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Essays on Current Use Property Taxation

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ESSAYS ON CURRENT USE PROPERTY TAXATION

BY

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PREFACE

This dissertation consists of four chapters that provide detailed information about the current use (CU) property taxation program and the determinants of program effectiveness. An introduction to the CU program and the approach of property assessment is given in the first chapter. This explores the CU assessment formula in general and reviews CU assessment of agricultural land in New Hampshire, giving an explanation of why the CU assessment of agricultural land in New Hampshire needs to be revised.

The second chapter, "Current Use Property Taxation in Conserving New Hampshire Land: An Empirical Investigation Using Multiple Imputations," is centered on the CU program in New Hampshire. Since the inception of the CU program in 1974, the program has been widely known and considered the corner stone in conserving undeveloped land from being developed for urbanized uses, such as commercial or residential development. About fifty percent of total land in the state is enrolled in the program. The purpose of the second chapter is to examine the factors that lead landowners to enroll land in the program. Town level data for the years 1999-2011 from 231 towns is used in the analysis. The factors addressed in the chapter cover some CU program related features and the influence of two central business districts, Boston in Massachusetts and Manchester in New Hampshire, in determining enrollment or withdrawal from the program. The chapter also focuses on comparing missing data treatment techniques that exist in the econometric literature. The missing data treatments considered are simple deletion, mean substitution and multiple imputations. The results suggest possible tax savings from the program as the major determinant in enrolling land in the CU program.

The third chapter, "Determinants of Current-Use Property Tax Programs in the U.S.," explores the determinants in implementing a CU program and imposing different CU withdrawal penalties in the U.S. All states, except Michigan, have implemented some sort of a CU assessment program during the years between 1956 and 1997. Owing to the period of program implementation, I chose to study the years between 1949-1997 to understand the factors that led to program implementation and specific distribution of withdrawal penalties. The techniques used in the third chapter are duration analysis, competing-risk regressions and random effect multinomial logit analysis. The results confirm that most CU programs are implemented due to unprecedented growth in urban land in states that aim to protect agricultural land. According to the results, CU program withdrawal penalties are less common in states that are highly dependent on agriculture.

The fourth chapter, "Evaluation of Current-Use Property Tax Programs Effectiveness," studies the CU programs' effectiveness in discouraging conversion of undeveloped land to more urbanized uses. Previous research, as well as findings from the previous two chapters, suggests that receiving a considerable property tax relief has been one of the major determinants of enrolling land in the CU program. However, some of the features of the CU program may discourage land development. The features emphasized in this chapter are CU withdrawal penalties and the presence of restrictive agreements on land development. A state level study and a case study from New Hampshire are presented in the fourth chapter. Finding detailed information on property tax rates and CU withdrawal penalties for all the states was a challenging task in the

analysis. Therefore, using available information on property taxes, capitalization rates and land assessment values; a simulated database consisting of state level CU withdrawal penalties was developed as part of the work done in the chapter. For the case study, new residential permits issued in a given year in New Hampshire are used as a proxy measure for residential land development rates. Results obtained using random effect panel analysis of the state level study do not support the hypothesis that CU withdrawal penalties result in slower development of land across states. However, the percentage of land enrolled in the CU program in New Hampshire suggests that an increase in land enrollment in the state CU program is linked to lower residential land development.

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ABSTRACT

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Conservation of agricultural and forestry land has taken on a new urgency as development patterns have exploded over the past few decades, due to demand for residential, industrial and commercial land uses in the U.S. As a result, numerous land conservation programs have been implemented over the years. Current Use Property Taxation is one of the land conservation programs that was initiated in the 1960s, introducing some property tax relief for landowners who wished to keep undeveloped productive land in current use without developing it for more urbanized uses.

The substantial property tax relief landowners receive by enrolling land in the Current Use program was believed to be the main determinant in avoiding property tax induced land development. However, the forgone property tax revenue was a concern for state and local governments. In order to recapture forgone tax revenues and also to discourage enrollment of land for short-term property tax gains, withdrawal penalties and restrictions on land development were introduced. Current Use program features are not consistent across states and the reasons for interstate differences are not clear.

This dissertation explores the factors that lead to such variations across states and whether such variations in fact lead to differences in land development. One chapter

focuses on detailing the factors that lead New Hampshire landowners to enroll land in the program, while another chapter explores the factors that determined differences in program features across states. The last chapter explores whether the Current Use program is effective in slowing the land development in the U.S. by considering a town-level case study from New Hampshire and also a state level analysis.

CHAPTER 1

1 INTRODUCTION

1.1 Introduction

Conversion of agricultural and forestland or other open space land for residential and commercial development has been a matter of great concern over the past few decades. Conservation of open space land not only delays haphazard development, but also promises benefits such as regional food supply and environmental pollution control. For many people, natural resources are an important part of their lives. Therefore, preservation of natural areas generally benefits the economic wellbeing of current and future residents. Development pressures result in an appreciation of land value. Although this value increment is beneficial for the landowner, it may not be helpful for their ability to pay increasing property taxes, especially if a landowner relies on income from the land in order to cover property tax bills. Property taxes based on the market value of open space in the urban fringe areas are more likely to be higher than the land's current potential income (Malme, 1993). Therefore, property taxes become a burden for landowners at the urban fringe. Hence, landowners may be enticed to sell a portion or all of the land when property taxes become a burden. Numerous property tax relief programs have been introduced (Stienbarger, 2004) over the years to provide an economic incentive for the owners to retain their lands in rural uses without selling for more urbanized uses.

The Current Use (CU) Property Taxation program is one of the preferential property taxation systems adopted in the U.S. to slow down the pace of tax-induced and market-induced development. The CU program focuses on the land's income potential in its traditional uses, rather than on the fluctuating real estate market value of undeveloped land in property tax calculations. Lands that qualify for the CU program include undeveloped farmland, forestland, certified tree farms, wetlands and even other sites unsuitable for agriculture. CU programs became a trend in states in the 1970s even though some states had adopted similar programs before 1970. Such programs have been widely accepted across the country over the past two decades. A property taxation system based on the current use of undeveloped land is an effective way to provide a shield against higher property taxes. Therefore, the CU Taxation program makes ownership of lands less burdensome for the urban fringe landowners (England, 2011).

The primary focus of this dissertation is to discuss CU program characteristics, its success factors, reasons for different program features and its effectiveness in land conservation in the U.S. However, empirical studies that support or confirm those theoretical suggestions are lacking. This dissertation contributes to the CU literature with three detailed empirical studies that unfolds in chapters 2 to 4. For the empirical studies, I consider CU program features at state level and in New Hampshire. Chapter 2 focuses on town level data in New Hampshire in predicting specific features that could attract landowners to enroll land in the program. Chapter 3 focuses on predicting specific determinants that lead to implementation of CU programs and imposition of withdrawal penalties in states at different years, starting from the 1950s to the end of the 1990s. Chapter 4 focuses on evaluating CU program features such as withdrawal penalties and restrictive agreements' effectiveness in conserving land in the U.S. Most of the CU programs are implemented at the local government level and therefore collection of data on CU programs at the state level was difficult. Consequently, a simulated dataset was developed for analyses done in Chapter 4 and the developed database is another contribution to the CU literature.

Unprecedented growth in conversion of land led to the initiation of many conservation programs that targeted protection of rural land and rural characteristics. Before I discuss the CU program, providing some background knowledge about alternative land conservation programs is important. As a result, the rest of this chapter is devoted to providing some information on alternative land conservation programs in the U.S., which follows with a detailed background of CU program characteristics. The most notable and highly discussed feature of CU programs is the use value assessment of lands enrolled in the CU program. Then, a theoretical explanation of the CU value assessment formula is presented in this chapter. The last section of the chapter reviews the existing CU assessment for agricultural land in New Hampshire.

1.2 Alternative Land Policies in Conserving Land

Potential benefits of preserving land are not only gained by the landowners living near conserved land, but also by the public living in the region too. Open space preservation or slowing of conversion of farm and forest land into residential and commercial purposes led to many legislations and programs. The programs or legislations introduced by government entities and private organizations in the past include exclusive agricultural zoning, purchase and transfer of development rights, conservation easements, tax-credit programs and public land etc.

The selection of a conservation program by a landowner depends on a couple of criteria. As shown in table 1.1, landowners can decide whether they want to maintain the ownership of the land or not and whether they need any monetary compensation for conservation etc. Hence, the "bundle of rights" that comes with the ownership of the land, may be exchanged or given-up upon conservation. The "bundle of rights" may include the right to occupy, lease, use, sell and develop the land at the owner's discretion. However, the important question is "why do landowners decide to conserve land?" The economic rewards the landowners receive are believed to be the primary incentives for conservation. Economic rewards may be received in terms of tax relief on income, property or estate taxes in return for conveying their real property rights.

With several alterative programs to land conservation, it is important that a landowner considers a program that fits his/her land conservation motivation. This section summarizes some of the land conservation programs and covers how those programs meet conservation efforts and the incentives landowners would receive for conservation.

Purchase of Development Rights (PDR): The rights to develop a land for residential or commercial purposes come with the ownership of land. The purchase of development rights involves the sale of rights to develop the land, while all other rights remain with the landowner. Once an offer to purchase development rights is made by a land trust or an agency linked to the local government, the selling of development rights by a landowner is a completely voluntary process. When an agreement is made between the landowner and the land trust or the local government's agency, a permanent deed restriction is placed on the property that restricts development, which ensures the land remains an agricultural, forestry or open space land in perpetuity. The owner could sell the land, lease the land or pass it to heirs with the deed restriction. According to Kline and Wichlens (1994), 18 states have active PDR programs. Once the land's development rights are sold, the value of the land basically comes down to the agricultural land value. This gives a substantial tax relief on inheritance tax liability (Kline & Wichlens, 1994).

<u>Transfer of Development Rights</u>: Transfer of development rights (TDR) is another option available to protect agricultural lands. With TDR, the rights to develop a land are transferred from one area to another. When the development rights are transferred, development densities ("building bonus") allowed in the areas being developed increase (Stinson, 1996). For example, TDR in an area which requires at least 1/4 acre per unit of development will increase the development densities by requiring only 1/6 acre per unit if "building bonuses" are received in return to TDR. The increase in density is an incentive for developers in a growth zone, known as a "receiving area," to buy development rights from a preservation area, known as a "sending area" (see figure 1.1). Although TDR programs' objectives resemble those of PDR, TDR needs to occur in a more controlled setting to determine "sending areas" and "receiving areas." With TDR, development rights can be directly transferred to a developer or to a TDR bank established by a local government.

<u>Conservation Easements</u>: A conservation easement is a restriction placed on a land parcel to protect natural or man-made resources, and is considered to be one of the primary tools of land conservation today (Bowers & Daniels, 1997; Gutanski, 2000; Lindstrom, 2008). Conservation easements allow continued use of land for agriculture, forestry, ranching

etc., while protecting the open space and natural value of the land. Using easements, private landowners decide to protect land by conveying some or most of their rights to use the land to a nonprofit organization, a government agency or a land trust that is responsible for ensuring that the requirements of easements are fulfilled. This legally binding contract may be for a specified time period or in perpetuity. The easement holder is responsible for monitoring and enforcing restrictions on the property as specified in the covenant (Andrus, 1982; Lindstrom, 2008). For example, if an agricultural land is specified as a conservation easement, then the easement holder needs to ensure that the agricultural land will remain conducive to agriculture in the future. As with other easements, agricultural easements limit or may prohibit development of the land for residential or commercial purposes. However, an easement agreement does not absolve the property owner from traditional responsibilities, such as property taxes, upkeep and maintenance. As discussed before, monetary benefits a landowner receives offer motivation for the owner to declare a land as an easement. Federal income tax and/or property tax benefits a landowner receives for easements are state and locally determined, and are substantial.

The federal tax incentives that encourage the donation of a conservation easement include the following: an income tax deduction based on the easement's appraisal value and exclusion of the easement's value from the property for estate tax purposes; and an additional estate tax exclusion of up to 40 percent of the value of the land included in the easement. Sometimes people refer to easements as PDR, although conservation easements are not actually equivalent to PDR. Conservation easements consider land conservation goals without regulation, without adversity and often even without government involvement.

Conservation easements are valuable as a land protection tool that complements regulation, land acquisition and tax policies to ensure optimum public benefits (Pidot, 2005).

Agricultural Zoning: Agricultural zoning, which began in the 1920s, aims to protect viability of agriculture in a region, in order to protect communities that are concerned about economic viability of agricultural activities. Local governments enact agricultural zoning through collaborative agreements with farmers, businesses, residents, developers or anyone who may be affected by zoning ordinance. Agricultural zoning governs regulations to prevent farmland from being converted to nonfarm uses and also to protect agricultural land from nonfarm intrusion. Establishing agricultural zoning makes agricultural land affordable for new owners and makes agricultural production profitable. Agricultural zoning also is helpful in preserving the rural character of a community, which prevents communities from constant increases in property taxes due to rises in land value and increases in demand for public services. With agricultural zoning, the density of residential development is controlled by requiring a minimum size of agricultural land in order to build a non-agricultural related dwelling. The minimum size of a lot depends on the intensity of the agricultural activity. For example, a farm with livestock and cropping operations may require 160 acres to get permission to build a nonagricultural dwelling, whereas, a farm allocated for horticultural activities may require a minimum of 25 acres. With some zoning, clustered residential development is allowed.

1.3 Current Use Property Taxation Program Features

The CU program that initiated in Maryland in 1956, introduced very important property tax reforms at state and local levels over the past few decades. Although the primary objective of the program is to provide property tax relief to agricultural and forestry landowners (in some states even open space land), some of the CU program features are in place to discourage land development as well. Variations in program features make the program differ across states in the areas of enrollment procedure, enrollment eligibility, use value assessment procedures, presence of restrictive agreements on development and the imposition of CU withdrawal penalties. This section summarizes variations of the above program features across states, which is followed by a theoretical description on how CU assessments are done. The impact of different features of the program on land conservation and land conversion is evaluated in later chapters.

In some states CU program enrollment is automatic. In other states where the enrollment is voluntary, landowners are still required to file an application. In either case, enrolled lands are assessed not at the market value, but at their current use value for tax purposes. In the states with automatic enrollment, landowners qualify for the tax benefit if the land qualifies for CU assessment. In contrast, in the states with voluntary enrollment, landowners qualify for the tax benefit at their discretion, which requires submission of an application to qualify for the tax benefit. To qualify for the tax benefit, applications may be submitted each year or just once as long as the use of the land is unchanged. There are 13 states with automatic enrollment, while 36 states operate with voluntary enrollment. In chapters 3 and 4, I evaluate the reasons for and outcomes of such differences in program enrollment across states.

Eligibilities to receive tax benefits also differ across states and vary in terms of the required minimum size of a parcel, a history of eligible use or a minimum cash income from specified rural use (England, 2011). For example, in New Hampshire for a land to qualify for the tax benefit, whether it be a farm, forest, an unproductive land or any combination of above lands, it has to be at least ten acres. If the land is a wetland, then the size of the land has to be less than ten acres. Otherwise, any size of agricultural or horticultural land qualifies, if the annual gross income from crop sales totals at least $2,500 per year. In contrast, Arizona does not have any minimum requirement for land size or a minimum cash income for a land to qualify for the benefit.

Another program feature that makes CU programs vary across states is the presence of restrictive agreements on development. If state CU programs include a restrictive agreement, landowners are required to refrain from land development for a certain number of years. For example, in California and Washington CU program landowners are refrained for ten years from developing the enrolled land. If a land is withdrawn before the maturity period of the restrictive agreement, penalties are imposed. Chapter 3 gives more details on restrictive agreements of states and chapter 4 evaluates whether these restrictive agreements lead to differences in land development compared to the states with no restrictive agreements.

Penalties for CU withdrawal, which include a payment fee for landowners who withdraw land from the program, result in differences in CU programs across states. Based on withdrawal penalties, CU programs can fall into one of two categories: preferential property taxation or deferred CU taxation. With preferential taxation, a CU withdrawal penalty is not imposed, and the landowners enjoy lower property taxes as long as lands are enrolled in the program. In contrast, in deferred taxation states, landowners are required to pay a penalty upon withdrawal from the program. The penalties can be based on the market value of land at the time of sale (market value penalty) or could be dependent on the amount of property tax savings landowners received (roll-back penalty) while enrolled in the program. Market value penalties range between 10-20% of the land's sale value, whereas the penalties based on property tax savings depend on tax savings from the past 3-10 years. The number of years considered in roll-back penalty varies from state to state. Chapters 3 and 4 provide further details on CU withdrawal penalties and evaluate possible influences of withdrawal penalties on land development.

1.4 Theoretical Background in Assessing Agricultural Current Use Land

Assessment of land for property tax purposes plays the major role in deriving tax relief for CU landowners. The transparency and accuracy in value assessment may be the main features attracting more landowners to enroll their land, and keeping those parcels enrolled in the program for a longer period of time or in perpetuity. Hence, accurate calculation of the income potential of CU land is important in most of the states. In contrast, some other states specify a certain percentage of the market value as the CU value. Basic challenges in use value assessment arise in determining the net income stream generated by agricultural land, and the appropriate capitalization rate to convert that net revenue stream to use value. The capitalization rate, which varies considerably across states, is the ratio between the projected net operating income produced by an asset and its current market value (Wyoming Department of Revenue, 2010). Most of the states rely on the Farm Credit

Services (FCS) or Federal Land Bank (FLB) rate of interest as a principal component of the capitalization rate (Kansas Department of Revenue, 2000).

The price of a developed land parcel is comprised of several components (Anderson, 2011). The components are capitalized net income of land, value of capital improvement, value of accessibility and value of expected future rent increase. According to Anderson (2011) and Helsley (1989), the location of land has no influence on the first two components.

$$P^{developed}(t,z) = \underbrace{\frac{A}{r}}_{\substack{\text{Capitalized}\\ \text{value of}\\ \text{annual}\\ \text{agricultural}\\ \text{rent}}} + \underbrace{C}_{\substack{\text{Value of}\\ \text{capital}\\ \text{improvement}\\ \text{(cost of}\\ \text{development)}}} + \underbrace{(\frac{1}{r})(\frac{T}{\bar{L}})[\bar{z}(t) - z]}_{\text{Value of accessibility}} + \underbrace{(\frac{1}{r})\int_t^{\infty} R_u(u,z)e^{-r(u-t)}.dt}_{\substack{\text{Value of expected}\\ \text{future rent increase}}} \quad (1.1)$$

Where

A : *Agricultural land rent*

r : *Discount rate*

c : *Value of capital improvement*

T : *Cost of commuting a unit of distance*

$\bar{L}$: *Mean lot size*

$\bar{z}$: *Boundary of urban area*

R_u : *Rent on the agricultural land*

t : *Time of development*

The value of agricultural land can be deduced from the above formula as follows:

$$P^{agric}(t,z) = \underbrace{\frac{A}{r}}_{\substack{\text{Capitalized}\\ \text{value of}\\ \text{annual}\\ \text{agricultural}\\ \text{rent}}} + \underbrace{(\frac{1}{r})\int_t^{\infty} R_u(u,z)e^{-r(u-t)}.dt}_{\substack{\text{Value of expected}\\ \text{future rent increase}}} \quad (1.2)$$

To simplify the above formula, i.e. if the value of expected future rents to agricultural land is ignored, the rent of an agricultural land would be only $\frac{A}{r}$. In current use property taxations, land values are assessed with the assumption that the land would remain in the current agricultural (or forestry) use in perpetuity. Therefore, the value of expected future rent increases are ignored in CU property tax calculations and the assessed value of agricultural land can be written as follows:

$$V(t) = \int_{0}^{\infty} A(u)e^{-r(u-t)}du \quad (1.3)$$

In the presence of property taxes, income potential of land as shown in (1.3) will be further discounted with the rate of property taxes. By incorporating property tax rates, equation 1.3 can further simplify to equation 1.4:

$$V(t) = \int_{0}^{\infty} A(u)e^{-(r+\tau)(u-t)}du \quad (1.4)$$

where *V(t)* is the value of property at time *t*, assuming net revenue stream is generated by the highest and best use of land. If land is enrolled in the CU program, the above stream of income is considered at perpetuity. Hence, the above 1.4 formula can be simplified as:

$$V^{CU} = \int_{0}^{\infty} A(u)e^{-(r+\tau)u}du \quad (1.5)$$

where V^{CU} is approximated (Anderson, 2011) as: $\frac{A}{(r+\tau)}$ (1.6)

Therefore, the discount rate applicable in assessing income potential of land enrolled in the CU program should consider both interest and property tax rates. See table 1.2 for details on how some states have determined the discount rate to assess properties enrolled in the CU program. As shown, federal land bank (FLB) loan rates and farm credit service (FCS) interest rates have been largely used in determining discount rates. However, it should be noted that not all states use FCS or FLB interest rates to determine discount rates. A detailed description of discount rate calculation is given in the next sub-section on CU valuation procedure in practice.

Not all states follow the suggested CU assessment formula in equation 1.6. I provide an example from Virginia's CU assessment procedure to understand the CU assessment components as suggested in equation 1.6 and CU literature. The components of assessment reviewed in this section include net farm income, interest rate (discount rate), property tax, risk and soil productivity, as described by Bruce & Groover (2010); assessments done are shown in table 1.3. The focus of this section is to review CU assessment procedure in New Hampshire with respect to equation 1.6. In the sections to follow, I describe how CU assessments are done, and suggest avenues to improve and revise agricultural assessments in New Hampshire.

Net Farm Income: In CU valuation of agricultural land, the determination of income from land is important. In equation 1.6, farming income is captured by A. When considering farming incomes, it is recommended to use a moving average of three to five years to calculate the average farm income per year. Averaging of farming income for different agricultural activities will help account for any income fluctuations due to weather or any disturbances due to market outcomes. According to the cooperative extension at the University of New Hampshire (UNH), agricultural use value assessments for the years 2006-

2011 are calculated based on the annual net returns to New Hampshire farmland for hay, corn and corn silage. Farmer surveys conducted in the spring of 2006 have been the source for farm budgets' information, and National Agricultural Statistical Service (NASS) agricultural price reports have been used to adjust agricultural prices for the years that follow the base year.

