions on the use of agricultural land with highly erodible soil and other environmental sensitive characteristics. Weibe *et al* (1996) analyze CRP and

WRP with respect to the acquisition of partial interests in private land in order to accomplish resource conservation and other objectives. The authors also cite that CRP agreements are in effect temporary conservation easements.

In a separate CRP study, Lant *et al* (1995) estimated possible new enrollment of highly erodible land into 10-year and 30-year CRP easement agreements for filter strips and recharge areas in the Corn Belt region of the U.S. The difference in rates offered were held constant with 30-year lump sum payments equivalent to 10 times the annual CRP rates for a 10-year contract (9.3% discount rate). Potential enrollments were hypothetically higher for 10-year CRP contracts than for a 30-year easement at the equivalent price incentive. This indicates a landowner temporal-preference for short-term contracts over longer-term agreements all else equal, which in turn may influence and enhance overall participation of any conservation policy or program through recognition of landowner responses to voluntary land protection programs of differing tenure.

Less abundant is economic literature on the formal and theoretical modeling of long-term real-property leases for undeveloped land-uses. But Capozza and Sick (1991) provide a strong theoretical analysis for evaluating relevant urban land-use choices for specified periods. They outline a financial model for valuing leased urban properties. Their analysis questioned why there was empirical evidence of significant discounts to long-term lease (80-100 years) values to real property compared with fee-simple land values. They postulate that the large part of the discount of leased properties from fee-simple properties can be explained by the "option to re-develop" maintained by the landowner. This is analogous to the issue of conservation easement term discounts from fee-simple (perpetual) value easements since the "option to develop" is retained by the landowner and released by a land agent at the end of the specified period.

2.4.4 Amenity Valuation Literature

Applied economic studies are numerous in estimating *PIVs* on agricultural lands. Ready *et al* (Fall 1997), Rosenberger and Walsh (1997), Bowker and Didychuk (1994), Beasley *et al* (1986), Bergstrom *et al* (1985), and Halstead *et al* (1984) each perform contingent valuation studies (CVM) for estimating the social benefits from protecting private agricultural lands. They focus on a household's willingness to pay via stated preference surveys for preserving agricultural land's *PIVs* by the tax-paying or voting citizens in the landscape where convertible agricultural lands are valued. Bergstrom *et al* (1985) and Bowker and Didychuk (1994) both concluded that no farmland protection program could be justified given the estimated non-market benefits are not sufficient to justify the cost of purchasing agricultural open-space in South Carolina and Canada, respectively. But Beasley *et al* (1986) and Halstead (1984) both concluded that public protection programs could be justified to capture public interest values in Alaska and Massachusetts respectively, if all benefits (local and visitors or internal and external) are included. Rosenberger and Walsh (1997) and Ready (1997) conclude that there is evidence of public support for land-use protection policies, but if a lesser populated landscape (community or county) is measured in terms of only local benefits, there may be inadequate support to offset greater market rents for any substantial threshold of acres protected. For a better comparison of society's estimated value for protection, Table 3 illustrates each study's *WTP* to protect an acre of convertible agricultural land for their respective landscape. All studies are adjusted to a common date and combined with current census household population estimates to provide current estimates of annual rental streams to protect an acre of convertible of agricultural land.

TABLE 2.3 SELECTED AGRICULTURAL LAND PROTECTION STUDIES AND ESTIMATES OF GEOGRAPHIC *WTP*

Study	Date	Geographic area	Households in Study Area	Good Valued	Method	Annual Value per 1000 Acres per Household (2001 dollars)	Annual Social Rent or *WTP* per acre
Bergstrom et al	1985	Greenville County South Carolina	149,556	Agricultural land	CVM	$0.22 - 0.56	$33
Beasley et al	1986	Natanuska-Susitna Valley Alaska	20,556	Agricultural land	CVM	$18.13	$373
Bowker and Didychuk	1994	Moncton Area New Brunswick, Canada	43,603	Agricultural land	CVM	$1.12 - 2.53	$49
Halstead	1984	Deerfield, East Longmeadow and Greenfield Townships Massachusetts	15,643	Agricultural land	CVM	$18.4 - 51.43	$288
Ready et al	1997	Average County Kentucky	13,255	Horse farms	CVM	$4.48 - 5.10	$59
Rosenberger and Walsh	1997	Routt County Colorado	7,963	Ranch land	CVM	$5.23 - 9.24	$42

Households based on 2000 Population Census and 2000 Canada Statistics

Annual values per household inflated to year 2001 dollars using April 2001 CPI

Annual social rent is product of minimum annual value with households in study area

Source: Hamlich and Anderson (June 2001) Table 4 pg 46.
Ready *et al* (1997)

Study results for annual social values per protected agricultural land acre as described in Table 2.3 show the majority of annual rents range between $33-$59 per acre. Two other studies show much higher *WTP* for agricultural land in Massachusetts and Alaska. These authors independently justify their greater rents on scarcity but for differing reasons. In Massachusetts, there is a greater population density relative to agricultural land and a general desire to balance development against agricultural land amenities. In Alaska, with an overall greater total of undeveloped land, the author's cited a relative scarcity of developable agricultural land near developing areas driving the value of protecting agricultural land higher.

A different econometric approach was performed by Lopez *et al* (1994), they estimated a supply and demand system for agricultural land that incorporated a marginal social benefits curve by inclusion of previous CVM willingness to pay studies (exogenous variables) for agricultural land in the northeast. This approach provides a framework for integrating two strands of literature: conceptualization of optimal land allocation and empirical CVM studies which estimated a total and marginal *WTP*. The authors concluded that social welfare would be maximized with about 20 percent more agricultural open space near urban centers.

A general and more recent study of Colorado by Loomis *et al* (2000) performed a basic meta-analysis of the non-market benefits literature with reference to Colorado agricultural land. Their synthesized results indicate that significant market transactions and placement of conservation easements incorporated a wide variety of captured public interest values. Their cumulative conclusion justifies continued agricultural land-use policy to operate and recognize market tools like conservation easements that provide possible improvements to social welfare.

Together, these former studies focus on the willingness-to-pay by society. Fewer studies have researched the willingness-to-accept land-use protection or conservation restrictions by landowners. Lant *et al* (1995) surveyed landowners in the Corn Belt region of the U.S. for acceptance of additional long-term CRP agreements. They conducted two separate but related surveys (mail and in-person interviews) to determine landowners' potential response to continuing the slightly modified CRP and a substantially longer contract for 30-year easements for cropland retirement. Respondents were surveyed in a CVM format across rental and lump sum payments schedules (10- and 30-years, respectively) and significant threshold levels of participation were estimated. In all cases the response for new participation was greater for 10-year contracts over thirty year contracts. They concluded improved response of participation could be attained for the 30-year contracts with modification to a preference of annual payments.

In a Northeastern U.S. landowner conservation easement survey, Elconin and Luzadis (1998) inquired about donor motivation and satisfaction from conservation easement placement. They concluded that motivation for placement was primarily triggered by personal attachment to the land, sense of altruism and commitment to stewardship. Their lowest levels of satisfaction were observed in tax and financial matters. The authors did note that successive or second generational landowners were less satisfied and would change their conservation easement if given the opportunity. A Colorado landowner study by Hoag *et al* (2001) found similar results as Elconin and Luzadis. A targeted sample of Colorado landowners was surveyed regarding their satisfaction with conservation easement placement. Results indicated that "maintaining agricultural land-use" was the most realized goal. Alternatively, expected financial goals were the least realized in the end. Thus, motivations for land protection stemmed more from tenure with less regard to financial improvements. Landowners that considered but chose not to place a conservation easement also cited inadequate financial compensation as their primary reason for not placing a conservation easement.

CHAPTER 3 METHODOLOGICAL ANALYSIS

This chapter defines the economic modeling necessary to analyze the objectives of the dissertation previously stated in chapter one. This involves enhancing conventional conservation easement valuation by establishing separate landowner and land agent economic models in an attempt to better understand the motivations of each accounting stance that together provide an improved measure of social welfare gains from agricultural land protection.

The approach begins with defining and conventionally modeling the valuation of an acre of convertible agricultural land through capitalization of future rental streams, contingent upon irreversible optimization of a one-time conversion into some other higher valued and more intensive land-use. This specification is then extended for the specific presence of non-market natural amenity attributes and personal factors that influence land valuation and significant to agricultural land ownership. Principal agricultural land valuation components are then isolated to derive separate conservation easement valuation models for alternative accounting stances involved in agricultural land protection based on the differential or residual growth values above agricultural returns influencing the price of agricultural land.

Agricultural landowners have a *WTP* for agricultural land-uses that in turn derives their *WTA* conservation easements via supply of convertible agricultural land for protection purposes. On the other hand, conservators, governmental organizations and land trusts in aggregation act on behalf of society's desire to protect or capture some vector of natural capital goods or *PIVs* accruing on private agricultural land. These entities serve to represent society's desire for maintaining agricultural land usage beyond what private market conditions indicate and represent land agent' *WTP* for protection. The valuation models are then furthered into a temporal optimization analysis since both landowner *WTA* and land agent *WTP* for *PIVs* protection are valuation choices of alternative optimal time paths for agricultural land conversion. Finally, a land agent's decisions for agricultural land protection are modeled in light of constrained optimization and choice among alternative parcels in time and space tradeoffs.

3.1 Conceptual Framework: Market Valuation of Agricultural Land

From a fundamental asset equation in a competitive land market, the price of agricultural land today equals the present discounted value of all future rental streams of land-uses generated with ownership. In its purest form, agricultural land can be treated as a differentiated factor of production and the implicit prices of constituent characteristics may be identified via hedonic estimation of land valuation (Plantinga 2001). That is, the price of agricultural land is a strict function of its productive capacity that is dependent on its underlying physical characteristics as an input in the production of agrarian and other market-based goods and services. This implies a landowner derives a temporal and irreversible land-use choice of sequential highest and best uses for optimal valuation of agricultural land. In landscapes with competing market-based land rents, a landowner's optimal land-use decision is the choice of a time path of rents that maximizes agricultural land's value. This defines a future one-way conversion from its traditional agrarian practice into other principally greater socially valued developed uses.

Consider today's price of agricultural land that anticipates the potential conversion to future non-agrarian uses in order to capture greater urban rents. Land is held in an agrarian state until other higher valued uses overcome current agrarian rents and an optimal financial decision is made to convert.

The market price of an agricultural acre today (t=0) faced by buyers and sellers is:

$$MP_{ag}(0) = \int_{0}^{T_{con}} Ae^{((\lambda - r_{ag})t)}dt + \int_{T_{con}}^{\infty} Ue^{((\alpha - r_{ag})t)}dt - Ce^{(-r_{ag} * T_{con})} \quad (3.01)$$

Where:	A	agricultural land cash rental rate in time t
	U	net urban land rental rate in time t
	C	conversion cost incurred when agricultural land is converted to urban use at $t = T_{con}$, with $T_{con} \in [0, \infty]$
	λ	growth rate for future agricultural rents $\lambda \sim N(\mu_{\lambda}, \sigma_{\lambda})$
	α	growth rate for urban rents $\alpha \sim N(\mu_{\alpha}, \sigma_{\alpha})$
	r_{ag}	agricultural landowner's risk equivalent discount rate

Equation (3.01) states that today's fee-simple price of convertible agricultural land, $MP_{ag}(0)$, equals the capitalized and discounted agricultural rents up to an optimal date of conversion ($t=T_{con}$) plus thereafter capitalized and discounted urban rents less a one-time cost of conversion.

This undeveloped or agrarian land valuation modeling approach follows directly from Plantinga and Miller (2001) Tegene *et al* (1999), Capozza and Sick (1994), and

Capozza and Helsley (1989). Equation (3.01) is the capitalized market value for a productive input (land) in agricultural production. This model holds that a landowner's allocation of land is purely a function of productive market rents generated across time and, given adequate information, a landowner is able to determine a time of conversion necessary to maximize the return on their land investment.

In this model formulation, agricultural and urban rents follow a potential nonlinear growth across time dependent on their respective growth rates. Thus the price of convertible agricultural land necessitates forecasting future rents and becomes a function of all underlying stock rents plus potential future temporal growth rate changes. Each rental stream is defined by:

$$A_t = A\,e^{\lambda t} \quad \text{and} \quad U_t = Ue^{\alpha t}$$

In this framework, a landowner's investment decision for determining its reservation price for agricultural land is dependent upon determining an optimal date of conversion to capture the highest and best sequential land-use rents available.

However, if agricultural land produces differing rents simultaneously (including non-market) then land valuation becomes more than an input factor choice but a combination of input and output rents that reflect an individual landowner's expected combination of future returns, which in turn influence an optimum conversion date. This endogenous determination of multiple rent flows defines a landowner's reservation price of agricultural land that in turn influences the market valuation.

For example, the integration of (3.01) results in equation (3.02), which shows that today's price of convertible agricultural land, is strictly equivalent to capitalized agricultural and urban rents:

$$MP_{ag}(0) = \frac{A}{r_{ag} - \lambda}(1 - e^{(\lambda - r_{ag})T_{con}}) + \left(\frac{U}{r_{ag} - \alpha} e^{((\alpha - r_{ag})T_{con})} - Ce^{(-r_{ag} * T_{con})} \right) \tag{3.02}$$

(a) (b) (c)

Equation (3.02) illustrates that if a landowner were to separate the net urban rents (c) and extinguish them, either though a sale or deed restriction covenant [(a) - (c)], the only remaining value for previously convertible agricultural land would be the pure capitalized agricultural value (b). If a landowner sold this restricted agricultural land for anything greater than the capitalized agricultural rents (b), then the price of agricultural land as described in (3.02) would be misspecified by omission of a key rent-producing land-use value. If a positive urban residual value did remain, the resulting inequality would result:

$$MP_{ag}(0) - \left(\frac{U}{r_{ag} - \alpha} e^{((\alpha - r_{ag})T_{con})} - Ce^{(-r_{ag} * T_{con})} \right) \geq \frac{A}{r_{ag} - \lambda}(1 - e^{(\lambda - r_{ag})T_{con}}) \tag{3.03}$$

Equation (3.03) describes that rent producing uses can be separated and/or isolated, yet as use values are extinguished, market valuation should reflect remaining rent producing characteristics. Land ownership is commonly described as a bundle of uses and the makeup of that bundle can change. Thus, the market value of agricultural land ought to reflect the summation of all permitted rent producing benefits.

With that economic necessity, recall land valuation literature in chapter two suggests that certain agricultural lands derive part of their value from a non-market rent that landowners (asset investors) individually recognize in their land allocation choices and reflects their reservation price held, which ultimately will reflect market prices paid for agricultural land. Both Rowe *et al* (2001) and Elconin and Luzadis (1998) have shown that personal motivations for agricultural land ownership influenced landowner's decisions (exhibited in their reservation price) more than strict market factors. Thus, part of agricultural land's value is generated from a non-market rent component that creates agricultural land-use value by the presence of its own natural amenities or some combination of personal factors that a landowner captures with private agricultural land ownership. This non-market rent holds agricultural land as attractive to own, control or gain value from the land itself.[10]

As such the market price of agricultural land as specified in (3.01) does not reflect a landowner's reservation price containing any non-market rent component. If agricultural land's market price implicitly incorporates some amenity rental value, exhibited through greater landowner reservation prices, then the current valuation overweighs or biases each right hand side component by the specified omission of a landowner non-market amenity rent influencing agricultural land valuation.

[10] Land itself becomes a good, valued for its own sake and possibly grows with time. Its use is non-consumptive in nature but still influences land allocation choices for these values hold land out of the capital market for land as an input. For example it could be the pride in maintaining family ownership, family heritage or traditional lifestyle that negatively influences a landowner at any particular point in time in allocating its land into other more productive land-uses.

3.2 Conceptual Framework: Agricultural Land Valuation and Externalities

With the recognition that some non-market benefits are reflected in the market price of agricultural land, equation (3.01) is advanced to include a non-market private amenity rent (*PAR*) that yields value to agricultural landownership that in turn influences its market price. More specifically, this attribute can be thought of as a scalar rent being the product of a quantitative vector of (n) differing attributes multiplied by a corresponding qualitative weight or non-market price vector. This rent product is also dependent on time: present (current enjoyment including heritage), and future (endowment and legacy) that grows with continued ownership.

A private non-market amenity rent reflected in agricultural land ownership value is different than other market rents since it reveals an exclusive or quasi-public good type attribute. That is, the public/private characteristics of the quantitative attributes vector will vary with respect to the good, such as open-space or critical habitat and will also vary with a landowner's weight held for that attribute. The following land valuation conceptual relationships improve (3.01) by accounting for a scalar amenity rent from the perspective of three valuation stances for an acre of agricultural land. Under these alternative accounting stances, a non-market amenity rent ranges from an individual landowner rent to a cumulative societal *PIVs* rents, depending on the characteristic preferences of the particular landowner or accounting stance. The value of an acre of agricultural land will vary as shown in conceptual equation's 3.04a, 3.04b, and 3.04c. The corresponding reservation price for accepting protection (and date of conversion) will vary from pure market returns valuation with no amenity to an alternative type of landowner whose non-market private amenity rents represent a significant portion of agricultural land's overall value (depressing conversion incentive) and approach a greater portion of the social amenity rent. Consequently, conversion is postponed by the extent of this greater non-market rent hurdle. At the far end of this landowner spectrum (social or collective landowner) exists amenity valuation for an acre of agricultural land that approximates societal *PIVs* and conversion will not voluntarily occur or is shifted outward in time to approximate the social date of conversion (T_{soc}).

Landowner:	$RP_{ag(i)} = f(A, U, C, PAR_i)$	$PAR_i = g_i(b_{1i}X_1, b_{2i}X_2, \ldots, b_{ni}X_n)$	(3.04a)
Market:	$MP_{ag} = f(A, U, C, PAR)$	$PAR = g(\beta_1 X_1, \beta_2 X_2, \ldots, \beta_n X_n)$	(3.04b)
Social:	$SP_{ag} = f(A, U, C, PIVs)$	$PIVs = g(\mu_{B1}X1, \mu_{B2}X_2, \ldots, \mu_{Bn}X_n)$	(3.04c)

In each stance, the price of agricultural land is directly influenced by a weighted array of non-market rents beginning with a unique and individual landowner's reservation price (4a) up to the cumulative social non-market vector present in the collective value for an acre of agricultural land (4c). A landowner's individual valuation (4a) is equivalent to (4b and 4c) in terms of the market rental components but represents only a single observation within the distribution of the market average or expected private amenity rent, i.e. $b_i \sim N(\beta, \sigma_\beta)$ in (4b) and a single member of the cumulative social value where, [$\Sigma\, b_i = \mu_{Bi}$] in (4c).

At the market level (3.04b), the price of agricultural land represents an average or expected value within a distribution of individual exchanges. While this is the only price directly observable, a market's collection of current buyers and sellers represents only part of society's total value due to the exclusiveness and rivalness of individual landownership recognized in the marketplace. This proportion is represented by β, a market fraction of the pure social amenity rent ranging between $[0 \leq \beta_i \leq \mu_{Bi}]$ depending on the degree of public good characteristics an attribute holds or the type of landowner valuing the private amenity characteristics.

At the pure social level of agricultural land ownership, all members of society have a cumulative weight or non-market price to represent societal WTP for agricultural land protection, $[\Sigma\, b_i = \beta = \mu_B]$. Alternatively, agricultural land with no social amenity value yields $[\Sigma\, b_i = \beta = 0]$ and there is no net positive externality gained with protection.

Equation (3.04c) represents the collective value of convertible agricultural land in the presence of a positive market externality rent. In the presence of a natural capital amenity or *PIVs* market externality there exists a social value for agricultural land that is greater than its market price. The social value would be less than the market price with a negative externality occurrence, such as noise or dust spillovers as well as non-point source water pollution.

The following specific definition for a private amenity value describes the valuation of an array of non-market interest values influencing the market price of convertible agricultural land:

$$PAR = \Sigma\,(\,B_{(1xn)} * X_{(nx1)}\,)] \qquad (3.05)$$

$B_{(1xn)}$ qualitative vector of attribute weights or non-market prices for all n amenity attributes within an average agricultural acre. This represents an average non-market price or weight vector across all acres within a market or landscape.

$X_{(nx1)}$ quantitative vector of levels for all n amenity attributes per agricultural acre. This represents an average attribute quantity vector across all acres within a market or landscape.

Equation (3.01) is rewritten to incorporate landowner *PAR* as conceptually described in (3.04b) and explicitly defined in the following modified market price of agricultural land:

$$MP_{ag}(0) = \int_0^{T_{con}} A \bullet e^{((\lambda - r_{ag})t)} dt + \int_0^{T_{con}} PAR \bullet e^{((\delta - r_{ag})t)} dt + \int_{T_{con}}^{\infty} U \bullet e^{((\alpha - r_{ag})t)} dt - C \bullet e^{(-r_{ag} * T_{con})} \quad (3.06)$$

Where: $PAR_t = PAR * e^{\delta t}$

δ growth rate for private amenity rents
$\delta \sim N(\mu_\delta, \sigma_\delta)$

This rent is assumed positively correlated with agricultural land-uses and negatively correlated with any other more intensive land-use. Like productive agricultural rents, private amenity rents also exhibit growth dependent upon δ. *PARs* are given up or lost upon conversion to more intensive land-uses.

Expanding (3.6) and taking the limit of each integral with respect to time ($t \rightarrow \infty$), yields the following capitalized market value for agricultural land.

$$MP_{ag}(0) = \underbrace{\frac{A}{r_{ag} - \lambda}\left(1 - e^{((\lambda - r_{ag})T_{con})}\right)}_{(i)} + \underbrace{\frac{PAR}{r_{ag} - \delta}\left(1 - e^{((\delta - r_{ag})T_{con})}\right)}_{(ii)} + \underbrace{\frac{U}{r_{ag} - \alpha} e^{((\alpha - r_{ag})T_{con})}}_{(iii)} \underbrace{- Ce^{(-r_{ag} * T_{con})}}_{(iv)} \quad (3.07)$$

Equation (3.07) states that the fee-simple market price of agricultural land today incorporates four components: (i) the present value of captured agricultural rents growing at λ up to conversion and lost there after, (*ii*) the present value of capitalized *PARs* growing at δ up to conversion and also lost there after, (*iii*) the present value of capitalized future urban rents growing at α after conversion and (*iv*) the present value of constant capital conversion costs incurred with urban use. Equation (3.07) includes all of (3.02) plus capitalized private amenity rents (ii). In all cases, the valuation of convertible agricultural land hinges upon a future date of conversion. This implicit determination is also critical with the decision to forego conversion with placement of a conservation easement.

Equation (3.07) reflects the market price of convertible agricultural land, yet any individual owner may have a different reservation price depending on their particular capitalized *PAR* value. While market rents remain unchanged across landowners, actual *PARs* are individually unique and agricultural land's market price captures only a reflection of individuals in the market and a portion of the cumulative *PIVs*.

3.3 Landowner's Decision to Convert and Conservation Easement Valuation

A landowner's decision to convert agricultural land is dependent on the economic signals within society. As economic growth (population and income) spurs the demand for land-dependent goods and services (*U* rents), it creates alternative incentives for an agrarian landowner to offset current agricultural and private amenity rents by higher land-use values. From a societal perspective, gains from conversion increase overall social welfare until *PIVs* lost outweigh the net developmental value gained on an acre of converted agricultural land. Since a landowner recognizes only *U*, *A*, and *PAR* but not *PIVs*, a landowner's decision to convert will not reflect society's agricultural land valuation or social date of conversion. Thus, land agents that act on behalf of society must determine the compensation necessary to induce a landowner to voluntarily keep a parcel of convertible agricultural land in its current less-intensive use for a period of time (protection length) that is equivalent to what society would choose as the optimal social date of conversion.

A landowner holds possessory interest in agricultural land-uses based on its investment return (including non-market rents) yielding a landowner *WTP* for and the underlying reservation price of ownership itself. Therefore, what drives a landowner's *WTP* for agricultural land is also in turn what derives some compensation amount necessary to equate with that same landowner's *WTA* voluntary protection. Thus, a landowner's opportunity cost of agricultural land in protection uses is its underlying alternative land-use rents.

Since conversion involves an irreversible decision, the current legally accepted approach for deriving a landowner's *WTA* is based on the perpetual capitalized residual growth value in agricultural land above its capitalized agricultural rents. This is a landowner's conservation easement value for perpetual protection and is derived from (3.07). Given the general requirement for permanent agreements, fee-simple easement valuation focuses on the market price of agricultural land less its underlying capitalized agricultural rents. This non-agrarian growth value approximates the residual growth value of agricultural land. This is found in:

$$\underbrace{\left[MP_{ag}(0)-\frac{A}{r_{ag}-\lambda}\right]}_{(i)}=\underbrace{\left[\frac{PAR}{r_{ag}-\delta}(1-e)^{((\delta-r_{ag})*T_{con})})\right]}_{(ii)}+\underbrace{\left[\frac{U}{r_{ag}-\alpha}e^{(\alpha*T_{con})}-\frac{A}{r_{ag}-\lambda}e^{(\lambda*T_{con})}-C\right]*e^{(-r_{ag}*T_{con})}}_{(iii)} \qquad (3.08)$$

Equation (3.08) shows that convertible agricultural land's residual growth value differential (*i*) is equal to a capitalized *PAR* value (*ii*) along with a conventional "option to convert value"[17] (*iii*).

In contrast, the conventional conservation easement appraisal approach from (3.01) holds this market residual growth value (*i*) to approximate a landowner's true conservation easement value or reservation price for development. But this same market price differential (*i*) from (3.01) fails to disaggregate the residual growth value into important secondary components contained within this valuation difference (*ii* and *iii*) as shown in (3.08).

In current form, the left hand side of (3.08) does represents the total growth in agricultural land value above pure agricultural rents but represents a landowner's *WTA* development not a landowner's *WTA* protection. This is because the capitalized *PAR* value (*ii*) is foregone with conversion but retained with a conservation easement agreement.

Since market-based appraisals are unable to distinguish the *PAR* component (*ii*) within (*i*) in (3.08), conventional appraisal estimates for conservation easement valuation are overstated in the presence of any landowner capitalized *PAR*. A landowner's true perpetual conservation easement value recognizes that pure capitalized private amenity rent is retained with protection and thus brought to the left hand side to equal:

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[17] Tegene *et al* (1999) (pg. 207) defined only the market terms on the right hand side of (3.08) to be a developmental option to convert value equal to the amount of compensation a well-informed landowner would require if the landowner were to give up the right to develop his/her agricultural land today with conversion to an urbanized use at $T_{convert}$.

$$CEV_{ag}(0) = \left[MP_{ag}(0) - \frac{A}{r_{ag} - \lambda} - \frac{PAR}{r_{ag} - \delta} \right]$$

$$= \left[\frac{U}{r_{ag} - \alpha} e^{(\alpha * T_{con})} - \frac{A}{r_{ag} - \lambda} e^{(\lambda * T_{con})} - \frac{PA\mathrm{Re}^{(\delta * T_{con})}}{r_{ag} - \delta} - C \right] * e^{(-r_{ag} * T_{con})} \qquad (3.09)$$

This in effect lowers a landowner's *WTA* protection below its developmental option value (i) from (3.01). Equation (3.09) is still dependent on a future date of irreversible conversion but reflects the present value of a landowner's permanent conservation easement as $CEV_{ag}(0)$. The right hand side of (3.09) represents a landowner's "true option to convert value," which requires future urban rents to be greater than currently accruing agricultural and private amenity rents given up and necessary conversion costs incurred. Specification of (3.09) also shows that a landowner's conversion date is postponed beyond what strict market conditions would deem optimal given the presence and real loss of capitalized *PAR* values.

With the preceding valuation approach, a landowner's only real decision for maximizing its investment return on an acre of agricultural land has been the determination of an optimal date of conversion reflected in a landowner's reservation price and any particular landscape's market price of agricultural land. Under normal market conditions of full information, a landowner chooses the optimal date of conversion, T_{con} to maximize the right hand side value of (3.09). To solve for the optimal time to convert, differentiate (3.07) with respect to T_{con}, and then set that partial differentiation result equal to zero. The optimal conversion date is found by solving this first order condition (FOC) for the unknown T_{con}. If urban, agricultural, or *PAR* rents are strictly a monotonic function of time (t), then the optimal time to convert is only when urban rents become equal to or greater than the complete opportunity cost of the current land use. If future rents travel paths are uncertain, then a single time period cannot be determined, rather the choice of the optimal time to convert becomes an implicit function of relevant rents. This can be best described by the marginal developmental hurdle value or the implicit first order condition relationship from (3.07) with respect to (T_{con}) that shows optimal conversion will occur when:

$$Ue^{(\alpha T_{con})} = PA\,\mathrm{Re}^{(\delta T_{con})} + Ae^{(\lambda T_{con})} + r_{ag}C \tag{3.10}$$

This FOC of valuation optimization for convertible agricultural land ensures the choice of a conversion date (T_{con}) that also maximizes $CEV_{ag}(0)$ for accepting permanent land-use protection. Equation (3.10) does show that the optimal date of conversion becomes more imminent when the right hand side option to convert value increases due to greater positive differences between more intensive land use opportunities and agricultural and *PARs*. An optimal T_{con} goes toward infinity as *PAR*, agricultural and conversion values outpace urban rents. Agricultural land has no conversion potential when future urban rents fail to equal or exceed existing and future *PAR* or agricultural rents and the corresponding net option to convert value becomes zero. Any change in the date of conversion directly influences $CEV_{ag}(0)$. From an initial date of conversion, $CEV_{ag}(0)$ increases as T_{con} becomes imminent and decreases as a change in T_{con} pushes outward.

The key and more significant result is with the recognition and addition of a landowner *PAR* value, the hurdle for developmental conversion actually becomes larger and more distant in time due to the necessity for additional urban rental growth to overcome the presence of amenity rents that are also lost with development. And with that, a landowner's true conservation easement reservation price for protection or minimum *WTA* protection actually becomes smaller. This creates a significant disparity between market appraisal valuation developmental difference and a landowner's economic opportunity cost of protection as recognized by a willing landowner.

Figure 3.1 describes the difference in rents captured and extended date of conversion with the recognition of a landowner amenity rent captured in the growth residual value within the market price of convertible agricultural land.

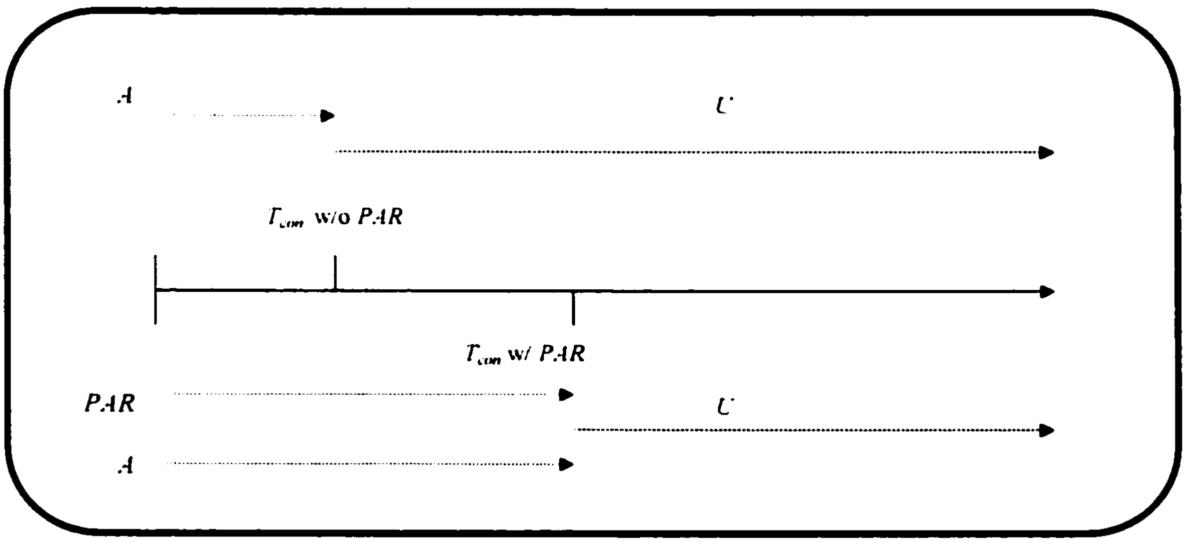

FIGURE 3.1 LANDOWNER CONVERSION TIMELINE WITH AND WITHOUT *PAR*

As shown in Figure 3.1 the size and intensity of a particular landowner's *PAR* value directly affects the optimal choice of a conversion date and the capitalized "true option to convert" value and ultimately determines a landowner's conservation easement value: $CEV_{ag}(0)$. Competing market rent U is weighed against complementary rents A and PAR, rather than just A.