In addition to the calculation of net farm income in CU assessment, consideration of the discount rate is important (equation 1.6). The following section provides a discussion on criteria used by most states to determine the discount rate component in CU assessment.

Interest Rate Component (Discount Rate): In most states, the interest rate component of the capitalization rate is derived using average annual effective interest rates on new loans under the FCS. According to the Internal Revenue Service (IRS) Bulletin (Department of the Treasury, 1996-2011), these interest rates have been used by other states in computing special use value of farm properties. Figure 1.2 shows average FCS rates from 1996-2011 for all FCS branches, and figure 1.3 shows actual FCS rates, 3-year averages and 5-year averages of FCS rates for CoBank, the FCS branch which serves farm credit services to Alaska, Connecticut, Idaho, Maine, Massachusetts, Montana, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont and Washington (Spokane & Springfield branches).

As shown in table 1.2, in most of the states, FCS rates used in CU assessment are the averages of FCS rates over a couple of years. Hence, annual or short-term fluctuations are absorbed in discount rate calculations. According to farmland CU assessment in New

Hampshire, the discount rate used during the years 2007-2011 (UNH, cooperative extension, 2012) has been 4% and has not been based on FCS or FLB rates. As shown in figure 1.3, FCS rates have declined considerably since 2001, and the lowest FCS rates are reported in 2006 in almost all the FCS branches. Since 2006, FCS rates have been on a slow rise. Hence, the discount rates used in CU assessment in New Hampshire need to be adjusted to account for such fluctuations.

<u>Property Tax Rate Component</u>: In addition to the FCS component, the property tax rate also needs to be considered in discount rate calculation (equation 1.6). Figure 1.4 shows New Hampshire's county level full value tax rates (FVTR) from 1999-2011. As shown, the Carroll county FVTRs have been consistently lower by $15-20 than all other counties. As discussed before, the interest rate component may equal the 3-year or 5-year averages of FCS rates. Similarly, the property tax rate component may also equal 3-year or 5-year averages obtained from the New Hampshire Department of Revenue Administration (NHDRA) equalization reports from 1999-2011. It is not clear whether CU assessment in New Hampshire uses annual averages of property tax rates or the property tax rate from each year. Using 3-year or 5-year averages of FVTRs would be more pertinent in accounting for short-term fluctuations of FVTRs.

<u>Risk Component</u>: The risks associated with farming may or may not impact areas uniformly (Bruce & Groover, 2010). Therefore, in calculating use values, accounting for risks is important. The risks that are associated with input costs, crop yields and prices are

adequately accounted for in calculating net return to farming. Consequently, risks associated with the above are not considered in use value calculation in New Hampshire. Other risks that need to be accounted for are droughts and floods. In most states, droughts are not considered a risk component that could lead to variations in use values across jurisdictions. The reason for lack of consideration is, in most cases, drought affects the state's agriculture uniformly; therefore, drought impact is uniformly distributed across state. Similarly, droughts need not be considered in use value calculation in New Hampshire due to relatively homogenous climate zones across jurisdictions, owing to the size of the state. However, flood risks need to be accounted for in use value calculation, because flood risks are mostly related to land's location, geography etc. Therefore, flood risks borne by specific jurisdictions in the state need to be accounted for. When considering New Hampshire, riverine flooding is the most common disaster in New Hampshire (New Hampshire Department of Emergency Planning, 2012). According to the Natural Hazard Mitigation Plan in 2010, significant riverine flooding impacts some areas of the state in fewer than ten-year intervals. Therefore in use value calculation, the capitalization rate needs to be increased (Virginia Polytechnic Institute and State University, 2010) for the areas that are prone to flooding. In Virginia, the risk adjustment is 5%.

National flood insurance (NFIns) statistics from the Federal Emergency Management Agency is the data source that can be used to determine the jurisdictions with high occurrences of flooding. NFIns information can be used to adjust capitalization rates for flood risks. According to NFIns statistics, approximately 3,600 flood insurance claims have been reported in New Hampshire since 1978, with paid claims totaling about $46,800,000 (see table 1.4). Twenty-six jurisdictions have been identified as high flood insurance claim areas (New Hampshire Department of Emergency Planning, 2012), based on the number of claims made. Using flood risk statistics in use value calculation would yield more accuarte assessment for agricultural land.

In addition to the above review on net farm income, discount rates and risk components in relation to CU assessment in New Hampshire, productivity of soil is also considered in CU assessment. In contrast to the land productivity index used in Virginia (see table 1.3), New Hampshire uses the soil productivity index. The following section describes how the soil productivity index is incorporated into the assessment of CU land in New Hampshire.

<u>Soil Productivity Component (Soil Productivity Index)</u>: The soil productivity index (SPI) rating system, developed by USDA soil conservation service (United States Department of Agriculture, 1993), has been used in CU assessment in New Hampshire. SPI is a numerical rating of soil's relative suitability for growing corn silage and grass legume hay, the crops selected by agricultural specialists as being the two most representative crops grown in New Hampshire. Therefore, SPI is calculated based on the soil's suitability for growing corn silage and grass legume hay. SPI considers indexes of soil production (P), cost of corrective measures (CM) and cost of continuing limitations (CL), and SPI can be written as follows:

SPI = P – (CM+CL), where P is the index of production or yield capability, CM is the index that accounts for costs in corrective measures to overcome soil limitations and CL is the index of costs resulting from continued limitations. Final SPI is an average of SPIs of corn silage and grass legume hay. In SPI, ranking ranges from 0-100, where 100 is assigned to the best agricultural soil and an SPI of 0 is assigned to the worst agricultural soil (United States

Department of Agriculture, 1993). The evaluation factors used in potential ratings are slope, available water holding capacity in the upper 40 inches, depth to bed rock, rock fragments in the surface layer, water table level, soil permeability and mean annual soil temperature. In New Hampshire, landowners are required to provide information on SPI if assessments are needs to be adjusted based on SPI (New Hampshire Department of Revenue Administration Current Use Criteria Booklet, 2012). Worksheets on assessing SPI are available to landowners to determine SPI (United States Department of Agriculture, 1993). According to USDA Soil Conservation Service, prime farmland in New Hampshire has an SPI range between 68-100. A sample of SPI calculation as described by the soil conservation service is provided in the table 1.5.

The above section provided a discussion on components used in assessing CU value of land using Virginia's assessment as an example that follows Anderson's (2011) theoretical model as shown in equation 1.6. I considered equation 1.6 when identifying the components that need to be revised in assessing agricultural land in New Hampshire. The following section provides a discussion on the history of CU assessment ranges in New Hampshire's agricultural and forestry land and the reasons why agricultural land assessment ranges need to be revised in the near future.

1.5 Current Use Assessment of Agricultural and Forestry Land in New Hampshire

Table 1.6 shows assessment ranges per acre for agricultural land in New Hampshire. As shown, assessment range for farmland has been consistently $25-425 per acre since 1995. This suggests the need for revising agricultural assessment ranges in New Hampshire. Constant assessment ranges can lead to a couple of drawbacks. Tax assessments need to be adjusted for inflation, changes in productivity of land, etc. Productivity may not be consistent for an extended time, which affects income potential of land. Therefore, landowners may be paying more property taxes than they are supposed to over the years. Also, towns may be losing some potential tax revenue. The methodology outlined in section 1.4 as suggested in equation 1.6 would be ideal in revising agricultural land assessment in New Hampshire. As discussed, the New Hampshire CU assessment formula needs to be revised by incorporating annual averages of FCS rates and property tax rates, and adjusting assessments with consideration to risk factors.

According to CU booklets issued by the New Hampshire's Department of Revenue Administration, forestland assessment ranges have been updated at least in four-year intervals. In New Hampshire, enrolled forestlands are assessed based on whether the landowner offers a forest management plan (with documented stewardship) or not. As shown in table 1.6, forestland enrolled with documented stewardship offers the additional incentive of further reduced assessment ranges. Both ownership categories are divided into three classifications (four prior to 1999). The classifications are white pine, hardwood (red oak, sugar maple, yellow birch, white birch, and other less common types of hardwood) and all other, which includes Christmas tree farms. The assessment ranges reflect market values of the timber or the product, the land's capacity to produce wood and other factors that directly affect harvesting of timber or products. These other factors may include the presence or absence of steep slopes, ravines, boulders, wetlands or other physical characteristics that influence the costs of harvesting the product or timber. The location of the forestland (whether it is located on a paved state road etc.) is another factor.

1.6 Conclusions and Suggestions

This chapter provides a brief introduction about land conservation programs in the U.S., highlights the importance of the program in conserving land and discusses a theoretical background on how CU assessments are done. The CU program is one of the leading land conservation programs in New Hampshire. The percentage of agricultural land in the program is about 30% of the total land enrolled in the program. Therefore, accurate assessment of agricultural land is important for landowners as well as for local governments. According to CU official reports, agricultural assessment values have been consistent for almost fifteen years. This clearly shows the need to revise agricultural assessment values in New Hampshire's CU program.

Following the theoretical model developed by Anderson (2011), an accurate prediction of discount rate is important for an accurate calculation of income potential of land for CU calculation. According to CU officials in New Hampshire, this rate has been constant at 4% over the past few years. Therefore, this chapter provides some suggestions for revising the methods on calculating discount rates to include in CU assessment in New Hampshire. Incorporating a multiyear average of Springfield FCS rates, property tax rates and adjustments for flood risks would lead to accurate calculation of discount rates to be used in New Hampshire's CU assessments.

Table 1.1: Finding a Path to Conserve Land

Do you wish to retain ownership of the land?	
Yes	**No**
Do you wish to protect the land permanently?	**Is monetary compensation needed?**
If Yes.....	**If Yes....**
Conservation restriction	Sale at fair market value[1] Donate to a charitable remainder trust[2]
If No....	
Deed covenants and restriction License or lease to conservation organization Management agreement Open space tax programs	**If No...**
	Lifetime donation of land
	Do you wish to limit the future use of the property when you convey title?
	If Yes....
	Conservation restriction Deed covenants and restrictions
	If No...
	"Free and clear" donation Bargain sale[3] Sale at fair market value

Source: Ward, 2001

[1] Selling land to a conservation organization
[2] An independently managed account that can provide immediate income tax deductions or return an annual income to the owner for a fixed number of years or for life
[3] A sale to a charitable organization or governmental agency at less than fair market value

Table 1.2: Capitalization Rate Determination in Current Use Assessment

State	Capitalization Rate
Arizona	Federal Land Bank (FLB) rate + 1.5%
Connecticut*	5 year rolling average (95%) of Farm Credit Service (FCS) rate + state tax rate
Illinois	5 year average FLB rate
Massachusetts	60 month average of FLB rate
North Dakota	12 year average of St. Paul FLB rate
Oregon	5 year average of FLB rate + effective tax rate
Utah	5 year average of FLB rate
South Carolina	FLB rate + effective local tax rate + risk adjustment (15%) + 0.3% for non-liquidity
Wisconsin	5 year average of loan rate
Wyoming	5 year average of Omaha FLB rate

Sources: Kansas Department of Revenue, 2002; *Connecticut Farm Bureau, 2005

Table 1.3: Worksheet for Estimating the Use Value of Agricultural Land in Prince Edward County, Virginia

1. Estimated net return per acre			**$3.58**	
2. Capitalization Rate Components i) Interest rate component ii) Effective tax rate component iii) Rate without risk component iv) Risk component v) Rate with flood risk component			 0.0717 0.0042 0.0759 (sum i and ii) 0.0038 (0.05 times iii) 0.0798 (sum iii and iv)	
3. Unadjusted use value per acre a. Without risk b. With risk			 $47.16 $44.86	
4. Soil index				
Class	Cropland Acreage	Productivity Index	Weighted Average	
I	418	1.5	627	
II	21,273	1.35	28,719	
III	10,617	1	10,617	
IV	8,196	0.8	6,557	
Total	40,504		46,519	
Soil Index Factor			1.149	
5. Use value adjusted by land class				
Class	Land Index[4]	Without Risk	With Risk	
I	1.31	$61.7	58.7	
II	1.17	$55.1	52.4	
III	1.00	$47.1	$44.8	
IV	0.69	$32.5	30.9	
V	0.52	$24.5	23.3	

Source: Bruce & Groover, 2010[5]

[4] Land Index = Productivity Index/Soil Index Factor
[5] For additional estimates visit http://usevalue.agecon.vt.edu/

Table 1.4: Flood Insurance Claims in New Hampshire at County Level

County	Total Losses* Reported by NFIP[6] (1978-2012)	Total Amount Paid (1978-2012)
Belknap	106	889,554
Carroll	250	1,814,998
Cheshire	216	5,317,836
Coos	71	410,854
Grafton	296	3,681,956
Hillsborough	571	9,686,358
Merrimack	286	6,204,004
Rockingham	1652	16,083,188
Strafford	128	2,211,261
Sullivan	37	300,837

* Includes all losses regardless of whether losses have been fully paid, not fully paid or closed without payment.
Source: Federal Emergency Management Agency, 2012

[6] NFIP: National Flood Insurance Program

Table 1.5: Soil Potential Index (SPI) Calculation in New Hampshire

Soil Type: Charlton Fine Sandy Loam, 3 to 8 Percent Slopes, Very Stony[7]				
	Corn Silage		Grass Legume Hay	
	Corrective Measure (CM)	Continuing Limitation (CL)	Corrective Measure (CM)	Continuing Limitation (CL)
Water table greater than 6′	0	0	0	0
Slope range 3 to 8 percent	2	1	0	0
Bedrock greater than 6′	0	0	0	0
Available water capacity: 4.8″	0	0	0	0
Stones cover 1 to 3 percent of the surface	18	5	18	2
Soil permeability 0.6 – 6.0 in/hr	0	0	0	0
Mean annual soil temperature greater than 47 F.	0	0	0	0
	20	6	18	2

$$SPI = \frac{100-(20+6)+100-(18+2)}{2} = \frac{74+80}{2} = 77$$

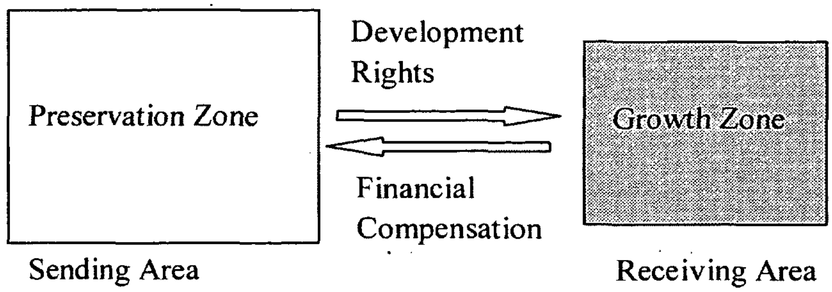
[7] Worksheets required in determining ranking for different soil characteristics can be obtained from the Soil Conservation Service, New Hampshire Department of Agriculture

Table 1.6: Current Use Land Assessment Ranges (Per Acre) in New Hampshire

Year	Farmland	Forestland with documented stewardship				Forestland without documented stewardship				Unproductive including wetland
		White Pine	Hardwood	All other	Naturally seeded Christmas trees	White Pine	Hardwood	All other	Naturally seeded Christmas trees	
1995	$25-425	$46-90	$15-27	$30-66	$50-75	$85-128	$43-65	$68-104	$50-75	$15
1996	$25-425	$46-90	$15-27	$30-66	$50-75	$85-128	$43-65	$68-104	$50-75	$15
1997	$25-425	$46-90	$15-27	$30-66	$50-75	$85-128	$43-65	$68-104	$50-75	$15
1998	$25-425	$46-90	$15-27	$30-66	$50-75	$85-128	$43-65	$68-104	$50-75	$15
1999	$25-425	$55-103	$15-33	$40-81	$40-81	$93-141	$47-72	$78-119	$78-119	$15
2000	$25-425	$55-103	$15-33	$40-81	$40-81	$100-152	$51-78	$82-125	$82-125	$15
2001	$25-425	$63-115	$15-36	$44-87	$44-87	$112-170	$55-84	$91-137	$91-137	$15
2002	$25-425	$63-115	$15-36	$44-87	$44-87	$112-170	$55-84	$91-137	$91-137	$15
2003	$25-425	$63-115	$15-36	$44-87	$44-87	$112-170	$55-84	$91-137	$91-137	$15
2004	$25-425	$63-115	$15-36	$44-87	$44-87	$112-170	$55-84	$91-137	$91-137	$15
2005	$25-425	$73-130	$15-44	$49-94	$49-94	$126-191	$62-94	$99-150	$99-150	$15
2006	$25-425	$73-130	$15-44	$49-94	$49-94	$126-191	$62-94	$99-150	$99-150	$15
2007	$25-425	$73-130	$15-44	$49-94	$49-94	$126-191	$62-94	$99-150	$99-150	$15
2008	$25-425	$73-130	$15-44	$49-94	$49-94	$126-191	$62-94	$99-150	$99-150	$15
2009	$25-425	$86-130	$20-34	$49-74	$49-74	$128-192	$57-86	$86-129	$86-129	
2010	$25-425	$97-146	$20-36	$43-64	$43-64	$138-207	$55-82	$76-114	$76-114	$20
2011	$25-425	$97-146	$20-36	$43-64	$43-64	$138-207	$55-82	$76-114	$76-114	$20
2012	$25-425	$91-137	$31-46	$22-34	$22-34	$125-188	$57-85	$47-71	$47-71	$20

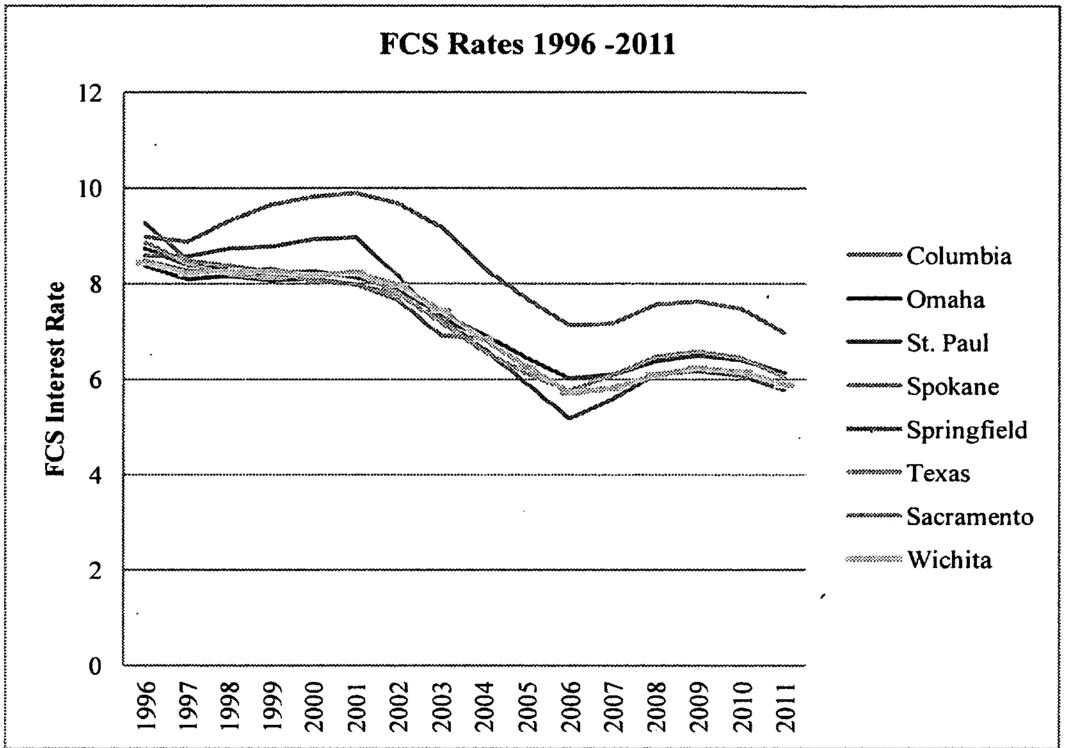
Source: New Hampshire Current Use Criteria Booklets (New Hampshire Department of Revenue Administration, 1995-2012)

Figure 1.1: Transfer of Development Rights



Source: Platt, 1996

Figure 1.2: Farm Credit Service (FCS) Interest Rates 1996 – 2011 by District



Source: Internal Revenue Bulletins 1996-2011, IRS

Columbia (AgFirst, FCB) – Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, Virginia, West Virginia

Sacramento (U.S. Agbank, FCB) – Arizona, California, Hawaii, Kansas, New Mexico, Nevada, Oklahoma, Utah

St. Paul (AgriBank, FCB) – Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, North Dakota, Ohio, Tennessee, Wisconsin

Omaha (AgriBank, FCB) – Iowa, Nebraska, South Dakota, Wyoming

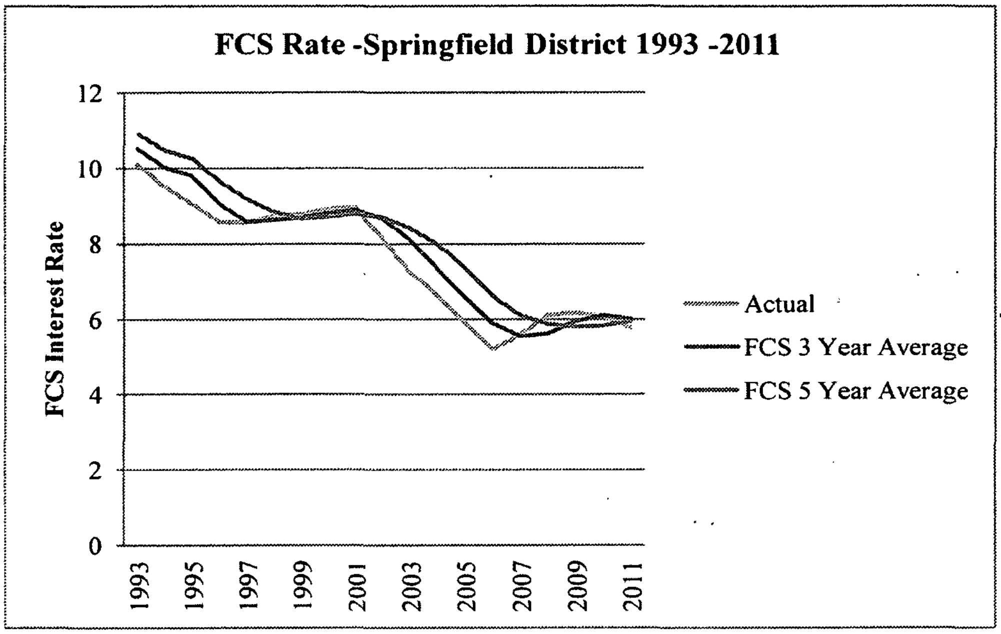
Spokane (CoBank, FCB) – Alaska, Idaho, Montana, Oregon, Washington

Springfield (CoBank, FCB) – Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont

Texas, FCB – Alabama, Louisiana, Mississippi, Texas

Wichita (U.S.Agbank, FCB) – Colorado, Kansas, New Mexico, Oklahoma

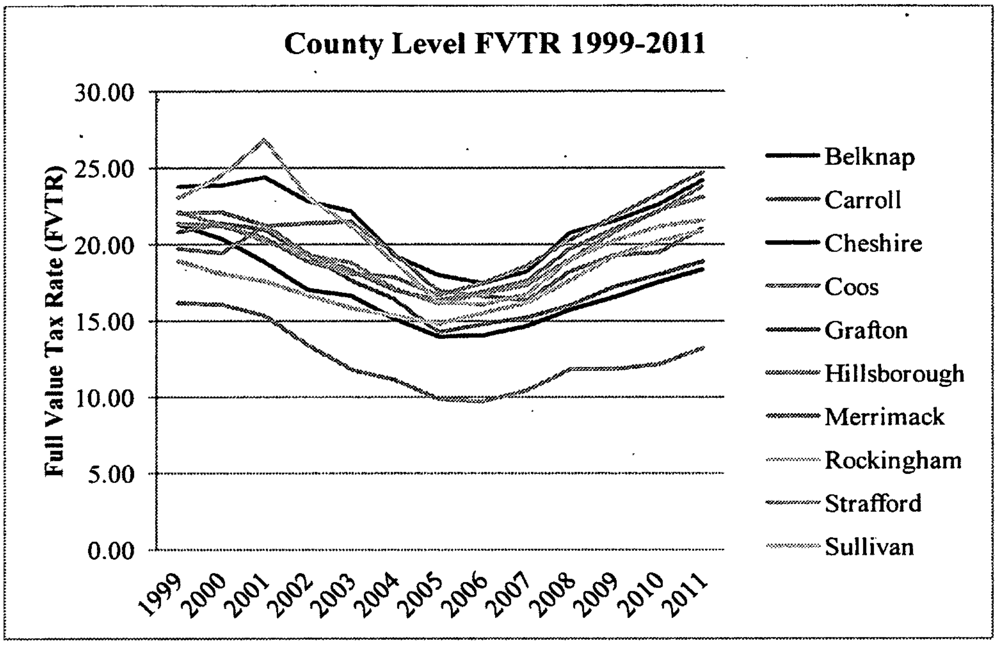
Figure 1.3: Springfield District Farm Credit Service (FCS) Interest Rates 1993 – 2011



Source: Internal Revenue Bulletin, Department of Treasury, Internal Revenue Services, Issues 1996-2011

*These interest rates are for Farm Credit District Springfield, MA (CoBank, ACB). Served states are Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

Figure 1.4: County Level Full Value Tax Rates* in New Hampshire 1999 – 2011



* Full value tax rates are per $1000 value.

Source: New Hampshire Department of Revenue Administration

CHAPTER 2

2 CURRENT USE PROPERTY TAXATION IN CONSERVING NEW HAMPSHIRE LAND: AN EMPIRICAL INVESTIGATION USING MULTIPLE IMPUTATIONS

2.1 Introduction

In 1973, the New Hampshire General Court enacted the current use (CU) law, known as RSA 79-A (New Hampshire's Current Use Coalition, 2007) in response to the campaigning done by the New Hampshire's CU coaltion, officially known as the Statewide Program of Action to Conserve our Environment (SPACE). Since then, the CU program in New Hampshire is considered to be the cornerstone of the state's conservation efforts, and nearly 3 million acres (about 50 percent of New Hampshire's land) are enrolled in the New Hampshire CU program (see table 2.1). The CU program in New Hampshire can be considered one of the state programs that incorporate some of the better land-conserving design features (New Hampshire's Current Use Coaltion, 2007).

CU assessment programs have led to many studies on the subject, ranging from theoretical models to empirical studies. Most empirical studies on CU programs generally agree that such programs provide a substantial tax relief to participating landowners (Brockett, Gottfried & Evans, 2003; Malme, 1993; Polyakov & Zhang, 2008). Despite the benefits gained by participating landowners, CU programs are often criticized. The most cited criticism regards the opportunity gained by land speculators. According to

Malme (1993), the penalty for the withdrawal from the CU program is not significant for major developers. The requirement of minimum acreage, use of land for the promised use for the last five years and binding contracts help to divert such speculators. Another criticism is the revenue loss for towns. This concern leads to another critique: does this imply a tax shift to homeowners and business properties? However, the concerns on the shift of tax burden or the loss of revenue are counterbalanced by the requirement of fewer public services for undeveloped land areas compared to residential areas and most of the commercial lands (American Farmland Trust, 2004). Some studies show evidence that casts doubt upon the success of the program in preserving undeveloped land (Brockett, Gottfried & Evans, 2003; Parks & Quimio, 1996; William, Gottfried, Brockett & Evans, 2004). According to Brockett et. al. (2003), the reasons for ineffective land conservation outcomes include development considerations that overpower the incentives provided by the program and lenient CU withdrawal penalties.

Despite the aforementioned arguments against the program, there are theoretical models that predict favorable outcomes from the program and have identified several testable implications (Anderson & Griffing, 2000; Capozza & Helsley, 1989; England & Mohr, 2003). However, empirical studies that verify the theoretical claims of these models are limited in number. New Hampshire's CU program is used as a case study to verify some theoretical claims contained in earlier studies by the authors referenced above.

Figure 2.1 shows the distribution of forest and agricultural land enrolled in the program in 2009. As shown, about 60-70 percent of land enrolled in the NH program is forested land, whereas about 30 percent of land is agricultural land. Most of the farmland enrollment in the program can be found closer to the Seacoast, the Merrimack River Valley and the Connecticut River Valley (Vermont and Massachusetts borders). This specific distribution of agricultural land enrollment in the CU program is worth exploring further. Therefore, the first objective of this chapter is to explore specific determinants of CU enrollment and CU withdrawal in New Hampshire over the period 1999-2011. Since the CU program is considered to be the major land conservation program, I study the significance of the CU program in conserving land, using data related to the CU program in New Hampshire. A drawback of available data for this chapter is a high percentage of missing observations in some variables, which could hinder the reliability of research findings. In addition to exploring the characteristics that lead to enrollment in and withdrawal of land from the CU program, this paper also focuses on some of the well known missing data statistical techniques. The missing data treatment methods compared are simple deletion, mean imputation and multiple imputation techniques. Hence, the second objective of this paper is to compare existing missing data treatment techniques and carry out the New Hampshire case study analysis.

This chapter is organized as follows. First, the theoretical models and hypotheses are summarized. The next section describes data, methodology and model specifications. Then I discuss the multiple imputations technique I used to treat missing data in the New Hampshire case study. Then I present results obtained using panel data analysis. The chapter concludes with a summary of key findings and a discussion on possible suggestions for successful implementation of the CU program in New Hampshire.

2.2 Conceptual Models Used for the Analysis and Hypotheses

This section summarizes the theoretical models used to generate predictions about CU programs. The models include the effects of Central Business Districts (CBD), property tax rates, withdrawal penalty and population growth on land values. The value of land is determined by four distinct components (Anderson, 1986; Capozza & Helsley, 1989). The first component is the value of accessibility, which depends on the transportation cost and the distance to the CBD. Close proximity to the CBD and accessibility increase land value (see figure 2.3). It is assumed that access to the CBD is no longer relevant at distances greater than Z*. The second component of land value is the conversion value. The presence of conversion value corresponds to a considerable value hike in lands located within a certain distance from (Z*) CBD. The third component of land value is the anticipated value of future rent increase. This expected rent increase depends on the distance to the CBD. It is assumed that the expected future rent increases are higher at the urban fringe.

The fourth and final component of land value is the CU value, which does not depend on the distance to the CBD. When we take these four components into consideration, it is clear that land prices decline with increases in distance to CBD. Therefore, the land parcels at the urban fringe face higher real estate market values and as a result, higher property taxes. Hence, landowners with agricultural or forestland at the urban fringe are more inclined to enroll in the CU program. The two business districts considered for empirical analysis for this study are Boston, MA and Manchester, NH. Following the land-value models proposed in the literature, this paper hypothesizes a higher proportion of CU enrollment and lower CU withdrawal in towns closer to Boston and Manchester, as opposed to towns located away from the above two cities. When consider the effect of population growth on rural land development, I hypothesize a decline in the acres of land enrolled in the CU program with higher growth in population. There are three possibilities when the effect of change in population on land allocation is considered. First, new populations may settle in a land that is already developed, thereby increasing urban density. Second, the new population may settle on undeveloped land that is enrolled in the CU program or, third, on land that is not enrolled in the program (see figure 2.4). Therefore, changes in land enrollment in the CU program due to changes in population may be hard to capture with simple population statistics. However, I test the hypothesis that an increase in population results in a decline in land enrolled in the CU program and higher withdrawal from the program. I assume if there is a higher growth rate in population, then there is a decline in the acres of land enrolled in the CU program to accommodate the increased population.

The theoretical model developed by England & Mohr (2003) implies some important testable predictions about CU assessment. Their inter-temporal model of land development includes features specific to the CU program. Following England & Mohr (2003), this paper hypothesizes higher CU enrollment and lower CU withdrawal in towns with higher property tax rates and higher average land value. According to the model, a landowner decides the timing of development (D), considering the pecuniary benefits before/after the development (c and u) and non-pecuniary benefits (n) only before the development. Therefore, the owner chooses a time to develop the land when the present value of her income stream is maximized. The model is:

$$\underbrace{\int_{t=0}^{t=D}[c(t)+n(t)-\tau A(t)]e^{-rt}dt}_{\substack{\text{Present value of returns}\\ \text{to undeveloped}\\ \text{land, net of taxes}}} - \underbrace{P(D)e^{-rD}}_{\substack{\text{Present value}\\ \text{of penalty}\\ \text{on withdrawal}}} + \underbrace{\int_{t=D}^{t=\infty}[u(t)-\tau A(t)]e^{-rt}dt}_{\substack{\text{Present value of}\\ \text{returns to developed}\\ \text{land, net of taxes}}} \quad (2.1)$$

In the above, τ is the property tax rate, r is the owner's discount rate, P is the penalty fee and t denotes time. Following England & Mohr (2003) model predictions, I hypothesize an increase in land enrollment for the program with higher τ and higher aerage land value (ALV). I use the term full value tax rate (FVTR) to denote the τ of England & Mohr (2003) model. ALV_{it} in town is calculated as follows:

$$ALV_{it} = \frac{\text{Residential land value} + \text{Commercial and Industrial land value}}{\text{Total land} - \text{Nontaxable conservation and CU land}}$$

This chapter also focuses on exploring the influence of daily traffic in a town on CU enrollment and CU withdrawal, hence development pressure. According to Ni et al. (2005) and Nordback et al. (2011), federal transportation funds are linked to vehicle miles travelled (VMT) and are calculated based on annual average daily traffic (AADT). (Ni, Leonard, Guin, & Feng, 2005; Nordback et al., 2011). With higher volumes in AADT, the flow of federal funding may increase the development pressure in town, resulting in lower CU enrollment and higher CU withdrawal.

Monetary benefits landowners receive by enrolling their land in the CU program in New Hampshire are promising. However, if a landowner decides to withdraw land from the CU program, a withdrawal penalty, known as land use change tax (LUCT) is imposed in New Hampshire. LUCT in New Hampshire is calculated based on the market value of land at the time of sale. Although, LUCT is not used as a variable in this chapter, LUCT and land withdrawal data indicate a disturbing problem - the missing data issue. In addition, some AADT were also missing due to the nature of data collection. In the section 2.4.1 a detailed explanation is presented on the above missing data. The values that are missing from AADT, LUCT and land withdrawn could not be ignored in the analysis. In treating missing data, I compared three missing data treatment techniques – simple deletion, mean imputation and multiple imputations, which are described in the following section.

2.3 Comparison of Missing Data Treatment Methods

Many techniques have been developed in the past as a solution for the missing data issue (Carter, 2006). However, researchers often use ad-hoc approaches (Honaker & King, 2010; Wayman, 2003) in handling missing data, which may ultimately do more harm than good. The approaches may include simple listwise deletion, mean substitution, and missing data imputation etc. Researchers agree about strengths and weaknesses of each method.

Listwise deletion or complete case analysis is the deletion of observations that have missing values on one or more of the variables in the data set. This means that the researcher removes all the records that have missing data on any variable. Listwise deletion is the default in most statistical software, but it may lead to significant sample size reduction available for the analysis depending on the proportion of discarded cases. If the discarded cases represent only a small proportion of the entire data set, then listwise deletion may be a reasonable approach (Honaker & King, 2010; Wayman, 2003). In listwise deletion, missing data are treated as missing completely at random. However, if the proportion of missing data increases and discarded cases differ systematically from the rest (data not missing completely at random), then listwise deletion may add serious bias towards estimates.

In some cases, the missing observations are replaced by an average of the variable; this process is known as mean imputation or mean substitution. Although this is considered to be a mean preserving method, it affects the marginal distribution of data. All the above methods do not eliminate the possibility of biased results (Philips & Chen, 2011). Although mean substitution approach preserves the marginal distribution of the variable, it affects the covariance and correlations between variables (Cameron & Trivedi, 2005).

2.3.1 Multiple Imputation

In 1987, Rubin proposed a multiple imputations scheme to treat missing data. Multiple imputation (MI) method has been widely used over the past by researchers in many study areas (Norman, 2009; Phillips & Chen, 2011; Kammerer, 2009; Siche et al, 2008). The first stage is the creation of set copies with the original data set and the generation of missing values using an appropriate modeling procedure. Then, any standard analysis can be performed with the new imputed data set.

According Rubin (1987), multiple imputations have several desirable features. Such features include its usability in any kind of analysis without specialized software, its yield of unbiased estimates, and the possibility of obtaining accurate estimates for standard errors etc. The literature with formal recommendations for the number of imputations is very minimal. It is often cited that 3 to 10 multiple imputations are enough to obtain valid inferences (Kammerer, 2009; Royston, Carlin, & White, 2009; Rubin, 1987, 1996).

According to Rubin (1987), the efficiency of an estimate based on m imputations is given by $\left(1+\frac{\gamma}{m}\right)^{-1}$ where γ represents the rate of missing information. Accordingly, the efficiencies achieved for various values of m and rates of missing information are shown in table 2.1. As shown, if the rate of missing information is very high, increasing the number of imputations will increase the efficiency of estimates. However, if the rate of missing information is lower (10%), then the gain is minimal with higher number of imputations.

In MI, each set of imputations creates a complete data set. The first step of the MI method is to estimate multiple values for each missing datum. This simulates multiple random draws from the data in order to estimate the unknown parameter. Then, each of the data set can be analyzed using standard complete data analysis (Schreuder & Reich, 1998). Multiple imputations include multiple copies of original data and imputations of missing values as required by the researcher (Carlin, Galati, & Royston, 2008). Accordingly, this method has three general stages (Rubin, 1996). In the first and second steps, missing values are replaced with a set of multiple plausible values and then analyses are performed on each imputed data set. In the last step, results obtained from multiple data sets are consolidated to get final estimates. Figure 2.5 shows the above three steps of the multiple imputation process.

Multiple imputations can be performed without a model or can be based on a model determined by the researcher (Cameron & Trivedi, 2005). In the regression based model approach, multiple imputations are done through a process of iterations. That is, missing values are iteratively generated based on the observed variables (Carlin et al., 2008).

2.4 Data and Methodology

This chapter evaluates the significance of the CU program in conserving land in New Hampshire by considering the effect of population change, the distance to two central business districts (CBDs), the average value of residential land (ALV), and the full value tax rates (FVTR) on the proportions of land enrolled and withdrawn in the New Hampshire CU program. In addition, this chapter compares different missing data treatment techniques.

The New Hampshire Department of Revenue Administration (NHDRA) maintains comprehensive information on CU taxation at the town level. After eliminating some possible outlier towns[8], 231 towns were considered for this analysis. The towns not included for the analysis are New Castle, Hart's Location and Newfields. The data required to determine CU program success are from NHDRA annual reports and CU reports from 1999-2011. NH population statistics are from the U.S. Census. The economic and developmental influences emanating from Boston are considerable for most of the New Hampshire towns, especially in the Southern portion of the state. Therefore, this study considers Boston as one of the Central Business Districts in the analysis, in addition to Manchester, which is the largest city in New Hampshire. The distance to each business district from each town is from Google map data[9]. Easy access to cities helps us to understand the development pressure for towns. Average Annual Daily Traffic (AADT) data are used to assess development pressures and AADT data were obtained from the New Hampshire Department of Transportation (DOT) traffic data

[8] With very high land values

[9] www.maps.google.com

for the years 1999-2011. AADT data used in this study are averages of traffic data collected from roads classified as collectors and arterials by New Hampshire DOT.

According to Berry (1993), most of the land withdrawn from the CU program in New Hampshire has been converted to residential land as opposed to commercial land. Average value of land could be a considerable determinant in enrolling land in the CU program (England & Mohr, 2003). Therefore, this study uses average value of land as a determinant in enrolling land in the CU program.

2.4.1 Missing Data Treatment

This paper focuses on the missing data issue in the dataset before proceeding to detailed analyses. In the NH dataset, only 70 percent of the observations reported contained no missing data, whereas about 30 percent of observations had at least one missing value. Most of the missing data were found in the variables CU acres removed and AADT in towns. According to New Hampshire CU law, lands withdrawn from the program are subjected to a penalty of 10 percent of market value; this is known as Land Use Change Tax (LUCT). Therefore, the CU acres removed and LUCT both should have been reported for any observation, if any land is withdrawn from the CU program. Most notably, AADT data were missing from certain years. Cases of missing data for those two variables were easily observable. A method to replace those missing values was important.

Missing data treatment techniques used are complete case analysis, mean substitution and multiple imputations. In the complete case method, observations with at least one missing value were dropped from the analysis. In mean substitution, mean values of variables were used to replace missing values (Osborne, 2013). Multiple imputations of this chapter were done using STATA's chained equations with commands *ice* and *mim*. The *ice* command creates the desired number of data sets and performs analyses across created data sets, which are followed by the pooling of estimates to derive final estimates.

Missing data treatment analysis in this chapter is done in two steps. First, I use a sub-set of original data containing variables with no missing values to compare the three missing data treatment techniques to find out the best method to treat missing data in the original data set. Second, missing data in the original data set is treated with the recommended technique from the first step. More details on the two steps of the missing data analysis are given below.

In the first step, the chosen variables with no missing values are full value tax rate (FVTR), average value of residential land (ALV), population change and distances to two central business districts in the study. In order to understand which method is more appropriate to treat missing values, I compared results generated from the sub-set of data with no missing values to the sub-set of data with artificially created missing observations. For this analysis, missing values for FVTR, ALV and population change were randomly inserted at missing rates of 5, 10 and 15 percent. Analyses were done using random effect panel data technique. All missing data treatments were compared to the results of the sub-set of data with no missing values. Multiple imputation technique was proven to be more effective in generating similar results to the results obtained from the sub-set of data with no missing values. Based on the results from the first step, the final analysis was performed after treating original data with three multiple imputations

(Carlin et al., 2008; Philips & Chen, 2011; Rubin, 1996). The models used in the analyses are described in the following section.

2.4.2 Model Specifications and Panel Data Analysis

In determining the factors that could influence landowners' decision to enroll and withdraw land from the CU program in New Hampshire, I estimate the following model:

$$Y_{it} = f(X_{it}^{C}, X_{i}^{CBD}) + \varepsilon_{it} \qquad (2.2)$$

In this model Y_{it} represents proportion of farmland or forestland (compared to total land), percentage of CU land enrolled in the New Hampshire CU program or CU land withdrawn from the program at town level; X_{it}^{C} is a vector of time dependent variables that might influence CU enrollment, CU withdrawal or land conservation. The variables considered are FVTR, ALV, population change (for 1,000) in each year, average annual daily traffic data (AADT), tax savings on CU land and percentage of CU acres receiving further tax reduction due to permitted recreational activities. The vector X_{i}^{CBD} contains two dummy variables - identifying towns located within 50 miles from Boston, MA and Manchester, NH.

2.5 Results and Discussion

In this study I was particularly interested in comparing some of the existing missing data treatment methods and in understanding land conservation efforts in New Hampshire in relation to the CU property taxation program. This section first presents the summary statistics of original data and then the results of missing data treatment comparison on the sub-set of data. Finally, discusses the results of the random effect panel data models of original CU data treated with 3 multiple imputations.

In New Hampshire, property taxes contribute to a larger share of state and local government tax revenue than in most other states. Hence, higher property taxes could be a burden for agricultural and forestry landowners if the income from land is not enough to cover property tax bills. Therefore, most landowners with undeveloped land are inclined to seek property tax relief. Since the initiation of the CU program, about 50% of land in New Hampshire has been consistently enrolled in the program in each year. Table 2.2 shows the percentage of land enrolled in the CU program in New Hampshire from 1999-2011. As shown in table 2.3, the average FVTR for the study period is $18.5 for $1000 of estimated market value. The FVTR are calculated using mill rates and equalization ratio. The equalization ratio is the percentage ratio of the total assessed values to the total market values of municipality's properties. An equalization ratio of 100 implies that a town is assessing properties at 100% of market value, and that, most likely, reassessments are done every year. An equalization rate less than 100 means properties in a town are assessed less than the market value. However if the equalization rate is greater than 100, properties in the town are assessed, on average, higher than market value for property tax purposes. According to New York State's Department of

Taxation and Finance (2013), this could be due to property value decrease since the last reassessment or due to not adjusting assessment values downward. In New Hampshire towns, the average equalization rate is 90.6 with a minimum of 35 and a maximum of 143. An equalization rate of 90.6 means that, on average, property taxes are calculated based on 90.6% of property's market value.