3.4 Temporary Landowner Conservation Easement Valuation

The preceding landowner conservation easement valuation has focused on the "true option to convert" value for an irrevocable decision of conversion at T_{con}. By itself this "true option to convert" value represents a perpetual valuation capitalization based on the irreversibility of more intensive land-uses considered by a landowner since any date of conversion is a one-time event effectively stipulating that land-use thereafter. Yet, if society does not always desire infinite protection agreements, temporary valuation of *WTA* protection by a landowner is necessary for any negotiated exchanges. While actual conversion is economically irreversible, conservation easement restrictions are economically and legally reversible. Thus, a landowner's valuation for less than permanent protection would be equivalent to a lease or temporary valuation of real property interests for a specified period.

To model this less than permanent valuation, Capozza and Sick (1991) defined a 'term specified real property lease' equal to the economic difference between the present value of a fee-simple property minus the present value of the fee-simple property yielded at the expiration of the specified term. This difference represents the discount away from fee-simple value for a temporary real property lease contract given specified duration or tenure. Following this approach, an equivalent definition can be applied to a landowner's valuation of temporary conservation easement agreements.

Consider the following general model for term conservation easement valuation specification for a protection period of T_L, with [$T_{con} < T_L < T_{soc}$].

$$TCE(0) = CEV(0) - CEV(T_L) * e^{(-\gamma * T_L)} \tag{3.11}$$

Where:

	$TCE(0)$	is the present value of a temporary conservation easement for the specified term T_L
	$CEV(0)$	is the relevant permanent conservation easement present value
	$CEV(T_L)$	is the relevant permanent conservation easement present value at the end of the specified tenure $t = T_L$
	$e^{(-\gamma * T_L)}$	is a lease discount factor
	γ	applicable term or net discount factor across the contract period
	T_L	specified tenure of temporary agreement

Equation (3.11) provides a basic conceptual explanation of the valuation discount associated with temporary property ownership or control. From a term conservation easement perspective, a landowner realizes a discount in its *WTA* protection with the recapture of future land-use interests given up during the easement tenure.

Recall a landowner's fee-simple conservation easement value described in equation (3.9). An agricultural landowner's $CEV_{ag}(0)$ is the present value of compensation required today for permanent agricultural land-use restrictions with urban conversion occurring at optimal T_{con}. Therefore, today's conservation easement valuation is based on an optimal future conversion regardless of when T_{con} actually transpires. Given the decision of a future conversion date, a conflict would seem to arise if $T_{con} > T_L$.

Would a land agent today be willing to pay a landowner some compensation for T_L periods of land-use protection when a landowner's own motivation would not voluntarily lead to conversion until after the term protection easement expires? In this case, during the period prior to conversion a landowner's own "true option to convert" value is negative or zero and any *WTA* value would also be negative or zero. In a relative since, conversion occurring beyond some realistic T_L periods of protection represents significantly less value in terms of a landowner's permanent $CEV_{ag}(0)$ today. Thus, while it may be legitimate to consider temporary valuation regardless of when conversion occurs due to possible future rents uncertainty, it is only relevant to focus on agricultural land with impending conversion dates that are less than a specified protection tenure. In either case, an agricultural landowner's term conservation easement value is dependent upon future conversion. The interval of time leading up to conversion and that subsequent interval to the end of the specified tenure are the central and relevant periods that a landowner's term easement valuation needs to consider.

The approach to valuing a landowner's term conservation easement value becomes the determination of the original perpetual conservation easement's diminished value due to postponement of the optimal date of conversion from T_{con} to T_L (recall the landowner's perpetual value is the cost to postpone from T_{con} to T_{soc} = *infinity*). This delayed time interval represents a value loss to a landowner because of foregone higher urban rents that more than offset agricultural, amenity, and conversion values delayed during this period but are realized again at the end of the term. Figure 3.2 describes a landowner's alternative rental streams due to term protection postponement. The top half of this figure describes the rental stream's time line for optimal conversion and valuation with $CEV_{ag}(0)_{T_{con}}$. Alternatively, if a landowner considers T_L periods of temporary protection (and period T_L to convert), then the resulting rental streams captured are represented in the bottom half of Figure 3.2 for $CEV_{ag}(0)T_L$. The period of time between T_{con} and T_L captures the relevant landowner market discount away from fee-simple easement valuation and this capitalized rental loss is a landowner's true term conservation easement value ($TCE_{ag}(0)_{T_L}$).

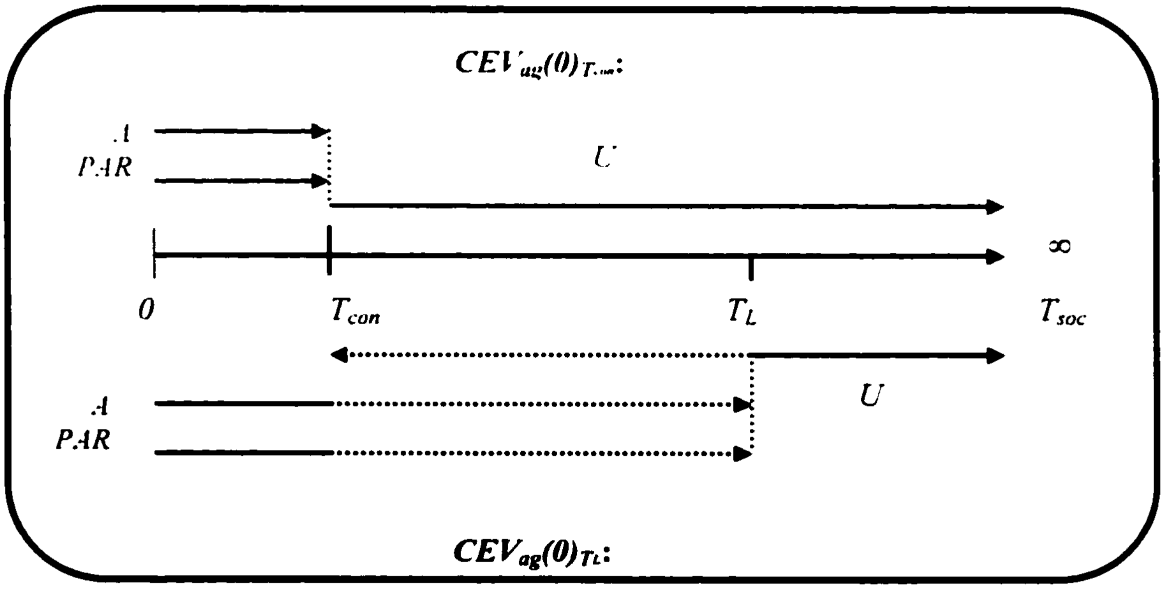

FIGURE 3.2 TIMELINE FOR ACCRUING LANDOWNER RENTS GIVEN A TEMPORARY CONSERVATION EASEMENT CONTRACT PERIOD

A landowner's temporary conservation easement value becomes the difference between permanent conservation easement valuation at T_{con} and permanent conservation easement valuation at T_L. Since a landowner recaptures the "true option to convert" value at T_L, a temporary conservation easement valuation is simply that net or differential value lost from post-optimal conversion. The term value in a sense represents the necessary compensation to keep a landowner financially indifferent with optimal conversion valuation. Therefore, the following integral can derive $TCE_{ag}(0)_{T_L}$:

$$TCE_{ag}(0)_{T_L} = \int_{T_{con}}^{T_L} Ue^{(\alpha - r_{ag})t}dt - \int_{T_{con}}^{T_L} Ae^{(\lambda - r_{ag})t}dt - \int_{T_{con}}^{T_L} PARe^{(\delta - r_{ag})t}dt - C(e^{(-r_{ag} * T_{con})} - e^{(-r_{ag}T_L)}) \quad (3.12)$$

Equation (3.12) describes a landowner's necessary compensation to offset the added loss from delayed conversion with the imposition of a conservation easement agreement through T_L periods.

Expansion of equation (3.12)'s integrals and consolidating factors yields a landowner's term conservation easement value, $TCE_{ag}(0)_{T_L}$ for the contract period (T_L) as:

$$TCE_{ag}(0)_{T_L} = b_1 \frac{U}{r_{ag} - \alpha} - b_2 \frac{A}{r_{ag} - \lambda} - b_3 \frac{PAR}{r_{ag} - \delta} - b_4 C = \left[CEV_{ag}(0)_{T_{con}} - CEV_{ag}(0)_{T_L}\right] \quad (3.13)$$

Where:

$$b_1 = (e^{(\alpha - r_{ag})T_{con}} - e^{(\alpha - r_{ag})T_L})$$

$$b_2 = (e^{(\lambda - r_{ag})T_{con}} - e^{(\lambda - r_{ag})T_L})$$

$$b_3 = (e^{(\delta - r_{ag})T_{con}} - e^{(\delta - r_{ag})T_L})$$

$$b_4 = (e^{-r_{ag} * T_{con}} - e^{-r_{ag} * T_L})$$

Equation (3.13) holds that a landowner recognizes a term conservation easement value by discounting each capitalized rent by a respective differential term discount factor (b_i). Each term discount factor amounts to the foregone or extended capitalized rental value from T_{con} to T_L. Equation (3.13) is equivalent to (3.11) in the sense it does discount away from the perpetual conservation easement valuation model by an amount necessary to compensate a landowner to be indifferent with initial optimal conversion.

3.5 Societal Valuation of Agricultural Land and Role of Land Agent

Now consider the valuation to society for protecting agricultural land from more intensive uses in order to assure *PIVs* production. If a social protection investment yields continual net *PIVs* rental stream, a land agent[18] would be willing to invest in protecting this rental stream up to the point where the value of the last acre protected is equal to the social cost of that acre in an alternative use. From a temporal optimization perspective, a land agent would be willing to invest for a period of time until the value gained to society in terms of the last periods *PIVs* rent is no longer greater than the value gained in a developed use in the subsequent future time periods.

This establishes a land agent's valuation approach for agricultural land protection. Within a landscape, society's valuation gained or its *WTP* for agricultural land protection will equal the present value of anticipated perpetual *PIVs* rents net of transactions cost streams for a given protected acre for a given time period. The decision for and value of protecting a convertible acre is reflected as the net capitalized *PIVs* continually captured net of incurred operating costs with conservation easement agreements.

Recall the social value of convertible agricultural land in (3.4c) includes a cumulative amenity interest rent that is the weighted summation of all individual *PAR*

[18] A land agent in this case is assumed to represent an omniscient social planner that considers all public interest values. Whereas, individual land trusts represent only segments of society as defined by their membership and organization's mission. It is also assumed that a representative singular land agent is held through out the remaining dissertation and represents the summation of all individual land trusts, conservancies and governmental organizations that act to protect agricultural land.

values (for all citizens not just cumulative landowners) society holds for an (n) attribute vector of *PIVs*. But also within (3.4c), market based rents remain the same regardless of the type of landowner, therefore societal valuation of agricultural land is chiefly concerned with the *PIVs* component relative to alternative convertible land-use rents that compete with less intensive agricultural uses. Therefore, regardless of possessory land ownership or a non-possessory interest in land-use restrictions the net social value of convertible agricultural land is concerned with *PIVs* rents valuation. For example, if society held ownership title to an acre of convertible agricultural land, agricultural and urban rents would remain market-based and thus could be held or sold, while still optimizing *PIVs*. In this way a land agent serves in an intermediary capacity for capturing the collective interest in natural capital amenities or *PIVs* generated on agricultural land via non-possessory land-use protection agreements that focus on the non-market values captured by restriction agreements that voluntarily extend a landowner's conversion date to match society's date of conversion.

Since *PIVs* are non-market goods, conventional land-use policy and appraisal valuation have held that public investments or actual expenditures on agricultural land-use protection measures hold an implicit protection value greater than the cost of foregone market development values (landowner costs). By this definition, land agents therefore need to react to developmental land-use values as the underlying or opportunity cost of protection. Yet, following this assumptive approach yields results such as Plantinga and Miller (2001). Their empirical study defined the value of development rights on agricultural lands as a function of population and location. This invariably leads to the spatial distribution of easement valuations following agricultural land with the highest conversion potential (or agricultural land nearest a metropolitan area). While this may be a driving factor in fee-simple open-space acquisition (i.e. public park land and collective natural areas), it has less to say about the rural agricultural land-use policy's target of natural amenity or *PIVs* protected with continued agricultural production. In the long run, following this decision criteria and valuation approach will invariably lead to inefficient and costly protection interest acquisitions where development is restricted even though the social value of the restriction is less than the social value of development.

Alternatively in this framework, land agents are held to capture a public good rent and not simply prohibit its demise via indirect outlay of an underlying landowner's opportunity cost of development. Thus, a land agent's conservation easement valuation model is developed to represent the summation of society's *WTP* to capture and promote *PIVs* via agricultural land protection restrictions.

Recall the previous conceptual agricultural land valuation relationship stated in (3.4c), but now stated in explicit form to represent the overall social value of an acre of convertible agricultural land today.

$$SP_{ag}(0)_{T_{soc}} = \int_0^{T_{soc}} Ae^{((\lambda - r_s)t)}dt + \int_0^{T_{soc}} PIVse^{((\rho - r_s)t)}dt + \int_{T_{soc}}^{\infty} Ue^{((\alpha - r_s)t)}dt - Ce^{(-r_s * T_{soc})} \qquad (3.14)$$

Where: $SP_{ag}(0)_{T_{soc}}$ social value of an acre of convertible agricultural land today

$PIVs$ societal public interest values or non-market amenity rents generated on an acre of restricted agricultural land per period with
$PIVs_t = PIVs * e^{\rho t}$

ρ societal amenity rental growth rate

$\rho \sim N(\mu_\rho, \sigma_\rho)$

r_s social discount rate for public land-use policy and public investment in *PIVs* agricultural land protection

with: A, U, C as defined before in (3.01)

Equation (3.14) holds the social value of convertible agricultural land is in the exact same form as the market price for agricultural land (3.06) except for the social cumulative *PIVs* rents for a particular private acre. (3.14) as specified also holds possible a future time period (T_{soc}) to exist when the social value from development is greater than the social value gained from continued agrarian use. Like a landowner that optimizes its asset investment, society as well will determine a date of conversion (T_{soc}) that maximizes the social welfare of agricultural land and need be reflected in optimal agricultural land-use policy. By allowance for a future T_{soc} does not impose conversion will occur nor does it assume that protection is eternal. If the societal value for protection outpaces all social opportunity costs, due to *PIVs* uniqueness (scarcity) and growth in demand for natural amenities, then T_{soc} will approach infinity and convertible agricultural land's social highest and best uses will always be agrarian. Yet, unknown future land-use needs may hold as well that future social developmental value to be greater than its value for protection. As such (3.14) provides an upper bound in *PIVs* value for society to be equivalent to the overall social value of agricultural land less its capitalized market rents. Expansion of (3.14) and taking the limit of each integral with respect to time as it approaches ($t \rightarrow \infty$), yields the following capitalized collective value for an acre of agricultural land today recognized by society:

$$SP_{ag}(0)_{T\,soc} = \frac{A}{r_s - \lambda}(1 - e^{((\lambda - r_s)T_{soc})}) + \frac{PIVs}{r_s - \rho}(1 - e^{((\rho - r_s)T_{soc})}) + \frac{U}{r_s - \alpha}e^{((\alpha - r_s)T_{soc})} - Ce^{(-r_s * T_{soc})} \qquad (3.15)$$

As with the previous landowner valuation model, first order conditions of social valuation optimization of convertible agricultural land from (3.15) with respect to time yield:

$$PIVse^{(\rho T_{soc})} = Ue^{(\alpha T_{soc})} - Ae^{(\lambda T_{soc})} - r_s C \tag{3.16}$$

Equation (3.16) is society's FOC for optimization of the social land value held in agricultural uses. (3.16) is also an implicit function with respect to T_{soc}, dependent on simultaneously changing market and non-market rents where socially desired conversion will only occur when the growth in value of urban rents net of agricultural rents and conversion costs at least approximates or exceeds the social non-market *PIVs* rents of a particular acre of agrarian land. Unlike current appraisal approaches that hold land-uses infinitely fixed, with an exogenous choice of unlimited duration, society may in fact be better off with some future changes in land-use away from agrarian even when including all positive externalities.

If a land agent reacts to social preferences via first order conditions (3.16) then the social price of agricultural land is maximized. An optimal choice of T_{soc} by a land agent that maximizes (3.15) in turn maximizes the difference between the social and market price of agricultural land. The positive difference is ultimately a land agent's measure of social value gained from protection. A land agent's effective conservation easement value becomes the positive non-market component generated between the social and market price of an acre of convertible agricultural land for a period of T_{soc}.

The difference between agricultural land's social value (3.15) and agricultural land's market price (3.7) defines the net value gained by society by remaining in an agrarian land-use through T_{soc}. This difference is separated into the two valuation components affecting social welfare. A land agent's *WTP* for T_{soc} periods of protection is the non-market portion of the positive gain in amenity or *PIVs* rents. The other component reflects cost to society in terms of foregone other rents for this gain. But a land agent is only concerned with maximizing *PIVs*. Rearranging (3.15) to isolate the capitalized non-market *PIVs* that public land-use policy targets derives:

$$\frac{PIVs}{r_s - \rho}\left(1 - e^{((\rho - r_s)T_{soc})}\right) = \left(SP_{ag}(0)_{T_{soc}} - \frac{A}{r_s - \lambda}\right) - \left(\frac{U}{r_s - \alpha}e^{((\alpha - r_s)T_{soc})} - \frac{A}{r_s - \lambda}e^{((\lambda - r_s)T_{soc})} - Ce^{(-r_s * T_{soc})}\right) \quad (3.17)$$

Equation (3.17) shows that *PIVs* rents are capitalized up to a possible social conversion date, which equates to the social value growth above the pure agricultural value less any future social option to develop values if T_{soc} is less than infinity. This right hand side value difference is the maximum amount society need surrender to induce capture of agricultural land's natural amenities desired by society for a given protection period or tenure holding $T_{soc} \in [0, \infty]$.

Equation (3.17) also holds that a land agent will optimize the stream of *PIVs* over time by maximizing the social value of agricultural land via the first order conditions in (3.16) given exogenous market conditions. From a land agent perspective, even though capitalized agricultural and urban market rents influence the social value of agricultural land their possessory interest is secondary and still considered retained by the underlying landowner and are not reflected in a land agent's valuation and optimization decision.

While all rents are reflected in social welfare, a land agent is only concerned with protecting the *PIVs* rental stream. Therefore, (3.17) is restated from a targeted public policy perspective with only the left hand side component to represent the non-market amenity values gained with protection and yields a land agent's conservation easement reservation price or *WTP* for protecting an acre of convertible agricultural land as:

$$SV_{LA}(0)_{T_{soc}} = \frac{PIVs}{r_s - \rho}\left(1 - e^{((\rho - r_s)T_{soc})}\right) \tag{3.18}$$

Equation (3.18) represents a land agent's upper bound conservation easement price ($SV_{LA}(0)_{T_{soc}}$) for protection for T_{soc} periods. By itself (3.18) describes the total value gained from a given *PIVs* rent today across all relevant optimal periods of protection regardless of when landowner conversion would actually occur.

In practice easement agreements have been limited to perpetual agreements. From (3.18) this represents only one choice of time periods that might be optimal. If the optimization condition from (3.16) holds that the value gained from protection always outpaces the social value from future development then societal *WTP* will reflect a perpetual conservation easement value. This is reflected in (3.19) which is a reduced form of (3.18):

$$SV_{LA}(0)_{Tsoc=\infty} = \frac{PIVs}{r_s - \rho} \tag{3.19}$$

Equation (3.19) represents society's capitalized valuation of indefinite protection. The legal requirement of perpetual conservation easement placement is then simply a special case when the optimal social date of conversion is forever away and T_{soc} = *infinity*.

3.6 Land Agent's Temporary Valuation of Agricultural Land Protection

A land agent's valuation for an acre of protected agricultural land from (3.18) is an unconstrained optimization in choice of T_{soc} across all relevant convertible acres within a landscape. Yet no public land-use policy tends to operate within an unconstrained optimization condition for agricultural land protection. In a more realistic constrained state, a land agent operates to maximize *PIVs* protected either via the reduced number of acres restricted relative to the unconstrained social optimal level all for a period of T_{soc} (spatial optimization) or alternatively seek to protect an optimal level of *PIVs* at any one period but for a duration less than T_{soc} (temporal optimization) in an attempt to improve social welfare with more immediate amenity rents across more acres protected in exchange for less *PIVs* in the future. The resulting optimization alternative becomes a societal portfolio optimization issue in a trade-off between acres (spatial) and time to capture *PIVs*. In either case, constrained *PIVs* optimization occurs somewhere less than a socially unconstrained level. In this view, a land agent may act to protect *PIVs* with constrained acres, each with a socially optimal period of protection or alternatively, an equivalent rational decision can be made to protect a greater level of *PIVs* (more acres) at any point but for less than a socially desired period.

Given the possibility that a land agent may choose a protection period of T_L that is less than T_{soc} due to a budget constraint or recognition of uncertainty in future rental streams, a land agent's valuation of an acre of *PIVs* would create a valuation discount away from T_{soc} due to the premature loss of *PIVs* rents at the end of the term period T_L as compared with the optimal T_{soc}.

The term conservation easement valuation specification previously stated in (3.11) showed that temporary valuation of real property is discounted due to the real loss in value given up at term expiration. For a land agent, the reversion of restricted land-use rights back to an agricultural landowner represents a real net loss to society. The magnitude of this discount thus directly influences the *WTP* for temporary protection of *PIVs*. The following Figure 3.3 shows the alternative time line of *PIVs* rents captured for an acre of agricultural land at T_L (constrained period) and T_{soc} (optimal period).

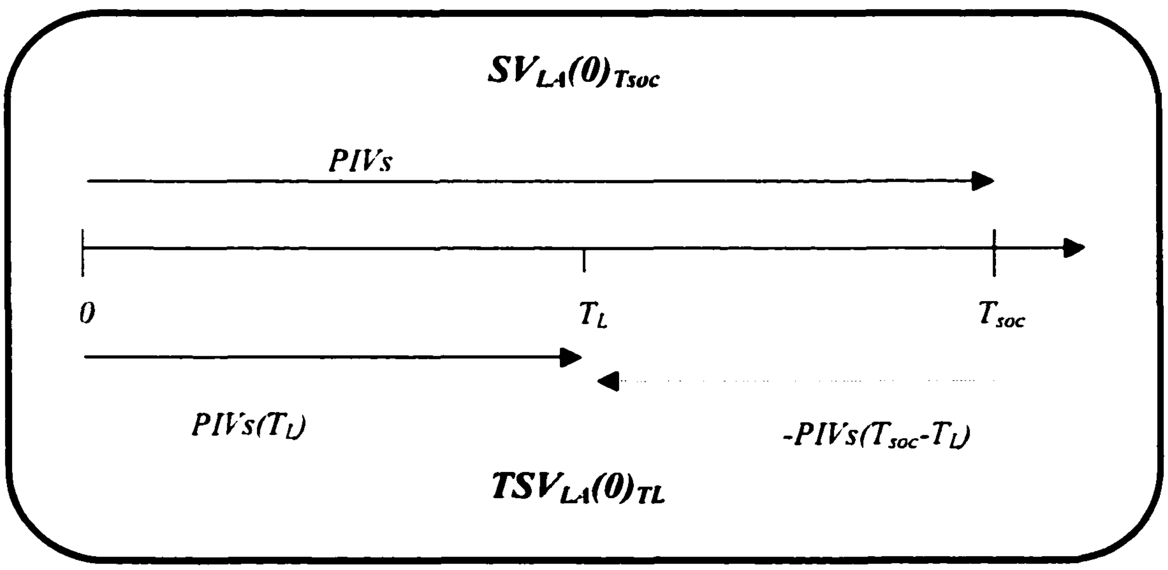

FIGURE 3.3 SOCIETAL *PIVs* RENTS TIMELINE FOR T_{soc} AND T_L

The top half of Figure 3.3 shows society's rental path for optimal temporal valuation for the protection of a convertible agricultural acre ($SV_{LA}(0)_{Tsoc}$). The bottom half of Figure 3.3 displays the time path of non-market rents captured for T_L periods of protection ($TSV_{LA}(0)_{TL}$) for an acre of convertible agricultural land. A land agent's discount for a less than optimal length of protection is difference between the capitalization of *PIVs* lost from T_L and T_{soc}. This is described as:

$$TSV_{LA}(0)_{T_L} = \int_0^{T_{soc}} PIVs * e^{(\rho - r_s)t} dt - \int_{T_L}^{T_{soc}} PIVs * e^{(\rho - r_s *)t} dt \tag{3.20}$$

Equation (3.20) holds that a land agent's temporary valuation of a conservation easement placed for a T_L period is equivalent to capitalized *PIVs* rents capitalized up through socially optimal T_{soc} less *PIVs* rents yielded for strictly T_L periods of protection. This is equivalent to the previous specification (3.18) for the optimal T_{soc} periods as long as society's $WTP = WTA$ reduced protection valuation across time periods. Equation (3.20) is restated to capture *PIVs* rents for the specific term as:

$$TSV_{LA}(0)_{T_L} = \int_0^{T_L} PIVs * e^{(\rho - r_s)*t} dt = \frac{PIVs}{r_s - \rho} * (1 - e^{(\rho - r_s)T_L}) \tag{3.21}$$

Equation (3.21) holds that a land agent will value an exogenous period of T_L by capitalizing those non-market rents only up to that period regardless of the social optimal term to protect.

The difference between a land agent's term and socially optimal term to protect, $TSV_{LA}(0)_{TL}$ and $SV_{LA}(0)_{Tsoc}$ represents appreciably lower societal *WTP* discount for unconstrained optimal *PIVs* given up. But they also represent a savings in investment that may be used for other more immediate *PIVs* protection today. Given unlimited funding, a land agent will always choose T_{soc} for each convertible acre with a social value greater than market prices, except public funding allocation is as a rule constrained either by law or funding may be simply inadequate to offset undue losses with accelerated urbanized conversion.

3.7 Land Agent Optimization of PIVs Across an Agricultural Landscape

The preceding land agent valuation models (3.18) for T_{soc} and (3.20) for T_L hold for capturing *PIVs* rents on a convertible agricultural land acre via a societal implicit choice of an optimal date of conversion (temporal unconstrained) or an explicit term (temporal constrained). In either case, a land agent's optimal decision is based on a temporal decision for protecting a convertible acre relative to available land-use policy funding. Thus far, the only criterion for determining relevant land-use policy investment or funding allocation for an individual acre has been to determine a period of protection that weighs the positive difference in the social value of agricultural land generated by *PIVs* rents against a landowner's true *WTA* for protection purposes for a specified term.

Alternatively, this temporal view needs to be combined back with the conventional constrained spatial optimization conditions. Within any landscape a land agent is also faced with the additional constraining choice of substitutable convertible acres at any single time period to protect. In this overall protection decision choice, a land agent is faced with a constrained objective that must not simply focus on the underlying landowner's costs (for various periods of protection) but also across a landscape's alternative *PIVs* not protected or foregone (today and future). In this portfolio view, any constrained conservation easement investment decision in one acre for some time period limits *PIVs* acquisitions in another. From a spatial optimization decision, a land agent's opportunity cost of protection is not only the underlying landowner "true option to convert value" of a particular acre but also the potentially higher valued opportunity cost of foregone *PIVs* on an alternative acre. Therefore, (T_{soc}) for a particular *PIVs* rent for a given agricultural acre also inversely affects the budget constraint against acquisition of an alternative period of protection for another acre of *PIVs* rents.

From this landscape viewpoint, let *(SW)* represent total societal value gained through protection of *(Y)* agricultural acres by means of multiple time sensitive conservation easement agreements. This equals the summation across (m) landowners each providing (Y_i) acres.

$$SW = \sum_{i=1}^{m} \left[TSV_{LA}(0)(T_i)(Y_i) \right] = TSV_{LA}(0)(T^*) * Y \qquad (3.22)$$

Equation (3.22) shows that the objective for the land agent is to maximize landscape welfare (*SW*). To accomplish this objective requires engaging in agricultural conservation easement agreements where the value for protection is greater than the acquisition costs of a landowner (*i*)'s true *WTA* protection. Further, a land agent is constrained by available member conservation funding contributions or budgetary constraint of public dollars allocated to agricultural land protection programs. Thus, the land agent's problem is a constrained maximization of *PIVs* given resource budget, (*F*) through constrained choice of (*Y*) protected agricultural acres and (T^*) period of protection. A land agent is faced with negotiating against individual landowner *i*'s reservation price, $TCE_{ag}(0)_i$. This is described in equation (3.23):

$$F = \sum_{i=1}^{m}(TCE_{ag}(0)(T_i^{*}) * Y_i) = TCE_{ag}(0)(T^{*}) * Y \tag{3.23}$$

Where: $TCE_{ag}(0)(T_i^*)$ landowner i's conservation easement reservation price for period T_i^*

Y_i landowner i's convertible agricultural acres protected where $Y = \Sigma Y_i$ or total acres protected within a landscape

F public funding or financial contributions for agricultural land protection

The decision for the land agent becomes not only what length of time is optimal to protect but what possible combination of substitutable acres between the landowners will maximize *SW*. By combining (3.22) and (3.23) into a constrained maximization problem, a land agent's decision involves choice of Y and T^* that maximizes *SW* within a relevant convertible landscape.

For tractability, consider the following constrained optimization equation for two landowner parcels each with an acre of convertible agricultural land (Y_1 and Y_2) and a budget that allows less than full protection:

$$\begin{aligned} \ell = {} & SV_{LA}(0)(T_1) * (Y_1) + SV_{LA}(0)(T_2) * (Y_2) \\ & + \eta(F - TCE_{ag}(0)(T_1) * (Y_1) - TCE_{ag}(0)(T_2) * (Y_2)) \end{aligned} \tag{3.24}$$

A land agent will maximize *PIVs* by the constrained optimal choice of Y_1 and Y_2 *along with* T_1 and T_2, given limited agricultural land protection funding available. In a portfolio or landscape view, societal welfare is maximized by a combination of acres and period of protection determined for each acre. By allowing determination of acres as well as time increases the flexibility and choice options to maximize the constrained optimization.