The percentage of missing values in variables of interest is given in table 2.4. As shown, the highest missing values are reported in AADT, CU acres removed and LUCT (30%). To avoid any possibilities of bias due to missing data, the original data needed to be treated with some missing data technique. In order to compare the three missing data treatment techniques, a sub-set of original data variables with no missing data (NMIS) was chosen, and regression results were compared with randomly assigned missing values at rates of 5, 10 and 15%. Table 2.5 shows the results of missing data treatments. The results of the three methods are compared with the regression results of NMIS data.

As shown in table 2.5 when the rate of missing data is 5%, regression results from all missing data treatments are much similar to the results reported with no missing values. More precisely, complete case results are closely comparable. However, when the rate of missing data is 10%, estimates obtained from data treated with complete case analysis and mean substitution deviate considerably from estimates with no missing values. However, estimates obtained after treating data with multiple imputation shows closely comparable estimates to estimates from NMIS data. Also, results show much closer estimates from 3, 5 and 8 imputations. When the rate of missing values increases to 15%, estimates generated from mean substitution and complete case analyses are not close to the estimates from NMIS data as in the case with 10% missing values. However, estimates obtained from 3 and 5 imputations provide promising results (see table 2.6). Compared to mean substitution and complete case analyses, results reported of data treated with multiple imputations have maintained the consistency of estimates regardless of the percentage missing. As suggested by Rubin (1987), my results show that marginal efficiency gain is lower by higher imputations compared to fewer imputations (see table 2.2).

In the CU data, about 12 percent of data were missing for the variables chosen for further analysis. With the missing data treatment results, 3 and 5 multiple imputations with 15% missing values generated closely comparable results compared to NMIS data set. Therefore, analyses done with the original CU data were restricted to 3 imputations, considering the comparable results and less marginal gain that could yield with higher imputations.

According to the theoretical predictions in the CU literature, I hypothesized an increase in CU enrollment (overall, farm or forest) with higher FVTR, higher AADT (due to development pressure), higher average land value and in towns located within 50 miles of Boston or Manchester. Also I assumed an increase in CU enrollment with further tax reductions given for agreeing to provide recreational adjustment and a decrease in CU enrollment with increases in population and tax on CU land (due to high assessment of CU land). Models 1-3 consider the total CU land percentage, the farmland CU land percentage and the forestland CU land percentage as dependent variables.

Table 2.7 shows the results of random effect panel data regression models on original data. As expected, towns with higher FVTR tend to have a significant increase in percentage of land enrolled in the CU program. Similarly, a higher percentage of forestlands is also enrolled in the program in towns with higher FVTR (model 3). However, the FVTR estimate does not support the hypothesis when considering the percentage of farmland enrolled in the program (model 2). However, the above result is not statistically significant. As expected, a higher percentage of farmland is enrolled in the program in towns closer to Boston and Manchester. Hence, farmland owners at the urban fringe are most likely inclined to get the tax relief from CU enrollment. However, the influence of two CBDs does not support the hypothesis when considering forestland and overall CU land percentage in the program. As expected, higher ALV leads to a significant increase in CU enrollment (models 1 and 3).

When considering the population growth, this study suggests a decrease in overall CU land enrolled in the program when there is an increase in population. Also, the results suggest an increase in CU enrollment if CU lands are allowed to receive additional tax deductions if recreation is permitted for the public. As expected, towns with higher development pressure (denoted from AADT) have a higher percentage of farmland enrolled in the CU program (see table 2.7, models 1-3). As discussed before, CU taxation depends on income potential of land. Hence, accurate assessment of CU land is important. As shown in model 1-3, if property taxes on CU land are higher (i.e. if CU assessments are higher), then this could lead to decreases in CU enrollment.

This paper also analyzes the factors that could lead to CU withdrawal. As hypothesized, if towns are closer to Boston or Manchester, CU withdrawal will be lower (model 4). As expected, withdrawal of CU land will be higher if growth in population is higher. However, it is not significant. To capture the effect of population growth on CU land proportion in the program may be difficult, because new populations may not necessarily settle only on CU land. Rather, they may be settling in already developed land or in lands that are not entitled for preferential tax benefits (see figure 2.4).

2.6 Conclusions and Suggestions for Further Research

In New Hampshire, the CU program is considered the corner stone in conserving undeveloped land from being developed for urbanized uses, such as commercial or residential development. Having about 50% of New Hampshire land enrolled in the CU program shows the importance of the program in New Hampshire. This chapter focuses on finding the factors that determine the performance of the CU program in New Hampshire using data from 1999-2011 is used for analyses.

In addition, this chapter also focuses on missing data issue in research. As suggested in past literature, ignoring missing data could lead to serious bias in research results. Therefore, three missing data treatment methods were compared to determine the most appropriate missing data treatment method for the data used in this study. Compared methods are complete case analysis (listwise deletion), mean substitution and multiple imputations. Results from missing data treatment suggest a couple of important outcomes. According to the results, if the percentage of missing data is low, then bias that results from missing data is low. Hence, all three methods generate almost similar results. However, as the percentage of missing values increases, then the three methods used to treat missing data in this study generate considerably different estimates. Hence, if the missing value percentage is high, results of this paper suggest a lower number of multiple imputations (3-5) are more appropriate to treat missing data compared to other methods. Therefore, missing data in the study were treated with 3 imputations for further analyses.

The CU program objective is to slow land development via providing tax relief for landowners if they promise to keep undeveloped land without converting it for more urbanized uses. This chapter focused on verifying how some factors could support the conservation of land in New Hampshire. CU information and related data for 231 towns for the period 1999-2011 were used for analyses. According to the results, property tax rates (FVTR) and average land value (ALV) of a town have played major roles in landowners' decision to enroll land in the CU program. Also the results suggest higher land enrollment in towns with higher FVTR and higher ALV. Which suggest possible tax savings from the programs play an important role in enrolling land in the program. Following theoretical models, this paper also hypothesized an increase in CU enrollment if towns are located closer to central business districts (CBDs). However, this paper does not support the above hypothesis. Above theoretical claim about the influence of CBDs is supported when considering the CU withdrawal model and suggests CU withdrawal is lower if a town is located closer to one of the CBDs considered in the study.

In New Hampshire, most farmlands are located closer to the Seacoast, the Merrimack River Valley and the Connecticut River Valley (Massachusetts and Vermont borders), whereas forestlands are in the rest of the state. Therefore, theoretical model predictions of landowners' behavior in enrolling land may be subjected to geographical distribution of farmland and forestland in New Hampshire (see figure 2.1) and need to be accounted for in further research work.

Tables

Table 2.1: Efficiencies Achieved for Various Values of m

	γ		
m	**0.1**	**0.3**	**0.5**
3	97	91	86
5	98	94	91
10	99	97	95
20	100	99	98

Table 2.2: Current Use Acres in New Hampshire

Year	CU Acres	CU Percent of Total Land
1999	2,803,462	52.66
2000	2,811,203	52.80
2001	2,806,783	52.72
2002	2,769,443	52.02
2003	2,744,020	51.54
2004	2743,971	51.54
2005	2,744,020	51.54
2006	2,720,822	51.11
2007	2,721,722	51.12
2008	2,701,589	50.75
2009	2,718,793	51.07
2010	2,748,535	51.63
2011	2,766,140	51.96

Table 2.3: Descriptive Statistics on Land Characteristics, Property Taxes and Other Socio Economic Variables

Variable		# of Obs.	Unit of Measurement	Mean	Std.Dev.	Min	Max
Land	CU land	3003	Percentage of total land	0.505	0.214	0.005	0.998
	Farm land	3003	Percentage of total land	8.667	10.715	0	100
	Farm CU	3003	Percentage of CU land	4.682	4.948	0	59.297
	Forest land	2999	Percentage of total land	54.944	30.198	0	100
	Forest CU	2999	Percentage of CU land	32.542	17.824	0	159.396
	CU removed	2172	Percentage of CU land	1.867	10.654	0	100
	CU removed	2172	Acres	119.872	867.725	0.04	14940.6
	CU parcel size	2988	Acres	47.814	57.612	4.383	1073.70
Property Tax	FVTR(t)	3003	For $1000 assessed value	18.598	5.172	5.403	41.104
	Equalization ratio	2998	Ratio	90.635	15.071	34.8	143
Distance	Boston	3003	Miles	99.781	41.675	33.9	218
	Manchester	3003	Miles	57.67	35.663	0	167
Land Value	Residential	3003	Dollars per acre	9678.78	15763.0	77.351	132497
	Commercial	2858	Dollars per acre	1872.54	5002.89	0.086	42301.0
	Current Use	3003	Dollars per acre	107.06	50.601	5.457	1365.30
Population Change		3003	Per 1000	11.367	38.776	-259.18	689.076
Average annual daily traffic (AADT)		2088		5965.48	5515.63	60	111887

Table 2.4: Percentage of Missing Data

Variable	Number Missing	Percentage Missing
CU percent of total land	0	0
Farm CU percent of total land	0	0
Forest CU percent of total land	4	0.1
CU removed	831	27.7
Land use change tax (LUCT)	853	28.4
Total CU parcels	15	0.5
Average parcel size	15	0.5
Full Value Tax Rate (FVTR)	0	0
Acres receiving recreational adjustment	159	5.3
Distance to Boston	0	0
Distance to Manchester	0	0
Average value of residential land	0	0
Population change	0	0
Average annual daily traffic (AADT)	915	30.5

Table 2.5: Missing Data Treatments Results on the Sub-set of Data with 5% and 10% Missing

		5% Missing						10% Missing					
				Imputations						Imputations			
Variables	**No Missing Data**	**Comp. Case**	**Mean Subs.**	**3**	**5**	**8**	**10**	**Comp. Case**	**Mean Subs.**	**3**	**5**	**8**	**10**
Full Value Tax Rate	0.132 (0.655)	0.125 (0.730)	0.151 (0.595)	0.169 (0.684)	0.184 (0.614)	0.293 (0.311)	0.297 (0.279)	0.407 (0.405)	0.299 (0.284)	0.265 (0.473)	0.236 (0.452)	0.140 (0.623)	0.177 (0.524)
Dis.to Bos<50 miles (D)	-0.210 (0.000)	-0.207 (0.000)	-0.219 (0.000)	-0.219 (0.000)	-0.219 (0.000)	-0.223 (0.000)	-0.223 (0.000)	-0.203 (0.000)	-0.223 (0.000)	-0.224 (0.000)	-0.224 (0.000)	-0.225 (0.000)	-0.225 (0.000)
Dis. To Manchester <50 miles (D)	-0.055 (0.018)	-0.054 (0.022)	-0.058 (0.013)	-0.056 (0.017)	-0.056 (0.016)	-0.057 (0.014)	-0.057 (0.014)	-0.053 (0.026)	-0.059 (0.011)	-0.056 (0.018)	-0.056 (0.018)	-0.058 (0.014)	-0.058 (0.014)
Residential land value (average)	-0.094 (0.000)	-0.100 (0.000)	-0.059 (0.000)	-0.050 (0.006)	-0.048 (0.001)	-0.032 (0.070)	-0.032 (0.051)	-0.122 (0.000)	-0.043 (0.000)	-0.024 (0.029)	-0.025 (0.015)	-0.019 (0.067)	-0.019 (0.066)
Population change	-0.090 (0.000)	-0.094 (0.001)	-0.073 (0.003)	-0.077 (0.050)	-0.061 (0.238)	-0.046 (0.102)	-0.045 (0.154)	-0.143 (0.000)	-0.091 (0.000)	-0.047 (0.357)	-0.051 (0.337)	-0.040 (0.383)	-0.041 (0.325)
Constant	0.559 (0.000)	0.558 (0.000)	0.557 (0.000)	0.556 (0.000)	0.555 (0.000)	0.552 (0.000)	0.552 (0.000)	0.557 (0.000)	0.554 (0.000)	0.553 (0.000)	0.554 (0.000)	0.554 (0.000)	0.554 (0.000)

Table 2.6: Missing Data Treatments Results on the Sub-set of Data with 15% Missing

		15% Missing					
				Imputations			
Variables	**No Missing Data**	**Comp. Case**	**Mean Subs.**	**3**	**5**	**8**	**10**
Full Value Tax Rate	0.132 (0.655)	0.934 (0.246)	0.503 (0.151)	0.119 (0.863)	0.115 (0.831)	0.312 (0.544)	0.365 (0.465)
Dis. to Boston <50 miles (D)	-0.210 (0.000)	-0.041 (0.619)	-0.230 (0.000)	-0.224 (0.000)	-0.223 (0.000)	-0.227 (0.000)	-0.226 (0.000)
Dis. to Manchester<50 miles (D)	-0.055 (0.018)	0.006 (0.843)	-0.063 (0.011)	-0.049 (0.050)	-0.049 (0.051)	-0.056 (0.020)	-0.057 (0.020)
Residential Land Value (Average)	-0.094 (0.000)	-0.332 (0.082)	0.042 (0.623)	-0.137 (0.181)	-0.159 (0.130)	-0.086 (0.596)	-0.067 (0.654)
Population Change	-0.090 (0.000)	-0.109 (0.039)	-0.049 (0.085)	-0.033 (0.416)	-0.039 (0.393)	-0.030 (0.403)	-0.031 (0.348)
Constant	0.559 (0.000)	0.558 (0.000)	0.548 (0.000)	0.557 (0.000)	0.558 (0.000)	0.551 (0.000)	0.550 (0.000)

Probability values are given in parenthesis.

Table 2.7: Regression Results after 3 Imputations

	Model 1	Model 2	Model 3	Model 4
Variables	**CU Percent of Total Land**	**Farm CU of Total Land**	**Forest CU of Total Land**	**CU Removed Percent of**
Full Value Tax rate	2.433*** (0.000)	-23.711 (0.144)	670.697*** (0.000)	473.715* (0.067)
Distance to Boston < 50 miles (D: Yes =1)	-0.223*** (0.000)	0.452 (0.658)	-16.583*** (0.000)	-0.839 (0.796)
Distance to Manchester < 50 miles (D: Yes =1)	-0.058** (0.012)	0.754 (0.207)	-2.393 (0.189)	-7.655** (0.014)
Average Land Value	0.028*** (0.000)	-0.502** (0.021)	0.058 (0.955)	-2.246 (0.360)
Population Change	-0.003 (0.897)	1.052 (0.355)	9.174* (0.092)	107.579** (0.017)
Acres Receiving Recreational Adjustment	0.001 (0.151)	0.040 (0.123)	0.310** (0.005)	1.826* (0.064)
Average Annual Daily Traffic (AADT)	0.001 (0.585)	0.085 (0.770)	0.067 (0.936)	0.131 (0.924)
Property Tax per Acre of CU Land	-0.002*** (0.000)	0.009 (0.192)	-0.175*** (0.000)	0.184** (0.003)
CU Tax Savings per Acre				0.072 (0.902)
Constant	0.545*** (0.000)	4.679*** (0.000)	26.174*** (0.000)	-3.661 (0.206)

Probability values are given in parenthesis. ***P<0.01, **P<0.05, *P<0.1

Table 2.8: Summarized Hypotheses and Results – Current Use Enrollment

	CU Enrollment		CU Withdrawal	
	Hypothesis	**Results Agree?**	**Hypothesis**	**Results Agree?**
Full Value Tax Rate	>0	Yes	<0	No
Located 50 miles from Boston	>0	No	<0	Yes
Located 50 miles from Manchester	>0	No	<0	Yes
Average Land Value	>0	Yes	<0	Yes
Population Change	<0	Yes	>0	Yes
Recreational Adjustment	>0	Yes	<0	No
Average Annual Daily Traffic	>0	Yes	<0	No
Tax on per acre CU land	<0	Yes	>0	Yes

Figures

Figure 2.1: Current Use Forestland and Agricultural Land (%) in New Hampshire Towns – 2009

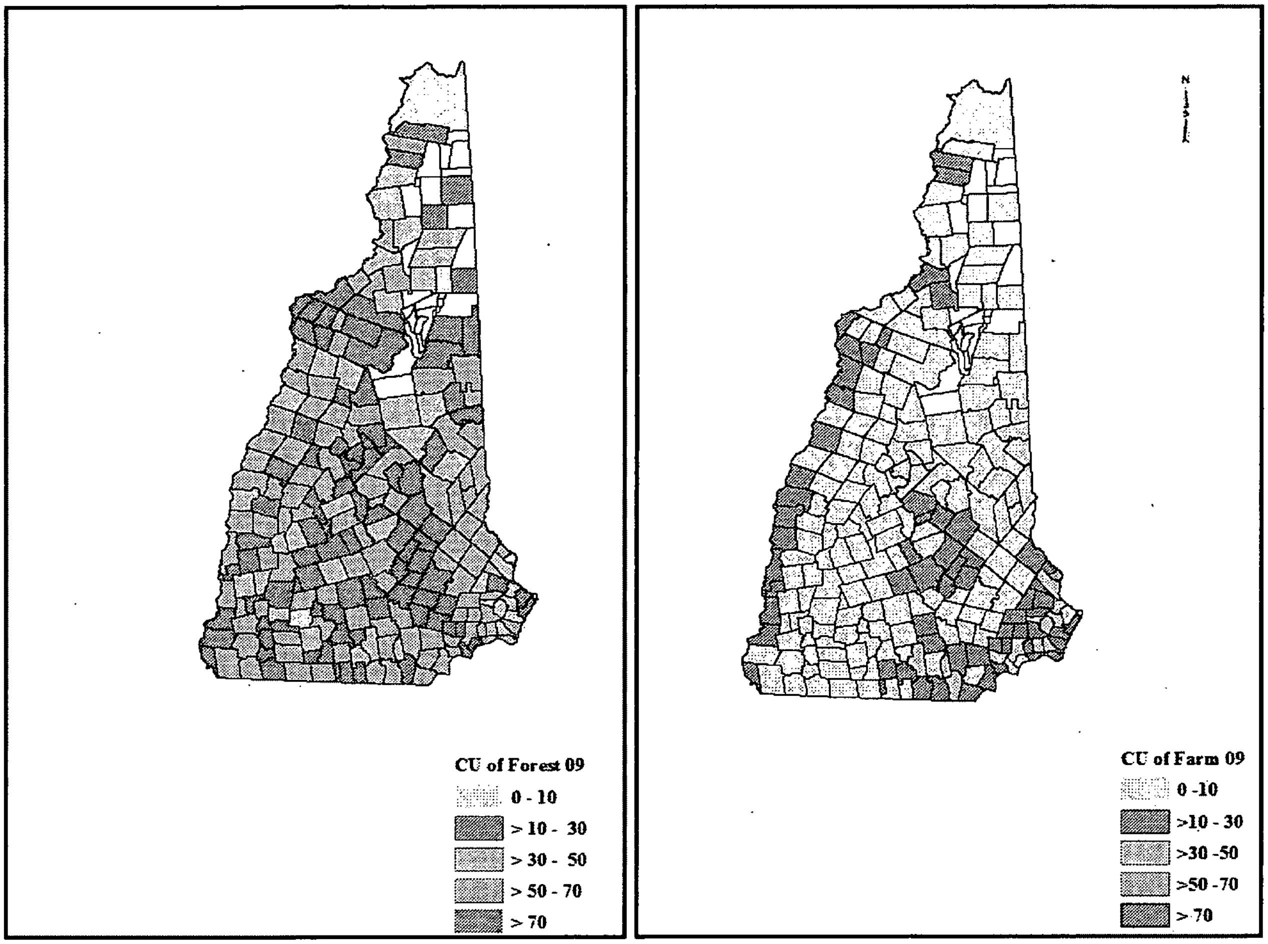


Figure 2.2: Current Use Land Change (%) in New Hampshire 1999 – 2009

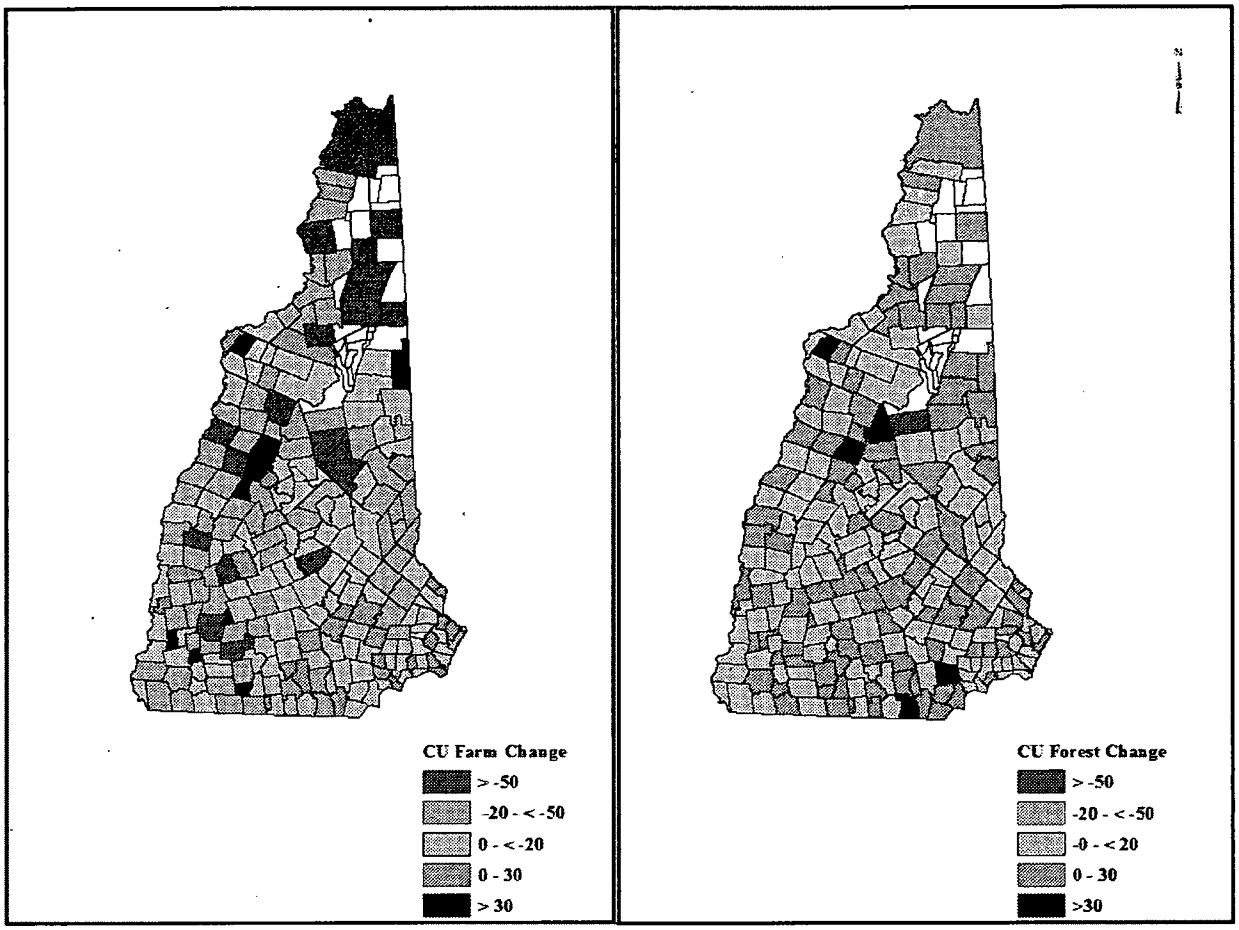
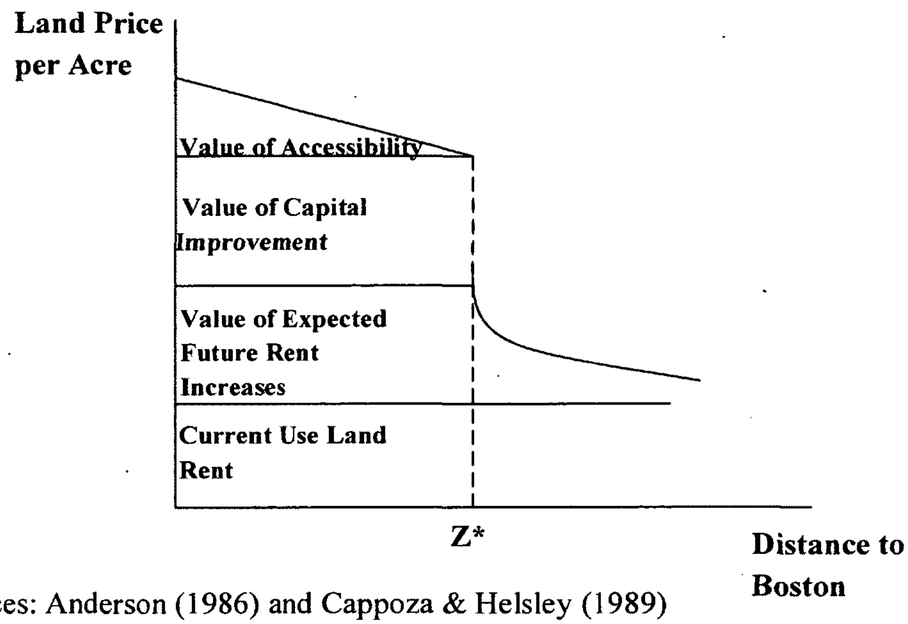


Figure 2.3: Determinants of Land Value



Sources: Anderson (1986) and Cappoza & Helsley (1989)

Figure 2.4: Effect of Change in Population on Land Allocation

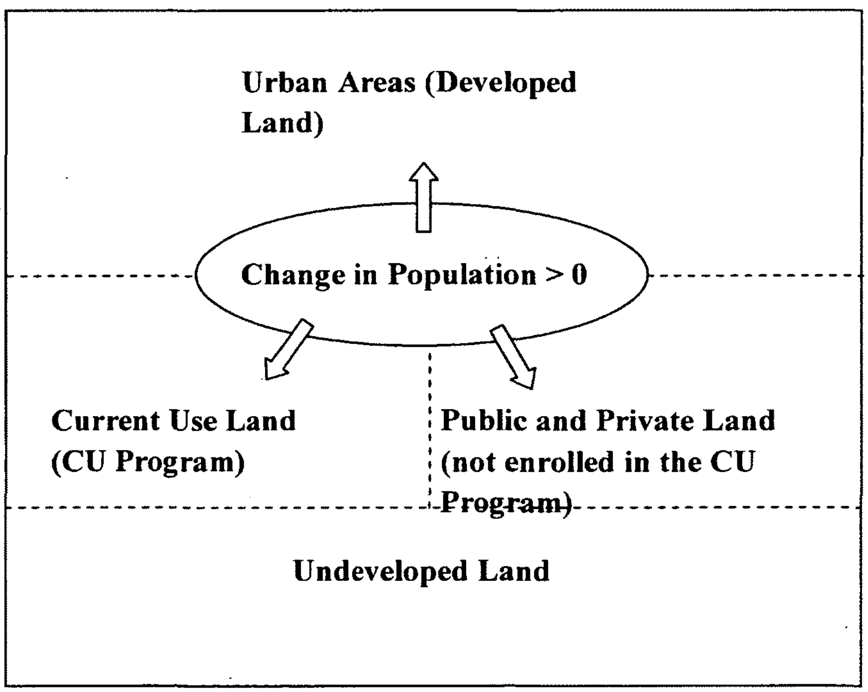
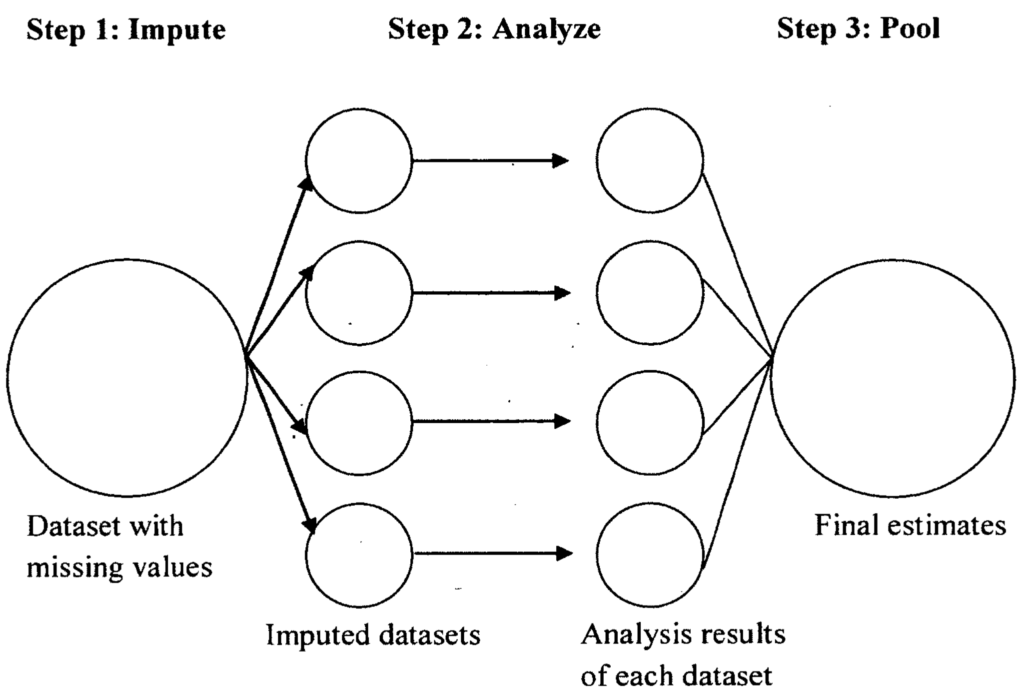


Figure 2.5: Multiple Imputation Process



CHAPTER 3

3 EVALUATION OF CURRENT USE PROGRAM FEATURES USING DURATION ANALYSIS AND COMPETING RISK REGRESSIONS

3.1 Introduction

Urbanization and other forms of development often lead to higher market values of land. When these higher market values are reflected in increased property tax obligations, the owners may sell off parcels to cover their property tax bills. Over the past few decades, all U.S. states have responded to this tax-induced development by implementing various policies to keep land in its current rural use. The current use (CU) property taxation program, one of such preferential taxation systems, has been present in the U.S. since 1956. CU valuation programs can result in considerable tax savings to landowners (Butler et al., 2010). In most states, lands utilized for agriculture or forestry (even open space land in some states) are eligible to receive this tax benefit from the program. CU programs operate at the state and local levels to provide incentives to private landowners who wish to keep their rural land intact without residential, commercial or industrial development.

Maryland was the first state to implement a preferential property taxation system, primarily due to a rapid increase in farmland price relative to net farm income after World War II (England, 2011). Thereafter, CU property taxation rapidly spread into other regions of the country. However, CU programs are considerably different across states in terms of enrollment requirement, CU assessment methods and penalties on withdrawal. Most notably, in some states even the preferential taxation program name is different. For example, the CU program in Pennsylvania is known as Clean and Green program (Pennsylvania Department of Agriculture, 2013). Irrespective of such variations across programs, all preferential assessment programs provide considerable tax savings to landowners.

With the sole exception of Michigan, all other states have implemented some sort of CU assessment program during the years between 1956 and 1997. The reasons for implementation of the program during these decades have not yet been fully explored. As stated in chapter 1, there are three types of CU programs that can be identified as pure preferential assessment, deferred taxation or CU assessment with restrictive agreements. In pure preferential assessment, landowners enjoy lower property taxes on enrolled land in the CU program with no withdrawal penalties if a land is withdrawn from the program. In contrast, if a CU program is categorized as deferred taxation, landowners enjoy the benefit of lower property taxes while enrolled in the program and face a withdrawal penalty if a land is withdrawn from the program. Figure 3.1 shows the states with pure preferential assessment and deferred taxation.

Figure 3.2 shows the categories of CU withdrawal penalties considered in this chapter, which are described as the second type of CU programs in the literature. CU withdrawal penalties are broadly based on the market value at the time of withdrawal or property tax savings received by the landowner after enrolling land in the program. CU program features vary considerably across states (see table 3.1) in terms of penalties that landowners face for withdrawal of land from the program. As shown in table 3.1, CU withdrawal penalties are different depending on whether penalties are based on market value or roll-back, and the roll-back penalties are vastly different based on the number of years of tax savings collected. Based on differences in CU withdrawal penalties, this chapter focuses on five categories of CU withdrawal penalties. The distribution of withdrawal penalties is shown in figure 3.2. The two penalties based on market value at the time of sale are fixed percentage market value penalty and the sliding scale (declining percentage) market value penalty that varies with the length of enrollment time. The three penalties based on tax savings are the rollback penalties with fixed number of years, sliding-scale rollback penalties and rollback penalties that charge an additional interest on tax savings received.

The third type of CU program is CU programs with restrictive agreements. Restrictive agreements refer to contractual obligations a participating landowner would enter upon enrolling land in the CU program. The contractual agreement usually obligates a landowner to keep land without developing it for certain number of years, usually ten, with the option to renew each year thereafter. If a landowner changes the land use before the contract matures, more serious penalties are imposed. Therefore, the distinction between deferred taxation and restrictive agreements is not always clear (Collins, 1976; Keene, 1976), unless when considering the required length of enrollment. Unlike the other two types of CU programs, restrictive agreements are considered to be least effective in awarding tax benefits to landowners. The reason is many owners do not prefer being locked in to an agreement for a longer time period. However, such contractual agreements are considered effective for bona fide farmers whose livelihood depends on farming and are not common across states. Only a fewer states have restrictive agreements on agricultural land, whereas some states have restrictive agreements only for open-space land that qualifies for CU assessment. The states with restrictive agreements on agricultural land are California, New York, Pennsylvania, Vermont and Washington, and Florida has restrictive agreements on open-space land. Figure 3.3 shows the distribution of CU programs with restrictive agreements across states.

Owing to the fact that no prior empirical research has detailed the reasons for CU program implementation and variation in CU penalties, I focus on two main objectives in this chapter. The first objective is to understand the determinants of CU program implementation, and the second objective is to explore the reasons for specific distribution of CU withdrawal penalties over the period 1949-1997. As discussed in detail in section 3.2, states' objectives of program implementation and withdrawal penalties have been mainly attributed to land use patterns and disproportional property tax burdens based on income from agricultural lands. That is, states have implemented the program to discourage conversion of rural land to more urbanized uses. Based on those theoretical claims, the hypotheses tested in this chapter are as follows. The first hypothesis is an increase in urban land and agricultural land increases the hazard rate of implementing CU programs. When considering the imposition of a withdrawal penalty, I hypothesize that states with a higher percentage of urban land and states with higher dependency on property taxes as the state's tax revenue source are more likely to impose a withdrawal penalty.

Three econometric analyses are used in this chapter. The techniques are duration analysis, competing-risk regressions and random effect multinomial logit analysis. The third objective of this chapter is to check the validity of the Independence of Irrelevant Alternatives (IIA) assumption, using the Hausman (Hausman & McFadden, 1984) test statistic. Although there are some widely accepted tests to assess the IIA assumption, various simulation studies have shown that these tests are not useful for assessing violations of the IIA assumption (Long & Freese, 2006) due to conflicting results provided from those tests. I used the Hausman and Wald statistics to compare whether those tests assess the IIA assumption consistently. In considering competing risk regressions, the first model I focus on is the cause-specific Cox regression model (1972). The second competing risk regression model is the model proposed by Fine and Gray (Fine & Gray, 1999; Steele, Goldstein, & Browne, 2004).

The fourth objective of this chapter is to compare the above two competing risk models in predicting CU withdrawal penalty imposition in the U.S. using 1949-1997 state level data. Detailed information on the above techniques is provided in the next section. The rest of the chapter is organized as follows: Section 3.3 provides information on data and empirical methodologies, and is followed by the results section. The last section provides conclusions and a discussion on possible avenues for further research on CU programs.

3.2 State Objectives in Current Use Assessment Laws

The objectives of implementing CU assessment law for property tax purposes must have been fairly different across states. However, those objectives fall into two major categories: improving equity of property tax burden and influencing land development (Hady & Sibold, 1974).

The equity argument basically revolves around two main criterions: the ability to pay and the benefits received. According to the ability to pay criterion, agricultural landowners pay too much in property taxes. Disproportionately high property taxes are generally more common among agricultural landowners, because of larger holding sizes. According to Hady and Sibold (1974), personal property taxes for agricultural landowners in the U.S. have hiked up to 7.6% in 1971 compared to 5.7% in 1961, which clearly supports the argument that there was a disproportionate increase in property tax burden for agricultural landowners in 1960s. This comparative rise in property tax burden compared to income of agricultural landowners must have been an apparent reason for property tax reforms that initiated across the U.S. in the 1960s and 1970s. According to the benefits received criterion of the equity argument, agricultural landowners pay property taxes entirely out of proportion to the services they require from the local government. As suggested in the ability to pay and benefits received criterions, property taxes needed to be adjusted according to income potential of agricultural land, which must have been a driving force behind CU program implementation by most of the states.

The second objective of CU program implementation considers the influence of the pace and direction of land development. Growing interest in the ecology and the environment, and the argument on property tax driven selling of land have been major reasons behind the land development argument (Hady & Sibold, 1974; Schoeplein & Schoeplein, 1972). The property tax driven land development may not be applicable for all agricultural landowners. Because some agricultural landowners may be sensitive to property taxes, others may not. For example, for some agricultural landowners, farming is part of their life and therefore, they may not be persuaded to sell land even when farming is not profitable. For such landowners, lower property taxes would make agricultural activities more profitable. Some other landowners may be holding on to agricultural activities until a profitable option opens up and will be willing to sell the agricultural land for more urbanized uses. Therefore, any property tax relief program is needed to distinguish bona fide agricultural landowners from speculators. As a result, some of the CU programs impose penalties upon withdrawal of land from the CU program. However, it is always argued whether withdrawal penalties are enough to hold back land speculators from selling land.

The above arguments summarize the objectives behind CU assessment laws. According to Rodgers and Williams (1983), some states have combined the objectives in provisions of their CU implementation. Table 3.2 summarizes the intents of the CU value assessment in some states. As shown, the CU program has implemented with combined objectives to alleviate the disproportionate property tax burden from agricultural landowners, while providing a tax incentive to protect agricultural land from conversion.

It is clear that CU withdrawal penalties have been included in CU legislations to discourage short-term property tax gains or/and to discourage land conversion. However, the penalties have always been criticized too, because, there is a possibility that landowners may place a value on non-pecuniary benefits of preserving land when deciding to enroll land in the program. This desire to provide non-pecuniary benefits by preserving the character of rural community and by ensuring continued flow of ecosystem services that would benefit the public, should have been accounted for as "eco-system services" provided by a landowner by keeping rural land out of development. The argument would be to impose a withdrawal penalty only if the savings from CU taxation are greater than the actual total benefit, i.e "fair-return," a community would receive by preserving the rural character.

3.3 Data and Methodology

This study analyzes the factors that determined the implementation of CU programs and imposition of withdrawal penalties. The period of analysis is from 1949-1997, which is broken down into four-year intervals, and is the period when most states, except Michigan, implemented some version of a CU program. I used 50 states for the analysis of CU implementation and only 49 states for analyses on CU withdrawal penalties. The data required for this study are from numerous sources, as described below. Land used for agricultural purposes, forestland, urban areas, total land area, farmland values and net farm income data are from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). Population statistics are from the U.S. Census Bureau. The data source for state level property tax revenue and income tax revenue is the Local Tax Collection Data of the U.S. Census. The article by Hady & Sibold (1974) on CU programs and the Hunting Heritage of the Multistate

Conservation Grant Program[10] were used to get CU program data. Details of the empirical strategies used in this chapter are described below. Theoretical background of the models used in this chapter is given in the appendix (see pages 145-153).

As described in 3.1, three types of CU programs can be identified. Figures 3.1 - 3.3 show the states with preferential assessment, differed taxation and restrictive agreements. Distinguishing between restrictive agreements from two other types of CU programs was challenging, and the duration analyses and competing risk regressions were done only considering preferential assessment and differed taxation.

3.3.1 Empirical Strategy: Duration Analysis

Objectives of this chapter are to understand the socio-economic and geographical factors that determined the implementation of the program and imposition of different penalty structures across states. The Cox Proportional Hazard model (Fox & Andersen, 2005; Kiefer, 1988) has been widely used in duration (event-history) analysis studies and therefore is used in this chapter in determining the effect of different covariates on CU implementation and imposition of a CU withdrawal penalty.

Assuming n states for the study, the Cox model has the form:

$$h_i(t) = e^{x_i' \beta} h_0(t) = c_i h_0(t), \quad i = 1, 2, ...n$$

where $x_i = (x_{i1}, x_{i2}, ..., x_{ik})'$ is the vector of covariates; $\beta = (\beta_1, \beta_2, ..., \beta_k)$ is the vector of regression coefficients; $h_i(t)$ is the hazard rate calculated for each state; and i and $h_0(t)$ represent the baseline hazard rate. The baseline probability function corresponding to this

[10] http://www.huntingheritage.org/

study is the probability of CU program implementation (or withdrawal penalty imposition) when all covariates are zero.

This chapter analyzes the influence of the following covariates (x_i):percentages of state's land area that are urban land, rural transportation land[11], farmland; net farm income, state's per capita income, population growth, dependency on property tax and income taxes as state's sources of revenue. As shown in figure 3.2, a specific regional distribution of penalties is observed. Therefore, in addition to the above variables, this chapter uses regional dummy variables to analyze the determinants in penalty imposition. The regions considered are Midwest, West, Northeast and South. According to Kiefer (1998), the validity of Cox regression results is conditional based on the assumption of proportional hazard for the model. If the proportional hazard assumption is violated, it indicates a time trend in the covariates studied. To overcome the biasness due to violation of proportional hazard, inclusion of time interactions of covariates is needed. The covariates with time trends are identified by Schoenfeld (Fox & Andersen, 2005) residuals plots. Therefore, initial Cox regression results were tested for the proportional hazard assumption, using the Global test and using Schoenfeld residuals plots. According to Fox (2005) and Kiefer (1988), any systematic departures from a horizontal line of Schoenfeld residuals plots are indicative of non-proportional hazards. If the proportional hazards assumption is not violated, no further analyses were done. In the case of proportional hazard assumption violation, interactions between covariates and time were included to the initial Cox regression model.

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[11] Rural transportation: Highways, roads, and railroad rights-of way, plus airport facilities outside an urban area

3.3.2 Empirical Strategy: Random Effect Multinomial Logit Regression

Random effect multinomial logit (RMNL) is used by researchers when the dependent variable is in the form of unordered discrete categories. In this chapter, dependent variables are the types of penalties imposed by states when a CU property is withdrawn from the program. As described before, five types of penalties were identified. To analyze the RMNL model, I used the STATA package's Generalized Linear Latent and Mixed Models (GLLAMMs) as suggested by Carolyn et. al. (2010). A description on RMNL is provided in section A.2 of the appendix (pages 148-149).

RMNL regression is used to find out which penalty categories should be combined for further analyses in competing risk regressions (see 3.3.3 for a discussion on competing risk regressions used in this chapter). Three RMNL regressions are considered. The dependent variables of the above RMNL regressions are different due to the number of penalty categories. Wald statistics was used to test whether any penalty categories can be combined, and, with the last model, I used Hausman (Hausman & McFadden, 1984) statistic to test Independence of Irrelevant Alternatives (IIA) hypothesis.

3.3.3 Empirical Strategy: Competing Risk Regression Model

This section describes the estimations used to determine characteristics of states that led to imposition of a CU withdrawal penalty using competing risk models, as described by the cause-specific Cox regression model and the Fine and Gray (F&G) competing risk model. Choosing between the Cox model and F&G is important for the researcher. For example, if the researcher wants to compare the hazard rate of a given event while ignoring the influence from other competing events, then the cause-specific Cox regression is recommended. In the F&G model, the incidence rate of the event is calculated while considering the influence of competing events. The F&G model is most widely used in competing risk models (Sun & Tiwari, 1995). This chapter focuses on providing a comparison of results using the above two competing risk regression models.