3.8 Accounting Stance Valuation Summary

The valuation models constructed in this chapter define the relevant factors influencing conservation easement exchange prices. Partitioning agricultural land's valuation into individual, market and social stances, allows the isolation and identification of each accounting stance's true valuation motivations expressed in their *WTA* and *WTP* for landowners and land agents, respectively. The landowner and land agent models provide an upper and lower reservation price boundary. These models determine a land agent's maximum *WTP* or its reservation price and a landowner's minimum *WTA* or its own reservation price. Both valuation models are also an attempt to draw out the limitations of the market price of agricultural land and its residual growth value in determination of a conservation easement price. The use of conventional agricultural land market prices and appraisal approaches fail to recognize and identify crucial differences among individual landowner's non-market components, which affect landowner *WTA* and the market price also fails to capture the true incentive to society in welfare gained with *PIVs* protection affecting land agent *WTP*.

In summary, both accounting stance valuation models provide an enhanced setting for individually negotiated conservation easement prices. Market conditions and effective bargaining ultimately will determine the extent a land agent is able to negotiate a lower accepted price from their overriding *WTP*. Likewise, a landowner's own knowledge of their conversion date and their financial motivations will dictate their ability to negotiate a conservation easement price greater than their *WTA*. Graphically, the valuation relationships developed in this chapter are illustrated in Figure 3.4.

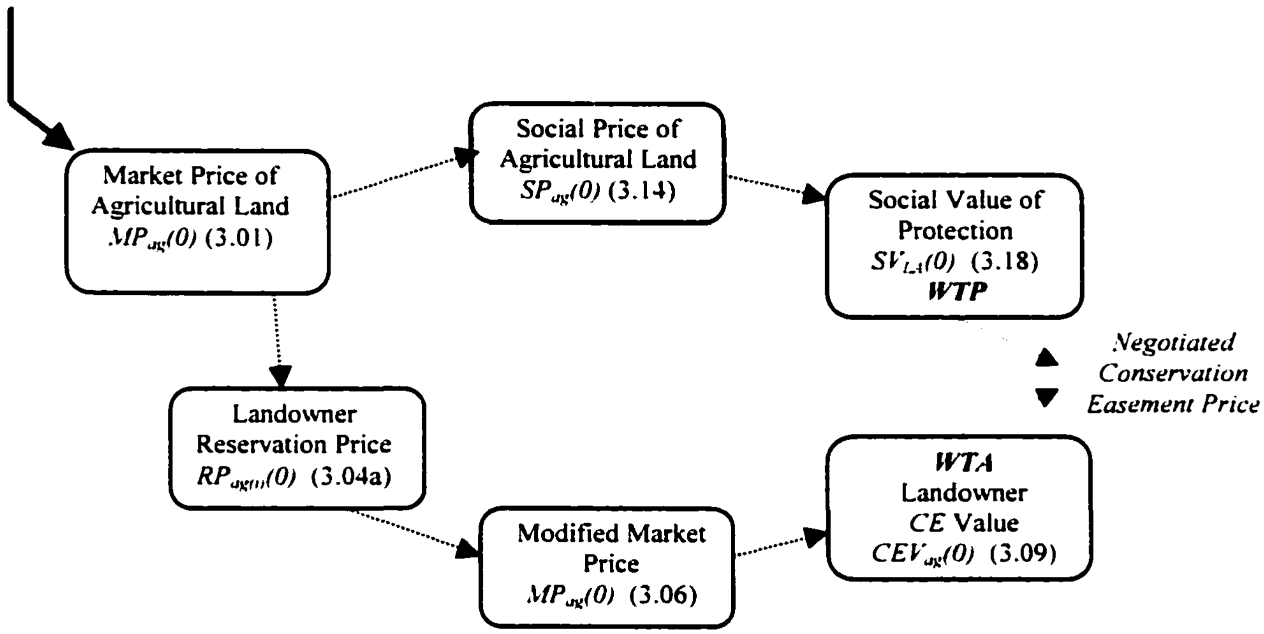

FIGURE 3.4 ASSOCIATING ALTERNATIVE ACCOUNTING STANCE AGRICULTURAL LAND VALUATION MODELS AND CONSERVATION EASEMENT PRICE

The transition from an initial pure market price of agricultural land to ultimately a conservation easement price involves establishing the noted equations described in Figure 3.4. By simple recognition that *PIVs* influence social value and landowner's private amenity rents influence the market price of agricultural land present both difficulties and enhancements to understanding conservation easement prices. But their recognition also shows that strict market appraisal approaches do not reflect either accounting stance's motivations for engaging in conservation easement placement.

The preceding models also show that both accounting stances derive their own future conversion dates. Given the allowance for a future social date of conversion, each stance's valuation models were modified to allow for temporary *WTA* and *WTP* by landowners and land agents, respectively. Choice of any temporary valuation may also occur due to limited resources that constrain the temporal choices. In either case, temporary valuation models allow for effective temporary protection valuation approaches necessary in negotiation of a term conservation easement price.

CHAPTER 4 AN ECONOMIC EXPLORATION OF CONSERVATION EASEMENT AGREEMENTS

The emphasis of this chapter builds upon economic theory to support the valuation models developed in chapter 3. The resultant combination of conceptual valuation models with improved economic insight serve to explain the likely behavior of landowners and land agents for improving conservation easement assessment and net welfare changes with these voluntary exchanges. This chapter also establishes the economic conditions that support the allowance of term-based conservation easement agreements.

This chapter progresses as follows. Central economic issues are identified and discussed that influence conservation easement valuation and the future probability of temporal based exchanges. With early recognition that land agents operate within a constrained optimization condition, this chapter builds on enhanced understanding of *WTA* and *WTP* for protection restrictions that influence each stance's real reservation prices where other conventional approaches have not. Together these add to modify the design of land-use policy that targets *PIVs* protection on convertible agricultural land within a portfolio framework of temporally mixed conservation easement acquisitions for improved social welfare.

4.1 *Market Exchanges and Social Welfare*

Any voluntary conservation easement exchange between landowner and land agent ensures the overlap of a landowner's *WTA* with a land agent's *WTP* and necessitates that social welfare was either maintained or increased via a conservation easement agreement. With any exchange, investment optimization conditions for both accounting stances implicitly determine a landowner's future conversion date and possible societal conversion. This time line is central to the overall valuation and resulting conservation easement exchange price. This requires that each stance derive individual valuations that incorporate relevant market and non-market factors. The ability of both stances to "walk away" from any agreement disciplines extravagant landowner claims and ensures an easement's value is bounded by each stances reservation prices.

But given the significant presence of non-market factors influencing both the landowner and land agent, all negotiated exchanges are unique and landscape specific. No single secondary data exist on conservation easement market prices that can be observed to estimate the system of valuation equations developed in chapter 3. Even contemporary conservation easement sales information fails to separate individual landowner motivations for placement or actual value gained to society from imposition. In addition, since general conservation easement placement has been limited to only permanent specifications, no secondary data or information exists on any temporal valuation trade-offs. Further, since conventional appraisals of conservation easement valuation are restrained to account for only the market based valuation of agricultural land, courts and land agents have relied on agricultural land's market price residual growth value to reflect the opportunity cost of the landowner as an indication of the acquisition cost and social gain in value from protection. This in itself leads to inappropriate easement valuation and exchanges by failure to adequately account for what drives *WTA* and *WTP*.

With the recognition that landowners and land agents have separate underlying opportunity costs (including foregone non-market costs), the conventional usage of agricultural land market price's growth residual value fails to represent either true landowner *WTA* or land agent *WTP*. For a landowner, their *WTA* protection was found in equation (3.09) of chapter three and holds that a landowner's true reservation price is less than their *WTA* development, and their own motivations extended their conversion date outward due to their *PARs*. Equation (3.08) is restated below to show that market price residual growth value for agricultural land is equivalent to an average landowner's *WTA* development not *WTA* protection:

(3.08) Landowner *WTA development*

$$\left[MP_{ag}(0)-\frac{A}{r_{ag}-\lambda}\right]=\left[\frac{PAR}{r_{ag}-\delta}\left(1-e)^{((\delta-r_{ag})*T_{con})}\right)\right]+\left[\frac{U}{r_{ag}-\alpha}e^{(\alpha*T_{con})}-\frac{A}{r_{ag}-\lambda}e^{(\lambda*T_{con})}-C\right]*e^{(-r_{ag}*T_{con})}$$

$$\downarrow \qquad\qquad\qquad \downarrow$$

$$WTA_{dev} = [\textit{Net Private Amenity}] + [\textit{Conventional Option To Convert}] \tag{4.01}$$

A landowner's non-market amenity rent adds to a landowner's conversion hurdle or reservation price for voluntary development (WTA_{dev}). Equation (4.01) defines a landowner's WTA_{dev} to be equivalent to the market based "option to convert value" plus all net amenity values given up after conversion. However, (4.01) also states that the value for protection purposes from a landowner's perspective may in fact be lower, given the *PAR* component is not lost with a conservation easement agreement. Equation (3.09) in chapter three shows that a landowner's true reservation price equaled:

(3.09) Landowner *WTA protection*

$$CEV_{ag}(0) = \left[MP_{ag}(0) - \frac{A}{r_{ag} - \lambda} - \frac{PAR}{r_{ag} - \delta} \right] = \left[\frac{U}{r_{ag} - \alpha} e^{(\alpha \cdot T_{con})} - \frac{A}{r_{ag} - \lambda} e^{(\lambda \cdot T_{con})} - \frac{PA\mathrm{Re}^{(\delta \cdot T_{con})}}{r_{ag} - \delta} - C \right] * e^{(-r_{ag} \cdot T_{con})}$$

$$\downarrow \qquad \downarrow \qquad \downarrow$$

$$WTA_{pro} = [\,WTA_{dev} - \textit{Capital Private Amenity}\,] = [\textit{Net Option To Convert}] \tag{4.02}$$

From a landowner's perspective, conventional appraisal approaches under-price WTA_{dev} by failing to include a capitalized private amenity rental value while simultaneously over-pricing WTA_{pro} for the same reason. An additional result of this misspecification is the failure to recognize that *PARs* add to the compensation hurdle for conversion that in effect voluntarily extends a landowners own conversion date beyond conventional valuation approaches. A landowner's land valuation first order conditions (3.10) require *PARs* to be included in the implicit optimization and must also be offset by urban rents before voluntary conversion occurs.

Conventional appraisal of agricultural land's market price for estimating a land agent's value gained also misspecifies a land agent's *WTP*. The true measure of the social gain in *PIVs* protection is derived not from agricultural land's market price but its social price (3.04c). Usage of the market price infers that the positive externality is fully incorporated into the market components of the price in the form of alternative rents, but agricultural land's market residual growth value represents only the social urban value. Recall a land agent's social valuation was defined in (3.17) and derived from the social price of agricultural land. This defines a land agent's maximum *WTP* for protection today regardless of when a landowner actually converts. The residual growth value of the social price of agriculture is different than the market price residual growth. In this case, the social option to convert value is based on a conversion date of T_{soc} and not a landowner's T_{con} and landowner *PAR* values are only a portion of overall total social amenity values. Thus, utilizing the market price of agricultural land for social value understates land agent's true *WTP*.

Consider the following as restated from (3.17):

(3.17) Land Agent *WTP*

$$SV_{LA}(0)_{T_{soc}} = \frac{PIVs}{r_s - \rho}\left(1 - e^{((\rho - r_s)T_{soc})}\right) =$$

$$= \left(SP_{ag}(0)_{T_{soc}} - \frac{A}{r_s - \lambda}\right) - \left(\frac{U}{r_s - \alpha}e^{((\alpha - r_s)T_{soc})} - \frac{A}{r_s - \lambda}(-e^{((\lambda - r_s)T_{soc})}) - Ce^{(-r_s * T_{soc})}\right)$$

$$\downarrow \qquad\qquad\qquad\qquad \downarrow$$

WTP = (social residual growth value) - (social option to develop value) (4.03)

If it is socially optimal for a permanent conservation easement, (4.03) reduces to the "social residual growth value" and describes a land agent's maximum *WTP* or reservation price which will always be larger than the conventional appraisal approach since the residual growth value of the social price of agricultural land is greater than the residual growth value of agricultural land's market price. However, a land agent also realizes that the value gained from today to T_{soc} will occur regardless up to a landowner's conversion. That is, a landowner's own *WTA* accounts for some future conversion, and therefore a land agent need only consider the value of those *PIVs* that landowner conversion extinguishes (T_{con} to T_{soc}). But a land agent may not know a landowner's conversion date, therefore negotiations are necessary for conservation easement price that will range somewhere between the minimum *WTP* and Maximum *WTP*. This difference is illustrated graphically in Figure 4.1.

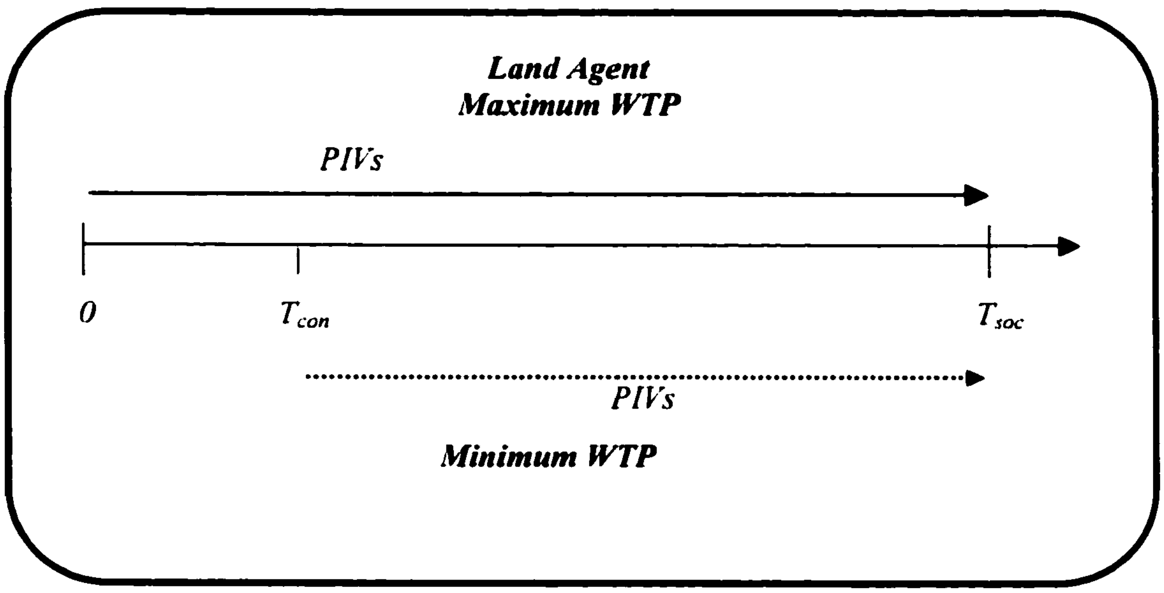

FIGURE 4.1 LAND AGENT MAXIMUM AND MINIMUM *WTP* FOR T_{SOC}

Since social welfare is concerned with both landowner *WTA* and land agent *WTP*, and both *WTA* and *WTP* are influenced beyond what agricultural land's market price considers, then improvements in social welfare can not be attained utilizing conventional approaches for valuation that rely on market price's residual growth value.

4.2 PIVs and the Opportunity Cost of Agricultural Land Protection

The actual empirical application of the valuation models in chapter 3 is problematic since conservation easement valuation is comprised of market and non-market values and individual bargaining is required in every outcome. But in recognition of this estimation difficulty, governing legislatures and the IRS have relied on the market-based opportunity costs of agricultural land in more intensive uses as a second best measure of a market valuation for protection. This defines agricultural land's market price growth residual value above pure capitalized agricultural rents. Thus, components of agricultural land's market price become the proxy for both social value gained and landowner costs to acquire.

Conventional reliance on agricultural land's market-based option to convert value as the "highest and best" land-use foregone, directly assumes that natural amenity (ρ) and urbanized (α) growth rates are driven by the same underlying market factors. While a rationale landowner may be indifferent to the actual "highest and best" use of its agricultural land (after privately incorporating his/her non-market values), a land agent is not indifferent whether the value for developmental purpose is somewhere equivalent to actual levels of *PIVs* accruing.[19] Boyd *et al* (1999) conclude that *PIVs* such as open-space need to be protected for their own intrinsic value, rather than for purposes precluding other land-uses, particularly if the net effect is to displace development to

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[19] It does follow that agricultural land characteristics with greater developmental values are typically positively correlated with natural amenity public interest values. Capozza and Helsley (1989) showed that urban land prices are driven by a rental growth premium, which is a function of location, accessibility, use intensity, and timing of investment. Location and accessibility are likely highly positively correlated with agricultural landscapes.

other even more inappropriate sites. It is rational that in some cases of agricultural land with significant conversion pressure, developmental uses from a social perspective will be greater than socially protected uses and vise versa. Kayser (2000) points out that like any land-use choice, agricultural land protection will preclude other uses, but it does not follow, however, that the value of the land for protection purposes equals the value of the uses preservation is restricting. Mundy and Adams (1991) further note that protection interests and developmental interests have different underlying motives with respect to time and scarcity. Finally, Mundy and Adams (1991) and McConnell (1989) both show that *PIVs* tend to grow at a non-linear rate across time due to increasing scarcity of unique natural amenities combined with a growing (population expansion and preference shift) demand for high amenity public goods. Therefore, reliance on the correlation that urban growth rates proxy *PIVs* growth both under and over estimates the future social *PIVs* demands on agricultural land.

A more relevant land agent opportunity cost is the alternative of the last dollar invested when a land agent is constrained to choose a fraction of the total convertible agricultural land within a landscape whose social value is positively greater than the market price. Consider for example, two convertible agricultural land parcels within a relevant landscape with equal developmental potential but differing levels of *PIVs*. Separate landowners with similar *PARs* would recognize the equivalent "net option to convert" costs for their *WTA* protection, but a land agent with limited funding, enough to protect only one parcel, must decide or prioritize protection conveyance. It is more relevant for a conservator to be concerned with capturing higher levels of *PIVs* and less for following developmental values. By explicitly choosing the parcel with the greater

PIVs, a conservator implicitly recognizes that the alternative parcel has the relevant opportunity cost of the unprotected *PIVs* social value and not simply the net developmental value present. Further, if the underlying "net option to convert" landowner cost is actually greater than the social value gained, then even equating the developmental opportunity cost as the implicit social value overstates the actual social value on the agricultural land. Which in turn would result in an over-investment of public funds towards agricultural land protection.

4.3 Duration Implications

Because of agricultural land's unlimited life, conventional and legal requirements stipulating perpetual conservation easement agreements by definition control land-use forever. Like irreversible conversion, which limits land-use choices to only future urban rents, perpetual conservation easement acquisition restricts future land-use options as well and prohibits the ability to capture future rents that would have otherwise benefited society but were not recognized at placement. A landowner's choice of permanent conversion is necessarily economically irreversible but permanent conservation restrictions need not be. Simply disallowing any temporal choice may be sub-optimal in the presence of constraining resources or the optimal social period of protection for a particular agricultural land may itself be for a limited duration. By not allowing for T_{soc} to be substantially less than infinity, both future social-use flexibility and land-use choice options (possibly including more intensive agricultural uses or vital urban uses) are extinguished. If protection is always held to perpetuity, land-use changes become unattainable even though long-term economic forecasts of land use needs are extremely difficult to ascertain.

This becomes an economic concern when agreements that seek to preserve the environmental status quo of the burdened agricultural land shift some defined ownership rights away that absolutely limit land-use choices of all future possessory ownership. If long-term social welfare is of true concern, then the market response of a future property owner to future land-use needs of society is likely to be more effective than a past owner's fixed blueprint. From a legal standpoint, this constraint is known as "dead hand control" (Korngold, 1984). Reliance on permanent agreements refrain landowners and land agents from adjusting to future land-use needs. Even if conservation remains a dominant future value, today's vision of what is environmentally significant may change tomorrow. Allowance of term-specified or limited duration conservation easement contract limits the negative impacts of "dead hand control.[20]

4.4 Uncertainty and Irreversibility: Forecasting Future Rental Growth

Optimal conservation easement valuation requires not only the need to distinguish between developmental growth and growth in societal demand for natural amenities on agricultural lands but forecasting or predicting these rental streams for the life of the easement. Both the market and social price of agricultural land models developed assume some type of growth rate and future travel path for each rental stream.

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[20] Korngold (1984) specifically advocates a reasonable maximum for private land-ownership where conservation easements are placed to be 20 years. He concludes that problems of dead hand control become significant after that date and either the public need assume fee-simple land ownership or the covenant need expire.

Recall the rental stream forecasts for the market and non-market factors of the valuation models:

$$A_t = A\,e^{\lambda t} \qquad \lambda \sim N(\mu_\lambda, \sigma_\lambda)$$
$$U_t = Ue^{\alpha t} \qquad \alpha \sim N(\mu_\alpha, \sigma_\alpha)$$
$$attch_t = attche^{\delta t} \qquad \delta \sim N(\mu_\delta, \sigma_\delta)$$
$$PIVs_t = PIVe^{\rho t} \qquad \rho \sim N(\mu_\rho, \sigma_\rho)$$

As stated, rental growth rates are assumed to follow a constant rate of growth (where zero is a viable growth rate) around some normal distribution.

The necessity to forecast future rents for the applicable protection period introduces uncertainty because the economic and environmental conditions underlying future (especially long-term) agricultural, urban, and amenity rents are unknown today. Uncertainty plays a significant role in complicating valuation for both landowners and land agents when evaluating permanent or fee-simple easement values because of the total number of rental forecasts and perpetual land-use decisions to protect or convert may be delayed but cannot realistically be reversed.

A landowner's decision to convert agricultural land is considered irreversible since development involves considerable investment, removal of which is rarely justified by the benefits of agricultural land restoration. Likewise, a land agent's desire to permanently restrict agricultural land-uses is equally irreversible since these legal covenants carry with the land regardless of underlying possessory agricultural landowner. In either case, the basic nature of irreversibility means that converting (conveying protection) today entails not only permanently forfeiting the agricultural use (non-agricultural uses) of the land but also foregoing possible new information (the source of prior uncertainty) that may alter either decision. It is this information that influences the timing and profitability of conversion or protection for a landowner and influences the value for protection purposes for a land agent.

Economic valuation for such uncertain and irreversible investments has relied on 'real-option theory' as advanced by Dixit and Pindyck (1994). Under this conceptual approach to enhance valuation, real options theory relies on the distributional assumptions of rents imputed and simply derives an additional fee-simple premium hurdle. This uncertainty premium is attached to the option-to-convert value necessary to induce protection and insure a landowner's choice for profitable conversion (investment decision) in the presence of uncertain and irreversible conditions held for capturing future urban rents.

Utilization of this approach does not reflect an enhanced overall view of future interactive market conditions nor does it actually advocate improvement in social welfare if only applied to landowner situation. Society pays for perpetual conservation easement valuation given the presence of uncertainty and irreversibility through greater easement prices today. This approach, if applied to both accounting stances, may serve to improve irreversible and uncertain investment (conversion or perpetual protection) valuation, but society is still left with permanently restrained or diminished land-use options. It seems more plausible for agricultural land protection policy to improve social welfare not by expanding the valuation specification but by directly limiting forecasting uncertainty and investment irreversibility's influence with less than permanent specifications. Irreversibility exists only under actual conversion or permanent conservation easement acquisition but a specific appeal to term conservation easements is that they are reversible (land-use choice and flexibility maintained) and the value of waiting (due to uncertainty) is captured back with temporally shortened *WTP*. Long-term uncertainty valuation is actually avoided at the expense of additional bargaining at the end of a protection period, but with additional land-use choices society gains by reallocating the land in the highest and best use at that time.

4.5 Discount Rates: Social and Private

Land agent protection and landowner conversion valuation are both generated by capitalizing future rents across time. For an optimal land-use decision today, capitalization requires discounting these future values to account for and assure optimal investment relative to a time preference. This is measured as the opportunity cost of postponement of receipt or outlay yielded by an upfront investment. That is, the returns to agricultural land from future *PIVs* protected or market rents captured yield some return to the investment that could otherwise be captured today in an alternative investment. Therefore, choice of a rate of discount is critical and highly sensitive to determination of the whole tilt of protection/conversion decisions for both landowners and land agents. Misspecification of a discount rate results in serious misallocation of scarce resources, especially when evaluating significant long-term or infinite rental streams like perpetual conservation easements. Distant rental streams represent much more (less) significant value with lower (greater) discount rates. Any change in a discount rate implies a change in the distribution of wealth to future society.

For a landowner, the choice of a discount rate is based on their private or market (optimal) opportunity cost of funds. Investment returns to agricultural land in terms of market and non-market rents must be evaluated against what could be captured in contemporary market investments given a landowner's own risk preference and compared to alternative investments with equivalent risk. A land agent's choice of a discount rate in light of a public good such as *PIVs* on convertible agricultural land heightens the difficulty in social valuation or land agent *WTP*. Due to the public good aspect of *PIVs* no single alternative market exists to evaluate a comparable return. If agricultural land markets make inadequate provisions for the future, given the presence of positive externalities, then a social rate of discount should be lower than that which would produce market equilibrium to ensure adequate provision of that public good.[21]

However, in the presence of an inter-temporal market externality, Baumol (1968) holds that *both* private and social discount rates are likely too high and need to be lowered rather than expand the difference between a higher private rate and artificially lower social rate to ensure efficient temporal resource allocation is met. This is based on the fact that scarce funds are removed from a full employment private sector and must be evaluated by their opportunity cost to society for less investment elsewhere (taxation pulls investment dollars away from their opportunity for private returns). But even with the recognition that a social discount rate needs to be economically accountable, land agents do not face the same time preference risk as private individuals and some account

[21] For a through discussion on the applicable rate of social discount see Baumol (1968), Hirshleifer (1966) and Solow (1974). There is still considerable academic divergence about what the optimality conditions of a social discount rate should be. Two distinct discourses have evolved: social opportunity costs (SOC) of capital outlays and/or the public's true social time preferences (STP). SOC infers that investment for public goods pulls resources out of the private market and therefore must be evaluated close to a market rate for efficient allocation. Where STP holds that market rates contain two premiums: risk (future uncertainty) and taxes not necessarily present with social investment and therefore warrants a lower rate, just as a risk-free market investments yield a lower rate of return.

must be allowed for long-term investments.[22] As such, an artificially lower rate recognizes society's preference with time but may actually decrease social welfare as private investment declines from excessive transfer into public investment. With this conflict, no single social discount rate may be optimal given alternative welfare criteria With respect to the preference of unique amenities any ad-hoc social justification for the need of an artificially lower rate may create undue inter-temporal social inequities.

Instead of reliance on a social discount rate to induce adequate public investment, Baumol (1968) recommends a public subsidy to compensate or induce direct investment of the desired public good rather than an indiscriminate lower social discount rate (SDR) below its opportunity costs.

Thus, a more correct specification and interpretation of the SDR is found in the denominator of the land agent's conservation easement valuation models (3.18) and (3.20) in chapter three. *PIVs* rents are capitalized and discounted by $(r_s - \rho)$. This denominator is in effect a social "protection yield"[23] or net SDR land agents recognize for agricultural land protection. The first component is an approximate risk-free market rate of discount that is offset by recognized growth in societal demand for future *PIVs*. The net social discount rate is effectively lowered by the potential growth in value of the *PIVs* rent thereby effectively expanding the capitalized value and inducing investment.

Yet, Baumol (1968) points out an additional social time preference issue for choice of a discount rate necessary for adequate protection of agricultural land. This involves consideration of optimal inter-temporal wealth distribution. Artificially

[22] This is especially true for measuring the potential loss (irreversibility) of unique or very scare natural amenities. See Fisher *et al* (1972) and Arrow and Fisher (1974) for more on environmental preservation due to irreversibility.
[23] "Protection yield" is defined for real asset in a similar manner as a "convenience yield" for a storable commodity. See Dixit and Pindyck (1994) for greater clarification of "convenience yield".

lowering a social rate of discount in order to increase further the prospective *PIVs* wealth of future generations may in fact be sub-optimal. If it is assumed that future U. S. wealth or overall standard of living will continue to grow through general technological progress similar to what has been experienced during the past century then the potential exists for a population's natural resource dependence per unit of domestic output of marketable goods will appreciably decline. This is the condition where urbanization continues but with a lessening impact and influence of conversion on agricultural land (decreasing agricultural land's urban rents growth). Then the choice of a social discount rate below social opportunity costs leads to an accelerated sacrifice or over investment (especially with permanent conservation easement protection) by society today to redistribute *PIVs* wealth to future citizens that would have otherwise been more optimal in expanded shorter term investments such as temporary conservation easements improving today's citizens wealth.[24]

4.6 Social Discount Rate and the Endowment Affect

While the choice of a social discount rate for long-term pubic investments is difficult enough, another issue arises when considering temporary valuation agreements for a term less then their social optimal period. Recall, equation (3.20) in chapter 3 holds that a land agent's term-specified conservation easement valuation is based on the optimal value gained for T_{soc} less the value given up (discount in their *WTP*) after T_L periods.

[24] This requires the assumption of a steady state population level. Baumol's focus is a possible net welfare gain from more short-term capture of public goods such as temporary agricultural land protection with expanded current benefits rather than an emphasis on long-term projects that disproportionately favor future societal welfare at the cost of today's citizens.

(3.20) Land Agent Term Conservation Easement Valuation

$$TSV_{LA}(0)_{T_L} = \int_0^{T_{soc}} PIVs * e^{(\rho - r_s)t} dt - \int_{T_L}^{T_{soc}} PIVs * e^{(\rho - r_s *)t} dt$$

$$(\,PIVs \text{ thru } T_L\,) = (\,PIVs \text{ thru } T_{soc}\,) - (\,PIVs \text{ from } T_L \text{ thru } T_{soc}\,) \tag{4.04}$$

If a land agent considers only protecting a temporal portion of socially desired *PIVs* protection tenure, then a preference difference in valuation may occur where the land agent discounts the *PIVs* rental stream value given up after term expiration to a greater extent than a normal asset holder, since all future protection values are relinquished and those rents become subject to being lost with irreversible landowner conversion potential again. This is valuation disparity is known as an endowment effect (Kahneman *et al* 1990). In agricultural land protection, this thought or effect has been commonly held in the land agent community for objecting to temporary valuation agreements. A land agent is in effect "giving up some socially important interest value" that allows a landowner to "cash in" (Sherrod 2001). Initially, a land agent is not in possession of land-uses restrictions and therefore must compensate a landowner, yet once a land agent has possessed these rights, yielding these protection values up may be different. This infers that a land agent's *WTA* for the period (T_{soc} - T_L) is valued differently then their *WTP* for acquiring temporary *PIVs* rents protection. If *PIVs* given up between (T_{soc} and T_L) are discounted to a greater extent (by r_s*) than other *PIVs* captured up to T_L, this would define a land agent's temporary conservation easement valuation to be less than simply capitalized *PIVs* rents through T_L. This holds that Equation's (3.20) and (3.21) from chapter 3 do not equate as shown in (4.05):

$$\left(\int_{0}^{T_{soc}} PIVs * e^{(\rho - r_s)t} dt - \int_{T_L}^{T_{soc}} PIVs * e^{(\rho - r_s *)t} dt \right) \neq \int_{0}^{T_L} PIVs * e^{(\rho - r_s)t} dt \qquad (4.05)$$

However, if a land agent is already operating in a constrained optimization condition, he/she has already perceived yielding value in those *PIVs* rents left unprotected. If society can only protect a portion of desired *PIVs*, then perceiving the need to always protect each agricultural acre forever within their budget may be equivalent spatial valuation inconsistency already present. Therefore, prohibiting the opportunity for temporary conservation easement agreements based on accelerated discounting of future *PIVs* yielded with a term-specified conservation easement is inconsistent if a land agent is already operating within a constrained spatial optimization condition of choosing less than desired *PIVs* protection and always protecting them with permanent conservation easement agreements.