As discussed before, five CU penalty categories were identified along with states that have no CU withdrawal penalty. The period of analysis is from 1949-1997, in which data reported in four-year intervals. The covariates (x_i) used for the Cox and F&G models are: percentage of urban land, rural transportation land, farmland, net farm income, state's per capita income, population growth, dependency on property tax and income taxes as a state's source of revenue. In addition, regional dummy variables are used. To analyze competing risks models, I used R packages *survival* and *cmprsk*.

3.4 <u>Results and Discussion</u>

Visual display is important in recognizing and displaying data that could have any geographical distribution. Penalties for withdrawing land for residential or commercial development apply to landowners in 35 states. Figure 3.1 shows the distribution of CU withdrawal penalties across the country. As shown, the states with some sort of CU withdrawal penalty are mostly concentrated in the East and West Coasts, whereas the states with no withdrawal penalty are to be found mostly in the Midwest. The states with no CU withdrawal penalties are Arizona, Arkansas, Colorado, Florida, Iowa, Kansas, Louisiana, Mississippi, Missouri, Montana, New Mexico, North Dakota, Oklahoma and South Dakota.

State summary statistics for the years 1949-1997 are shown in table 3.3. As shown, the mean net farm income per acre declined from $64 in 1949 to $52 in 1997. Similarly, the percentage of farmland decreased to 4 percent in 1997, compared to 6 percent in 1949. In contrast, the percentage of urban land increased to 6.6 percent in 1997 from 2 percent in 1949.

3.4.1 Duration Analysis Results

In the duration analysis, the factors considered for implementation of the program are percentage of urban land, rural transportation land, farmland, net farm income, state's per capita income, population growth, dependency on property tax and income taxes as state's sources of revenue. The sample consists of all states in the U.S. for the period 1949-1997. As expected, urban land, farmland and population growth have increased the hazard rate of implementing CU program. As shown in table 3.4, a one percent increase in urban land increases the CU implementation by seven percent, and a one percent increase in farmland increases the CU implementation by one percent. Also, the results suggest that if a state is highly dependent on property taxes as the source of revenue, then a one percent increase in property tax dependence results in an 11 percent drop in CU implementation risk.

Above results are valid only if the proportional hazard assumption is not violated. To test the proportional hazard assumption, I used two tests: the Global test and the

Schoenlfeld residual plots. Performing two diagnostic tests was important to cross validate the results. The statistics of the Global test are shown in table 3.6. As shown from the Global test, the assumption of proportional hazard cannot be rejected. The results from the Global test are also confirmed from Schoenlfeld residual plots as shown in figure 3.4.

Table 3.5 shows two Cox regression model results on CU withdrawal penalty imposition. As discussed before, the model on CU penalty imposition was also tested for proportional hazard assumption using Global test and Schoenlfeld residual plots on covariates focused on in this chapter. The Global test results (table 3.6) on the imposition of withdrawal penalties suggest marginal evidence of non-proportional hazard of the model. Schoenlfeld residual plots in figures 3.5 and 3.6 also show noticeable departures from the time axis on the variables farmland, per capita income and Midwest regional dummy variables, which indicates that there is a time trend on those variables for penalty imposition. The variables with possible time trend needed to be corrected because of proportional hazard assumption violation. In this chapter, I use time interactions of the above mentioned suspected variables (farmland, per capita income and Midwest regional dummy) as a remedy for proportional hazard assumption violation. The results obtained after including time interactions are shown in table 3.5. As expected, the coefficient of the time interaction variable of the Midwest regional dummy is negative (see table 3.5) and statistically significant. This implies that the hazard rate of imposing a penalty in the Midwest is lower, and, overtime, the hazard rate in imposing a penalty has gone up. The results also suggest that an increase in farmland by 1% results in a decrease in hazard rate of CU withdrawal penalty imposition by 86%. Also, the results suggest an increase in hazard rate in imposing a CU withdrawal penalty with increase in per capita income in a state.

3.4.2 Random Effect Multinomial Regression Results on Combining Different Penalty Categories

This section of the analysis focuses on finding the validity of IIA assumption by comparing Wald test and Hausman statistics. For this analysis, I initially considered six penalty categories (0-5) on CU withdrawal. Penalty category 0 represents states with no penalty; 1 represents states with a fixed market value penalty; 2 represents states with a sliding scale market value penalty; 3 represents the states that collect years of tax savings as the penalty (roll-back penalty); 4 represents states that collect additional interest on calculated roll-back penalty; and 5 represents the states with sliding scale roll-back penalty. Multinomial Logit (MLogit) is often used in the case of unordered categorical dependent variables. Because of the longitudinal nature of the data, a random effect multinomial logit (RMNL) regression is used to analyze the reasons for specific distribution of penalty categories.

First, the data were analyzed using an RMNL model with six penalty categories. I also wanted to find out whether any of the above categories could be combined in the analysis. I used Stata's Generalized Linear Latent and Mixed Model (GLLAMM) command (Rabe-Hesketh, 2004) for RMNL analysis. RMNL results with six penalty categories are shown in table 3.8.

Following the first RMNL estimation, I performed the post estimation Wald test to verify whether any of the dependent variable categories could be combined. The null hypothesis of the Wald test is as follows: All coefficients except intercepts associated with a given pair of outcomes are zero (i.e., categories can be collapsed). According to Long and Freese (2006), if two dependent variables are indistinguishable, then combining the two dependent variables will yield more efficient estimates. Using RMNL estimates with six categories, the Wald test was performed. The statistics are shown in table 3.9. As shown, none of the categories 1-5 should be combined with the 'no penalty' category. Wald test statistic results for categories 1 and 2 reject the hypothesis of the Wald test and, as a result, penalty categories 1 and 2 were combined for further analysis. By combining the categories 1 and 2 (market value penalty and declining market value penalty with the length of enrollment), the six categories are reduced to five. Further analysis was carried out using RMNL analysis and the Wald test, to see any possible combination of dependent variables from five categories as shown in tables 3.10 and 3.11. As shown in table 3.10, the results still suggest possible combination of C1′ with C4′ (market value and declining sliding scale roll back) or C2′ with C4′ (roll back penalty and declining roll back penalty). The C2′ and C4′ categories were combined which resulted in four penalty categories in total. Similarly, RMNL analysis and the Wald test were carried out with four penalty categories. Results are shown in table 3.12 and 3.13. As shown in table 3.13, none of the penalty categories needs to be combined for further analyses.

According to RMNL results using the four penalty categories (see table 3.12), states with higher percentage of urban land have a higher probability of imposing a market value penalty as opposed to roll-back penalties. This result is consistent with predictions from the duration analysis. Results suggest an important finding in terms of assessing the imposition of CU withdrawal penalties in relation to farmland in a state.

That is, states with higher percentages of farmland are less likely to impose any withdrawal penalties. This finding confirms one of the objectives of CU programs: states have implemented this program to protect undeveloped lands in their current use rather than resort to conversion. Results suggest an interesting finding about state's dependence on property taxes. My hypothesis was that penalties are imposed to recapture local government's property tax forgone, especially when property tax contributes to a larger share of the revenue of the state. As shown in table 3.12, results do not support the above hypothesis. Interestingly, the hazard rate of imposing a CU withdrawal penalty rises with increases in income tax percent and per capita income in a state.

An assumption of multinomial logit models is that outcome categories for the model have the property of independence of irrelevant alternatives (IIA). That is, inclusion or exclusion of categories should not have any effect on the results. In the literature there are arguments against this assumption casting doubts about the tests (Long and Freese, 2006) due to the generation of conflicting results. As discussed before, I performed several RMNL analyses and Wald tests to understand the most appropriate combination of penalties for this chapter. I started with six penalty categories and my results suggested the combination of some penalty categories. IIA test statistics for RMNL analyses with five and six penalty categories failed due to poor convergence of results of the full model (with all penalty categories) and restricted form models (with one less penalty category). This proves that the Wald test statistics of penalty category combination and Hausman test (IIA assumption) statistics complement each other. The Hausman test statistic used to check IIA assumption was performed after RMNL analysis with four penalty categories. Dropping the penalty category 3″ (see table 3.7), a reduced form of the RMNL model was tested against the full model. The Hausman test statistic is 4.91 with a chi^2 probability of 0.426. The results suggest that the IIA assumption holds true for the RMNL model with four penalty categories. That is, inclusion or exclusion of categories has no effect on results. The Wald test result also concluded that no further combination of categories is required. Hence, penalties are independent from each other. Therefore, my results suggest that the Hausman test is valid to test IIA assumption.

As described before, CU penalties across states vary considerably, and I identified five penalty categories (see figure 3.2). The objective of RMNL analysis described in section 3.4.2 is to statistically understand whether any penalties are independent of each other in order to consider them as belonging to separate penalty categories. With the results obtained from this section, the four independent penalty categories are used in competing risk regression analysis in the next section.

3.4.3 Competing Risk Regressions Results

This section presents a summary of results obtained from competing risk regressions which are shown in tables 3.14 and 3.15. I used cause-specific Cox regression and F&G models to analyze unordered penalty categories with an emphasis on the time of the penalty imposition.

In competing risk models, I hypothesized a correlation between the increase in hazard of penalty imposition and higher percentages of urban area, population growth, state's dependence on property taxes as a source of tax revenue and an increase in rural transportation land percentage. Also, I hypothesized there would be a decrease in hazard with increases in farmland percentage in a state and state's dependence on income taxes as a source of tax revenue. As discussed before, in the cause-specific Cox (CSC) regression, competing risks are ignored in analyzing the effect of covariates on a particular risk. In the F&G models, the incidence rate of the event is calculated while considering the influence of competing events, i.e. F&G considers cumulative incidence function. The results are shown in table 3.14. According to Dignam et al. (2012), the coefficients of the CSC regression are interpreted as explained below. Let's say a covariate from the CSC regression has a coefficient of 0.033. That is, the covariate will increase the hazard rate by 3 percent for an increase in covariate by one unit $[e(0.033)=1.033]$. If a covariate from CSC regression has a coefficient of -0.033, then the covariate will decrease the hazard rate by 3 percent for an increase in covariate by one unit $\left[e(-0.033)=0.97\right]$.

As expected, the percentage of urban land in a state significantly increases the hazard rate of imposing a market value CU penalty. The same result is applicable for fixed value and sliding scale roll-back penalties, but not in roll-back with some interest rate added. Contrary to expectation, CSC regression results suggest a decrease in CU penalty imposition with an increase in state's dependence on property taxes as a tax revenue source. Interestingly, the first two CSC regressions suggest a significant increase in CU penalty imposition with a state's high dependence on income taxes as the tax revenue source.

When consider F&G competing risk model results, increases in urban land and farmland result in an increase in cumulative incidences of imposing a market value penalty by about 5 percent (insignificant) and a decrease in cumulative incidence of imposing a market value penalty by about 1 percent sequentially. As expected, cumulative incidence of imposing market value penalty is increased by about 1 percent with respect to the increase in population by a unit. Also, the results suggest, if a state is dependent on property taxes as its tax revenue, such states are highly likely to impose a market value penalty. The dependence on property taxes in imposing a penalty is also supported by roll-back penalties with an added interest rate, but not fixed rate or declining rate roll-back penalties.

3.5 Conclusions and Suggestions for Further Research

CU assessment programs have become popular among private landowners across the United States. However, the diversity in program regulations across states are contributing to different rates of enrollment, length of enrollment and the timing of development for urban uses. Theoretical studies have examined CU programs in general. Due to the localized nature of the program (at the town, county or state level) most of the previous studies have focused on a single state instead of making cross-state comparisons. Therefore, this study contributes to the literature with a comprehensive comparison of CU programs across the United States.

This chapter focuses on finding the factors that determined CU program implementation and imposition of withdrawal penalties across states. The duration analysis results support arguments that CU programs have been implemented to protect undeveloped land in their current use. Most of the competing risk and RMNL models suggest increasing hazard rates/probabilities of imposing withdrawal penalties in states with higher percentage of urban land and decreasing hazard rates/probabilities when imposing withdrawal penalties in states with higher percentage of farmland. Also, competing risk models used in the chapter suggest that an increase in dependence on property tax revenue as a source of tax revenue for states, increases the hazard of imposing a withdrawal penalty.

The results confirm that most CU programs have been implemented to support agricultural landowners and as a result of the influence in growth in urban land. The duration model that incorporates time effects shows some noteworthy results. That is, over time the tendency of imposing penalties has declined in states with higher proportions of farmland. Comparison of cause-specific Cox regression and the F&G model in analyzing competing risks is important. Compared to the cause-specific regression, F&G results more closely correspond with my hypotheses on the covariate effect of CU withdrawal penalty imposition.

This chapter also aimed to test the validity of IIA assumption in a RMNL setting. To verify the validity of IIA assumption, I tested the independence of penalty categories using the Wald test, and combined categories if two penalties were not different from each other. This independence of penalties resulted in four penalty categories instead of the six penalty categories I started with. Interestingly, IIA assumption was violated when I used five and six penalty categories, proving that some penalty categories are not independent from each other. The Hausman statistic with four penalty categories (resulting from merging two penalties to other existing categories) proved the validity of IIA assumption in an RMNL setting.

In this chapter, I focused on finding the factors that determined CU program implementation and imposition of withdrawal penalties in the U.S. However, it would be important to explore whether the differences in CU programs across states in terms of withdrawal and enrollment requirements led to differences in land development rates. Chapter 4 will focus on the above issue to find out whether different penalties have led to different rates in land development.

Table 3.1: Current Use Program Summary

State	Automatic/by Application	Penalty	Tax Incentive for Conservation Easement	State Purchase of Land for Conservation Income Tax Credit	Year Started
Alabama	Application	3 years of tax saving	No	Yes	1975
Alaska	Application	7 years of tax saving and 8% interest	Yes	No	1967
Arizona	Automatic	No	Yes	No	Before 1974
Arkansas	Automatic	No	No	No	1969
California	Application	12.5 % of market value	Yes	Income Tax Credit	1965
Colorado	Application	No	Yes	Yes	1967
Connecticut	Application	10% conveyance fee in the first year and 1% by the 10th year	Yes	Yes	1963
Delaware	Automatic	Preceding 10 years of tax saving	Yes	Yes	1968
Florida	Application	No	Yes	Yes	1959
Georgia	Application	1st or 2nd year: 5 times of tax savings 3rd or 4th year : 4 times of savings 5th or 6th year: 3 times of tax savings 7th or 8th year : 2 times of tax savings	Yes	Yes	1978
Hawaii	Automatic	10 years of tax saving	No	No	1961
Idaho	Automatic	10 years of tax saving	Yes	Income Tax Credit	1971
Illinois	Automatic	3 years of tax saving and 5% interest	Yes	Yes	1970
Indiana	Automatic	10 years of tax saving and 10% interest	Yes	No	1961
Iowa	Automatic	No	No	No	1967
Kansas	Automatic	No	No	No	1979
Kentucky	Automatic	3 years of tax saving	No	No	1969
Louisiana	Application	No	No	No	1978
Maine	Application	5 years of tax saving, or any lesser number of tax years starting with the year first classified	Yes	No Income Tax Credit	1970
Maryland	Automatic	5% transfer tax if 20+ acres, 4% if less	No	Income Tax Credit	1956
Massachusetts	Application	Conveyance fee begins in year 1 (10%) and down to 1% in year 10 (Approved, not implemented 1972)	No	Yes	1972
Michigan	No Current Use Program		Yes	Yes	
Minnesota	Application	3 years of tax saving	Yes	No	1969
Mississippi	Application	No	No	Income Tax Credit	1980

State	Automatic/by Application	Penalty	Tax Incentive for Conservation Easement	State Purchase of Land for Conservation Income Tax Credit	Year Started
Missouri	Automatic	No	No	No	1967
Montana	Application	No	Yes	No	1973
Nebraska	Application	3 years of tax saving	No	No	1972
Nevada	Application	6 years of tax saving	No	No	1975
New Hampshire	Application	10 percent of the full and true value	No	No	1974
New Jersey	Application	3 years of tax saving	No	No	1963
New Mexico	Application	No	No	Income-Tax Credit	1971
New York	Application	5 years of tax saving and 10% interest	No	Income Tax Credit	1972
North Carolina	Application	6 years of tax saving	No	Income Tax credit	1973
North Dakota	Application	No	No	No	1973
Ohio	Application	3 years of tax saving	Yes	No	1973
Oklahoma	Automatic	No	No	No	1968
Oregon	Application	10 years of tax saving	No	Yes	1963
Pennsylvania	Application	7 years of tax saving and 6% interest	Yes	No	1966
Rhode Island	Application	10% of market value for the first 6 years and declines to 0% by 15th year	No	No	1968
South Carolina	Application	5 years of tax saving	Yes	Income Tax Credit	1976
South Dakota	Automatic	No	No	No	1966
Tennessee	Application	3 years of tax saving for open-space and 5 years of tax saving for forests	Yes	No	1976
Texas	Application	5 years of tax saving and 7% interest	No	No	1966
Utah	Application	5 years of tax saving	Yes	No	1969
Vermont	Application	20% of market value (10% if enrolled > 10 years)	Yes	No	1969
Virginia	Application	Roll-back: 5 most recent tax years	Yes	Yes	1970
Washington	Application	7 years of tax saving and 20% interest; also, 20% penalty, unless a two year "Notice to Withdraw" is given after 8th year	No	No	1968
West Virginia	Application	5 years of tax saving and 9% interest	No	No	1977

State	Automatic/by Application	Penalty	Tax Incentive for Conservation Easement	State Purchase of Land for Conservation Income Tax Credit	Year Started
Wisconsin	Application	10% of the market value and use value difference : < 10 acres 7.5% of the market value and use value difference : 10 -30 acres 5% of the market value and use value difference : > 30 acres	Yes	No	1974 (1995 implementation)
Wyoming	Application	7 years of tax saving and 18% interest	Yes	No	1973

Source: http://huntingheritage.org (Multistate Conservation Grant Program), Hady & Sibold (1974)

Table 3.2: State Objectives in Current Use Assessment

State	The Intent of the CU Value Assessment Law
Alabama	Alleviate pressure on landowners to convert their agricultural land to other uses.
Arkansas	Protect agricultural landowners from external influences that might increase the value of their property out of proportion to its income potential.
Connecticut	Prevent the forced conversion of agricultural lands to more intensive uses.
Florida	Lower property taxes on agricultural lands in order to reduce the pressure on farmers to convert agricultural lands to other uses.
Georgia	Provide a mechanism to reduce the pressure on landowners to convert agricultural land to other uses.
Kentucky	Prevent the premature conversion of farmland to other uses.
Mississippi	Ensure that the farmer is not put in a position in which it would be more advantageous to sell the property.
North Carolina	Provide tax relief to bona fide agricultural landowners to prevent premature conversion of farmland to other uses.
Oklahoma	Facilitate uniform ad valorem tax assessment procedures throughout the state.
Pennsylvania	Encourage property owners to retain their land in agricultural or forestland use, and to provide some tax relief to landowners.
South Carolina	Ensure that the assessment of agricultural land is reasonable and the penalty system is to ensure properties remain in agricultural classification.
Tennessee	Alleviate land conversion pressures placed on agricultural land as a result of urbanization and property taxation.
Texas	Keep property from diverted from agricultural to other urbanized uses due to increasing property tax burden.
Wisconsin	Provide property tax relief for agricultural landowners and to reduce urban sprawl.
Virginia	Encourage preservation of agricultural and open spaces within the reach of concentrated areas of population.

Sources: Rodgers and Williams (1983); Legislative Audit Bureau, State of Wisconsin (2010); Connecticut Department of Revenue Administration ().