4.7 Summary

The preceding economic issues bring to the forefront the difficulty in defining agricultural land protection policy that ensures an equitable level of social welfare is being achieved. These issues are significant to shape and influence land-use conservation policy by recognizing that:

- Conventional usage of agricultural land market price's growth residual value fails to represent either true landowner *WTA* or land agent *WTP*.

- Landowners and land agents have separate underlying opportunity costs (including foregone non-market costs) that are not reflected in the market price of agricultural land.

- Legal stipulation of permanent tenure is different than economic optimization for permanent protection.

- Social welfare is influenced by irreversible landowner conversion, but social welfare is also influenced by land agent dependence of permanent conservation easement agreements.

- Choice of a social discount rate below social opportunity costs leads to an accelerated sacrifice or over investment (especially with permanent conservation easement protection) by a land agent that may be better served by more immediate agricultural land protection investments.

- Accelerated discounting of *PIVs* yielded with shorter term-specified conservation easement agreements over socially optimal temporal valuation by land agents may exist across temporal choices more than constrained spatial optimization conditions. This indicates less preference by land agents for accepting temporary conservation easement agreements due to this temporal endowment effect.

CHAPTER 5 VALUATION OUTCOMES AND MODEL ILLUSTRATIONS

The conservation easement valuation models developed in chapter three and supported in chapter four together enhance the economic understanding of *WTP* and *WTA* for agricultural land protection. The emphasis of this chapter is to utilize these models to demonstrate and illustrate each accounting stance's decision process in terms of their temporal valuation tradeoffs and incorporate their likely responses into a constrained landscape optimization or portfolio decision.

Because there is no conventional market for easements, the typical approach for valuing property is of limited use in determining conservation easement prices. While other non-possessory property interests (i.e. mineral, water, oil/gas, or access) have generally active markets, conservation easements are less active and tend to have imperfect competition involving only a few buyers (within a landscape). Further, given the focus of non-market rents in both valuation models, landowners and land agents must still negotiate an exchange price for any voluntary agreement (Boyd 1999).

Where standard appraisal or conventional agricultural land protection choices have held the protection period exogenously fixed at infinity, this dissertation's current land agent model relies on an implicit determination of this date via the ratio of societal *PIVs* relative to other socially desirable use rent schedules (land agent first order conditions). This is analogous to a landowner's implicit determination of an optimal conversion date. Together, these individual optimization determinations provide the upper and lower bounds for each accounting stance's reservation price and establish a land-use time line that provides a starting point for evaluating alternative temporal valuation scenarios. Where reservation prices overlap, there is an opportunity for landowners or land agents to improve their own welfare and not at the sacrifice of overall social welfare. Where reservation prices are poorly understood and mis-specified, there is an opportunity to improve societal welfare.

To establish viable temporal agricultural land protection valuation outcomes, this chapter demonstrates both graphically and numerically, estimation tradeoffs and sensitivity to important factors influencing each accounting stance's valuation for temporary conservation easement placement. Initially, landowner and land agent models are estimated for a numerical baseline of expected conditions and then intentionally varied given alternative assumptions about future conditions influencing both landowner and social conversion dates that ultimately influences each stance's reservation prices and likelihood for exchange.

5.1 Valuation and Time

Central to all agricultural land protection valuation is the reliance on capturing *PIVs* rents relative to their opportunity costs across an extended time period. The basic function of any conservation easement agreement is to shift a landowner's conversion date to match that of society's conversion date via compensation in an exchange. The expected value gained to society from delayed conversion is the positive difference between the social and market price of agricultural land. The cost of this gain though will vary depending not on the market price but rather the individual landowner's reservation price that is influenced by their specific level of *PARs*. This is the basic tenet for understanding protection valuation relative to time. This approach can also be extended in the same manner if a societal protection term is chosen that is less then socially optimal. Land agents will discount their *WTP* by indication of less preference protection duration than otherwise desired. A landowner will discount its *WTA* by indication of greater preference of developmental use rights retained. Thus, any exchange involving a temporal choice for protecting a convertible agricultural acre recognizes differing levels of compensation necessary compared to what would have been converted or protected in an unconstrained or temporally permanent choice.

Understanding this valuation tradeoff with time is especially important for analyzing current land-use policy that is limited to perpetual agreements or confronted with only spatial *PIVs* tradeoff given inadequate funding. If a land agent is limited to a dichotomous option of zero or infinity protection duration, no trade-offs exist within a constrained optimization decision that would recognize temporal valuation savings relative to spatial *PIVs* shortfalls with only permanent agreements. This is expounded by the recognition of future rents uncertainties and unknown but changing social values within an evolving community or landscape. If a land agent is forced to make an all or nothing investment decision for protecting an acre of agricultural land given limited funds and future unknowns, permanent conservation easement placement may be sub-optimal from a temporal standpoint for improving social welfare.

5.2 *Graphical and Numerical Conservation Easement Valuation*

To illustrate how each accounting stance valuation model differs, consider an initial deterministic example. Table 5.1 numerically summarizes assumed market and non-market annual rents (\$/acre), their associated growth rates (%), annual discount rates (%) and implicitly determined conversion dates necessary to estimate each valuation model today. While the following examples are used for illustrative purposes, they are intended to represent a current approximation of general annual rental values and growth rates across a cross-sectional landscape for a representative community in the west. Even if the numerical assumptions fail to reflect a specific situation, each valuation model's relative sensitivity becomes the pertinent measure derived from these assumed values. The information contained in Table 5.1 will be used for both the landowner and land agent throughout the remainder of this chapter. These expected values are derived from a variety of sources.[25]

TABLE 5.1 BASELINE MARKET AND NON-MARKET ANNUAL FACTORS INFLUENCING AGRICULTURAL LAND VALUATION

	\$/ac		rate		\$/ac & rate		time
U	60	α	0.03	$PIVs$	52	T_{soc}	102
PAR	10	δ	0.02	ρ	0.03	$T_{con\ w/o\ PAR}$	2
A	61	λ	0.01	r_s	0.05	T_{con}	10
C	25	r_{ag}	0.05	r_s^*	0.045	T_L	50

[25] Agricultural rents are an average of mountain states cash rents by NASS. Urban rents are assumed to approximate current agricultural rental averages (Tegene *et al* 2000), *PIVs* are a conservative average of *WTP* studies cited in Table 2.3. The discount rate is risk-free rate and conversion costs are fixed amount, both of which are practically equivalent to other studies (Capozza and Sick 1991, and Tegene *et al* 2000) and *PARs* are assumed for illustrative purposes. Term periods are implicitly determined from the valuation models except for the explicit choice for the term (T_L).

5.2.1 Landowner Illustrations

The baseline assumptions hold that a landowner recognizes approximately equal agricultural ($A = \$61$) and urban ($U = \$60$) rents and the market average captured *PARs* are \$10 per acre. All rents grow by their respective growth rate, and the growth rate for urban rent (α=0.03) is three times greater than agrarian (λ=0.01). If a landowner converted today, there would be a one-time \$25 per acre incursion of conversion costs (C). All rents are subject to a landowner risk-free discount rate (r) of 5 percent.

Substituting the appropriate values from Table 5.1 into the specified agricultural land pricing models yields the following market prices of agricultural land with respective anticipated conversion dates of (T_{con} w/o *PAR* = 2) and (T_{con} w/ = 10).[26] Recall equations (3.02) and (3.07) stated:

(3.02) Conventional: $T_{con} = 2$

$$MP_{ag}(0) = \frac{A}{r_{ag} - \lambda}(1 - e^{(\lambda - r_{ag})T_{con}}) + \frac{U}{r_{ag} - \alpha}e^{(\alpha - r_{ag})T_{con}} - Ce^{(-r_{ag}T_{con})}$$

$$\$2{,}977 = 117 + [2{,}882 - 23]$$

(3.07) Modified: $T_{con} = 10$

$$MP_{ag}(0) = \frac{A}{r_{ag} - \lambda}(1 - e^{(\lambda - r_{ag})T_{con}}) + \frac{PAR}{r_{ag} - \delta}(1 - e^{(\delta - r_{ag})T_{con}} + \frac{U}{r_{ag} - \alpha}e^{(\alpha - r_{ag})T_{con}} - Ce^{(-r_{ag}T_{con})}$$

$$\$3{,}031 = 500 + 86 + 2460 - 15$$

[26] Conversion dates of 2 and 10 were initially solved numerically according to the first order condition equation (3.10). Further discussion of these dates follows and an alternative estimation technique is discussed and shown in Appendix II.

Without the presence of any landowner *PARs*, the price of agricultural land as modeled in (3.02) is actually less due to the more immediate conversion to urban rents.[27] Otherwise, the modified agricultural land price model captures a decade of *PAR* and agrarian rents before a landowner's first order condition makes it optimal to convert.

From each agricultural land-pricing model above, a landowner's conventional and modified permanent conservation easement value is estimated. These represent a landowner's alternative reservation prices or *WTA* protection.

For example, recall equations (3.03) and (3.09) are a landowner's conventional and modified conservation easement value for accepting permanent protection for an acre of convertible agricultural land as shown below.

(3.03) Conventional: $T_{con\ \text{w/o}\ PAR} = 2$

$$CEV_{ag}(0) = \left[MP_{ag}(0) - \frac{A}{r_{ag} - \lambda} \right] = \left[\frac{U}{r_{ag} - \alpha} e^{(\alpha * T_{con})} - \frac{A}{r_{ag} - \lambda} e^{(\lambda * T_{con})} - C \right] * e^{(-r_{ag} * T_{con})}$$

$$\$1{,}452 = [2{,}977 - 1{,}525] = (2{,}882 - 1{,}407 - 23)$$

(3.09) Modified: $T_{con} = 10$

$$CEV_{ag}(0) = \left[MP_{ag}(0) - \frac{A}{r_{ag} - \lambda} - \frac{PAR}{r_{ag} - \delta} \right] = \left[\frac{U}{r_{ag} - \alpha} e^{(\alpha * T_{con})} - \frac{A}{r_{ag} - \lambda} e^{(\lambda * T_{con})} - \frac{PAR}{r_{ag} - \delta} e^{(\delta * T_{con})} - C \right] * e^{(-r_{ag} * T_{con})}$$

$$\$1{,}172 = [3{,}031 - 1{,}525 - 333] = 2{,}456 - 1{,}022 - 247 - 15)$$

[27] In a real land market, there is only one price for a homogeneous acre of agricultural land. This would require adjusting actual agricultural and urban rents to correct the specification. In the example, urban and agricultural rents are over-specified by rent omission, therefore (3.02) and (3.07) are not exactly equal.

A landowner's conventional and modified conservation easement valuations are numerically summarized in Table 5.2. This table illustrates a comparison of the difference in landowner valuation by recognition of *PARs* influencing landowner's *WTA* protection.

TABLE 5.2 LANDOWNER CONSERVATION EASEMENT PER ACRE VALUES

Model	T_{con}	$MP_{ag}(0)$	WTA_{dev}	$CEV_{ag}(0)$	$TCE_{ag}(0)$
		($/acre)			
(3.03) Conventional (w/o PAR)	2	2,977	1,452	1,452	
(3.09) Modified	10	3,030	1,505	1,172	
(3.13) Term	50	2,679			351

While both agricultural land pricing models have slightly different *WTA* development ($1,452 and 1,505), the conventional easement valuation is 24 percent greater then the modified approach ($1,452 and 1,172). This is from the recognition of $10 per acre *PARs*. The explicit allowance for capitalized private amenity rents lower a landowner's *WTA* development while delaying conversion from year 2 until year 10.

Also defined in Table 5.2 is a landowner's term conservation easement value for accepting an explicit protection period of 50 years. This valuation follows from equation (3.13) that a landowner's term easement value compensates a landowner for delaying conversion from year 10 to year 50. This equation can be varied across differing periods commencing after a landowner's own conversion date up to infinity (socially permanent).

Graphically, all three landowner valuation relationships are better described in Figure 5.1.

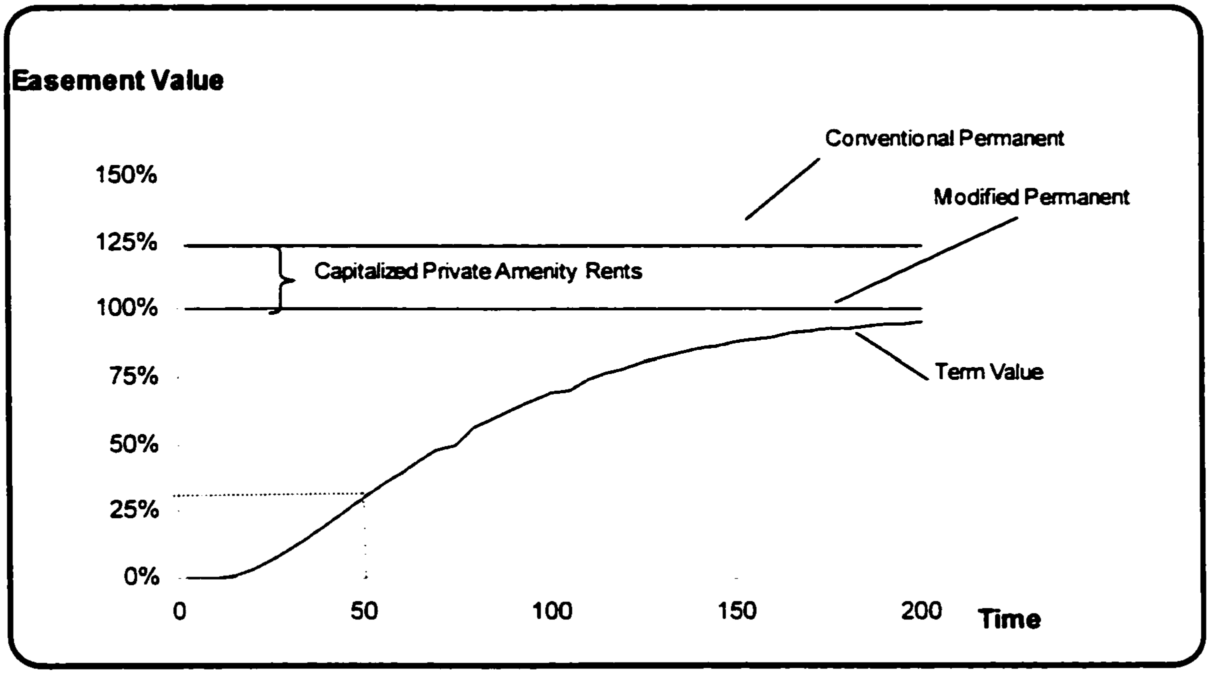

FIGURE 5.1 CONVENTIONAL VERSUS MODIFIED LANDOWNER CONSERVATION EASEMENT VALUATION

Figure 5.1 illustrates the trade-off between a landowner's conventional, modified perpetual and term conservation easement values. The actual values have been indexed to 100 (base modified permanent CE value) for illustrative purposes. For the given assumption of a possible term valuation, if a landowner considered a 50-year temporary easement his/her term easement valuation would be equivalent to 30 percent of the modified permanent value. This represents a landowner's *WTA* discount to delay conversion for the specified term of the temporary easement ($351 of 1,172). Note that a term value approaches zero (discount approaches full value) as the term period nears a landowner's own conversion date. Alternatively, the value of a term conservation easement asymptotically approaches the permanent value after 200 years (>96% and discount approaches zero). The key point for this illustration is that a landowner recognizes a sizable discount away from their permanent conservation easement reservation price or *WTA* for a relevant shorter period of protection.

5.2.1.1 First Order Conditions

All values used to describe Figure 5.1 are dependent on the given assumptions in Table 5.1. They are also implicitly dependent on a landowner's own land price optimization for determination of a conversion date. A landowner's first order conditions (3.10) define the temporal tradeoff between competing land-use rents dependent on future expected rental rates. As shown below, for the given rents, a landowner' optimal period to convert occurs at $T_{con} = 10$, which maximizes the modified market price of an acre of agricultural land.

(3.10) Landowner first order conditions:

$$Ue^{(\alpha T_{con})} = PA\,\mathrm{Re}^{(\delta T_{con})} + Ae^{(\lambda T_{con})} + r_{ag}C$$

$$60 * e^{(.03*10)} = 10 * e^{(.02*10)} + 60 * e^{(.01*10)} + 0.05 * 25$$

For example, a landowner will convert at year 10 if no protection agreement (temporary or permanent) is reached. This trade-off relationship is better described in Figure 5.2 for differing expected urban rental growth (α). Changes in urban rental growth are negatively correlated with landowner choice of conversion date. The opposite is true for changes in agricultural rents, *PARs*, or conversion costs that positively influence the conversion date.

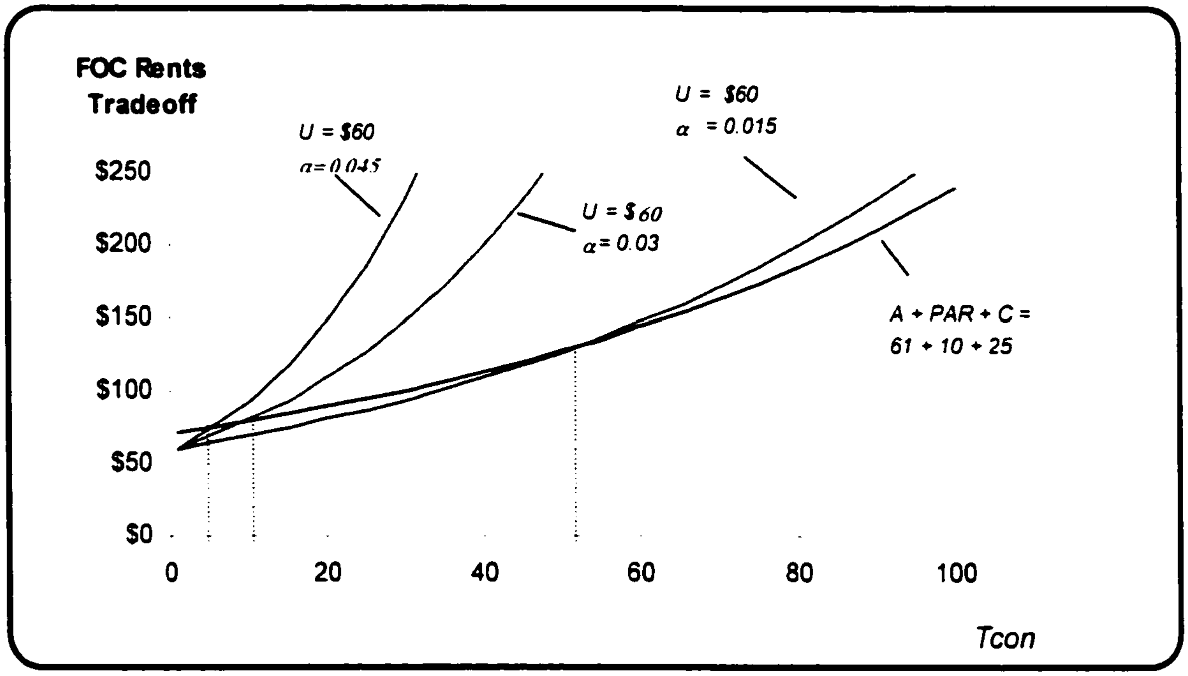

FIGURE 5.2 LANDOWNER DETERMINATION OF OPTIMAL TIME TO CONVERT

Maintaining the assumption that agrarian use is the current best use, a landowners only real decision is the determination of the relative growth of developed-use rents as compared with future net agrarian rents defining a possible future conversion date. The lower bound of conversion occurs ($T_{con} = 0$) when the initial period of growth in urban rents outpaces the net agrarian growth. With the current growth rates, returns to urban rents are immediately greater when $U = \$72$. If annual urban rental growth drops by fifty percent to 0.015, conversion would not occur until $T_{soc} = 55$. A landowner's upper bounds for conversion will be infinity and never occur if net growth in landowner's agrarian rent always outpaces returns from urban use.

This relationship is specifically critical to valuation outcomes that actually involve a future change in use. What this means is, if net agrarian rents always out pace or always fall short of urban rents, then conversion will either never occur or likely already has occurred. By imposition that land in an agrarian use has only a one-way conversion choice, then the only real concern is when and if urban rents outpace net agrarian rents. Actual specific determination of T_{con} is unsolvable by itself if growth rates continually change along differing paths given uncertainty and preference changes. Recall, a landowner's FOC (3.10) is a single equation with multiple unknowns and changes in agricultural rents and *PARs* work to offset any parallel changes in urban rents leaving T_{con} unknown. Since (3.10) does not have a closed form solution, no single date exists if more than one rent changes or is unknown. Thus, (3.10) is an implicit function underlying the determination of both a landowner's reservation price or conversation easement value for agricultural land.

An alternative approach to imputing numerical assumptions for defining a landowner's conversion decision is to approximate this relationship in an explicit and observable form. This allows a more direct estimation of a landowner's conversion without having to know all unique information faced by an individual landowner and provides direction as to how rental growth influences conversion at any point in time. Consider that T_{con} is an explicit function of urban rental growth α, agrarian rental growth λ, and *PAR* growth δ, for the given initial stock rent levels (U, A, and *PAR*). A conceptual form of this relationship is

$$T_{con} = f(\alpha, \lambda, \delta\text{: } U, A, \text{and } PAR) \qquad (5.01)$$

Since all three rates are expected growth in rents (market and non-market), these forecasted values derive an estimate of future landowner conversion. Since both market and non-market rents must be forecast estimates, a full factorial design or experimental approach is taken that generates combinations of possible growth rate observations that could possibly occur. This approach is derived as a portion of the more general Response Surface Methodology experimental research.[28] A full-factorial design is used to approximate a discrete five-point distribution for each growth rate (k) or influencing factors that generate a set of experimental observation combinations that each influence conversion. The number of specific growth rate observation combinations is defined as the five defined points for each growth rate raised to the power of influencing factor's k. This results in a (5^3) generation or 125 differing combinations that could represent possible combinations of growth rates that influence optimal conversion (T_{con}). These data combinations[29] are then inserted into (3.10) to derive corresponding estimates of T_{con}. Together, the entire data set provides an approximation of differing conversion dates dependent on 125 different growth rate combinations. (5.01) is then regressed in an attempt to define the influence of each growth rate on conversion and provide an estimate of their individual absolute and relative change influencing a landowner's date of conversion. A least squares logarithm-linear regression model of (5.01) yields:

$$\widehat{\ln(T_{con})} = \underset{(28.5)}{3.4} - \underset{(14.7)}{45.8}*\text{alpha} + \underset{(27.8)}{30.3}*\text{lambda} + \underset{(5.5)}{5.96}*\text{delta} \quad \text{(t-stats)} \tag{5.02}$$

$R^2\text{adj} = 0.93$

[28] This is more fully described in the Appendix II.
[29] See Appendix II for a full description of estimated growth rate combinations used in regression analysis.

For the given expected growth rate values, the expected conversion date and point elasticities are as follows:

$$11.5 \text{ years} \cong e^{(\ln(Tcon))} = e\text{^}[3.4 - 45.89*(.03) + 30.3*(.01) + 5.96*(.02)]$$

$$\varepsilon_{Tcon,\ alpha} = (-45.8) * (.03) = -1.40$$

$$\varepsilon_{Tcon,\ lambda} = (30.3) * (.01) = 0.30$$

$$\varepsilon_{Tcon,\ delta} = (5.96) * (.02) = 0.12$$

The logarithm-linear regression equation (5.02) estimates that a landowner's implicit first order conditions are primarily influenced by growing urban rents as shown by its point elasticity is elastic ($\varepsilon_{Tcon,\ alpha} = -1.4$) as compared with much smaller agrarian rents and *PARs* influences on the price of agricultural land. The overall estimate is a fairly strong fit with as expected signs influencing conversion.

5.2.1.2 Temporary Valuation

A landowner's temporary valuation is influenced by the same rental relationships in the permanent specification. Variation in landowner *PARs* shift the term discount curve outward with greater amenity and inward with individual landowners recognizing less non-market amenity rents on their convertible agricultural land. With current assumptions, Figure 5.3 shows that with a term of 50 years, a landowner would be willing to accept a seventy percent discount away from permanent valuation given the initial *PAR* assumption. But the same landowner would only reduce his/her term value by fifty-seven percent without any *PARs* to his/her agricultural land, along with converting earlier at $T_{con} = 2$. Still, if a landowner had twice the capitalized *PAR* value he/she would discount a term conservation easement value by seventy-eight percent for the same 50 year term and not convert until T_{con} = 18. Thus, for a protection period of 50 years, every additional $1 of landowner *PAR* decreases his/her term easement by one percent and extends their conversion date outward by nearly one year (.84 years per $1 change).

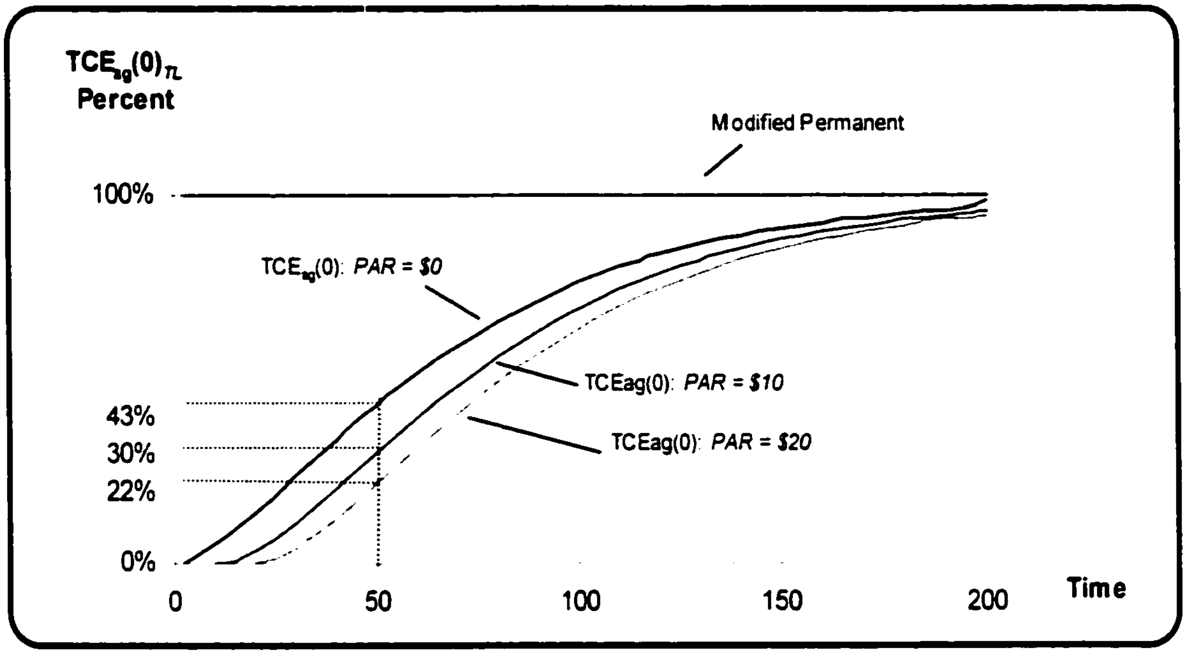

FIGURE 5.3 LANDOWNER TERM CONSERVATION EASEMENT DISCOUNT CURVE

5.2.2 Land Agent Illustrations

A corresponding illustration can be demonstrated for a land agent's conservation easement valuation given an expected level of *PIVs* rents annually generated for a particular convertible acre. The initial valuation assumptions hold that a land agent recognizes *PIVs* of $52 for an acre protected. *PIVs* rents are assumed to grow three percent annually (ρ = .03) and a land agent faces an initial discount rate of five percent (r

= .05). Like a landowner, a land agent is concerned with choosing a social date of conversion that maximizes the social price of convertible agricultural land given the net positive *PIVs* generated with continued agrarian land-use. Maximization of agricultural land's social price (3.15) is equivalent to maximizing the $SV_{LA}(0)_{Tsoc}$ a land agent's social conservation easement value (3.18). Any determination of a possible social conversion date infers that a future period exists where the social value of development is greater than the value for protection purposes. As with the landowner's conversion decision, social first order conditions of optimization ensure a relevant choice of T_{soc} will range between zero and infinity.

Substituting the appropriate values form the information contained in Table 5.1 into the social price of agricultural land yields a maximum value when social conversion occurs at T_{soc} = 102 years. This defines a maximum social price for an acre of agricultural of land (3.15) as:

(3.15) Social Price of Agricultural Land $\quad T_{soc} = 102$

$$SP_{ag}(0)_{T\,soc} = \frac{A}{r_s - \lambda}\left(1 - e^{(\lambda - r_s)T_{soc}}\right) + \frac{PIVs}{r_s - \rho}\left(1 - e^{(\rho - r_s)T_{soc}}\right) + \frac{U}{r_s - \alpha}e^{(\alpha - r_s)T_{soc}} - Ce^{(-r_s * T_{soc})}$$

$$\$4{,}151 = 1{,}499 + 2{,}262 + 390 - 0.15$$

In this social valuation perspective, gains from continued agrarian rents and distant urban rents add to agricultural land's social value. When T_{soc} = 102, capitalized *PIVs* rents are maximized relative to competing rents and *PIVs* are thereafter foregone with socially desired conversion.

Substitution of these assumptions into a land agent's conservation easement valuation models (3.18) for alternative social conversion dates, (3.19) for permanent, and (3.21) for a term specified period of 50 years, yields the following social valuation preferences for a land agent's conservation easement valuation.

(3.18) Term optimal $\qquad T_{soc} = 102$

$$SV_{LA}(0)_{T_{soc}=102} = \frac{PIVs}{r_s - \rho}\left(1 - (e)^{(\rho - r_s)T_{soc}}\right)$$

$$\$2{,}261 = 2{,}600 * (.87)$$

(3.19) Permanent $\qquad T_{soc}$ = infinity

$$SV_{LA}(0)_{T_{soc}=\infty} = \frac{PIVs}{r_s - \rho}$$

$$\$2{,}600 = 2{,}600 * (1)$$

These conservation easement valuation results are further summarized in Table 5.3 for the given deterministic assumptions.

TABLE 5.3 LAND AGENT CONSERVATION EASEMENT VALUES (WTP) PER ACRE

		---------------	($/acre)	-------------
Model	T_{soc}	$SP_{ag}(0)$	$SV_{LA}(0)$	$TSV_{LA}(0)$
(3.19) Permanent	infinity	4,125	2,600	
(3.18) Term Optimal	102	4,151	2,261	
(3.21) Term Specified	50	4,064		1,644

Table 5.3 provides a comparison of valuation outcomes for a land agent depending on the social date of conversion. For the given assumptions, it is socially optimal to convert after a period of 102 years. This is conversely reflected in (3.18) being less in total value than (3.19) (\$2,262 < 2,600). In this case the social price of agricultural land is maximized with future conversion and thus the social conservation easement value reflects only the term protected. In a different view, all periods of *PIVs* otherwise captured after (T_{soc} = 102) adds only thirteen percent additional value (\$2,600-2,262)/2,600.

Graphically, these valuation models are illustrated in Figure 5.4.