Table 3.3: State Summary Statistics

Variables	Unit of Measurement	1949				1997			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Net Farm Income	Dollars per acre	64.97	45.04	6.70	242.06	52.26	48.40	3.27	215.48
Urban Land	Percentage of total land	2.01	3.29	0.06	16.49	6.63	8.55	0.16	36.06
Rural Transport Land	Percentage of total land	4.79	1.87	1.94	11.84	8.19	6.15	2.63	39.18
Forest Land	Percentage of total land	39.58	21.93	1.35	83.99	37.68	22.45	1.00	85.82
Farmland	Percentage of total land	6.10	2.19	1.07	9.86	4.21	2.54	0.02	9.43
Property Tax Rev.	Percentage of total tax revenue	5.38	5.55	0.00	28.34	1.93	3.97	0.00	17.95
Sales Tax Rev.	Percentage of total tax revenue	60.29	14.00	30.13	84.38	48.81	15.81	5.93	85.78
Income Tax Rev.	Percentage of total tax revenue	16.59	12.32	0.00	49.74	36.73	16.80	0.00	73.93
Per Capita Income	Dollars	5458.2	1149.9	2932.7	7533.6	15278	2137.7	11763	21730
Population Growth	Per 1000	111.56	54.72	-37.84	222.01	54.79	48.89	-13.60	259.18

Table 3.4: Cox Regression Results – Current Use Program Implementation

	Coef Pr(>|z|)	exp(coef)	Std.Err.
Urban Land %	0.071* (0.061)	1.074	0.038
Farmland %	0.014* (0.073)	1.014	0.008
Population Growth	0.007** (0.004)	1.007	0.002
Property Tax Revenue%	-0.116* (0.081)	0.890	0.067
Rural Trans. Land%	0.055 (0.474)	1.057	0.077
Per Capita Income	5.6E-05 (0.624)	1.000	0.0001
Income Tax Revenue%	0.001 (0.902)	1.001	0.010
Concordance Coeff	0.7	P:0.074	
Likelihood Ratio	16.1	P:0.0242	
Wald Test	16.61	P:0.0201	
Score (Log Rank) Test	17.21	P:0.0161	

Table 3.5: Cox Regression Results - Imposition of Current Use Withdrawal Penalty

	Before Proportional Hazard Test			**After Proportional Hazard Test**		
	Coef Pr(>|z|)	exp(coef)	Std.Err	Coef Pr(>|z|)	exp(coef)	Std.Err
Urban Land %	0.039 (0.357)	1.039	0.042	0.055 (0.195)	1.057	0.043
Farmland %	-0.012 (0.246)	0.988	0.010	-0.134** (0.003)	1.143	0.045
Population Growth	0.001 (0.877)	1.001	0.004	-0.002 (0.705)	0.998	0.004
Property Tax Revenue %	-0.038 (0.626)	0.963	0.077	-0.070 (0.380)	0.933	0.079
Rural Trans. Land%	0.007 (0.926)	1.007	0.078	-0.033 (0.689)	0.968	0.083
Per Capita Income	0.0001 (0.417)	1.000	0.000	0.002*** (0.000)	1.002	0.001
Income Tax Revenue %	0.008 (0.523)	1.008	0.012	-0.006 (0.646)	0.994	0.013
Dummy Variables						
Midwest (Dummy)	-0.411 (0.578)	0.663	0.739	-9.422*** (0.001)	0.000	2.770
West (Dummy)	0.064 (0.919)	1.066	0.630	0.657 (0.308)	1.929	0.644
North East (Dummy)	0.254 (0.717)	1.289	0.702	0.335 (0.648)	1.398	0.734
Time-Trend (TT)						
Farmland % TT				-0.025*** (0.001)	0.975	0.007
Midwest Region TT				1.495*** (0.000)	4.461	0.420
Per Capita Income TT				0.0001*** (0.000)	1.000	0.000
Concordance Coeff	0.764	P:0.066		0.791	P:0.066	
Likelihood Ratio	18.24	P:0.051		32.17	P:0.002	
Wald Test	19.92	P:0.031		37.81	P:0.000	
Score (Log Rank) Test	23.98	P:0.007		37.62	P:0.000	

Table 3.6: Regression Diagnostics - Proportional Hazard Assumption

	CU Program Implementation			Imposition of CU Withdrawal Penalty		
	Rho	**Chi-Square**	**Pr(>|z|)**	**rho**	**Chi-Square**	**Pr(>|z|)**
Urban Land %	-0.006	0.003	0.960	-0.096	0.400	0.527
Farmland %	-0.102	0.615	0.433	-0.371**	4.970	0.026
Population Growth	-0.023	0.019	0.889	0.160	0.699	0.403
Property Tax Rev. %	-0.030	0.047	0.828	-0.078	0.208	0.648
Rural Trans. Land%	0.005	0.002	0.969	0.217	1.910	0.167
Per Capita Income	-0.046	0.100	0.752	-0.30***	8.150	0.004
Income Tax Rev. %	-0.166	1.371	0.242	0.060	0.149	0.700
Dummy Variables						
Midwest (Dummy)				0.300**	6.430	0.011
West (Dummy)				-0.004	0.001	0.978
North East (Dummy)				0.171	1.640	0.200
Global	NA	2.649	0.915	NA	15.400	0.117

Table 3.7: Classification of Current Use Withdrawal Penalties

Penalty Category	Description
C0	No CU withdrawal penalty
C1	Market value penalty – Fixed rate
C2	Market value penalty – Declining rate
C3	Roll-back penalty – Fixed rate
C4	Roll-back penalty fixed rate with additional interest
C5	Roll-back penalty – Declining rate
C1′	Market value penalty – Fixed rate + Declining rate (C1+C2)
C2′ = C3	Roll-back penalty – Fixed rate
C3′ = C4	Roll-back penalty with additional interest
C4′ = C5	Roll-back penalty – Declining rate
C1″ = C1′	Market value penalty – Fixed rate + Declining rate (C1+C2)
C2″	Roll-back penalty – Fixed rate + Declining rate (C3 +C5)
C3″ = C4	Roll-back penalty with additional interest

Table 3.8: Random Effects Multinomial Logit Regression Log-odds Ratios of Penalty Determination

Variables	Market Value (C1)	Market Value Sliding Scale (C2)	Roll-back Penalty (C3)	Roll-back with Interest (C4)	Roll-back Declining (C5)
Urban land %	0.959 (0.682)	3.303** (0.003)	0.952 (0.613)	0.751** (0.019)	1.212 (0.259)
Farmland %	3.8E-7** (0.000)	1.9E-8* (0.040)	2.88E-6*** (0.000)	7.0E-6*** (0.000)	1.3E-7*** (0.000)
Property tax %	0.836 (0.312)	0.000** (0.008)	0.677* (0.029)	0.823 (0.243)	0.282 (0.118)
Income tax %	1.102** (0.003)	1.176 (0.034)	1.081** (0.009)	1.005 (0.868)	1.134** (0.008)
Population growth	0.982 (0.082)	0.930 (0.093)	0.979* (0.031)	0.954*** (0.000)	1.004 (0.834)
Rural transport. land %	1.319 (0.127)	0.105* (0.036)	1.339 (0.096)	1.416 (0.052)	0.592 (0.223)
Per capita income	1.003*** (0.000)	1.002** (0.006)	1.003*** (0.000)	1.004*** (0.000)	1.003*** (0.000)

Table 3.9: Penalty Category Combination Test

Test	Chi2(Prob)	Combine or Not
C1=C0	32.3 (0.000)	No
C2=C0	20.84 (0.004)	No
C3=C0	31.63 (0.000)	No
C4=C0	35.44 (0.000)	No
C5=C0	28.52 (0.000)	No
C1=C2	11.93 (0.103)	Yes
C3=C4	38.83 (0.000)	No
C3=C5	7.56 (0.0373)	No
C4=C5	23.48 (0.001)	No

Table 3.10: Random Effects Multinomial Logit Regression Log-odds Ratios of Penalty Determination – 5 Categories

Variables	Market Value (C1′)	Roll-back Penalty (C2′)	Roll-back with Interest (C3′)	Roll-back Declining (C4′)	Independent
Urban land %	1.020 (0.776)	0.925 (0.259)	0.735** (0.002)	1.042 (0.752)	22.92 (0.000)
Farmland %	0.000E-7*** (0.000)	0.000E-5*** (0.000)	0.000E-5** (0.000)	0.000E-6*** (0.002)	8.41 (0.077)
Property tax %	0.837 (0.300)	0.716 (0.054)	0.834 (0.260)	0.411 (0.218)	25.95 (0.000)
Income tax %	1.100*** (0.001)	1.081** (0.004)	1.004 (0.899)	1.131** (0.003)	6.21 (0.184)
Population growth	0.987 (0.237)	0.984 (0.109)	0.959*** (0.000)	1.008 (0.633)	31.91 (0.000)
Rural transportation land	1.179 (0.328)	1.263 (0.149)	1.324 (0.091)	0.661 (0.253)	8.41 (0.077)
Per capita income	1.003*** (0.000)	1.003*** (0.000)	1.003*** (0.000)	1.003*** (0.000)	35.23 (0.000)

Table 3.11: Penalty Category Combination Test – 5 Categories

Test	Chi2(Prob)	Combine or Not
C1′=C0	37.24 (0.000)	No
C2′=C0	32.07 (0.000)	No
C3′=C0	36.90 (0.000)	No
C4′=C0	29.85 (0.000)	No
C1′=C2′	32.4 (0.000)	No
C1′=C3′	45.62 (0.000)	No
C1′=C4′	8.45 (0.294)	Yes
C2′=C3′	37.39 (0.000)	No
C2′=C4′	7.21 (0.407)	Yes
C3′=C4′	23.42 (0.000)	No

Combined C2′ and C4′, not C1′ and C4′ penalty categories

Table 3.12: Random Effects Multinomial Logit Regression Log-odds Ratios of Penalty Determination – 4 Categories

Variables	Market Value (C1″)	Roll-back Penalty + Roll-back Declining (C2″)	Roll-back with Interest (C3″)	Independent
Urban land %	1.021 (0.762)	0.928 (0.282)	0.737*** (0.002)	22.15 (0.000)
Farmland %	0.000E-7*** (0.000)	0.000E-5*** (0.000)	0.000E-5*** (0.000)	27.2 (0.000)
Property tax percent	0.843 (0.306)	0.716* (0.048)	0.838 (0.264)	5.8 (0.121)
Income tax percent	1.099*** (0.001)	1.083** (0.003)	1.005 (0.867)	31.14 (0.000)
Population growth	0.987 (0.197)	0.984 (0.097)	0.959*** (0.000)	36.16 (0.000)
Rural transportation land	1.179 (0.321)	1.245 (0.170)	1.312 (0.096)	4.44 (0.217)
Per capita income	1.003*** (0.000)	1.003*** (0.000)	1.003*** (0.000)	36.16 (0.000)
IIA Statistics Chi2 (Prob) Dropped category 3	4.91 (0.426)			

Table 3.13: Penalty Category Combination Test – 4 Categories

Test	Chi2(Prob)	Combine or Not
C1″=C0	37.14 (0.000)	No
C2″=C0	32.29 (0.000)	No
C3″=C0	37.04 (0.000)	No
C1″=C2″	32.75 (0.000)	No
C1″=C3″	45.36 (0.000)	No
C2″=C3″	38.55 (0.000)	No

Table 3.14: Cause-specific Cox Regression Results

	Market Value Penalty		**Roll-back Penalty with Declining Roll-back**		**Roll-back Penalty with Additional Interest**	
	Coef Pr(>|z|)	exp(coef)	Coef Pr(>|z|)	exp(coef)	Coef Pr(>|z|)	exp(coef)
Urban Land %	0.109* (0.086)	1.115	0.096 (0.241)	1.100	-0.099 (0.541)	0.906
Farmland %	0.007 (0.859)	1.007	-0.021 (0.294)	0.979	0.003 (0.901)	1.003
Population Growth	0.009 (0.205)	1.009	0.004 (0.492)	1.004	-0.011 (0.308)	0.989
Property Tax Revenue %	0.202 (0.520)	1.224	-0.071 (0.627)	0.931	0.017 (0.934)	1.017
Rural Trans. Land%	0.106 (0.621)	1.111	0.236 (0.106)	1.266	0.234 (0.209)	1.264
Per Capita Income	-0.001 (0.132)	0.999	-0.001** (0.002)	0.999	0.000 (0.986)	1.000
Income Tax Revenue %	0.047 (0.189)	1.048	0.032 (0.157)	1.032	-0.041 (0.111)	0.960
Dummy Variables						
Midwest (Dummy)	-16.680 (0.842)	0.000	2.220* (0.068)	9.205	0.312 (0.842)	1.366
West (Dummy)	0.109 (0.076)	1.115	0.636 (0.520)	1.889	0.448 (0.814)	1.564
North East (Dummy)	3.140 (0.998)	23.100	-0.555 (0.680)	0.574	1.207 (0.371)	3.343
Concordance Coeff	0.883 SE 0.119		0.809 SE 0.09		0.755 SE 0.11	
Likelihood Ratio	18.34 (0.049)		15.25 (0.123)		8.29 (0.600)	
Wald Test	9.5 (0.485)		14.04 (0.171)		8.25 (0.604)	
Score (Log Rank) Test	26.68 (0.002)		16.61 (0.083)		10.3 (0.415)	
RSquare	0.312		0.267		0.156	

Table 3.15: Fine and Gray Competing Risk Regression Results

	Market Value Penalty		**Roll-back Penalty with Declining Roll-back**		**Roll-back Penalty with Additional Interest**	
	Coef Pr(>|z|)	exp(coef)	Coef Pr(>|z|)	exp(coef)	Coef Pr(>|z|)	exp(coef)
Urban Land %	0.047 (0.300)	1.048	0.057 (0.590)	1.058	-0.145** (0.046)	0.865
Farmland %	-0.019 (0.380)	0.981	-0.024 (0.220)	0.976	-0.002 (0.950)	0.998
Population Growth	0.008* (0.096)	1.009	-0.002 (0.590)	0.998	-0.012 (0.330)	0.988
Property Tax Revenue %	0.145 (0.270)	1.156	-0.033 (0.810)	0.967	0.032 (0.890)	1.033
Rural Trans. Land%	-0.007 (0.960)	0.993	0.110 (0.350)	1.116	0.182 (0.350)	1.199
Per Capita Income	0.000 (0.900)	1.000	0.000 (0.130)	1.000	0.000 (0.480)	1.000
Income Tax Revenue %	0.039* (0.075)	1.040	0.027 (0.240)	1.028	-0.042** (0.034)	0.958
Dummy Variables						
Midwest (Dummy)	1.690 (0.160)	5.441	0.544 (0.560)	1.723	-0.398 (0.840)	0.672
West (Dummy)			-0.025 (0.970)	0.976	-0.447 (0.830)	0.640
North East (Dummy)	2.220 (0.034)	9.204	-1.832 (0.200)	0.160	0.576 (0.530)	1.778
Pseudo Log-likelihood	-23.7		-63.1		-29.9	
Pseudo likelihood ratio test	13.8		8.44		9.16	

Figure 3.1: Preferential Current Use Taxation Versus Deferred Taxation States

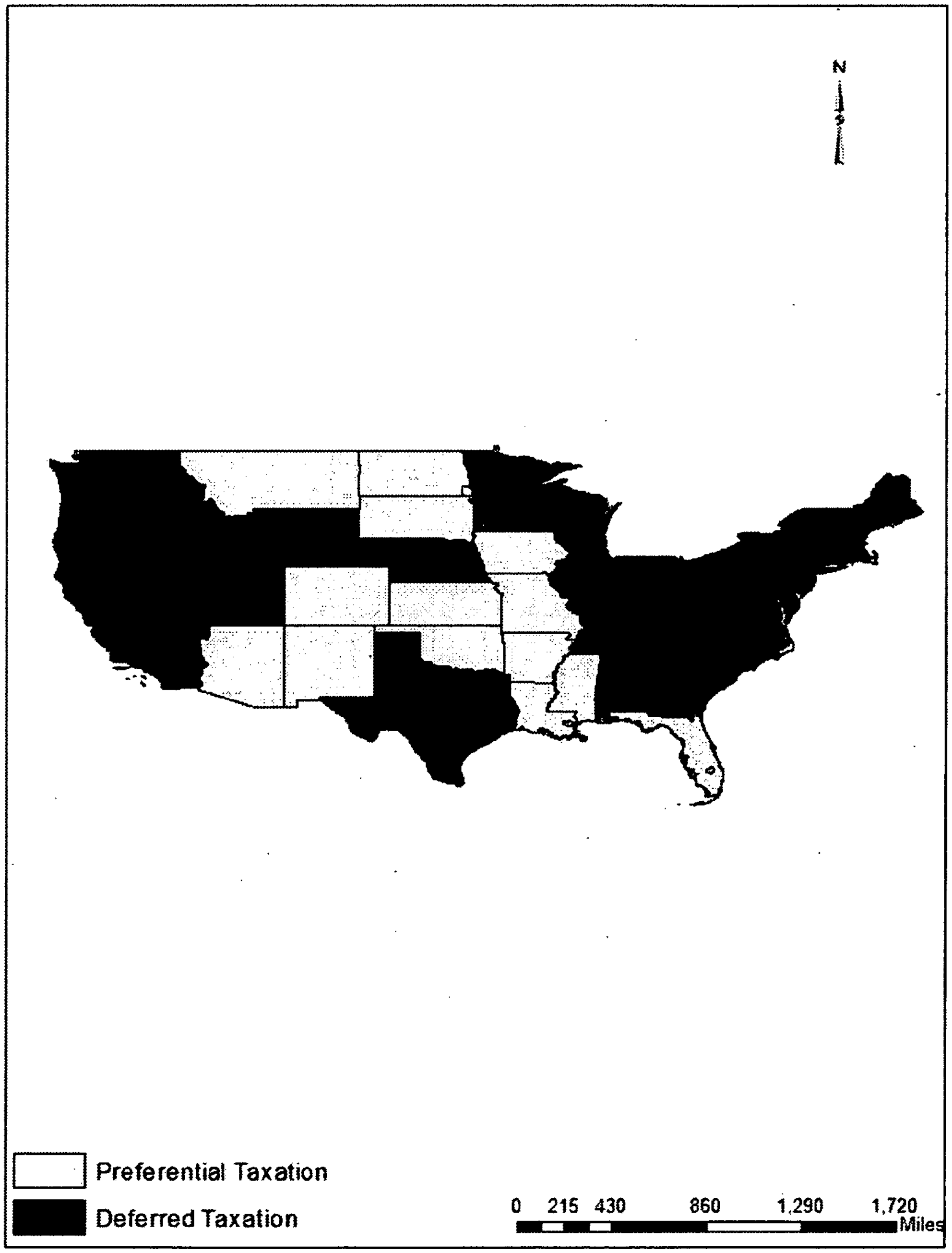


Figure 3.2: Current Use Withdrawal Penalty Categories

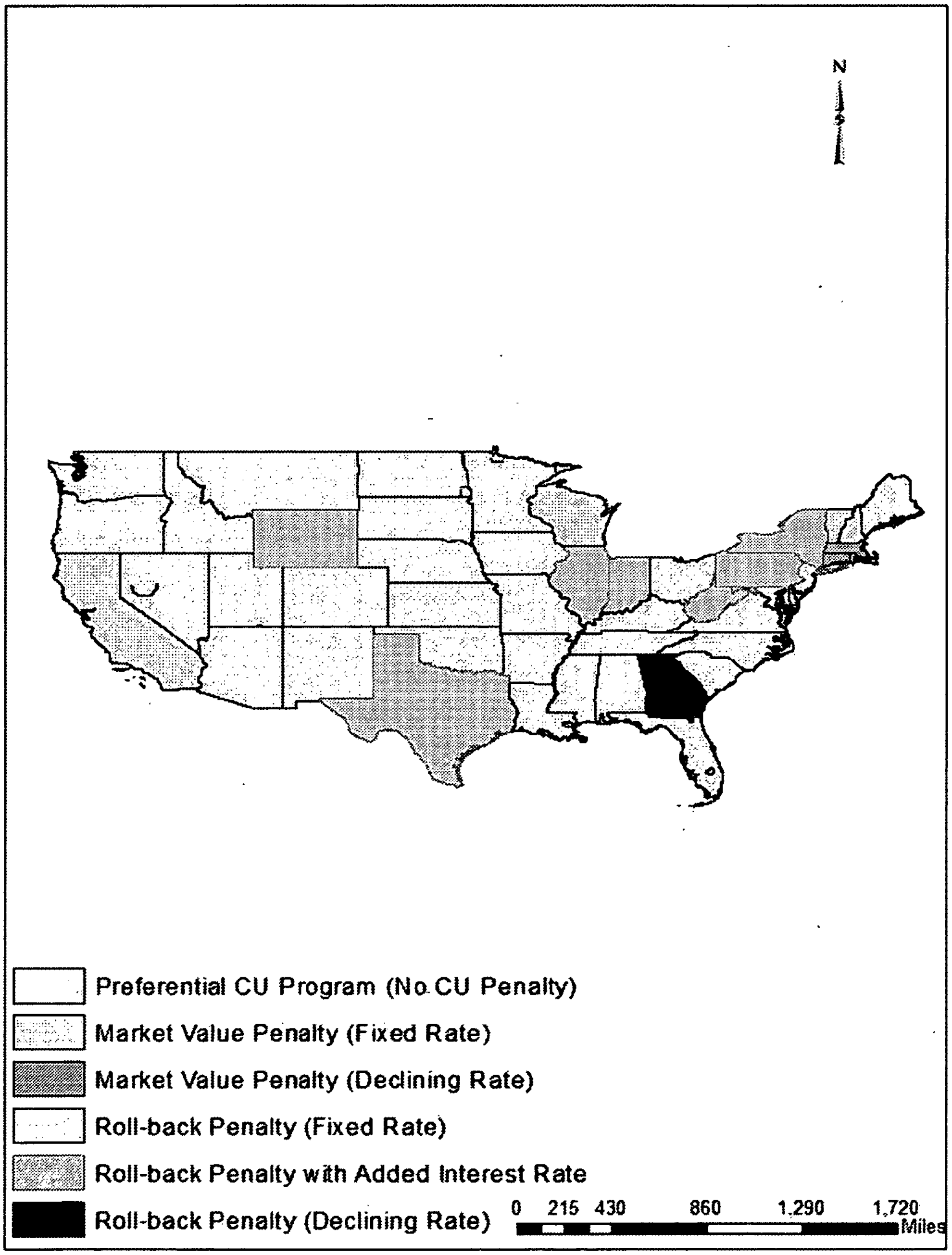


Figure 3.3: Current Use Program with Restrictive Agreements on Agricultural Land

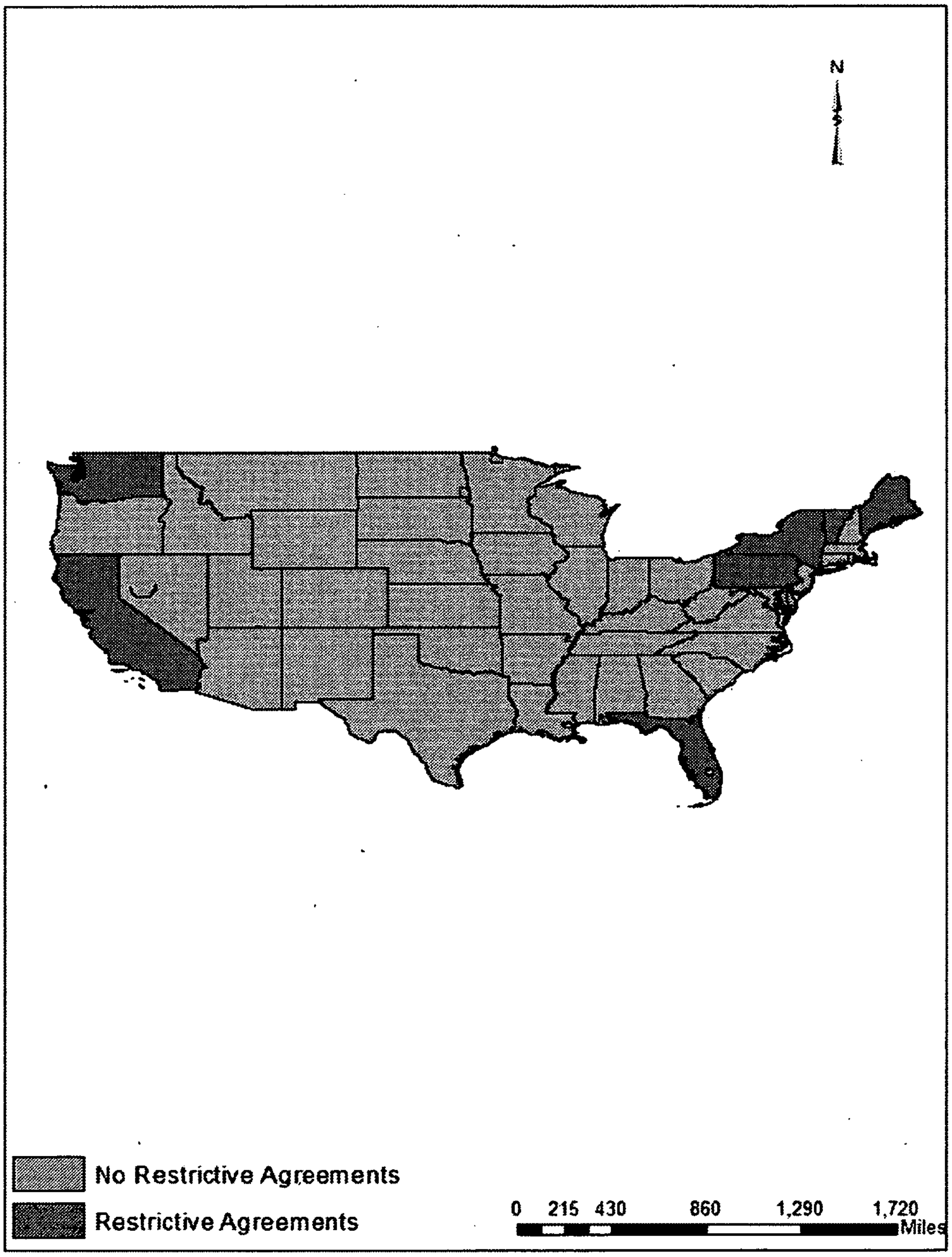


Figure 3.4: Proportional Hazard Diagnostic Schoenfeld Residuals Graphs – Program Implementation