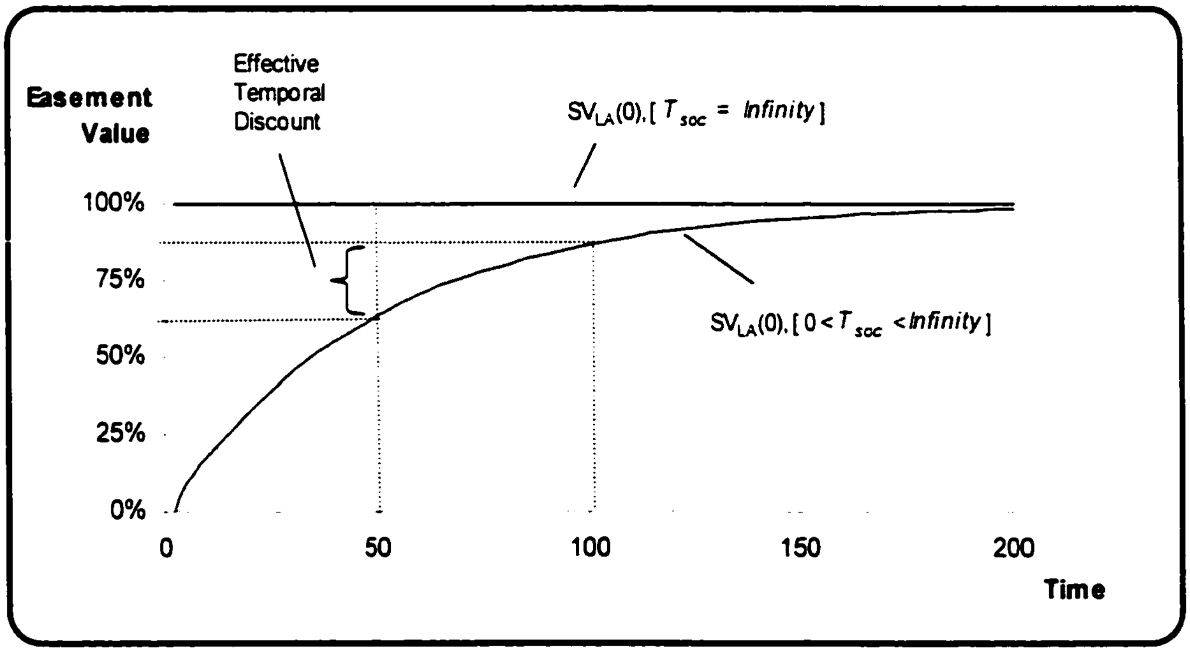

FIGURE 5.4 LAND AGENT CONSERVATION EASEMENT VALUATION ACROSS TIME

Figure 5.4 graphically illustrates the differing *WTP* for all possible periods of T_{soc}. Both term optimal (3.18) and term specified (3.21) valuation models are described along the same term discount trade-off curve. For the term specified period of $T_L = 50$, the estimated term value ($1,644) reflects only sixty-three percent of a land agent's permanent conservation easement value. But a more effective discount value is the associated *WTA* discount away from the optimal term value. A land agents' *WTP* for a period of 50 years is seventy-three percent of their *WTP* for 102 periods.

5.2.2.1 First Order Conditions

A land agent's term and permanent conservation easement valuation models shown within Figure 5.4 are dependent upon a land agent's social first order conditions (3.16). This implicit determination ensures that recognizing the temporal tradeoffs between social PIVs and net market rents generated with conversion maximizes the social value of agricultural land. This social optimality condition is more fully described in Figure 5.5 for alternative social *PIVs* rental growth rates. Any positive change in *PIVs* rents shifts the socially desired conversion date outward. As future *PIVs* rents approach or stay greater than underlying net market rents or "social option to convert" values held by some underlying possessory landowner, conversion is forever postponed.

Recall (3.16), this equation is restated as an implicit relationship in a ratio form of *PIVs* relative to net market rents, where every rental combination greater than 1, implies do not convert for social optimization.

(3.16) Land agent's first order condition ratio

$$PIVs\left(e^{(\rho T_{soc})}\right) \Big/ \left(Ue^{(\alpha T_{soc})} - Ae^{(\lambda T_{soc})} - r_s C\right) =$$

$PIVs$/(net market rents)	if	> 1	protect forever
		< 1	develop
		= 1	determines T_{soc}

This first order condition is can be graphically shown as Figure 5.5.

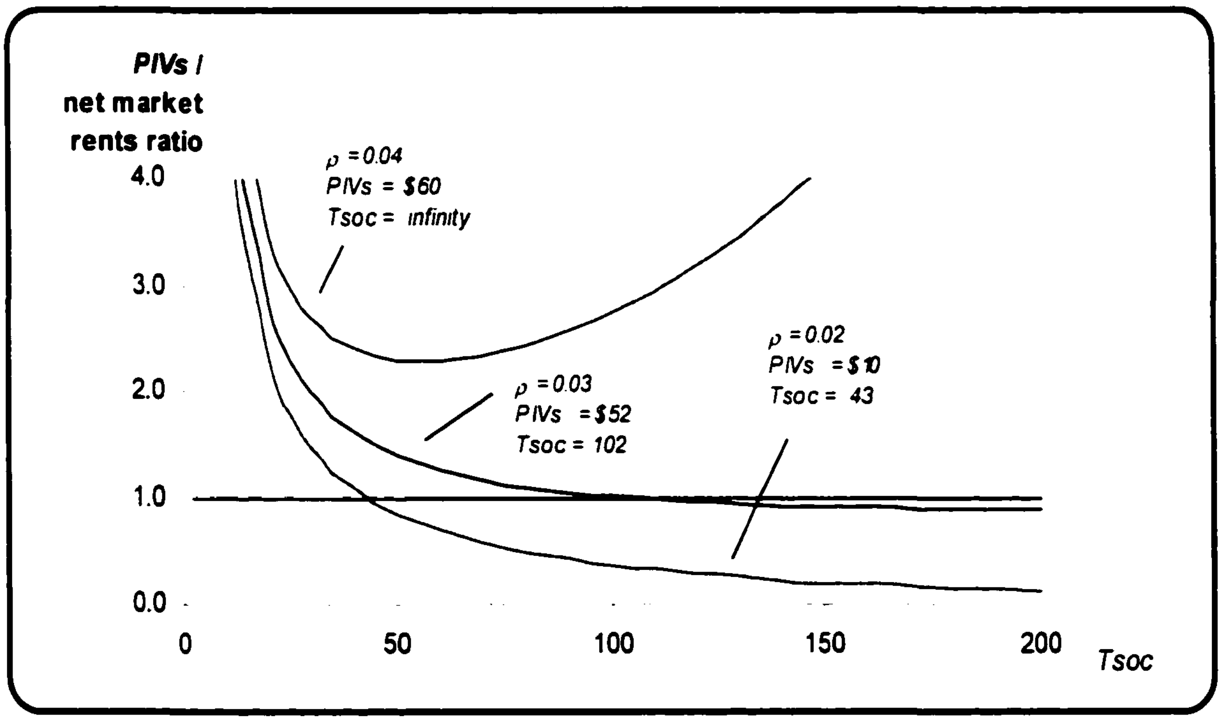

FIGURE 5.5 LAND AGENTS TEMPORAL FOC RENTS RATIO TRADEOFF

Figure 5.5 shows for the numerical example (*PIVs* = \$52 and $\rho = 0.03$) that it is socially optimal for conversion to occur at year 102. The first order condition in ratio form intersects the value one from above at year 102. If initial *PIVs* grow initially faster then net market rents then the social conversion date extends outward. If the ratio of *PIVs* rents to competing net market rents always exceeds 1.0, social conversion will never occur and T_{soc} =infinity. For the given net market rents, as *PIVs* growth reaches and exceeds 0.03 annual rate then the social value for protection will approach and exceed any offsetting future development value. Likewise, if net market rents accelerate to a greater extent than the social value for protection, the social date of conversion becomes more imminent.

Specific determination of T_{soc} is unsolvable if growth rates are stochastic and change along differing time paths given market uncertainty and social preference changes. In this case, social FOC's (3.16) is equivalent to the landowner condition of a single equation with multiple unknowns and changes in net market rents may work to offset any parallel changes in *PIVs* rents moving T_{soc} inward and outward simultaneously. Since (3.16) is implicit to determination of a land agent's reservation price or conversation easement value for protecting agricultural land, determination of any possible conversion date is critical and sensitive to a land agent's valuation.

Following the same estimation approach as the previous landowner model, an explicit T_{soc} relationship is estimated. This describes social conversion as a function of included growth rates. This allows a direct estimation of a land agent's conversion decision without having to define all unique information necessary to provide relative rental growth influences on conversion at any point in time. Consider that T_{soc} is an explicit function of *PIVs* rental growth (ρ) and net market rents: urban (α) and agrarian (λ), for the given initial stock rent levels (*PIVs*, *U*, and *A*,).

A least squares logarithm-linear regression model approximating the relationship of (3.16) yields (5.03):

$$\ln(\hat{T}_{soc}) = \underset{(21.9)}{1.5} + \underset{(8.2)}{14.9*rho} - \underset{(-4.8)}{7.8*alpha} + \underset{(3.5)}{8.6*lambda} \quad \text{(t-stats)} \tag{5.03}$$

$R^2adj = 0.54$

The estimated conversion date and derived point elasticities for the assumed numerical growth rates are shown as follows:[30]

$$6.1 \text{ years} \cong e^{(\ln(Tsoc))} = e\text{^}[1.5 + 14.9*(.03) - 7.77*(.03) + 8.62*(.01)]$$

$$\varepsilon_{Tsoc.\ rho} = (14.9)*(.03) = 0.45$$

$$\varepsilon_{Tsoc.\ alpha} = (-7.77)*(.03) = -0.23$$

$$\varepsilon_{Tsoc.\ lambda} = (8.62)*(.01) = 0.09$$

This regression model did not fit nearly as well as the landowner estimation. For the given expected growth rates, the estimated social date of conversion was only 6.1 years, which is not close to the defined FOC requirement implicitly determined with strict deterministic assumptions for the given growth rates. The reason for the poor estimation results are likely due either to the functional form (log/linear) or simply the experiential

[30] See Appendix III for complete regression results, data and further explanation of the experimental design for the assumed distribution and generation of observations.

data set defined an improper distribution of the expected growth rates. The individual coefficients do exhibit all the expected signs influencing social conversion but all corresponding point elasticities are all inelastic in their influence on conversion. For example if ρ increased from .03 to .04 (all else constant) this would individually shift social conversion outward only 2.7 years (.45% of 6 years). This relative influence estimate is below expected results due to the models limited explanation of the variations in T_{soc}.

5.2.2.2 Temporary Valuation

The FOC of the previous section are a necessary condition for land agent optimization of the social value of agricultural land. These conditions ensure that the optimal land use choices maximize the social value of agricultural land and reflect social welfare improvements. But any restraint on the land agent choice of T_{soc} changes the land agent decision from unconstrained to constrained optimization. In this case, a land agent's decision is for a period of protection somewhere less than T_{soc} (not zero with perpetual). Consideration of any exogenous shorter-term period necessitates a land agent to discount its *WTP* for accepting a period of protection ($T_{soc} - T_L$) less than an unconstrained social optimal choice. Recall equation (3.21) showed the *PIVs* rents offered up by a land agent are equivalent in valuation as the implicit social optimal value for the same term specified period.

(3.21) Land Agent Term Valuation: no endowment holding $T_L = T_{soc(50)} = 50$

$$SV_{LA}(0)_{T_{soc(T_L)}} = TSV_{LA}(0)_{T_L} = \frac{PIVs}{r_s - \rho} * (1 - e^{(\rho - r_s)T_{soc(T_L)}}) = \frac{PIVs}{r_s - \rho} * (1 - e^{(\rho - r_s)T_L})$$

$$1{,}644 = 2{,}600 * (.632)$$

However equation (4.05) in chapter 4 held that a land agent's *WTA* less periods of protection might not equal their *WTP* for those same periods initially protected. This was considered a land agent's endowment effect. In this situation a land agent discounts his/her *WTA* to a greater extent due to the perceived loss of protection more than his/her *WTP* for those periods ($T_{soc} - T_L$) with a term agreement protection. Recall that equation's (4.04) and (4.05) hold:

(4.05) Land Agent Term Valuation with endowment holding $T_L \neq T_{soc(TL = 50)}$

$$TSV_{LA}(0)_{T_L} = \frac{PIVs}{r_s - \rho}(1 - e^{((\rho - r_s)T_{soc})}) + \frac{PIVs}{r_s^{\bullet} - \rho}(e^{((\rho - r_s^{\bullet})T_{soc}} - e^{((\rho - r_s^{\bullet})T_L)})$$

$$(\,PIVs\ thru\ T_L\,) = (\,PIVs\ thru\ T_{soc}\,) - (\,PIVs\ from\ T_{soc}\ back\ to\ T_L\,)$$

$$1{,}375 = 2{,}600 * (.87) + 3{,}467 * (-.2557)$$

In this case, a land agent must define his/her term *WTP* as a sum of his/her socially desired *WTP* less his/her *WTA* discount for a fractional period given up. Figure 5.6 illustrates two temporary conservation easement discounts. The lower curve is affected by an additional endowment discount by a land agent dependent on his/her associated *WTA* protection yield on *PIVs* foregone.

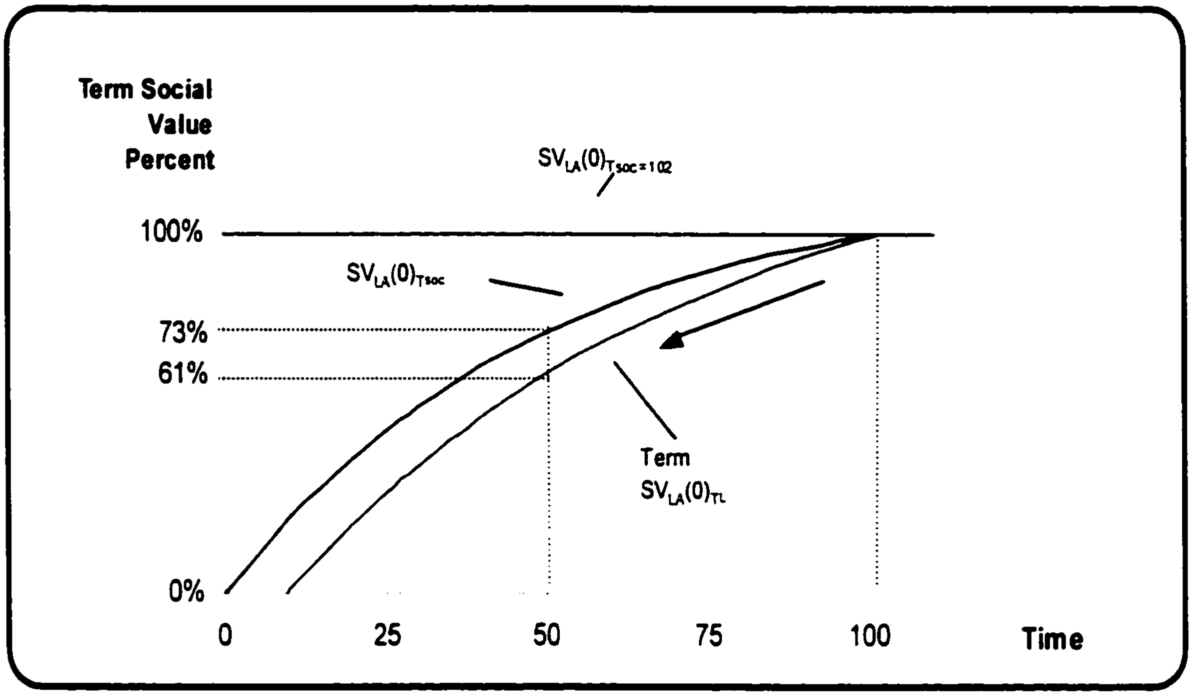

FIGURE 5.6 LAND AGENT TERM CONSERVATION EASEMENT DISCOUNT

A land agent's situation shown in Figure 5.6 illustrates an additional term valuation discount where the effective protection yield (r_s -ρ) utilized in estimating his/her *WTP* for T_{soc} is greater than the protection yield (r_s*-ρ) employed in his/her *WTA* discount back to T_L. The illustration in Figure 5.6 of a land agent endowment effect is based on a land agent having a separate and lower social discount rate that creates a larger discount on *PIVs* rents given up during that socially desired period given up as compared with an optimal condition of a term social value for 50 periods of protection. Equation (4.05) yields a discount greater than if it were otherwise socially optimal to convert that same period. In the numerical example, Figure 5.6 shows that for the baseline assumptions there is a corresponding discount away from the optimal social value of seventy-three percent to only sixty-one percent for 50 periods of agricultural land protection. Thus, a land agent still has a viable yet reduced *WTP* for temporary protection. This implication of an endowment effect influencing temporary valuation is not defined as rational land agent justification for preference to permanent specification, but rather to identify the condition that transfer of perceived *PIVs* rents ownership to the land agent for those future protection periods, than yielded away tends to enhance the generally accepted preference for permanently protection conservation easement agreements.

5.3 Portfolio Approach to Optimization Within a Landscape

Term specified conservation easement agreements add an additional approach in land-use policy that enhances temporal flexibility in protection choices. The appeal for temporary conservation easement placement is for improved social welfare when a land agent is constrained by some limiting resource. Common examples include limited funding, an inactive and discontinuous parcel sized land market, uncertain and changing future social values, or possibly a technical or legal constraint (landowner's property is legally encumbered and will not grant subordination), all within a mixed agricultural landscape.

Since conservation easement agreements typically involve large irregularly sized parcel acquisitions within inactive or discontinuous land markets, any constrained permanent conservation easement placement may result in over protection of more abundant agricultural land with less social valuation preference. In this situation, a land agent may improve the level of *PIVs* protected with term specified conservation easement agreements. From a portfolio viewpoint, reduced initial investment savings from any term agreement stimulates or allows more strategic protection by either expanding more initial protection or by waiting (extra savings with delayed investment opportunity) for more desired agricultural land parcels to become available to protect. In this view, a land agent's choices are more concerned with continual and changing portfolio acquisitions that maximize protecting *PIVs* and not simply trying to accumulate abridged and discrete permanently restricted agricultural land.

The collective presence of multiple land agent constraining conditions creates a needed opportunity for greater land protection choices. To examine both the conventional and alternative land agent decision choices from a portfolio view, consider the following simplified situation.

Within a developing landscape, two single agricultural acre parcels are identified for protection possibility. Each has equivalent levels of *PIVs* intensity, and for this example T_{soc} = infinity (conventional assumption). If a land agent is faced with a funding constraint that limits only one permanently protected acquisition, a land agent's decision is strictly a constrained spatial optimization choice. The land agent's decision is described in Figure 5.7.

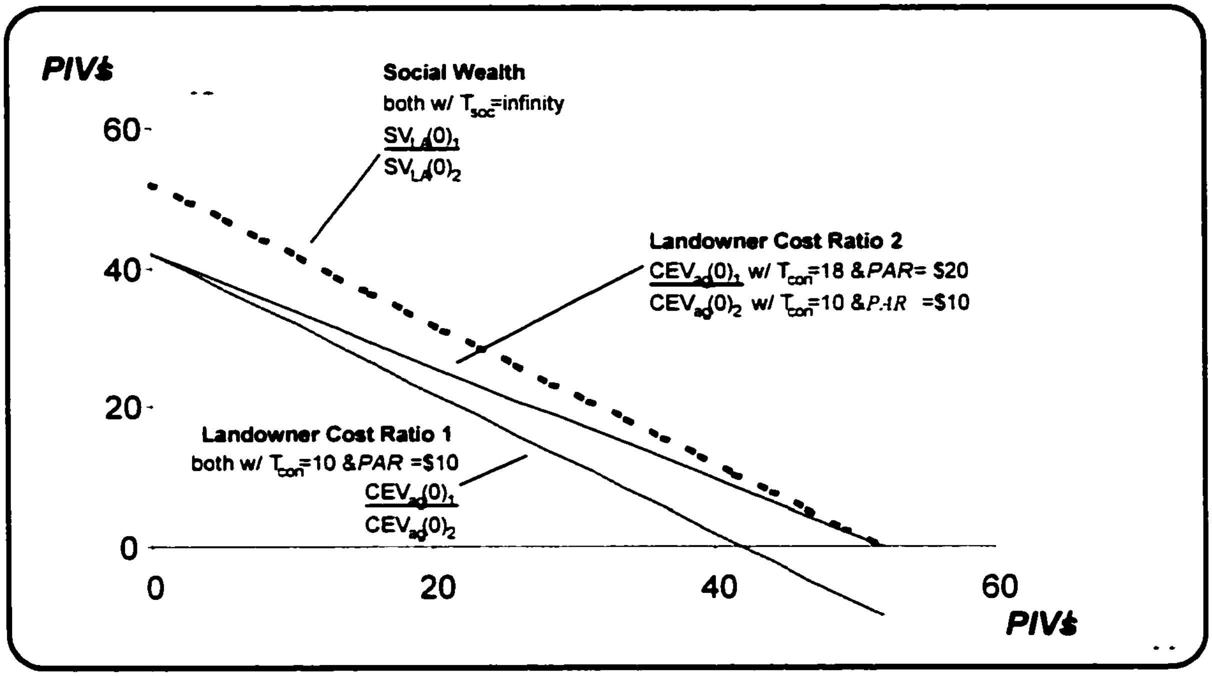

FIGURE 5.7 LAND AGENT CONSTRAINED SPATIAL OPTIMIZATION TRADEOFF BETWEEN TWO ONE-ACRE PARCELS

In Figure 5.7, a land agent's optimal choice between two equally desired single acre parcels become equivalent to permanently acquiring that parcel with the least landowner acquisition cost defined by a corner solution of the lower landowner cost ratio. Two separate landowner cost curves (landowner cost ratio 1 and landowner ratio cost 2) are shown to compare alternative situations with differing landowner costs.

As shown, a land agent first recognizes the spatial *PIVs* tradeoff as depicted by the dotted line. Since both parcels have the same *PIVs* intensity, the tradeoff between the two yields a linear substitution one for the other. A corner solution will always result unless each landowner has the exact same underlying rent capitalized into his/her reservation price to accept. In this case, a land agent would be indifferent between choosing either parcel since the intersection of the 'landowner cost ratio 1' curve would be tangent to the 'social value' curve due to the fact that his/her acquisition cost ratio is identical to the social value tradeoff curve. Actual placement of each curve was intentionally separated for illustrative purposes but the placement of either landowner acquisition ratio curve is dependent upon a land agent's resource budget. The gain to a land agent in this situation, is when he/she face the 'landowner cost ratio 2.' It assumes parcel one has a lower landowner *WTA* (or reservation price) due to greater landowner s held by that landowner ($20/acre), thus lowering the cost relative to parcel two (*PAR*-$10/acre). Thus, with equal *PIVs* intensity a land agent will recognize that landowner with a *WTA* protection that most closely associates with his/her conservation purpose as evidenced by a greater level that effectively lowers the land agent's acquisition costs.

Conversely, a land agent could view this same optimization decision from a temporal tradeoff. From this view, a land agent would choose between temporal or term periods of protection for each available parcel instead of a single choice between two parcels, via a term conservation easement agreement. Figure 5.8 illustrates a land agent's temporal tradeoff between the same two parcels with equal *PIVs* intensity.

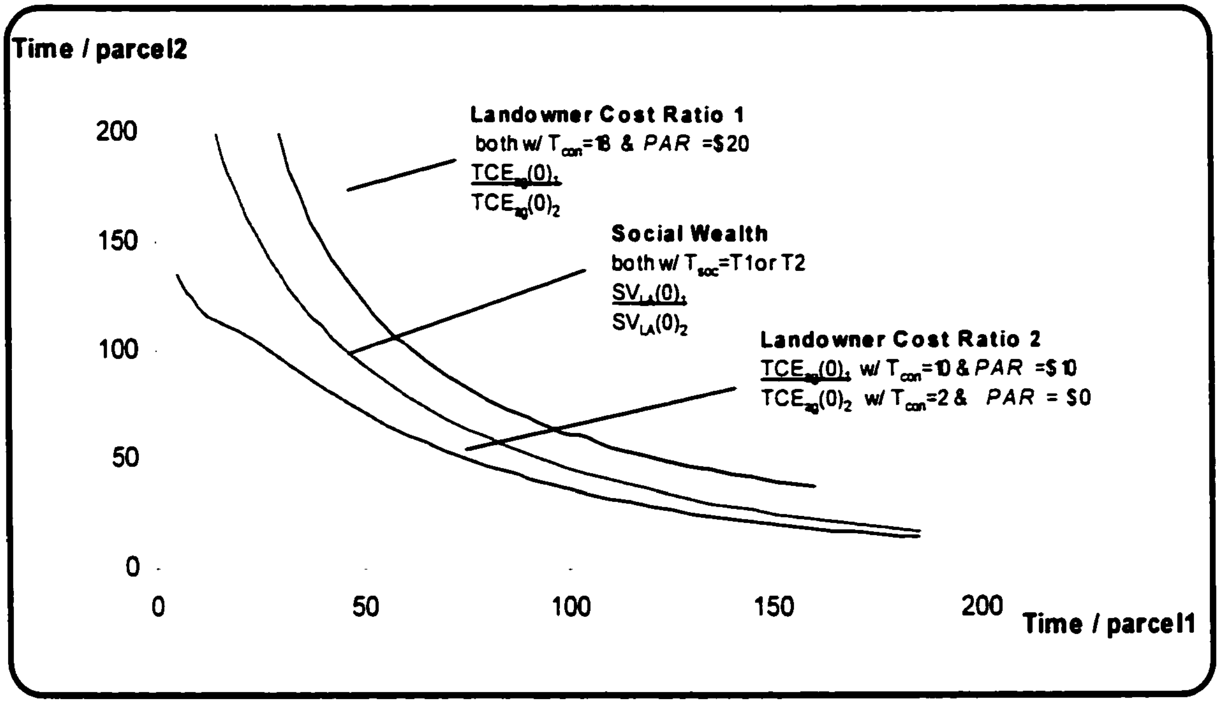

FIGURE 5.8 LAND AGENT CONSTRAINED TEMPORAL OPTIMIZATION TRADEOFF BETWEEN TWO ONE-ACRE PARCELS

In Figure 5.8, a land agent recognizes a temporal social value trade-off curve that is convex due to the temporal discount associated with today's value of distant periods of protection. For this example, a land agent's decision is to determine the optimal time combination between two parcels that maximizes social value from protecting either parcel for a combination of periods. In this constraining choice, a land agent is faced with a temporal landowner *WTA* tradeoff curve. If as before, the landowner acquisition costs are identical between the two parcels and the landowner and land agent recognize the same discount rate, a land agent would be no worse off in terms of net social value gained by choice of a combination of less than permanent periods of protection. This is illustrated with the 'landowner cost ratio 1 curve.' It is simply a temporal redistribution of *PIVs* captured. However, if the two parcels with equivalent social value have different underlying landowner acquisition costs (again due to differing levels of capitalized landowner), a land agent's constrained optimal temporal choice will again be an endpoint solution. This is illustrated with the 'landowner cost ratio 2' curve in Figure 5.7. If parcel 1 has greater landowner rents relative to parcel 2 the landowner cost ratio curve will asymptotically become tangent to the social value curve at T_{soc1} = infinity for parcel 1.

5.3.1 Accounting for Limited Funding With Heterogeneous Parcels

The preceding basic portfolio illustrations allow for the possibility of welfare improvements via temporary agreements. However, to better illustrate the overall gains from a diversified investment strategy, another more detailed landscape example is provided to expound the frequent constraints of irregular parcel sizes with differing social values and landowner acquisition costs within a landscape. A land agent must evaluate all of this in optimizing *PIVs* protection. Further, with only a two parcel landscape, the situation of interest is not when a land agent compares and chooses among two parcels and parcel one has both a greater social value and lower landowner acquisition costs (and consequently, the alternative parcel has a lower social value with greater landowner acquisition costs) because a land agent will always choose the more optimal parcel (most value and least costs) for the optimal social time period. Gains from a portfolio strategy enhance the condition when the opposite (and likely) condition is true that two parcels have differing social value and inversely differing landowner acquisition costs.

In this example as described in Figure 5.9, a land agent is faced with the constrained decision of optimizing *PIVs* protection across two agricultural land parcels within a landscape. Parcel one is considered to be more desirable from a social perspective given the array of amenities present on that particular agricultural land. Alternatively, parcel two is slightly larger but on a per acre basis has an expected lower *PIVs* rental stream. Assume initially that both parcels have an unconstrained T_{soc} that approaches infinity. Also, landowner conservation easement *WTA* values have increased to reflect more impending but differing dates of conversion and provide a realistic example for having to choose between two highly convertible and socially desirable protected properties.[31]

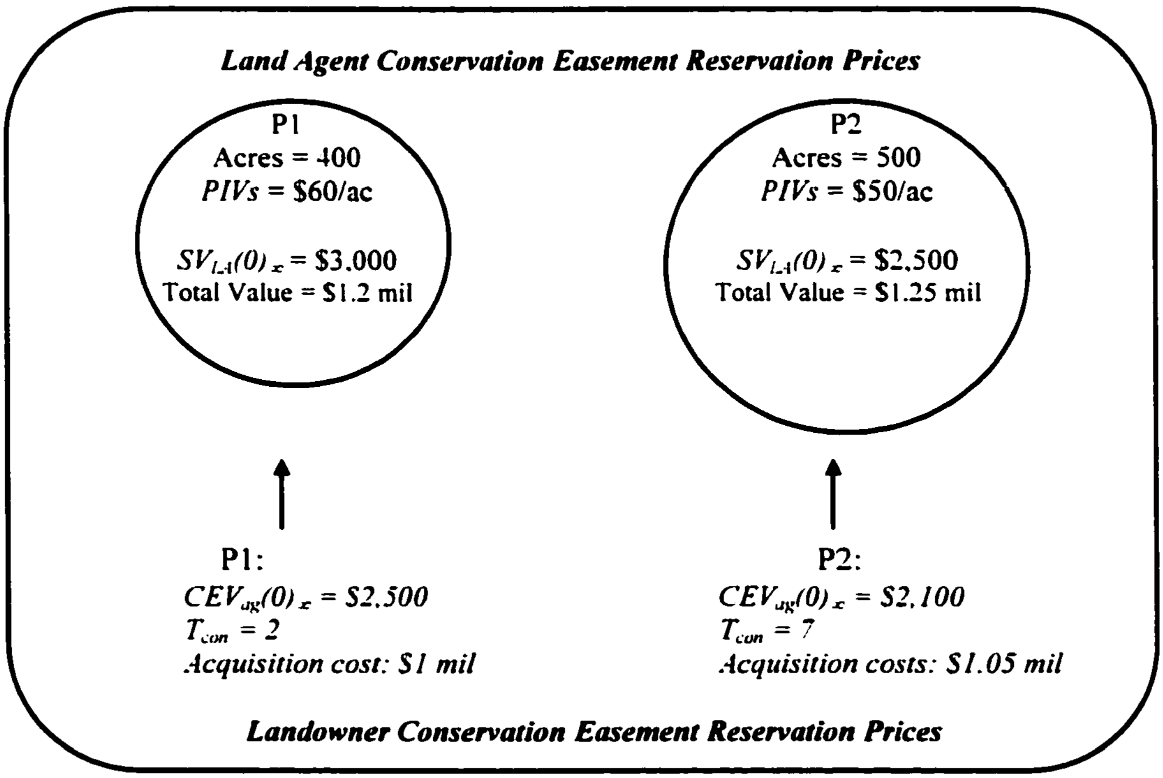

FIGURE 5.9 ALTERNATIVE PARCEL INVESTMENT OPTIONS WITHIN A LANDSCAPE

[31] In this example, the emphasis if for comparing more impending conversion and to allow for differing landowner costs. Therefore, assume U_1 = \$104, U_2 = \$100, A_1=A_2 = \$100, PAR_1 = \$6 and PAR_2 = \$12. Unless other wise noted the remaining numerical assumptions hold from Table 5.1.

To evaluate a land agent's possible protection choices defined in Figure 5.9, assume a land agent has \$1 million of expected funding (budget) with which to make a protection investment. In the best case bargaining situation (conservation easement price settled at a landowner's *WTA*), a land agent would be limited to selecting only parcel one permanently given the greater acquisition cost of parcel two. Any other choice forces a land agent to evaluate each parcel from a possible temporal perspective to maximize *PIVs* protected.

While the choice of protecting parcel one is a rational decision to protect the more immediate converting and inexpensive parcel, parcel two is actually more affordable on a per acre basis. Parcel two has a lower landowner conservation easement value, given twice the capitalized rent incorporated into landowner two's *WTA* reservation price as compared with parcel one (\$2,100 < \$2,500). But given its larger size, its actual acquisition cost is greater than parcel one (\$1.05 mil. > \$1.0 mil). However, if a land agent were to consider acquiring both properties with temporary conservation easement combinations, a land agent's possible social value will differ from the conventional constraint for protecting only parcel one permanently.

Consider the following options or combination for alternative temporal protection periods that could feasibly protect parcel's one (P1) and two (P2), if a land agent invested its \$1 million across differing term combinations for the given landowner *WTA* values. Table 5.4 shows that a land agent may acquire protection options ranging from the conventional permanent choice of parcel one to term combinations between parcel one (P1) and parcel two (P2) of (100, 40), (50, 80), (30, 112) or (0, 190) respectively. Given the land agent's funding limit, the maximum that parcel two could be protected by itself is for 190 years. Given a $1 million budget against a landowner *WTA* of $1.05million generates only ninety-five percent of the permanent acquisition value. A landowner's term discount away from permanent conservation easement *WTA* of ninety-five percent is equivalent to 190 years.

TABLE 5.4 LAND AGENT PORTFOLIO CHOICES BETWEEN TWO AGRICULTURAL LAND PARCELS

	Term		Landowner *WTA*		Social Value			Endowment Modified SV
	P1	P2	P1	P2	P1	P2	Total	
	Years		($1 Million)					
Conventional	Infinity	0	1.0	0	1.2	0	= 1.2	1.2
Option 1	100	40	0.74	0.26	1.04	0.69	= 1.73	1.18
Option 2	50	80	0.38	0.62	0.76	1.00	[redacted]	1.19
Option 3	30	112	0.19	0.81	0.54	1.11	= 1.65	1.02
Option 4	0	190	0	1.0	0	1.22	= 1.22	1.16

Results in Table 5.4 show a selection of differing combinations of protection agreements, all possible with a budget of $1 million. From a temporal combinations perspective, a land agent's conservation easement value of *PIVs* protected is not maximized with the conventional choice of only parcel one. Rather, options 1-4 all yield a greater net return than the single permanent conservation easement placement on parcel one. For example, if a land agent considered option 1, a 100-year agreement on parcel one, the resulting expenditure savings could protect 40 years of parcel two, given landowner two's *WTA*. This presumes that the land agent captures all negotiated valuation advantages per acre.[32] For every acre of parcel one protected there is a net gain

[32] This does not need to hold to still show that gains in a portfolio mix are at least as good as conventional permanent conservation easement placement. Therefore even if actual agreed conservation easement prices

of $500 per acre ($3,000 / $2,500) as compared with parcel two that assumes only $400 per acre ($2,500 / $2,100). By assuming a land agent is able to negotiate at a landowner's *WTA*, the given $1 million available would generate overall greater social wealth with any alternative option. Also, all net gains with the four options are based on the supposition that no land agent endowment affect reduces his\her *WTP* for the shorter time periods (by greater discounting of their *WTA* less protection on socially desired future periods). The last column in Table 5.4 shows the net social value gained from each option assuming that an endowment effect was perceived by a land agent for each combination of periods. If a land agent discounts the protection value given up on either parcel's term protection period over strictly permanent tenure to a greater extent by utilizing a lower discount rate for this incremental time period (0.045 instead of the assumed constant r = .05), then the social value captured would diminish possible gains from portfolio term specification. But yielding away parcel one's period of *PIVs* protection comes with the gain of additional parcel two's *PIVs* protected for additional and immediate period of tenure. Therefore, in this example the endowment is unexpected since a land agent is trading future *PIVs* on parcel one for more immediate *PIVs* on parcel two. In present value levels, a temporal portfolio mix held by a land agent increases social wealth. Option 2 yields the greatest social gains with a combination of 50 years for parcel one and 80 years for parcel two and is 75 percent greater than simple permanent protection of parcel one.

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result somewhere between a land agent's reservation price to pay and a landowner's reservation price to accept, society is still better off with a combination of term agreements if a land agent is constrained in their decision choices.

5.3.2 Accounting for *PIVs* Uncertainty

Table 5.4 showed that a land agent would protect an enhanced value of *PIVs* given a portfolio mix or combination of term conservation easement agreements in the presence of differing landowner costs and irregular parcel sizes while faced with a restricted funding budget. Held constant in that determination was the future travel path for each parcel's *PIVs* growth. Initial assumptions held that *PIVs* rents grow at an annual 3 percent ($\rho = .03$) rate, or the effective 'conservation yield' held by a land agent was 2 percent ($r - \rho = 0.02$) on all future rents for both parcels. This deterministic time path holds no risk of valuation changes and establishes no need for any future adjustments in protection agreements held. However, *PIVs* growth is likely to change due to the difficulty in predicting society's long-term demand for *PIVs* on agricultural land. Thus part of the decision for a land agent is to weigh future speculative *PIVs* against a known landowner conservation easement *WTA* value today. Hence, uncertainty is central to forecasted *PIVs* gained with protection.

Consider if *PIVs* growth rate is allowed to vary away from the expected rate of three percent and further assume that changes occur independently between parcels immediately after placement. For example, assume that the *PIVs* growth rate increases to 0.04 or falls to 0.01 with equal but unknown probability that affects a single parcel while the other parcel maintains the same rate (if the growth rate changed equally in the same direction to both parcels there is no resulting differences). To model the relevant changes in social welfare, four differing growth rate scenarios are illustrated in Table 5.5

TABLE 5.5 LAND AGENT PORTFOLIO SOCIAL VALUES GIVEN UNCERTAIN *PIVs* GROWTH

	Term		SV base	ρ (P1) | ρ (P2)			
	P1	P2	.03 | .03	.01 | .03	.03 | .01	.04 | .03	.03 | .04
				Social Value ($ million)			
Conventional	Infinity	0	1.2	0.6	1.2	[illegible]	1.2
Option 1	100	40	1.73	1.42	[illegible]	2.21	1.86
Option 2	50	80	1.76	[illegible]	1.36	1.94	2.14
Option 3	30	112	1.65	1.53	1.16	1.73	[illegible]
Option 4	0	190	1.22	1.22	0.63	1.22	2.12

Table 5.5 describes the resulting social values realized for each land agent temporal protection option against changing *PIVs* growth rates for each respective parcel. Shaded results in Table 5.5 show the greatest gain for the given growth rate scenarios. Recall the assumed initial growth rate was (ρ = .03) for both parcels and yielded alternative social values for the given term options in Table 5.4. Table 5.5 shows the results of changing one parcel's growth rate to .04 while the other remained at .03 as well as a likely situation if one parcel's growth rate instantaneously dropped to .01 while the other remained at .03. To compare the differences from changing growth rates, the base social values are restated in the base column of Table 5.5 and provide a comparison for evaluating each option outcome if the differing growth rate change occurs. For example, for the conventional option, if parcel one's expected growth rate instantaneously changed to (= 0.01) then all capitalized *PIVs* from protecting parcel one diminish by one half ($0.6 instead of $1.2 million), while the value of parcel two remains unchanged (0 of 0).

Results of Table 5.5 show that if a land agent emphasized protection for the agricultural parcel that grew unexpectedly more then his/her investment expanded positively. However, choosing either to protect only parcel one or two and its corresponding growth rate declined to only .01, then his/her investment value would fall below his\her acquisition costs and would be sub-optimal. A land agent would have been better off choosing greater levels of protection in the opposite parcel.

Uncertainty social value results thus far indicate that no single option is best for avoiding losses or accelerating unexpected gains. This is because permanent conservation easement agreements are the best option if the probability of changes in growth rates is greater on the positive side and growth rates unexpectedly increase on that corresponding parcel. At the same time, a permanent agreement of one parcel while the other parcel's growth rate declined leaves the land agent's investment unchanged. But a combination option yields the better strategy if a land agent wants to minimize the potential variability and diminished growth from alternative and unknown parcel growth rate changes.

To further illustrate these missed and averted values, Table 5.6 describes a land agent's social value differences resulting from missed (regret) positive values as compared with the optimal choice option available to the land agent given each alternative growth rate combinations.

TABLE 5.6 LAND AGENT REGRET WITH *PIVs* GROWTH RATE UNCERTAINTY

	ρ(P1) | ρ(P2)								
	.03 | .03	.01 | .03		.03 | .01		.04 | .03		.03 | .04	
	SV base	SV	regret	SV	regret	SV	regret	SV	regret
	Social Value ($ million)								
Conventional	1.2	0.60	0.99	1.20	0.34	[redacted]		1.20	1.04
Option 1	1.73	1.42	0.17	[redacted]		2.21	0.19	1.86	0.38
Option 2	[redacted]	[redacted]		1.36	0.18	1.94	0.46	2.14	0.10
Option 3	1.65	1.53	0.06	1.16	0.38	1.73	0.67	[redacted]	
Option 4	1.22	1.22	0.37	0.63	0.91	1.22	1.18	2.12	0.12

Table 5.6 shows that if there is equal probability that *PIVs* growth rate varies from its expected value to either .01 or .04, then a land agent's regret is the differences shown in each associated column for each two-parcel temporal combination options. These regret values are determined as the difference away from the option with the greatest social value. For example in the (.01/.03) column, the greatest social value would be captured with option 2, thus every other option has a regret value that a land agent would realize if he/she did not choose option 2. Overall, option one provides the minimized-maximum regret across all option choices for the given changes in *PIVs* growth rates between the two agricultural parcels (0.38 is the smallest maximum).

A land agent portfolio summary of Table's 5.5 and 5.6 is described in Table 5.7. Given equal uncertainty for increased or diminished growth in *PIVs* rents and a land agent's appeal to minimize possible unanticipated lower growth ($\rho = 0.01$), a temporal portfolio strategy of option one or two will improve social welfare more than conventional permanent conservation easement placement given a limited resource for acquisition.

TABLE 5.7 LAND AGENT REGRET AND SOCIAL WELFARE SUMMARY

	SV Regret Maximum	SV Regret Deviation
Conventional	1.04	0.79
Option 1	[redacted]	[redacted]
Option 2	0.46	[redacted]
Option 3	0.67	0.37
Option 4	1.18	0.65

Table 5.7 also shows that the temporal combinations of options 1 and 2 hold the lowest variation in expected social value across the four growth rate uncertainty combinations. Given the real possibility of uncertain future conditions, these two choices would be preferred due to the risk of over-temporal investment of parcel one or two given possible changes in *PIVs* growth. This land agent preference would change if the known distribution or expectation of *PIVs* growth were either not normal (greater probability to increase rather than decrease) or asymmetric. In this case, emphasis would be toward more permanent agreements.

5.4 Summary

This focus of this chapter builds upon both landowner and land agent conservation easement valuation models with respect to time. Illustrations are used to justify the presence of landowner and land agent temporal discounts away from conventional permanent conservation easement valuation in their *WTA* and *WTP* reservation prices. First order conditions of optimization for both accounting stances were shown to be critical but implicit to conservation easement valuation for determination of a landowner and land agent date of conversion. Given neither accounting stance's FOC have a closed form solution, separate explicit relationships were estimated for each accounting stance to determine possible influences on conversion by corresponding rental growth rates.

The final section of this chapter illustrated a land agent portfolio investment strategy in a constrained optimization situation that showed social welfare improvements via a combination of term conservation easement agreements over conventional permanent conservation easement specification. Given the likely uncertainty of future demand for PIVs and continued public resource constraints, it is in these types of situations or conditions where temporal based conservation easement agreements may be the most viable to landowners and land agents.

CHAPTER 6 APPROACHES TO FUTURE AGRICULTURAL LAND-USE POLICY

Continued public support for agricultural land protection calls for analyses to improve land-use policy choices. Given the economic preference for more responsive and less regulatory approaches, conservation easement agreements remain a special choice within public land-use policy. Chapter's 1 and 2 of this dissertation defined the general stimuli for conservation easement placement to be that these "public/private" partial interest acquisitions are less costly than full title to agricultural property, require little in the way of new administrative burdens, and necessitate almost no additional direct land-use regulation (Boyd *et al* 1999). However, as shown in chapters 4 and 5, conservation easement acquisitions also involve an exchange of market and non-market values creating duai property ownership interests that must reflect both a social value gained against a landowner's acceptance to measure overall welfare improvement. Thus, the premise of this dissertation has been to delineate an improved understanding of landowner and land agent valuation stances that yield motivations for acceptance and preferences for protection imposition.

This chapter proposes to develop an effective acquisition strategy for agricultural land protection given the information generated for each valuation stance in chapter's 3-5. The emphasis of this chapter is not to detail all steps in an acquisition policy for protecting agricultural land, but rather to focus on relevant points that enhance effective conservation easement placement. Key positions are subsequently addressed that improve valuation and welfare that are largely absent or understated in actual valuation approaches and policy implementations.

6.1 What is Effective Agricultural Land Conservation Easement Policy?

Effective land-use conservation policy is concerned with efficient and fair agricultural land protection acquisitions that enhance social welfare. Since conservation easements are quasi-market based voluntary agreements allowing either party to freely decline or walk away if his/her reservation price is not met, excessive under or over compensation is avoided. But that in itself does not guarantee optimal land protection policy choices or outcomes. Usage of conservation easements in agricultural land protection policy must also recognize the following conditions that are discussed in detail below: 1- an effective land-use policy for agricultural land must recognize and target what is actually protected and not implicitly rely on what is restricted as equivalent. 2- conservation easements must be able to accommodate or balance changing landscape and landowner needs since a continuous relationship is required between them. 3- any conservation easement protected land must be evaluated in terms of only a partial interest, since it is just that. Holding and evaluating easement protected agricultural land as equivalent to strict public land is a social inequitable misconception and results in unfairness to underlying landowner uses. And 4- realize that land agents operate in a constrained optimization stance. Any constrained allocation of public dollars precludes other *PIVs* or socially desired investments. Flexibility and choice should be emphasized for any policy to be effective rather than dependence on strict adherence to legal stipulations and control.

6.1.1 Focus on Values Protected

Conservation easement valuation based on the legal dependence of the market appraisal process to determine a conservation easement's price fails to account for why a conservation easement is even placed. While other studies have held that *PIV's* opportunity cost is a relevant acquisition value *i.e.* agricultural land's market residual growth value above pure agrarian rents is a viable measure for social value[33], this dissertation shows that same value provides only an indication of landowner *WTA* development over protection. Land agents must recognize gains in protection reflect the net positive value difference between agricultural land's social and market prices and not the growth residual value in agricultural land's market price. Recall that the social value of agricultural land with a positive externality is greater than the market price; simply utilizing the market price's growth residual value fails to adequately capture total social preference. A land agent's motivation to protect *PIVs* needs to be based on the enhanced value society gains with protection and reflected in his/her *WTP*. "Net option to convert" values (3.09 chapter 3) are reflected in a landowner's *WTA* valuation decision not land agents.

While it is recognized that a conservation easement's negotiated price is often determined by idiosyncratic interactions between land agents and landowners, a cost

[33] Boyd *et al* (1999) hold that the social value is independent of agricultural land's market price, and by thoughtful planning; one can maximize protection by accounting for the costs of acquisition. Further they hold that agricultural land's developmental opportunity cost is invariant to policy tools and therefore the relevant value for land agents is to minimize the differing transactions costs of each protection tool.

effective conservation policy would be one that takes full advantage of opportunities to acquire *PIVs* on agricultural land whose owners are the most receptive and/or those landowners with the greatest mutual overlap of rents that matches societal values

In this view, the interplay of non-market values between landowners and land agents must not be ignored. Even if *PIVs* cannot be directly valued, the respective vector present on any convertible acre can be ranked and defined for choice preferences.[34] Also, empirical *WTP* studies for agricultural land are becoming more common and they provide a direct measure of social value. *WTP* studies do entail greater discovery costs but they need not be used for every single exchange and are only applied as a contributing factor to land agent valuation as more conservation easement placements occur or become common within a landscape. Finally, continued justification of public open-space programs cannot be justified by landowner development costs, since they themselves represent social value for development uses and not the social value for protection uses.

6.1.2 Landowner Plays a Central Role in Effective Agreements

Conservation easements by definition require policy to focus on incentives that motivate conservation, *i.e.* the landowner plays the empowered role to ensure continued *PIVs* are produced and protected even with fair compensation. The unique, dual-vested partnership held by a private landowner and non-private land agent requires that conservation easement placement consider both accounting stance's interests to ensure long-term success. Enhanced landowner *WTA* values developed in chapter three, through

[34] The USDA has developed several national amenity interest value measures. For example, there is available a national amenity scale for counties and an environmental benefits index that incorporates non-market values into land use policy.

recognition of landowner's own private values increase the likelihood of mutually desired exchanges. Enhanced *WTA* also improves a landowner's probability of actually receiving compensation by the recognized financial commitment that capitalized values resemble that is attractable with grant matching opportunities.

But the more restrictive the requirement to ensure social gain comes at the expense of flexibility to future land-use choices for both stances. Individual landowners have a shorter planning vision than society. Long-term or perpetual agreements that are socially optimal and negotiated with only the current landowner, indirectly imposes a "dead-hand control" issue previously discussed in chapter 5. Imposition of more intensive land-use restrictions only by default presupposes agrarian-uses remain the "highest and best" uses. Failure to account for necessary land-use flexibility from a landowner's perspective increases the probability of future conflict.

Since all conservation easements require a conservation purpose and that purpose can vary dramatically, social or landowner goals are usually not completely homogeneous. A one-conservation purpose fits all view, will dramatically hamper landowner participation. Hence, there is a continued need for differing types of land agents (both locational and conservation purpose) whose conservation mission reflects differing emphasis on the vector of *PIVs* society desires. Increased participation by landowners may be better served by utilizing a land agent whose mission most clearly matches their values. This in turn will enhance superior allocation of scarce public funds by more fully capturing the non-market values sought by the land agent and held by the landowner.

6.1.3 Concentrate on Realistic Policy Goals

Conservation easements add to a land-use policy mix of approaches for landscape or community planning. But conservation easements are not direct regulation. Holding protected agricultural land in the same reference as fee-simple pubic land, such as parks or forest reserves imposes an unfair condition on agricultural land or unrealistic policy goal that may actually reduce social welfare. Protected agricultural lands are still private agricultural lands that must retain real "alienability." From an integrated land-use perspective, conservation easements are better suited to supplement and not replace more strict public land acquisitions. The often-lauded cost savings of perpetual conservation easements as compared with fee-simple acquisition in turn limits any one's influence on responding to changing land-use needs. That is, one of the prominent reasons conservation easements are attractive (lower acquisition costs) limits their broad scope or generalized effectiveness in land-use planning and policy.

Given the potentially large geographical scope of conservation easement placement, integrated flexibility should not be ignored. Even the social gains that conservation easement agreements aim to promote require constantly evolving process. Perpetual conservation easements that lack adequate means for modification mandated by public policy run counter to land-use policy that's receptive to the needs of all citizens. Reliance on permanent conservation easement placement with the plausible future transfer of the land itself to new owners less sympathetic to the original goals of the conservation easement creates an unavoidable conflict that temporary conservation easement agreements might avoid.

Effective conservation easement agreements also need to be tailored to the local landscape. Those closest to the community recognize social values within any landscape and stand to gain or lose the most with placement. Since conservation easements are really a working partnership, both accounting stances trust for each other will be best held if their vested interests are derived at the same level (or perceived fairness).

6.1.4 Optimize With Portfolio Perspective

Section 5.3 in chapter 5 illustrated that if land agents are in some way constrained in their decision choices to optimize *PIVs* protected, then effective land-use policy must operate from the perspective of a portfolio investment. Conventional spatial optimization inherently requires foregoing certain *PIVs* forever in tradeoff with selectively protecting others (other socially desired PIVs are foregone today to ensure future capture on other agricultural land). Thus, land agents already implicitly recognize that certain *PIVs* are foregone in their permanent choices. But with explicit recognition of restraint conditions that prevent *PIVs* optimization within a landscape, creates an opportunity to treat land-use policy as a spatial and temporal portfolio perspective. Land agents need to recognize the possible gains from a combination of temporary protection agreements in a mix with permanent conservation easement placement in an effort to reduce uncertainties (evolving and changing social needs, unknown changing land values, and illiquid or rigid land markets) that diminish long-term *PIVs* protected. If a well-informed land agent is free to engage in a strategic mix of temporal and spatial differing protection agreements within a changing landscape, that land agent will be able to make effective decision choices regarding continual protection of socially desired *PIVs* today and more effectively in the future.

6.2 Limits to Policy and Summary

Conservation easement placements that recognize both spatial and temporal tradeoffs to optimize *PIVs* protected are still uniquely derived exchange agreements that require individual negotiations. Thus, the social gains created with placement are nevertheless dependent on the incentives for motivating landowner's own conservation decisions. Incentives are clearly best defined by a conservation easement price that ensures *WTA* and *WTP* for protection agreements are equal to or better off then without any agreement.

Since conservation easements are unique in their recognition of dual public and private interests, their functions are best served by recognizing the goals of both accounting stances. Thus, conservation easements by themselves may best serve to influence a landscape's land-uses rather than used strictly for impeding development. If only social *PIVs* goals are considered then the savings gained from landowner's willing participation will be lost. Likewise, treating conservation easements as a farm income support program fails to recognize what society is attempting to protect. Both stances have something to gain with a fair agreement and a lot to lose with an overly restrictive imposition.

CHAPTER 7 CONCLUSIONS

This dissertation investigates the valuation specification of conservation easement prices. The impetus for this analysis is an attempt to amend current land-use policy's pure market approaches to permanent valuation and recognize that non-market factors really drive landowners and land agents to voluntarily come together for protecting convertible agricultural land.

The conventional reliance on agricultural land's market price and its developmental residual growth value to represent landowner and land agent reservation prices fails to recognize what motivates each accounting stance. This dissertation conceptually specified a landowner's individual reservation price for agricultural land, which yields a landowner's *WTA* protection that is less than the conventionally derived *WTA* development. Further, this dissertation shows that the positive difference between the social price of agricultural land and its market price defines a land agent's true *WTP* and is always greater than its market based opportunity costs, *i.e.* agricultural land's market price's residual growth value. Together, these improved valuation specifications serve to more fully explain the skewed distribution of conservation easement exchange prices currently observed between zero and only a fraction of conventional market price's residual growth values.

Central to understanding agricultural land's protection valuation is the recognition of a future date of conversion for both the landowner and land agent. Specified first order conditions of optimization for both the landowner and land agent show that more than market factors influence a conversion date. The recognition of a landowner's own non-market rents acts to add to the conversion hurdle and voluntarily extend a landowner's own conversion date. Conventional conservation easement placement holds a land agent's conversion date is always at infinity. While permanent specification may be optimal for agricultural land with unique and scarce *PIVs*, without allowance for less than permanent conservation easements, land-use flexibility and choice are lost with these unique dual-interest agreements. This dissertation extends the recognition that land agent's typically operate with constrained protection investment choices while facing uncertain future demand for amenity protection. Allowances for temporary conservation easement agreements are introduced through a portfolio investment approach to land-use protection policy that enhances optimal public interest value (*PIVs*) protection and ultimately social welfare.

Landowner's appeal for temporary conservation easement agreements is reflected in the real term discount away from their *WTA* permanence. This real discount arises from gains in retaining long-term land-use control while maintaining values for the protection period.

The final objective of this dissertation sought to enhance land-use policy by developing an effective acquisition strategy for agricultural land protection given the information generated for each valuation-modeling stance. Four key improvements to conservation easement acquisition policy were defined that center around the premise that conservation easements are a unique two-way ownership interest agreement. First, conservation easements must recognize the real values they are protecting, conventional reliance on agricultural land's developmental opportunity costs miss targets the direction and priority for protection. Second, landowner involvement is critical to the long- term success of these quasi-private agreements. The landowner plays the empowered role to ensure continued *PIVs* are produced and protected. Third, realize that conservation easements restrict a landowner to agrarian uses, which in turn puts greater emphasis or dependence on the agricultural uses. Holding protected agricultural land in the same reference as fee-simple pubic land, such as parks or forest reserves, imposes an unfair policy goal on agricultural land that is likely to create future conflicts that may actually reduce social welfare. And fourth, land agents must recognize the true opportunity costs of protection are not simply the underlying landowner development rents but in the face of constraining resources their real opportunity costs are the unprotected *PIVs* that each investment dollar must be weighed against.

REFERENCES

Alpe, M. and Mucklow, C. J. 1997. *Methods Used to Value a Conservation Easement Lease*. Report prepared for the Yampa River System Legacy Project.

Arrow, K. J. and Fisher, A. C. May 1974. "Environmental Preservation, Uncertainty and Irreversibility." *Quarterly Journal of Economics*. V88(2). 312-319.

Baumol, W. J. September 1968. "On the Social Rate of Discount." *American Economic Review*. V57(4). 47-59.

Beasley, S. D. Workman, W. G. and Williams, N. A. October 1986. "Estimating Amenity Values of Urban Fringe Farmland: A Contingent Valuation Approach: Note." *Growth and Change*. V17(4). 70-78.

Bergstrom, J.C. August 2001. "The Role and Value of Natural Capital in Regional Landscapes." *Journal of Agricultural and Applied Economics*. V33(2). 283-296.

Bergstrom, J.C. Dillman, B. L. and Stoll, J. R. July 1985. "Public Environmental Amenity Benefits of Private Land: The Case of Prime Agricultural Land." *Southern Journal of Agricultural Economics*. V17(1). 139-49.

Bick S. and Jr. Haney, L. H. 2001. The Landowner's Guide to Conservation Easements. Kendall/Hunt Publishing. Dubuque, Iowa. 128p.

Bowker, J. M. Didychuk, D. D. October 1994. "Estimation of the Non-Market Benefits of Agricultural Land Retention in Eastern Canada." *Agricultural and Resource Economics Review*. V23(2). 218-225.

Bourdreaux, J. D. Meiners, E.R. and Zywicki, J.T. Winter 1999. "Talk is Cheap: The Existence Value Fallacy." *Environmental Law*. V29(4). 765-809.

Boyd, J. Caballero, K. and Simpson, D.R. April 1999. *The Law and Economics of Habitat Conservation: Lessons from an Analysis of Easement Acquisitions*. Discussion Paper 99-32. Washington, D.C. Resources For the Future. 42p.

Boyd, J. Caballero, K. and Simpson, D.R. Summer 1999. "Carving Out Some Space: A Guide to Land Preservation Strategies." *Resources*. n136. 10-13.

Buist, H. Fischer, C. Michos, J. and Tegene, A. 1995. *Purchase of Development Rights and the Economics of Easements*. AER No. 718. U.S. Department of Agriculture. Economic Research Service. Washington, D.C. 20p.

Capozza, D. and Helsley, R. 1989. "The Fundamentals of Land Prices and Urban Growth." *Journal of Urban Economics*. V26(3). 295-306.

Capozza, D. and Li, Y. 1994. "The Intensity and Timing of Investment: The Case of Land." *American Economic Review*. V84(4). 889-904.

Capozza, D. and Sick, G. 1991. "Valuing Long-Term Leases: The Option to Redevelop." *Journal of Real Estate Finance and Economics*. V4(2). 209-223.

Capozza, D. and Sick, G. 1994. "The Risk Structure of Land Markets." *Journal of Urban Economics*. V35(3). 297-319.

Carlson, L. D. June 1999. *Agriculture's Role in Colorado's Growth Debate*. Resource Analysis. Colorado Department of Agriculture. Website visited February 2001. http://www.ag.state.co.us/resource/documents/99AgLawRoundupPaper0618.doc.

Cheever, F. 1996. "Public Good and Private Magic in the Law of Land Trusts and Conservation Easements: A Happy Present and Troubled Future." *Denver University Law Review*. V73(4). 1077-1112.

Coase, R. 1960. "The Problem of Social Cost." *The Journal of Law and Economics*. V3. 1-44.

Colorado Close-Up. November 2000. Colorado Office of State Planning and Budgeting. Website visited December 2000. <http://www.state.co.us/gov_dir/govnr_dir/ospb/CCU-1100.pdf>.

Colorado Data Book. 1999. Colorado Office of Economic Development. Website visited December 2000. http://www.state.co.us/oed/bus_fin/contents.html.

Colorado Government. 2000. *Credit Against Tax-Conservation Easement*. §39-22-522 C.R.S.

Commission. December 2000. *Colorado's Legacy to its Children*. The Governor's Commission on Saving Open Space, Farms, Ranches. State of Colorado. 16p.

Crosson, P. 1985. "Agricultural Land: A Question of Values." *Agricultural and Human Values*. V3. 6-13.

Cummings, R. G. Harrison, G.W. and Rutstrom E. E. March 1995. "Homegrown Values and Hypothetical Surveys: Is the Dichotomous Choice Approach Incentive-Compatible?" *The American Economic Review.* V85(1). 260-266.

Daniels. T. C. Autumn 1991. "The Purchase of Development Rights: Preserving Agricultural Land and Open Space." *Journal of American Planning Association.* V57. 421-431

Daniels, T. C. and Bowers, D. 1997. Holding our Ground: Protecting America's Farms and Farmland. Island Press. Covelo, California. 334p.

Dixit, A. K. and Pindyck, R. S. 1994. Investment Under Uncertainty. Princeton University Press. Princeton, NJ. 468p.

Dow, T. P. December 2001. "The Unique Benefits of Conservation Easements in Colorado." *The Colorado Tax Lawyer.* V30(12). 49-52.

Elconin, P. and Luzadis, V. Summer, 1998. "Landowner Satisfaction with Conservation Easements." *Wild Earth.* 49-51.

Englebrecht, T. D. Spring 2000. "Conservation Easements: Tax and Valuation Attributes of Contributions of Partial Interests in Property." *Journal of Taxation Investments.* V17(3). 195-207.

Esseks, J. D. Draft, E. S. and McSpadden, M. L. May 1998. *Owners' Attitudes Towards Regulation of Agricultural Land, Technical Report on a National Survey.* Working Paper Series 98-3. American Farmland Trust.

Feather P. Hellerstein, D. and Hansen, L. April 1999. *Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP.* AER No. 778. Economic Research Service. U.S. Department of Agriculture. Washington, D.C. 60p.

Fischel, W. A. May 1982. "The Urbanization of Agricultural Land: A Review of the National Agricultural Lands Study." *Land Economics.* V58(2). 236-259.

Fisher, A C. Krutilla, J. V. and Cicchetti, C J. September 1972. "The Economics of Environmental Preservation: A Theoretical And Empirical Analysis." *American Economic Review.* V62(4). 605-619.

Gardner, B. D. December 1977. "The Economics of Agricultural Land Preservation." *American Journal of Agricultural Economics.* V59. 1027-1036.

Ginsberg, W. R. 1988. "Term and Termination: When Easements Aren't Forever." In The Conservation Easement Handbook: Managing Land Conservation and Historic Preservation Easement Programs. Edited by Janet Diehl and Thomas S. Barret. San Francisco, California. Trust for Public Land. Alexandria, Virginia. Land Trust Exchange.

Gustanski, J. A. and Squires, R. H. 2000. Protecting the Land: Conservation Easements Past, Present, and Future. Island Press. Covelo, California. 566p.

Halstead, J. April 1984. "Measuring the Non-market Value of Massachusetts's Agricultural Land: A Case Study." *Journal of Northeastern Agricultural Economics Council.* V13(3). 226-247.

Hansen, W. S. Spring 1996. "Public Interest Values and NonEconomic Highest and Best Use: The Appraisal Institute's Position. *Valuation Insight and Perspective.* 27-29, 48.

Heimlich, R. E. and Anderson, W. D. June 2001. *Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land.* AER No. 803. Economic Research Service. U.S. Department of Agriculture. Washington D.C. 88p.

Hoag, D. Seidl, A. and Marshall A. July 2001. *Landowner Satisfaction with Conservation Easement Placement in Colorado.* Paper Presentation. Western Agricultural Economics Association. Logan, Utah.

House Bill 01-1090. 2001. *Concerning an Increase in the Income Tax Credit for the Donation of a Perpetual Conservation Easement.* General Assembly State of Colorado.

Hirshleifer J. May 1966. "Investment Decision Under Uncertainty: Application of the State Preference Approach." *Quarterly Journal of Economics.* V80(2). 252-277.

Kahneman, D. Knetsch, J and Thaler R. December 1990. "Experimental Tests of the Endowment Effect and the Coase Theorem." *The Journal of Political Economy.* V98(6). 1325-1348.

Kayser, C. J. Spring, 2000. "Before-and-After Valuation of Conservation Easements." *Journal of Real Estate Taxation.* V27(3). 184-207.

Kline, J. and Wichelns, D. November 1996. "Public Preferences Regarding the Goals of Farmland Preservation Programs." *Land Economics.* V72(4). 538-549.

Kline, J. and Wichelns, D. May 1994. "Using Referendum Data to Characterize Public Support for Purchasing Development Rights to Farmland." *Land Economics.* V70(2). 223-233.

Kling, R. and Sparling E. September 1998. *Competition for Ranch Lands: Public Policy and Ranching versus Recreation in the Colorado Rockies.* Competition for Land. American Farmland Trust. 52p.

Korngold, G. 1984. "Privately Held Conservation Servitudes: A Policy Analysis in the context of in Gross Real Covenants and Easements." *Texas Environmental Law Review*. V63(387). 433-495.

Krieger, D. April 1999. *Saving Open Spaces: Public Support for Farmland Protection*. Center for Agriculture in the Environment. Working Paper Series WP99-1. American Farmland Trust. 73p.

Kueter, R. L. and Weston, S. M. October 2000. *The Coming Pressures for Term Conservation Easements*. Presentation at the 2000 Land Trust Alliance Rally. Portland, Oregon.

Kueter, L.R. Jay, J.E. and Kueter, D. L. 2000. *Conservation Easements in the West.* Technical Service Report No. 15. The Rocky Mountain Land Use Institute. College of Law. University of Denver. 29p.

Land Trust Alliance. 2000. *National Land Trust Census*. Website Visited January 2002. http://www.lta.org/newsroom/census_summary_data.htm

Lant, C. L. Kraft, S. E. and Gillman, K. R. 1995. "Enrollment of Filter Strips and Recharge Areas in the CRP and USDA Easement Programs." *Journal of Soil and Water Conservation*. V50(1). 193-200.

Libby, L. W. January 1997. *Farmland Protection Policy: An Economic Perspective*. Center for Agriculture in the Environment. Working Paper Series WP97-1. American Farmland Trust. 11p.

Loomis, J. Rameker, V. and Seidl, A. February 2000. *Potential Non-Market Benefits of Colorado's Agricultural Lands: A Review of Literature*. Extension Report 00-02. Department of Agricultural and Resource Economics. Colorado State University.

Lopez, R. A. Shah, F. A. and Altobello, M. A. 1994. "Amenity Benefits and the Optimal Allocation of Land." *Land Economics*. V70(1). 53-62.

McConnell, K. E. 1989. "The Optimal Quantity of Land in Agriculture." *Northeastern Journal of Agricultural and Resource Economics*. V18. 63-72.

McGranahan, D. A. September 1999. *Natural Amenities Drive Rural Population Change.* AER No. 781. U.S. Department of Agriculture. Economic Research Service. Washington D.C. 25p.

Mishan, E. J. May-June 1969. "The Relationships between Joint Products, Collective Goods and External Effects." *Journal of Political Economy*. V77(3). 329-348.

Mundy, B. and Adams, V. January 1991. "The Valuation of High-Amenity Natural Land." *The Appraisal Journal*. V59. 48-53.

Mundy, B. and Kinnard, W. N. April 1998. "The New NonEconomics: Pubic Interest Values, Market Values, and Economic Use." *The Appraisal Journal*. V66. 207-214.

Myers, B. Summer 2000. "Is a Conservation Easement Right for You?" *Range Magazine*. V8(2). 24.

Page, S. L. 1997. An Application of the Analytic Hierarchy Process and Conjoint Method to Analyze Farm management Decisions. Unpublished Master's Thesis. Colorado State University. Fort Collins, Colorado. 182p.

Pattison, D. December 1986. "Eight Approaches to the Valuation of Temporary Easements." *Right of Way*. 11-12.

Plantinga, A. and Miller, D. J. February 2001. "Agricultural Land and the Value of Right to Future Land Development." *Land Economics*. V77(1). 56-67.

Plantinga A. November 2000. "Essay: Conservation Easements." *AERE Newsletter*. 11-14.

Ready, R. C. Berger, M.C. and Blomquist G. C. Fall 1997. "Measuring Amenity Benefits from Farmland: Hedonic Pricing versus Contingent Valuations." *Growth and Change*. V28(4). 438-458.

Rosenberger, S. R. November 1998. "Public Preferences Regarding the Goals of Farmland Preservation Programs: Comment." *Land Economics*. V74(42). 557-565.

Rosenberger, S. R. and Walsh, G. R. December 1997. "Non-market Value of Western Valley Ranchland Using Contingent Valuation." *Journal of Agricultural and Resource Economics*. V22(2). 296-309.

Rosenberger, R. S. Walsh, R. G. McKean, J. A. and Mucklow, C. J. 1996. *Benefits of Ranch Open Space to Local Residents*. C.S.U. Cooperative Extension Service. Bulletin XCM-201. Department of Agricultural and Resource Economics. Colorado State University.

Rowe, H I. Bartlett, E. T. and Swanson, L. E. Jr. July 2001. "Ranching Motivations in 2 Colorado Counties." *Journal of Range Management*. V54(4). 314-321.

Schwab, C. R. 1994. TCM. 194-232.

Sherrod, L. 2001. Personal communication. Executive Director, Colorado Cattlemen's Agricultural Land Trust. http://cca.beef.org/pages/ccalt-home.htm/.

Sick, G. 1989. Capital Budgeting with Real Options. Monograph 89-3. Solomon Brothers Center. Leonard N. Stern School of Business. New York University.

Solow, R .M. 1974. "The Economics of Resources or the Resources of Economics." *American Economic Review*. V64(1). 1-15.

Snow, J. January-February 1992. "Reserved Interest Deeds: An Alternate Approach to Drafting Conservation Easements." *The Back Forty*. National Center for Agricultural Law. V2(7). 1-6.

Stewart A. P. and Libby W. L. 1997. *Determinants of Farmland Value*. Center for Agriculture in the Environment. Working Paper Series 1997-10. American Farmland Trust. http://www.farmland.org/cae/wp/wp97-10.html.

Tegene, A. Weibe K. and Kuhn, B. May 1999. "Irreversible Investment Under Uncertainty: Conservation Easements and the Option to Develop Agricultural Land." *Journal of Agricultural Economics*. V50(2). 203-219.

Tibbets, J. 1998. *Open Space Conservation: Investing in Your Community's Economic Health*. Lincoln Institute of Land and Policy. Cambridge Massachusetts. 34p.

U.S. Department of Agriculture. February 2001. *1997 National Resources Inventory: Highlights*. Revised December 2000. National Resource Conservation Service. Washington D.C. http://www.nhq.nrcs.usda.gov/land/pubs/97highlights.htm.

U.S. Department of Commerce. 2002. DP-1. *Profiles of General Demographic Characteristics*. Quick Tables. Bureau of Census. Population Distribution Branch. Washington, D.C. Website visited April 2002. http://www.census.gov/population/estimates/state/st-99-3.txt.

U.S. Department of Commerce. 2002. *Annual Personal State Income*. Bureau of Economic Analysis. Website visited April 2002. http://www.bea.doc.gov/bea/regional/spi/

U.S. Department of Commerce. 1999. *Estimates of the Resident Population of States: July 1 1990 to July 1, 1999*. Bureau of Census. Population Distribution Branch. Washington, D.C. Website visited March 2001. http://www.census.gov/population/estimates/state/st-99-3.txt.

Veslany, K. ed. January 2001. *Purchase of Development Rights: Conserving Lands, Preserving Western Livelihoods*. Western Governor's Association. Trust for Public Land. National Cattlemen's Beef Association. 26p.

Vesterby, M. Heimlich, R. and Krupa, K. August 2001. *Major Land Uses in the United States, 1997*. AER No. 973. U.S. Department of Agriculture. Economic Research Service. Washington D.C. 57p.

Vesterby, M. Heimlich, R. and Krupa, K. March 1994. *Urbanization of Rural Lands of the United States*. AER No. 673. U.S. Department of Agriculture. Economic Research Service. Washington D.C. 47p.

Vicary, B. January 1994. "Trends in Appraising Conservation Easements." *The Appraisal Journal*. V62. 138-143.

Vickner, S. S. 1994. A Dynamic Optimization Model for Policy Analysis of Corn Production and Nitrate Leaching. Unpublished Master's Thesis. Colorado State University. Fort Collins, Colorado. 91p.

Walsh, R. G. McKean, J. A. Rosenberger, R. S. and Mucklow, C. J. November 1994. Recreation Value of Ranch Open Space. C.S.U. Cooperative Extension Service. Bulletin XCM-167. Department of Agricultural and Resource Economics. Colorado State University.

Wiebe, K. Tegene, A. and Kuhn, B. April 1997. "Managing Public and Private Land Through Partial Interests." *Contemporary Economic Policy*. V25. 35-43.

Wiebe, K. Tegene, A. and Kuhn, B. November 1996. *Partial Interest in Land: Policy Tools for Resource Use and Conservation*. AER No. 744. U.S. Department of Agriculture. Economic Research Service. Washington D.C. 58p.

APPENDIX I

Conservation Easement Enabling Legislation Summary Including Colorado Income Tax Credit Law

Placement of a conservation easement is based on recognized statutory legislation. Defined below are the federal and state authorizing legislation for the creation of conservation easements.

The Uniform Conservation Easement Act (UCEA) is the primary federal legislation and related state laws have laid the foundations enabling land agents to protect private agricultural lands. The National Conference of Commissioners on Uniform State Laws approved the UCEA in 1981. Included with the act are a series of notes or comments prepared by the commissioners. The prefatory note contains an explanation of the entire act.

A. UNIFORM CONSERVATION EASEMENT ACT of 1981

Prefatory Note

The Act enables durable restrictions and affirmative obligations to be attached to real property to protect natural ana historic resources. Under the conditions spelled out in the Act, the restrictions and obligations are immune from certain common law impediments, which might otherwise be raised. The Act maximizes the freedom of the creators of the transaction to impose restrictions on the use of land and improvements in order to protect them, and it allows a similar latitude to impose affirmative duties for the same purposes. In each instance, if the requirements of the Act are satisfied, the restrictions or affirmative duties are binding upon the successors and assigns of the original parties. The Act thus makes it possible for Owner to transfer a restriction upon the use of Blackacre to Conservation, Inc., which will be enforceable by Conservation and its successors whether or not Conservation has an interest in land benefited by the restriction, which is assignable although unattached to any such interest in fact, and which has not arisen under circumstances where the traditional conditions of privity of estate and "touch and concern" applicable to covenants real are present. So, also, the Act enables the Owner of Heritage Home to obligate himself and future owners of Heritage to maintain certain aspects of the house and to have that obligation enforceable by Preservation, Inc., even though Preservation has no interest in property benefited by the obligation. Further, Preservation may obligate itself to take certain affirmative actions to preserve the property. In each case, under the Act, the restrictions and obligations bind successors. The Act does not itself impose restrictions or affirmative duties. It merely allows the parties to do so within a consensual arrangement freed from common law impediments, if the conditions of the Act are complied with. These conditions are designed to assure that protected transactions serve defined protective purposes (Section 1(1)) and that the protected interest is in a "holder" which is either a governmental body or a charitable organization having an interest in the subject matter (Section 1(2)). The interest may be created in the same manner as other easements in land (Section 2(a)). The Act also enables the parties to establish a right in a third party to enforce the terms of the transaction (Section 3(a)(3)) if the possessor of that right is also a governmental unit or charity (Section 1(3)).

The interested protected by the Act are termed "easements." The terminology reflects a rejection of two alternatives suggested in existing state acts dealing with non-possessory conservation and preservation interests. The first removes the common law disabilities associated with covenants real and equitable servitudes in addition to those associated with easements. As statutorily modified, these three common law interests retain their separate existence as instruments employable for conservation and preservation ends. The second approach seeks to create a novel additional interest, which, although unknown to the common law, is, in some ill-defined sense, a statutorily modified amalgam of the three traditional common law interests.

The easement alternative is favored in the Act for three reasons. First, lawyers and courts are most comfortable with easements and easement doctrine, less so with restrictive covenants and equitable servitudes, and can be expected to experience severe confusion if the Act opts for a hybrid fourth interest. Second, the easement is the basic less-than-fee interest at common law; the restrictive covenant and the equitable servitude appeared only because of then-current, but now outdated, limitations of easement doctrine. Finally, non-possessory interests satisfying the requirements of covenant real or equitable servitude doctrine will invariably meet the Act's less demanding requirements as "easements." Hence, the Act's easement orientation should not prove prejudicial to instruments drafted as real covenants or equitable servitudes, although the converse would not be true.

In assimilating these easements to conventional easements, the Act allows great latitude to the parties to the former to arrange their relationship as they see fit. The Act differs in this respect from some existing statutes, such as that in effect in Massachusetts, under which interests of this nature are subject to public planning agency review.

There are both practical and philosophical reasons for not subjecting conservation easements to a public ordering system. The Act has the relatively narrow purpose of sweeping away certain common law impediments which might otherwise undermine the easements' validity, particularly those held in gross. If it is the intention to facilitate private grants that serve the ends of land conservation and historic preservation, moreover, the requirement of public agency approval adds a layer of complexity, which may discourage private actions. Organizations and property owners may be reluctant to become involved in the bureaucratic, and sometimes political, process which public agency participation entails. Placing such a requirement in the Act may dissuade a state from enacting it for the reason that the state does not wish to accept the administrative and fiscal responsibilities of such a program.

In addition, controls in the Act and in other state and federal legislation afford further assurance that the Act will serve the public interest. To begin with, the very adoption of the Act by a state legislature facilitates the enforcement of conservation easements serving the public interest. Other types of easements, real covenants and equitable servitudes are enforceable, even though their myriads of purposes have seldom been expressly scrutinized by state legislative bodies. Moreover, Section 1(2) of the Act restricts the entities that may hold conservation and preservation easements to governmental agencies and charitable organization, neither of which is likely to accept them on an indiscriminate basis. Governmental programs that extend benefits to private donors of these easements provide additional controls against potential abuses. Federal tax statutes and regulations, for example, rigorously define the circumstances under which easement donations qualify for favorable tax treatment. Controls relating to real estate assessment and taxation of restricted properties have been, or can be, imposed by state legislatures to prevent easement abuses or to limit potential loss of local property tax revenues resulting from unduly favorable assessment and taxation of these properties. Finally, the American legal system generally regards private ordering of property relationships as sound public policy. Absent conflict with constitutional or statutory requirements, conveyances of fee or non-possessory interests by and among private entities is the norm, rather than the exception, in the United States. By eliminating certain outmoded easement impediments, which are largely attributable to the absence of a land title recordation system in England centuries earlier, the Act advances the values implicit in this norm.

The Act does not address a number of issues, which, though of conceded importance, are considered extraneous to its primary objective of enabling private parties to enter into consensual arrangements with charitable organizations or governmental bodies to protect land and buildings without the encumbrance of certain potential common law impediments (Section 4). For example, with the exception of the requirement of Section 2(b) that the acceptance of the holder be recorded, the formalities and effects of recordation are left to the state's registry system; an adopting state may wish to establish special indices for these interests, as has been done in Massachusetts.

Similarly unaddressed are the potential impacts of a state's marketable title laws upon the duration of conservation easements. The Act provides that conservation easements have an unlimited duration unless the instruments creating them provide otherwise (Section 2©). The relationship between this provision and the marketable title act or other statutes addressing restrictions on real property of unlimited duration should be considered by the adopting state. The relationship between the Act and local real property assessment and taxation practices is not dealt with; for example, the effect of an easement upon the valuation of burdened real property presents issues, which are left to the state and local taxation system. The Act enables the structuring of transactions so as to achieve tax benefits which may be available under the Internal Revenue Code, but parties intending to attain them must be mindful of the specific provisions of the income, estate and gift tax laws which are applicable. Finally, the Act neither limits nor enlarges the power of eminent domain; such matters as the scope of that power and the entitlement of property owners to compensation upon its exercise are determined not by this Act but by the adopting state's eminent domain code and related statutes.

1. [Definitions].

As used in this Act, unless the context otherwise requires:

(1) "Conservation easement" means a nonpossessory interest of a holder in real property imposing limitations or affirmative obligations the purposes of which include retaining or protecting natural, scenic, or open-space values of real property, assuring its availability for agricultural, forest, recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural, archaeological, or cultural aspects of real property.

(2) "Holder" means:

(i) a governmental body empowered to hold an interest in real property under the laws of this State or the United States; or

(ii) a charitable corporation, charitable association, or charitable trust, the purposes or powers of which include retaining or protecting the natural, scenic, or open-space values of real property, assuring the availability of real property for agricultural, forest, recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural, archaeological, or cultural aspects of real property.

(3) "Third-party right of enforcement" means a right provided in a conservation easement to enforce any of its terms granted to a governmental body, charitable corporation, charitable association, or charitable trust, which, although eligible to be a holder, is not a holder.

Comment

Section 1 defines three central elements: What is meant by a conservation easement; who can be a holder; and who can possess a "third-party right of enforcement." Only those interests held by a "holder," as defined by the Act, fall within the definitions of protected easements. Such easements are defined as interests in real property. Even if so held, the easement must serve one or more of the following purposes: Protection of natural or open-space resources; protection of air or water quality; preservation of the historical aspects of property; or other similar objectives spelled out in subsection (1).

A "holder" may be a governmental unit having specified powers (subsection (2)(i)) or certain types of charitable corporations, associations, and trusts, provided that the purposes of the holder include those same purposes for which the conservation easement could have been created in the first place (subsection (2)(ii)). The word "charitable", in Section 1(2) and (3), describes organizations that are charities according to the common law definition regardless of their status as exempt organizations under any tax law.

Recognition of a "third-party right of enforcement" enables the parties to structure into the transaction a party that is not an easement "holder," but which, nonetheless, has the right to enforce the terms of the easement (Sections 1(3), 3(a)(3)). But the possessor of the third-party enforcement right must be a governmental body or a charitable corporation, association, or trust. Thus, if Owner transfers a conservation easement on Blackacre to Conservation, Inc., he could grant to Preservation, Inc., a charitable corporation, the right to enforce the terms of the easement, even though Preservation was not the holder, and Preservation would be free of the common law impediments eliminated by the Act (Section 4). Under this Act, however, Owner could not grant a similar right to Neighbor, a private person. But whether such a grant might be valid under other applicable law of the adopting state is left to the law of that state. (Section 5(c).)

2. [Creation, Conveyance, Acceptance and Duration].

(a) Except as otherwise provided in this Act, a conservation easement may be created, conveyed, recorded, assigned, released, modified, terminated, or otherwise altered or affected in the same manner as other easements.

(b) No right or duty in favor of or against a holder and no right in favor of a person having a third-party right of enforcement arises under a conservation easement before its acceptance by the holder and a recordation of the acceptance.

(c) Except as provided in Section 3(b), a conservation easement is unlimited in duration unless the instrument creating it otherwise provides.

(d) An interest in real property in existence at the time a conservation easement is created is not impaired by it unless the owner of the interest is a party to the conservation easement or consents to it.

Comment

Section 2(a) provides that, except to the extent otherwise indicated in the Act, conservation easements are indistinguishable from easements recognized under the pre-Act law of the state in terms of their creation, conveyance, recordation, assignment, release, modification, termination or alteration. In this regard, subsection (a) reflects the Act's overall philosophy of bringing less-than-fee conservation interests under the formal easement rubric and of extending that rubric to the extent necessary to effectuate the Act's purposes given the adopting state's existing common law and statutory framework. For example, the state's requirements concerning release of conventional easements apply as well to conservation easements because nothing in the Act provides otherwise. On the other hand, if the state's existing law does not permit easements in gross to be assigned, it will not be applicable to conservation easements because Section 4(2) effectively authorizes their assignment.

Conservation and preservation organizations using easement programs have indicated a concern that instruments purporting to impose affirmative obligations on the holder may be unilaterally executed by grantors and recorded without notice to or acceptance by the holder ostensibly responsible for the performance of the affirmative obligations. Subsection (b) makes clear that neither a holder nor a person having a third-party enforcement right has any rights or duties under the easement prior to the recordation of the holder's acceptance of it.

The Act enables parties to create a conservation easement of unlimited duration subject to the power of a court to modify or terminate it in states whose case or statute law accords their courts that power in the case of easement. See Section 3(b). The latitude given the parties is consistent with the philosophical premise of the Act. However, there are additional safeguards; for example, easements may be created only for certain purposes and may be held only by certain "holders." These limitations find their place comfortably within similar limitations applicable to charitable trusts, whose duration may also have no limit. Allowing the parties to create such easements also enables them to fit within federal tax law requirements that the interest be "in perpetuity" if certain tax benefits are to be derived.

Obviously, an easement cannot impair prior rights of owners of interests in the burdened property existing when the easement comes into being unless those owners join in the easement or consent to it. The easement property thus would be subject to existing liens, encumbrances and other property rights (such as subsurface mineral rights), which pre-exist the easement, unless the owners of those rights release them or subordinate them to the easement. (Section 2(d).)

3. [Judicial Actions].

(a) An action affecting a conservation easement may be brought by:

(1) an owner of an interest in the real property burdened by the easement;

(2) a holder of the easement;

(3) a person having a third-party right of enforcement; or

(4) a person authorized by other law.

(b) This Act does not affect the power of a court to modify or terminate a conservation easement in accordance with the principles of law and equity.

Comment

Section 3 identifies four categories of persons who may bring actions to enforce, modify or terminate conservation easements, quiet title to parcels burdened by conservation easements, or otherwise affect conservation easements. Owners of interests in real property burdened by easements might wish to sue in cases where the easements also impose duties upon holders and these duties are breached by the holders. Holders and persons having third-party rights of enforcement might obviously wish to bring suit to enforce restrictions on the owners' use of the burdened properties. In addition to these three categories of persons who derive their standing from the explicit terms of the easement itself, the Act also recognizes that the state's other applicable law may create standing in other persons. For example, independently of the Act, the Attorney General could have standing in his capacity as supervisor of charitable trusts, either by statute or at common law.

A restriction burdening real property in perpetuity or for long periods can fail of its purposes because of changed conditions affecting the property or its environs, because the holder of the conservation easement may cease to exist, or for other reasons not anticipated at the time of its creation. A variety of doctrines, including the doctrines of changed conditions and *cy pres*, have been judicially developed and, in many states, legislatively sanctioned as a basis for responding to these vagaries. Under the changed conditions doctrine, privately created restrictions on land use may be terminated or modified if they no longer substantially achieve their purpose due to the changed conditions. Under the statute or case law of some states, the court's order limiting or terminating the restriction may include such terms and conditions, including monetary adjustments, as it deems necessary to protect the public interest and to assure an equitable resolution of the problem. The doctrine is applicable to real covenants and equitable servitudes in all states, but its application to easements is problematic in many states.

Under the doctrine of *cy pres*, if the purposes of a charitable trust cannot carried out because circumstances have changed after the trust came into being or, for any other reason, the settler's charitable intentions cannot be effectuated, courts under their equitable powers may prescribe terms and conditions that may best enable the general charitable objective to be achieved while altering specific provisions of the trust. So, also, in cases where a charitable trustee ceases to exist or cannot carry out its responsibilities, the court will appoint a substitute trustee upon proper application and will not allow the trust to fail.

The Act leaves intact the existing case and statute law of adopting states as it relates to the modification and termination of easements and the enforcement of charitable trusts.

4. [Validity].

A conservation easement is valid even though:

(1) it is not appurtenant to an interest in real property;

(2) it can be or has been assigned to another holder;

(3) it is not of a character that has been recognized traditionally at common law;

(4) it imposes a negative burden;

(5) it imposes affirmative obligations upon the owner of an interest in the burdened property or upon the holder;

(6) the benefit does not touch or concern real property; or

(7) there is no privity of estate or of contract.

Comment

One of the Act's basic goals is to remove outmoded common law defenses that could impede the use of easements for conservation or preservation ends. Section 4 addresses this goal by comprehensively identifying these defenses and negating their use in actions to enforce conservation or preservation easements.

Subsection (1) indicates that easements, the benefit of which is held in gross, may be enforced against the grantor or his successors or assigns. By stating that the easement need not be appurtenant to an interest in real property, it eliminates the requirement in force in some states that the holder of the easement must own an interest in real property (the "dominant estate") benefited by the easement.

Subsection (2) also clarifies common law by providing that an easement may be enforced by an assignee of the holder.

Subsection (3) addresses the problem posed by the common law's recognition of easements that served only a limited number of purposes and its reluctance to approve so-called "novel incidents." Easements serving the conservation and preservation ends enumerated in Section 1(1) might fail of enforcement under this restrictive view. Accordingly, subsection (3) establishes that conservation or preservation easements are not unenforceable solely because they do not serve purposes or fall within the categories of easements traditionally recognized at common law.

Subsection (4) deals with a variant of the foregoing problem. The common law recognized only a limited number of "negative easements" - those preventing the owner of the burdened land from performing acts on his land that he would be privileged to perform absent the easement. Because a far wider range of negative burdens than those recognized at common law might be imposed by conservation or preservation easements, subsection (4) modifies the common law by eliminating the defense that a conservation or preservation easement imposes a "novel" negative burden.

Subsection (5) addresses the opposite problem - the unenforceability at common law of an easement that imposes affirmative obligations upon either the owner of the burdened property or upon the holder. Neither of those interests was viewed by the common law as true easements at all. The first, in fact, was labeled a "spurious" easement because it obligated the owner of the burdened property to perform affirmative acts. (The spurious easement was distinguished from an affirmative easement, illustrated by a right of way, which empowered the easement's holder to perform acts on the burdened property that the holder would not have been privileged to perform absent the easement.)

Achievement of conservation or preservation goals may require that affirmative obligations be incurred by the burdened property owner or by the easement holder or both. For example, the donor of a facade easement, one type of preservation easement, may agree to restore the facade to its original state; conversely, the holder of a facade easement may agree to undertake restoration. In either case, the preservation easement would impose affirmative obligations. Subsection (5) treats both interests as easements and establishes that neither would be unenforceable solely because it is affirmative in nature.

Subsections (6) and (7) preclude the touch and concern and privity of estate or contract defenses, respectively. Strictly speaking, they do not belong in the Act because they have traditionally been asserted as defenses against the enforcement not of easements but of real covenants and of equitable servitudes. The case law dealing with these three classes of interests, however, had become so confused and arcane over the centuries that defenses appropriate to one of these classes may incorrectly be deemed applicable to another. The inclusion of the touch and concern and privity defenses in Section 4 is a cautionary measure, intended to safeguard conservation and preservation easements from invalidation by courts that might inadvertently confuse them with real covenants or equitable servitudes.

5. [Applicability].

(a) This Act applies to any interest created after its effective date, which complies with this Act, whether designated as a conservation easement or as a covenant, equitable servitude, restriction, easement, or otherwise.

(b) This Act applies to any interest created before its effective date if it would have been enforceable had it been created after its effective date unless retroactive application contravenes the constitution or laws of this State or the United States.

(c) This Act does not invalidate any interest, whether designated as a conservation or preservation easement or as a covenant, equitable servitude, restriction, easement, or otherwise, that is enforceable under other law of this State.

Comment
There are four classes of interests to which the Act might be made applicable: (1) those created after its passage which comply with it in form and purpose; (2) those created before the Act's passage which comply with the Act and which would not have been invalid under the pertinent pre-Act statutory or case law either because the latter explicitly validated interests of the kind recognized by the Act or, at least, was silent on the issue; (3) those created either before or after the Act which do not comply with the Act but which are valid under the state's statute or case law; and (4) those created before the Act's passage which comply with the Act but which would have been invalid under the pertinent pre-Act statutory or case law.

It is the purpose of Section 5 to establish or confirm the validity of the first three classes of interests. Subsection (a) establishes the validity of the first class of interests, whether or not they are designated as conservation or preservation easements. Subsection (b) establishes the validity under the Act of the second class. Subsection (c) confirms the validity of the third class independently of the Act by disavowing the intent to invalidate any interest that does comply with other applicable law.

Constitutional difficulties could arise, however, if the Act sought retroactively to confer blanket validity upon the fourth class of interests. The owner of the land ostensibly burdened by the formerly invalid interest might well succeed in arguing that his property would be "taken" without just compensation were that interest subsequently validated by the Act. Subsection (b) addresses this difficulty by precluding retroactive application of the Act if such application "would contravene the constitution or laws of (the) State or of the United States." That determination, of course, would have to be made by a court.

6. [Uniformity of Application and Construction].

This Act shall be applied and construed to effectuate its general purpose to make uniform the laws with respect to the subject of the Act among states enacting it.

B. C.R.S.38-30.5-101 *et. Seq:* Colorado Conservation Easement Statutes

At the state level, the Colorado legislature enacted a Conservation Easement Act in 1976, five years before national adoption of UCEA (Gustanski and Squires, 2000). Subsequent enabling Colorado legislation is based on C.R.S.38-30.5-101 *et. Seq*. These statutes provide the legislative intent of establishing a conservation easement in gross and are stated below.

C.R.S. 38-30.5-101, Legislative Intent

The general assembly finds and declares that it is in the public interest to define conservation easements in gross, since such easements have not been defined by the judiciary. Further, the general assembly finds and declares that it is in the public interest to determine who may receive such easements and for what purpose such easements may be received. **Source: L. 76:** Entire article added, p. 750, § 1, effective July 1

C.R.S. 38-30.5-102, Conservation Easements in Gross

"Conservation easement in gross", for the purposes of this article, means a right in the owner of the easement to prohibit or require a limitation upon or an obligation to perform acts on or with respect to a land or water area or airspace above the land or water owned by the grantor appropriate to the retaining or maintaining of such land, water, or airspace, including improvements, predominantly in a natural, scenic, or open condition, or for wildlife habitat, or for agricultural, horticultural, recreational, forest, or other use or condition consistent with the protection of open land having wholesome environmental quality or life-sustaining ecological diversity, or appropriate to the conservation and preservation of buildings, sites, or structures having historical, architectural, or cultural interest or value. **Source: L. 76:** Entire article added, p. 750, § 1, effective July 1.

C.R.S. 38-30.5-103, Nature of Conservation Easements in Gross

(1) A conservation easement in gross is an interest in real property freely transferable in whole or in part for the purposes stated in section 38-30.5-102 and transferable by any lawful method for the transfer of interests in real property in this state.
(2) A conservation easement in gross shall not be deemed personal in nature and shall constitute an interest in real property notwithstanding that it may be negative in character.
(3) A conservation easement in gross shall be perpetual unless otherwise stated in the instrument creating it.
(4) The particular characteristics of a conservation easement in gross shall be those granted or specified in the instrument creating the easement.
Source: L. 76: Entire article added, p. 751, § 1, effective July 1.

C.R.S. 38-30.5-104, Creation of Conservation Easements in Gross

(1) A conservation easement in gross may only be created by the record owners of the surface of the land by a deed or other instrument of conveyance specifically stating the intention of the grantor to create such an easement under this article.
(2) A conservation easement in gross may only be created through a grant to a governmental entity or to a charitable organization exempt under section 501 (c) (3) of the "Internal Revenue Code of 1986", as amended, which organization was created at least two years prior to receipt of the conservation easement.
(3) Repealed.
(4) Conservation easements relating to historical, architectural, or cultural significance may only be applied to buildings, sites, or structures which have been listed in the national register of historic places or the state register of historic properties, which have been designated as a landmark by a local government or landmarks commission under the provisions of the ordinances of the locality involved, or which are listed as contributing building sites or structures within a national, state, or locally designated historic district.
Source: L. 76: Entire article added, p. 751, § 1, effective July 1. **L. 85:** (3) repealed and (4) amended, p. 1203, § 3, 1, effective July 1. **L. 99:** (2) amended, p. 632, § 49, effective August 4.

C.R.S. 38-30.5-105, Residual Estate

All interests not transferred and conveyed by the instrument creating the easement shall remain in the grantor of the easement, including the right to engage in all uses of the lands affected by the easement which are not inconsistent with the easement or prohibited by the easement or by law.
Source: L. 76: Entire article added, p. 751, § 1, effective July 1.

C.R.S. 38-30.5-106, Recordation Upon Public Records

Instruments creating, assigning, or otherwise transferring conservation easements in gross must be recorded upon the public records affecting the ownership of real property in order to be valid and shall be subject in all respects to the laws relating to such recordation. **Source: L. 76:** Entire article added, p. 751, § 1, effective July 1.

C.R.S. 38-30.5-107, Release-Termination

Conservation easements in gross may, in whole or in part, be released, terminated, extinguished, or abandoned by merger with the underlying fee interest in the servient land or in any other manner in which easements may be lawfully terminated, released, extinguished, or abandoned. **Source: L. 76:** Entire article added, p. 751, § 1, effective July 1.

C.R.S. 38-30.5-108, Enforcement-Remedies

(1) No conservation easement in gross shall be unenforceable by reason of lack of privity of contract or lack of benefit to particular land or because not expressed as running with the land.
(2) Actual or threatened injury to or impairment of a conservation easement in gross or the interest intended for protection by such easement may be prohibited or restrained by injunctive relief granted by any court of competent jurisdiction in a proceeding initiated by the grantor or by an owner of the easement.
(3) In addition to the remedy of injunctive relief, the holder of a conservation easement in gross shall be entitled to recover money damages for injury thereto or to the interest to be protected thereby. In assessing such damages, there may be taken into account, in addition to the cost of restoration and other usual rules of the law of damages, the loss of scenic, aesthetic, and environmental values.
Source: L. 76: Entire article added, p. 752, § 1, effective July 1.

C.R.S. 38-30.5-109, Taxation

Conservation easements in gross shall be subject to assessment, taxation, or exemption from taxation in accordance with general laws applicable to the assessment and taxation of interests in real property. Real property subject to one or more conservation easements in gross shall be assessed, however, with due regard to the restricted uses to which the property may be devoted. The valuation for assessment of a conservation easement, which is subject to assessment and taxation, plus the valuation for assessment of lands subject to such easement, shall equal the valuation for assessment, which would have been determined as to such lands if there were no conservation easement. **Source: L. 76:** Entire article added, p. 752, § 1, effective July 1.

C. Federal and State Income and Estate Tax Laws With Regard To Conservation Easements:

1. Qualifications:

The Internal Revenue Code, states that if a conservation easement qualifies for a charitable deduction under section 170(h) (to a qualified entity defined under Section 501(c)(3)), and the conservation easement is granted exclusively for conservation purposes. Then a landowner qualifies for estate and income tax savings. Conservation purposes include the following:

The preservation of land areas for outdoor recreation or education of the general public

a. The protection of wildlife habitat or similar ecosystems
b. The preservation of open space, including farmland or forestland, for the scenic enjoyment of the general pubic or pursuant to a governmental conservation policy
c. The preservation of historically important land or certified historic structure

2. Federal Chartable Income Tax Deduction:
   a. May be used against ordinary income as well as capital gains
   b. Limited to apply to only 30% of annual gross income
   c. Eligible for year of placement and for the following five years
   d. Easement must meet IRS's donative eligibility requirements

3. C.R.S. 39-22-522: State of Colorado Income Tax Credit
   a. House Bill 99-1155 provides an initial tax credit against Colorado income tax for the donation of a conservation easement.
      i. Limited to $100,000
      ii. For use up to 20 years
      iii. Effective January 01, 2000
      iv. Only one donation per income tax year
   b. In 2000 HB 00-1348 enacted two supplements to HB 1155, one created the ability to transfer the credit and the allowance of a refund of the tax credit subject to some limitations.
   c. In 2001 House Bill 01-1090 enabled a Colorado Income tax credit for a donated conservation easement; commencing after 01/01/2003. Direct tax payer credit for 100% of first $100,000 and 40% of all amounts of the donation in excess of $100,000 but not to exceed $260,000.

4. Estate Tax benefits

   For estate tax purposes, section 2055(f) of the Internal Revenue code (IRC) allows the granting of donated easements to lower the taxable value of an estate, and therefore lower the value of the federal estate tax.

2001:	$675,000 unified credit
2002	$1,000,000
2004-2005	$1,500,000
2006-2008	$2,000,000
2009	$3,500,000

   a. Section 508 of the Taxpayers relief act of 1997. Estate Tax With Respect to Land Subject to a Qualified Conservation Easement.

Section 2031(c) states that a donated conservation easement meeting IRS qualifications under 170(h), is eligible to further reduce estate taxation of real agricultural property

i. Allows beneficiaries to exclude form the taxable estate 40% of the otherwise taxable value of land subject to a qualifying conservation easement, if the easement reduces the FMV by at least 30% with a maximum
2001: $400,000
2002: $500,000
ii. If the easement does not reduce the property's value by at least 30%, the applicable percentage will be reduced below 40% by two percentage points for each percentage point by which the value of the conservation easement is less than 30% of the property's value.

b. Section 551of H.R. 1835, P.L. 107-16, enacted in 2001 eliminated geographic restrictions of section 508, TRA 1997, making property anywhere in the U.S. eligible.

c. Without easement placement, landowners are still eligible for estate tax relief under Section 2032A of IRC. By taking a "special-use" valuation to exempt up to $750,000 of the value of the farm in an estate under certain conditions:
   i. The heirs must elect the special-use valuation within nine months of the owner's death
   ii. At least 50 percent of the estate must be made up of farm assets
   iii. At least 25 percent of the estate must be farm real estate
   iv. The farm must have been actively managed by the immediate family for five of the eight years prior to the owner's death
   v. The farm must remain a working farm and cannot be sold for at lest ten years after the inheritor acquires it

d. As amended by TRA 1997, a qualified conservation easement is not treated as a disposition triggering the recapture requirements of Section 2032A. But this is not true for conservation easements that were acquired in exchange for consideration and not through a donor contribution.

5. Sale of a conservation easement
   a. The sale of a conservation easement is taxed as a capital gain. IRS Revenue Ruling 77-414 allows a landowner to use the basis in the land and buildings to offset the taxable capital gain from the sale of a conservation easement.
   b. Like-kind property exchanges can delay capital gain taxation. The IRS recognizes certain like exchanges for real farm property investment from the sale of a conservation easement

APPENDIX II

Summary of Full Factorial Design and Discrete Distribution for Growth Rates Influencing T_{con} and T_{soc} Used to Develop All Differing Combinations of Data Observations Used to Estimate Conversion Dates

The definitional information is drawn from Vickner (1997) and Paige (1999).

To establish an explicit experimental design that allows individual and independent growth rates uncertainty to influence future conversion dates requires the establishment of a range of operation or an approximated discrete distribution assumed for each expected variable level of the influencing factors. Five points were assigned to each growth rate, a high (H), low (L) and mid-point (M) along with an estimated axial high (AH) and an axial low (AL) value. The axial points (AP), or extreme values which lie slightly below and above the (H) and (L) levels, were calculated using the following formula:

$$AP = [M \pm \phi(H - M)] = [M \pm \phi(H - L]$$

Where:

$$\phi = \left[\frac{(FN)^{1/2} - F}{2}\right]^{1/2}$$

And: $F = 2^K$ and $N = 2^k + 2k + 1$

This defines an approximate distribution around each growth rate for estimating forecasted values.. Two separate data sets were created. One influencing landowner conversion, with its three growth rates (α, δ, λ for landowner) and the other data set for a land agent's conversion date (α, λ, ρ for land agent conversion). Each growth rate was assigned a five-point normal distribution that resulted in 125 possible combinations (three growth rates each with five points) for each data set that could influence their respective conversion date. Each relevant combination was inserted into the respective first order conditions for the landowner (3.10) and land agent (3.16) to generate the expected conversion date with each possible combination of growth rates. Each data set was then truncated to separate out negative dates of conversion (growth rate combinations that would have yielded conversion already). The remaining data sets were each then regressed to define the individual influences of each growth rate on the respective date of conversion.

APPENDIX II continued

Landowner Log-linear Model

Regression Statistics	
Multiple R	0.967
R Square	0.935
Adjusted R S	0.932
Standard Er	0.143
Observation	75

ANOVA

	df	SS	MS	F	Significance F
Regression	3	20.85	6.95	338.98	0.00
Residual	71	1.46	0.02		
Total	74	22.30			

	Coefficients	Standard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.39	0.12	28.51	0.00	3.16	3.63	3.16	3.63
Alpha	(45.77)	3.11	(14.70)	0.00	(51.97)	(39.56)	(51.97)	(39.56)
lambda	30.33	1.09	27.77	0.00	28.15	32.51	28.15	32.51
delta	5.96	1.09	5.46	0.00	3.79	8.14	3.79	8.14

Land Agent Log-linear model

Regression Statistics	
Multiple R	0.75
R Square	0.56
Adjusted R S	0.54
Standard Er	0.19
Observation	72

ANOVA

	df	SS	MS	F	Significance F
Regression	3	3.31	1.10	29.16	0.00
Residual	68	2.58	0.04		
Total	71	5.89			

	Coefficients	Standard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.45	0.07	21.87	0.00	1.32	1.58	1.32	1.58
rho	14.91	1.81	8.22	0.00	11.29	18.53	11.29	18.53
lambda	8.62	2.46	3.50	0.00	3.71	13.53	3.71	13.53
alpha	(7.77)	1.62	(4.81)	0.00	(10.99)	(4.54)	(10.99)	(4.54)

APPENDIX II continued

Landowner

	60.0	61.0	10.0		
	Alpha	lambda	delta	r	0.05
				C	25
AH	0.0422	0.0222	0.0322		
H	0.0400	0.0200	0.0300		
M	0.0300	0.0100	0.0200	gamma	1.22
L	-0.0100	-0.0100	0.0000		1.22
AL	-0.0188	-0.0144	-0.0044		

Land Agent

	52.0	61.0	60.0
	rho	lambda	alpha
AH	0.0422	0.0222	0.0422
H	0.0400	0.0200	0.0400
M	0.0300	0.0100	0.0300
L	0.0100	0.0000	0.0000
AL	0.0056	-0.0022	-0.0066

		Alpha	lambda	delta	Tcon*		rho	lambda	alpha	Tsoc
1	AH,AH,AH	0.0422	0.0222	0.0322	9.83	AH,AH,AH	0.0422	0.0222	0.0422	-256.24
2	AH,AH,H	0.0422	0.0222	0.0300	9.66	AH,AH,H	0.0422	0.0222	0.0400	-30.15
3	AH,AH,M	0.0422	0.0222	0.0200	9.00	AH,AH,M	0.0422	0.0222	0.0300	-43.58
4		0.0422	0.0222	0.0000	8.01		0.0422	0.0222	0.0000	-21.62
5		0.0422	0.0222	-0.0044	7.83		0.0422	0.0222	-0.0066	-17.74
6	AH,H,AH	0.0422	0.0200	0.0322	8.96	AH,H,AH	0.0422	0.0200	0.0422	92.07
7		0.0422	0.0200	0.0300	8.82		0.0422	0.0200	0.0400	-27.33
8		0.0422	0.0200	0.0200	8.25		0.0422	0.0200	0.0300	-37.81
9		0.0422	0.0200	0.0000	7.39		0.0422	0.0200	0.0000	-22.69
10		0.0422	0.0200	-0.0044	7.24		0.0422	0.0200	-0.0066	-18.43
11	AH,M,AH	0.0422	0.0100	0.0322	6.39	AH,M,AH	0.0422	0.0100	0.0422	63.62
12		0.0422	0.0100	0.0300	6.31		0.0422	0.0100	0.0400	-18.83
13		0.0422	0.0100	0.0200	6.00		0.0422	0.0100	0.0300	-23.10
14		0.0422	0.0100	0.0000	5.51		0.0422	0.0100	0.0000	-31.09
15		0.0422	0.0100	-0.0044	5.42		0.0422	0.0100	-0.0066	-23.06
16	AH,L,AH	0.0422	-0.0100	0.0322	4.06	AH,L,AH	0.0422	-0.0100	0.0422	48.74
17		0.0422	-0.0100	0.0300	4.03		0.0422	-0.0100	0.0400	-14.34
18		0.0422	-0.0100	0.0200	3.90		0.0422	-0.0100	0.0300	-16.63
19		0.0422	-0.0100	0.0000	3.67		0.0422	-0.0100	0.0000	-74.59
20		0.0422	-0.0100	-0.0044	3.63		0.0422	-0.0100	-0.0066	-34.35
21	AH,AL,AH	0.0422	-0.0144	0.0322	3.76	AH,AL,AH	0.0422	-0.0144	0.0422	46.47
22		0.0422	-0.0144	0.0300	3.73		0.0422	-0.0144	0.0400	-13.65
23		0.0422	-0.0144	0.0200	3.62		0.0422	-0.0144	0.0300	-15.71
24		0.0422	-0.0144	0.0000	3.42		0.0422	-0.0144	0.0000	-44.00
25		0.0422	-0.0144	-0.0044	3.38		0.0422	-0.0144	-0.0066	-40.07
26	H,AH,AH	0.0400	0.0222	0.0322	11.14	H,AH,AH	0.0400	0.0222	0.0422	69.97
27		0.0400	0.0222	0.0300	10.92		0.0400	0.0222	0.0400	113.58
28		0.0400	0.0222	0.0200	10.07		0.0400	0.0222	0.0300	-46.11
29		0.0400	0.0222	0.0000	8.85		0.0400	0.0222	0.0000	-22.20
30		0.0400	0.0222	-0.0044	8.64		0.0400	0.0222	-0.0066	-18.14
31	H,H,AH	0.0400	0.0200	0.0322	10.03	H,H,AH	0.0400	0.0200	0.0422	64.88
32		0.0400	0.0200	0.0300	9.85		0.0400	0.0200	0.0400	101.69
33		0.0400	0.0200	0.0200	9.14		0.0400	0.0200	0.0300	-39.79
34		0.0400	0.0200	0.0000	8.11		0.0400	0.0200	0.0000	-23.30
35		0.0400	0.0200	-0.0044	7.93		0.0400	0.0200	-0.0066	-18.85
36	H,M,AH	0.0400	0.0100	0.0322	6.91	H,M,AH	0.0400	0.0100	0.0422	48.44
37		0.0400	0.0100	0.0300	6.82		0.0400	0.0100	0.0400	68.07
38		0.0400	0.0100	0.0200	6.46		0.0400	0.0100	0.0300	-23.91
39		0.0400	0.0100	0.0000	5.89		0.0400	0.0100	0.0000	-32.00
40		0.0400	0.0100	-0.0044	5.79		0.0400	0.0100	-0.0066	-23.62
41	H,L,AH	0.0400	-0.0100	0.0322	4.27	H,L,AH	0.0400	-0.0100	0.0422	38.91
42		0.0400	-0.0100	0.0300	4.23		0.0400	-0.0100	0.0400	51.29
43		0.0400	-0.0100	0.0200	4.09		0.0400	-0.0100	0.0300	-17.06
44		0.0400	-0.0100	0.0000	3.84		0.0400	-0.0100	0.0000	-78.50
45		0.0400	-0.0100	-0.0044	3.79		0.0400	-0.0100	-0.0066	-35.28
46	H,AL,AH	0.0400	-0.0144	0.0322	3.94	H,AL,AH	0.0400	-0.0144	0.0422	37.41
47		0.0400	-0.0144	0.0300	3.91		0.0400	-0.0144	0.0400	48.66
48		0.0400	-0.0144	0.0200	3.78		0.0400	-0.0144	0.0300	-16.09
49		0.0400	-0.0144	0.0000	3.57		0.0400	-0.0144	0.0000	-45.62
50		0.0400	-0.0144	-0.0044	3.52		0.0400	-0.0144	-0.0066	-41.18
51	M,AH,AH	0.0300	0.0222	0.0322	28.55	M,AH,AH	0.0300	0.0222	0.0422	39.67
52		0.0300	0.0222	0.0300	26.93		0.0300	0.0222	0.0400	45.76
53		0.0300	0.0222	0.0200	22.11		0.0300	0.0222	0.0300	257.60
54		0.0300	0.0222	0.0000	17.29		0.0300	0.0222	0.0000	-25.61
55		0.0300	0.0222	-0.0044	16.60		0.0300	0.0222	-0.0066	-20.44
56	M,H,AH	0.0300	0.0200	0.0322	22.20	M,H,AH	0.0300	0.0200	0.0422	37.42
57		0.0300	0.0200	0.0300	21.22		0.0300	0.0200	0.0400	42.88
58		0.0300	0.0200	0.0200	18.05		0.0300	0.0200	0.0300	202.84
59		0.0300	0.0200	0.0000	14.56		0.0300	0.0200	0.0000	-26.95
60		0.0300	0.0200	-0.0044	14.04		0.0300	0.0200	-0.0066	-21.26

APPENDIX II continued

		Alpha	lambda	delta	Tcon*
61	M.M.AH	0.0300	0.0100	0.0322	11.10
62		0.0300	0.0100	0.0300	10.85
63		0.0300	0.0100	0.0200	9.93
64		0.0300	0.0100	0.0000	8.64
65		0.0300	0.0100	-0.0044	8.42
66	M.L.AH	0.0300	-0.0100	0.0322	5.57
67		0.0300	-0.0100	0.0300	5.51
68		0.0300	-0.0100	0.0200	5.25
69		0.0300	-0.0100	0.0000	4.84
70		0.0300	-0.0100	-0.0044	4.76
71	M.AL.AH	0.0300	-0.0144	0.0322	5.02
72		0.0300	-0.0144	0.0300	4.97
73		0.0300	-0.0144	0.0200	4.76
74		0.0300	-0.0144	0.0000	4.41
75		0.0300	-0.0144	-0.0044	4.35
76	L.AH.AH	-0.0100	0.0222	0.0322	-5.61
77		-0.0100	0.0222	0.0300	-5.66
78		-0.0100	0.0222	0.0200	-5.90
79		-0.0100	0.0222	0.0000	-6.51
80		-0.0100	0.0222	-0.0044	-6.68
81	L.H.AH	-0.0100	0.0200	0.0322	-5.94
82		-0.0100	0.0200	0.0300	-6.00
83		-0.0100	0.0200	0.0200	-6.27
84		-0.0100	0.0200	0.0000	-6.96
85		-0.0100	0.0200	-0.0044	-7.15
86	L.M.AH	-0.0100	0.0100	0.0322	-8.20
87		-0.0100	0.0100	0.0300	-8.30
88		-0.0100	0.0100	0.0200	-8.78
89		-0.0100	0.0100	0.0000	-10.11
90		-0.0100	0.0100	-0.0044	-10.50
91	L.L.AH	-0.0100	-0.0100	0.0322	-82.19
92		-0.0100	-0.0100	0.0300	-85.07
93		-0.0100	-0.0100	0.0200	-99.96
94		-0.0100	-0.0100	0.0000	10.00
95		-0.0100	-0.0100	-0.0044	-200.00
96	L.AL.AH	-0.0100	-0.0144	0.0322	-2.59
97		-0.0100	-0.0144	0.0300	-0.83
98		-0.0100	-0.0144	0.0200	9.10
99		-0.0100	-0.0144	0.0000	83.25
100		-0.0100	-0.0144	-0.0044	-500.00
101	AL.AH.AH	-0.0188	0.0222	0.0322	-4.43
102		-0.0188	0.0222	0.0300	-4.46
103		-0.0188	0.0222	0.0200	-4.61
104		-0.0188	0.0222	0.0000	-4.97
105		-0.0188	0.0222	-0.0044	-5.06
106	AL.H.AH	-0.0188	0.0200	0.0322	-4.63
107		-0.0188	0.0200	0.0300	-4.67
108		-0.0188	0.0200	0.0200	-4.83
109		-0.0188	0.0200	0.0000	-5.23
110		-0.0188	0.0200	-0.0044	-5.33
111	AL.M.AH	-0.0188	0.0100	0.0322	-5.89
112		-0.0188	0.0100	0.0300	-5.95
113		-0.0188	0.0100	0.0200	-6.20
114		-0.0188	0.0100	0.0000	-6.83
115		-0.0188	0.0100	-0.0044	-7.00
116	AL.L.AH	-0.0188	-0.0100	0.0322	-13.71
117		-0.0188	-0.0100	0.0300	-13.92
118		-0.0188	-0.0100	0.0200	-14.98
119		-0.0188	-0.0100	0.0000	-18.14
120		-0.0188	-0.0100	-0.0044	-19.15
121	AL.AL.AH	-0.0188	-0.0144	0.0322	-20.74
122		-0.0188	-0.0144	0.0300	-21.11
123		-0.0188	-0.0144	0.0200	-23.09
124		-0.0188	-0.0144	0.0000	-29.60
125		-0.0188	-0.0144	-0.0044	-31.94

	rho	lambda	alpha	Tsoc
M.M.AH	0.0300	0.0100	0.0422	29.84
	0.0300	0.0100	0.0400	33.36
	0.0300	0.0100	0.0300	101.92
	0.0300	0.0100	0.0000	-37.56
	0.0300	0.0100	-0.0066	-26.89
M.L.AH	0.0300	-0.0100	0.0422	25.11
	0.0300	-0.0100	0.0400	27.67
	0.0300	-0.0100	0.0300	68.35
	0.0300	-0.0100	0.0000	-104.67
	0.0300	-0.0100	-0.0066	-40.75
M.AL.AH	0.0300	-0.0144	0.0422	24.33
	0.0300	-0.0144	0.0400	26.75
	0.0300	-0.0144	0.0300	64.01
	0.0300	-0.0144	0.0000	-55.60
	0.0300	-0.0144	-0.0066	-47.80
L.AH.AH	-0.0100	0.0222	0.0422	25.50
	-0.0100	0.0222	0.0400	27.86
	-0.0100	0.0222	0.0300	50.71
	-0.0100	0.0222	0.0000	35.15
	-0.0100	0.0222	-0.0066	30.10
L.H.AH	-0.0100	0.0200	0.0422	24.26
	-0.0100	0.0200	0.0400	26.37
	-0.0100	0.0200	0.0300	45.44
	-0.0100	0.0200	0.0000	40.29
	-0.0100	0.0200	-0.0066	33.92
L.M.AH	-0.0100	0.0100	0.0422	20.00
	-0.0100	0.0100	0.0400	21.40
	-0.0100	0.0100	0.0300	32.05
	-0.0100	0.0100	0.0000	187.48
	-0.0100	0.0100	-0.0066	113.69
L.L.AH	-0.0100	-0.0100	0.0422	17.25
	-0.0100	-0.0100	0.0400	18.28
	-0.0100	-0.0100	0.0300	25.63
	-0.0100	-0.0100	0.0000	-314.03
	-0.0100	-0.0100	-0.0066	-63.85
L.AL.AH	-0.0100	-0.0144	0.0422	16.79
	-0.0100	-0.0144	0.0400	17.77
	-0.0100	-0.0144	0.0300	24.66
	-0.0100	-0.0144	0.0000	-107.61
	-0.0100	-0.0144	-0.0066	-76.39
AL.AH.AH	-0.0188	0.0222	0.0422	23.98
	-0.0188	0.0222	0.0400	26.08
	-0.0188	0.0222	0.0300	45.75
	-0.0188	0.0222	0.0000	30.99
	-0.0188	0.0222	-0.0066	26.75
AL.H.AH	-0.0188	0.0200	0.0422	22.84
	-0.0188	0.0200	0.0400	24.72
	-0.0188	0.0200	0.0300	41.15
	-0.0188	0.0200	0.0000	34.82
	-0.0188	0.0200	-0.0066	29.61
AL.M.AH	-0.0188	0.0100	0.0422	18.90
	-0.0188	0.0100	0.0400	20.15
	-0.0188	0.0100	0.0300	29.34
	-0.0188	0.0100	0.0000	86.23
	-0.0188	0.0100	-0.0066	62.45
AL.L.AH	-0.0188	-0.0100	0.0422	16.35
	-0.0188	-0.0100	0.0400	17.27
	-0.0188	-0.0100	0.0300	23.63
	-0.0188	-0.0100	0.0000	-541.47
	-0.0188	-0.0100	-0.0066	-74.54
AL.AL.AH	-0.0188	-0.0144	0.0422	15.92
	-0.0188	-0.0144	0.0400	16.79
	-0.0188	-0.0144	0.0300	22.75
	-0.0188	-0.0144	0.0000	-139.96
	-0.0188	-0.0144	-0.0066	-90.02

APPENDIX III

Information Used to Calculate Conservation Easement Values for Landowner and Land Agent in Tables 5.1 – 5.3.

LandownerConservation Easement Valuation

			Capitalized rents ($/ac)			
	$ per acre	attch	U	A	C	WTAdev
Pag(0)w/o	$ 2,977		2,882.4	117.2	(22.6)	$ 1,452
Pag(0)	$ 3,030	85.8	2,459.9	499.7	(15.2)	$ 1,505
Pag(0)(50)	$ 2,679	259.0	1,103.6	1,318.6	(2.1)	$ 1,154
Convert:		w/ attach	10			
		w/o attch	2			
			option to convert ($/ac)			
		attch	U	A	C	
		-0.742	0.820	-0.672	-0.609	factor
		333	3,000	1,525	25	fee simple
CEVag(0)	$ 1,172	(247)	2,460	(1,025)	(15)	
Convert @ Tcon = 10						
		-0.2231	0.3679	-0.1353	-0.0821	factor
		333	3,000	1,525	25	fee simple
CEVag(0)	$ 821	(74)	1,104	(206)	(2)	
Convert @ TL = 50						
		(0.5193)	0.4521	(0.5370)	(0.5267)	factor
$TCE_{ag}(0)_{TL=50}$	$ 351	(173)	1,356	(819)	(13)	fee simple

Land Agent Conservation Easement Valuation

			Capitalized rents ($/ac)				$SV(0)T_{soc}$ or T_L
			PIV	U	A	C	WTP
SPag(0)	$	4,151	2,261	391	1,499	(0)	$ 2,261
T_{soc} = 102							
Spag(0)		4,125	2600		1525		$ 2,600
T_{soc} = infinity							
Spag(0)	$	4,064	1,644	1,104	1,319	(2)	$ 1,644
$T_{soc} = T_L = 50$							

APPENDIX III continued

Landowner Temporary CE Value

Term	Term CE Value	Permanent CE Value @Term	Term Percentage
10	0	1,172	0.0%
15	11	1,161	0.9%
20	38	1,134	3.3%
25	78	1,094	6.6%
30	126	1,046	10.7%
35	179	993	15.3%
40	236	936	20.1%
45	293	879	25.0%
50	351	821	30.0%
55	408	764	34.8%
60	463	709	39.5%
65	516	656	44.0%
70	566	605	48.3%
72	586	586	50.0%
80	659	513	56.2%
85	701	471	59.8%
90	740	432	63.2%
95	777	395	66.3%
100	811	361	69.2%
102	823	349	70.3%
110	871	301	74.3%
115	897	275	76.6%
120	921	250	78.6%
125	944	228	80.5%
130	964	208	82.3%
135	983	189	83.9%
140	1,000	172	85.3%
145	1,016	156	86.7%
150	1,030	142	87.9%
155	1,043	129	89.0%
160	1,055	117	90.0%
165	1,066	106	90.9%
170	1,075	96	91.8%
175	1,084	87	92.5%
180	1,093	79	93.2%
185	1,100	72	93.9%
190	1,107	65	94.4%
195	1,113	59	95.0%
200	1,118	54	95.4%
300	1,164	7	99.4%
400	1,171	1	99.9%

Land Agent Temporary CE Valuation

Time	Term CE Value	Term CE Value W Endow	Endowment Discount	Term C CE Percent	Term E Percent W Endow
0	0		0	0%	0%
5	247	(614)	3,214	10%	-24%
10	471	(382)	2,982	18%	-15%
15	674	(166)	2,766	26%	-6%
20	857	34	2,566	33%	1%
25	1,023	219	2,381	39%	8%
30	1,173	391	2,209	45%	15%
40	1,432	699	1,901	55%	27%
50	1,644	964	1,636	63%	37%
60	1,817	1,192	1,408	70%	46%
70	1,959	1,389	1,211	75%	53%
80	2,075	1,558	1,042	80%	60%
90	2,170	1,703	897	83%	66%
100	2,248	1,828	772	86%	70%
102	2,261	1,850	750	87%	71%
110	2,312	1,936	664	89%	74.5%
120	2,364	2,029	571	91%	78%
130	2,407	2,109	491	93%	81%
140	2,442	2,177	423	94%	84%
150	2,471	2,237	363	95%	86%
160	2,494	2,287	313	96%	88%
170	2,513	2,331	269	97%	90%
180	2,529	2,369	231	97%	91%
190	2,542	2,401	199	98%	92.4%
200	2,552	2,429	171	98%	93.4%
210	2,561	2,453	147	99%	94%
220	2,568	2,474	126	99%	95%
230	2,574	2,492	108	99%	96%
240	2,579	2,507	93	99%	96%
250	2,582	2,520	80	99%	97%
260	2,586	2,532	68	99%	97%
270	2,588	2,542	58	100%	98%
280	2,590	2,550	50	100%	98%
290	2,592	2,557	43	100%	98%
300	2,594	2,563	37	100%	99%
400	2,599	2,593	7	100%	100%