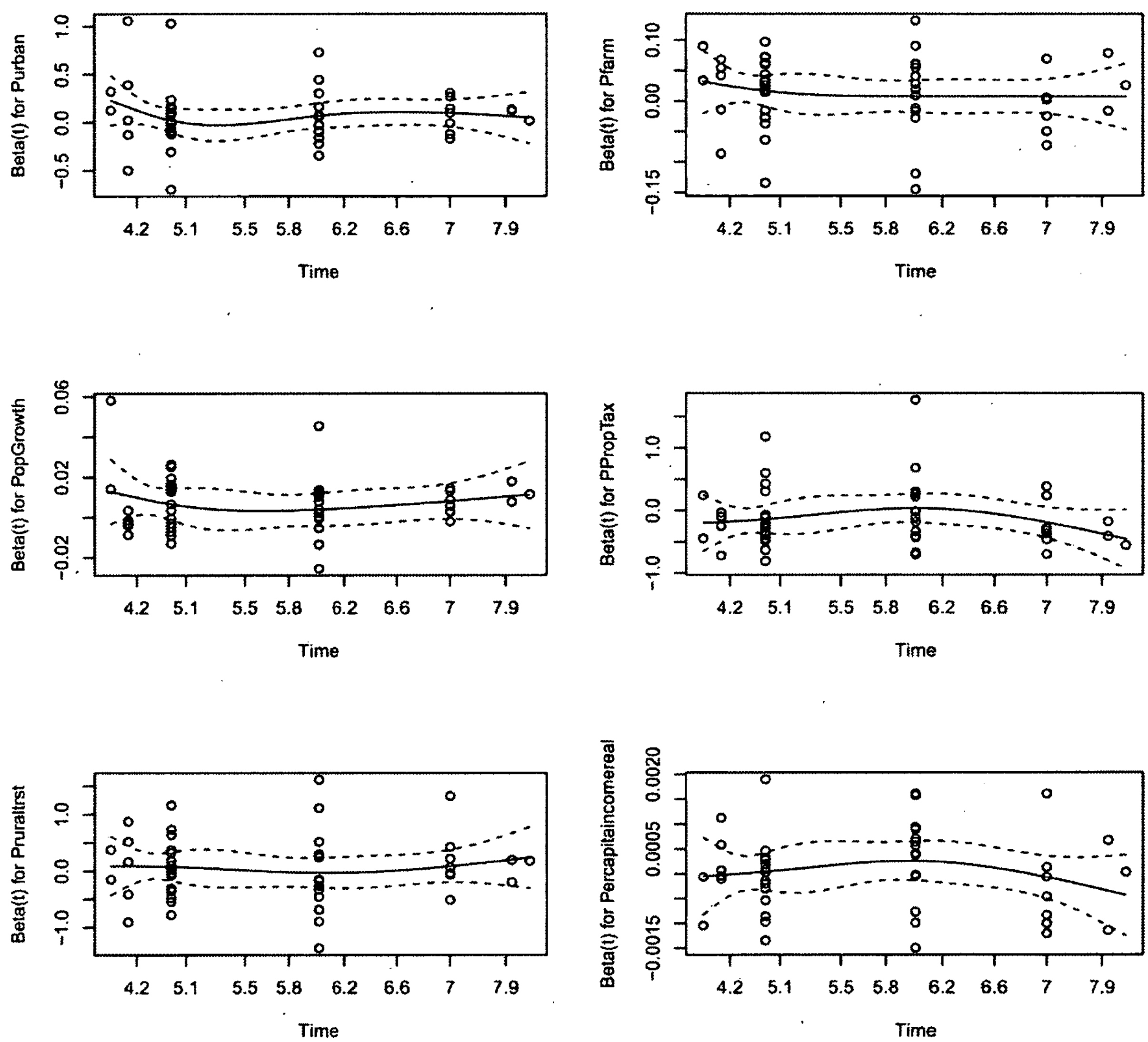


Figure 3.5: Proportional Hazard Diagnostic Schoenfeld Residuals Graphs – Current Use Withdrawal Penalty

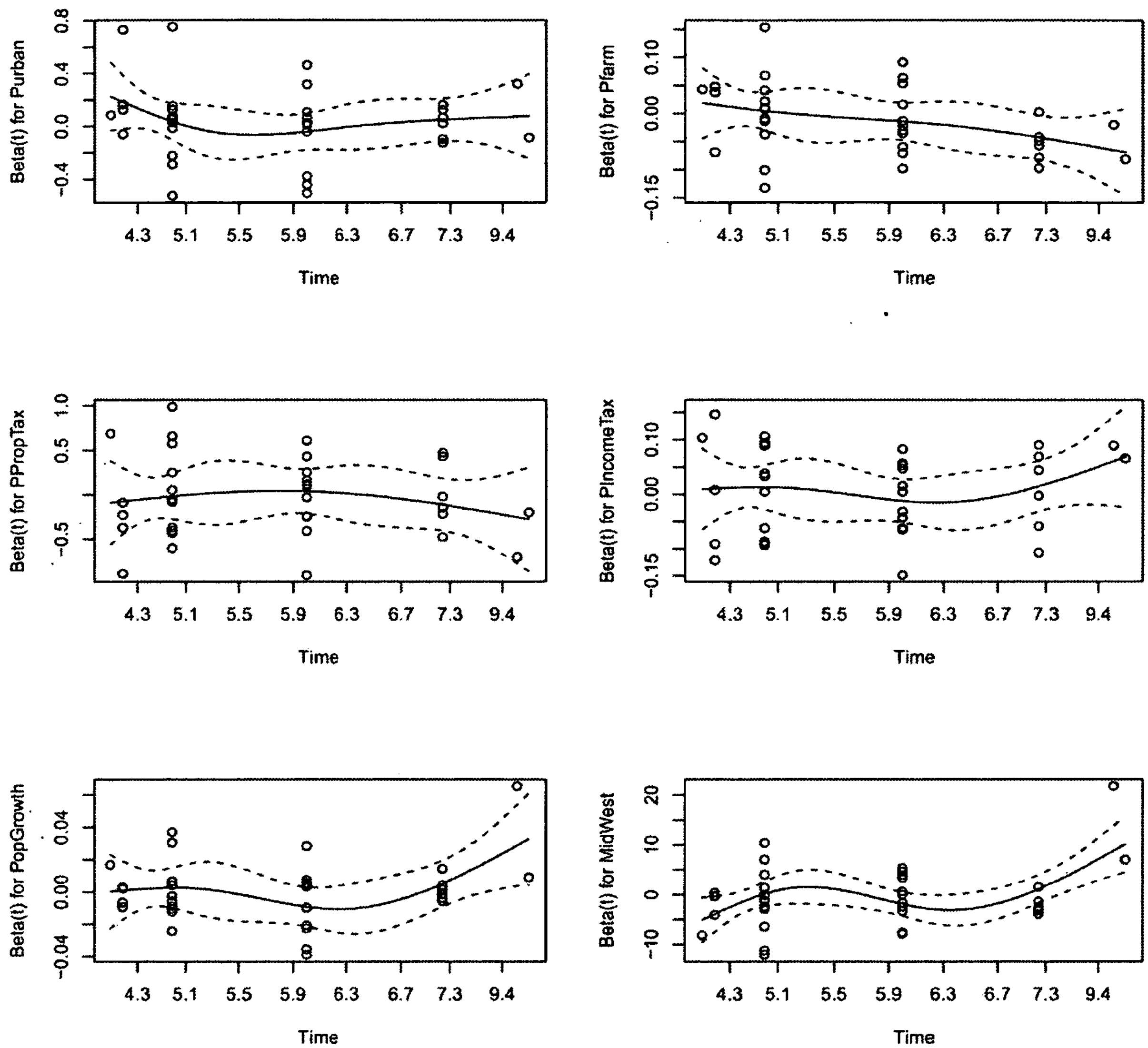
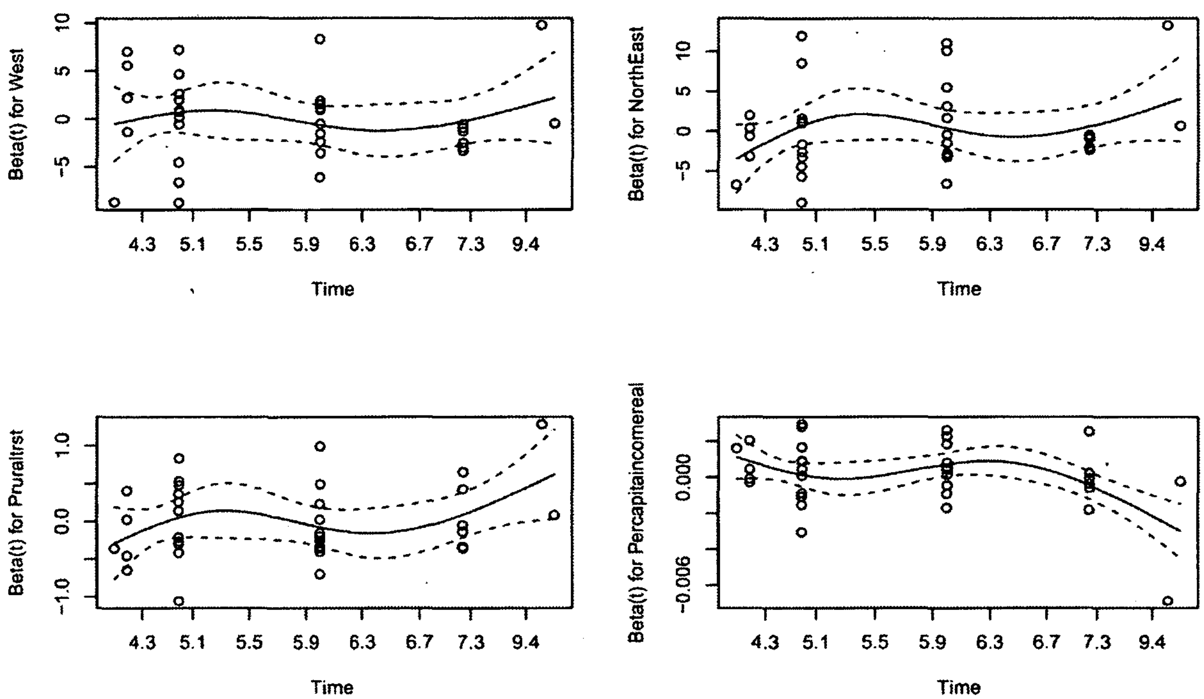


Figure 3.6: Proportional Hazard Diagnostic Graphs – Current Use Withdrawal Penalty



CHAPTER 4

4 EVALUATION OF EFFECTIVENESS OF CURRENT USE PROPERTY TAX PROGRAMS

4.1 Introduction

Current use (CU) taxation focuses on providing property tax relief to landowners with agricultural, forestry or even sometimes with open-space undeveloped land. Previous research, including the findings from chapter 2, shows that receiving a considerable property tax relief has been one of the major determinants of enrolling land in the CU program. Although not directly stated, legislators believed that the provided property tax relief might discourage conversion of land to urbanized uses such as residential and commercial development. The CU program's effectiveness in discouraging conversion of land has been widely discussed over the years. Some specific features of the CU program may help to delay the conversion of land. The features that could delay the conversion are restrictions on conversion and CU withdrawal penalties.

The first CU program feature focused on in this chapter is CU withdrawal penalties. Based on CU withdrawal penalty structures, CU programs can be broadly categorized into two approaches: preferential assessment and deferred taxation. Under the preferential assessment approach, lands qualified for CU programs are assessed at value in use, and the owner will not pay any penalty in case of withdrawal from the program for developed uses. In the deferred taxation approach, a tax recapture penalty is imposed when the land is withdrawn from the program. Those penalties may discourage withdrawal of enrolled land from the program and may make short-term CU enrollment costly for the landowner. A detailed description of states' CU programs was given in chapter 3.

While stricter CU penalties upon withdrawal may reduce the rate of conversion of CU land to developed uses, how precisely those penalties are designed matters. For example, England and Mohr (2003) advocate stricter penalties that decline with the length of enrollment of parcels in the program. That is, if a land is enrolled for a longer period, penalties on withdrawal will be lessened as opposed to early withdrawal. This is an important theoretical suggestion that needs empirical verification. Based on their model, I hypothesize that the states with rising CU withdrawal penalties experience higher rates in land development, compared to the states with declining penalties over time. This chapter focuses on understanding whether features of CU penalties lead to differences in land development in the U.S. I use a simulated database consisting of penalties across the U.S. to understand the effect of penalties on land development.

The second CU program feature considered in this chapter is the presence of restrictive agreements (Collins, 1976; Hady & Sibold, 1974; Keene, 1976; Rodgers & G.H.Williams, 1983) on enrollment in the program, considered the third category of the CU program. The states with restrictive agreements are Hawaii, California, Washington, New York, Maine, Pennsylvania, Vermont and Florida. Restrictive agreements obligate the landowners to refrain from developing the land for urban uses for a certain number of years. A detailed description on restrictive agreements was provided in chapter 3. Considering the effect of restrictive agreements, I hypothesize, that states with restrictive agreements on land development experience lower rates of land development over the years.

Unavailability of state level CU information is a drawback in this study to compare the influence of CU acres on development across states. Therefore, this chapter first focuses on the simulated data developed using available information related to the CU program. Using the simulated data, my first objective of this study is to verify whether higher penalties and rising penalties over time lead to different rates of land development across states for the years 1987-2007. Along with CU withdrawal penalties, restrictive agreements used by some states may delay the rate of land development. Therefore the second objective of this chapter is to find out whether restrictive agreements of some CU programs lead to differences in land development.

In contrast to the unavailability of state level CU data, the New Hampshire CU program maintains a comprehensive database about the program. Therefore, the New Hampshire CU program's statistics for the years 1999-2011, along with residential permit issue information, are used to test whether residential development has slowed down over the years due to enrollment of land in the CU program. The hypothesis is that towns with a higher percentage of CU land have lower rates in residential land development. The number of new residential permits issued during the period of study is used as a proxy for residential development in New Hampshire. The third objective of this chapter is to find whether the CU program has had any influence on residential development in New Hampshire.

4.2. Theoretical Background of Current Use Withdrawal Penalty

The studies that focus on CU taxation programs span from theoretical models to empirical studies. It is generally agreed that such programs give substantial tax relief to participating landowners and as a result reduce the rates of land conversion for more urbanized uses (Anderson, 1998; Anderson & Griffing, 2000; Polyakov & Zhang, 2008). However, there are studies that actually show evidence that casts doubts about the success of the programs (Parks & Quimio, 1996; William, R.Gottfried, Brockett, & Evans, 2004). Theoretical models about this preferential taxation program have focused on different determinants affecting enrollment in the program and the timing of development. The model developed by England and Mohr (2003) especially focuses on withdrawal penalties for lands enrolled in the CU program.

According to the model, a landowner decides the timing of development (D), considering the pecuniary benefits before/after the development (c and u) and non-pecuniary benefits (n) only before the development. Therefore, the owner chooses a time to develop the land when the present value of her income stream is maximized. In the model the landowner maximizes:

$$\underbrace{\int_{t=0}^{t=D}[c(t)+n(t)-\tau A(t)]e^{-rt}dt}_{\substack{\textit{Present value of returns}\\ \textit{to undeveloped}\\ \textit{land, net of taxes}}} - \underbrace{P(D)e^{-rD}}_{\substack{\textit{Present value}\\ \textit{of penalty}\\ \textit{on withdrawal}}} + \underbrace{\int_{t=D}^{t=\infty}[u(t)-\tau A(t)]e^{-rt}dt}_{\substack{\textit{Present value of}\\ \textit{returns to developed}\\ \textit{land, net of taxes}}} \quad (4.1)$$

In the above, τ is the property tax rate, r is the owner's discount rate, P is penalty fee and t denotes time. According to program specifications, most of the states assess undeveloped land by capitalizing the pecuniary income, while other states assess undeveloped parcels based on some fraction of market value of land. This model considers undeveloped land value based on land's capitalized income. Accordingly, the assessed value of an undeveloped land parcel is (if it remains undeveloped): *A (t)* $=\int_{t'=t}^{t'\to\infty} c(t')e^{-r(t'-t)}dt'$. The assessed value of a developed land parcel can be written: *A (t)* $=\int_{t'=t}^{t'\to\infty} u(t')e^{-r(t'-t)}dt'$ (for $t \geq D$). Also, the model assumes constant $\bar{c}$ and $\bar{n}$ of undeveloped land, whereas the pecuniary benefits of developed land grow at the rate of g and therefore, $u(t)=\bar{u}e^{gt}$. In addition, the authors assume, initial $\bar{u}>\bar{c}$ and a positive non-confiscatory property tax rate (τ). That is, the tax burden never exceeds the pecuniary return to land. Hence, $0 < \tau < r\text{-}g < 1$. By substituting the above assumptions to equation 1, landowner's solution can be derived as:

$$\underbrace{((1-\frac{\tau}{r})\bar{c}+\bar{n})}_{\substack{\text{Instantaneous}\\ \text{return from}\\ \text{undeveloped}\\ \text{land}}} - \underbrace{P'(D)}_{\substack{\text{Effect of}\\ \text{penalty}\\ \text{changing}}} + \underbrace{rP(D)}_{\substack{\text{Value of}\\ \text{delaying}\\ \text{penalty}}} = \underbrace{((1-\frac{\tau}{(r-g)})\bar{u}e^{gD})}_{\substack{\text{Instantaneous return}\\ \text{from developed}\\ \text{land}}} \qquad (4.2)$$

After solving the above equation the model confirms that a landowner pays attention to the *P* (penalty) as well as c(change in penalty over time) in determining the time of development (D). Accordingly, if a landowner delays development of her land, she gains *rP(D)*, where the importance of larger penalties is emphasized. If penalties decline over time, then $P'(D)$ will be less than zero $P'(D)<0$. That is, a penalty that decreases over time encourages a landowner to keep land enrolled in the program to enjoy lower penalties in the future. Hence, the benefit of delaying land development increases if penalties decrease with the length of enrollment. Therefore, England and

Mohr (2003) advocate stricter penalties that decline over time as the optimal kind of penalty to slower land development.

4.3 Data and Empirical Strategy

Data: This paper relies on several data sources. Land data are from the U.S. Department of Agriculture (USDA) and National Resource Inventory (NRI) of Natural Resource Conservation Service. Developed land data are from NRI for the period 1982-2007 (US Department of Agriculture, 2009). Land used for agricultural purposes (crop land, forest land), urban areas, and total land areas are from the USDA for the years 1987, 1992, 1997, 2002 and 2007. Agricultural land values and net farm income data for the years are from the Economic Research Service (ERS) of USDA. Population statistics are from the U.S. Census Bureau. The data source for state level property tax revenue and income tax revenue is the Local Tax Collection Data of U.S. Census. Tax burden data and the average property tax rate in 2000 are from the Tax Foundation. Data on the assessed value ratio of properties is collected from the Lincoln Institute of Land Policy. State level CU program data are from Hady & Sibold (1974) and the Hunting Heritage of the Multistate Conservation Grant Program (Hady & Sibold, 1974).

Data used for the case study in New Hampshire are from the New Hampshire Department of Revenue Administration (NHDRA). The Department of Commerce of the U.S. Census Bureau is used as the source to obtain statistics on residential permits issued for new privately owned residential housing in New Hampshire. The data sources used for different variables is summarized in table 4.1.

Property Tax Rate Simulations: The variation in property tax rates among states, counties and towns makes it difficult to do a property tax rate comparison. Therefore, a property tax rate simulation was performed for further analysis. I obtained tax burden compared to per capita income, as reported in Tax Foundation Data, for all the states from 1982-2007. The property tax rate in 2000 was obtained from official records of each state's revenue department.

A sample of property tax simulation done using New Hampshire data in the year 2001 is described below. According to the Tax Foundation[12], the property tax burden per capita income ratio in New Hampshire was 7.3. The property tax rate in New Hampshire in 2000 was 19.9 for $1000 of assessed value of properties. Based on the tax burden per capita and the property tax rate in the year 2000, I calculated the tax burden to property tax ratio in the year 2000.

$$\frac{Property\ Tax\ Rate_{2000}}{Property\ Tax\ Burden\ per\ Capita\ Income_{2000}} = \frac{19.9}{7.3} = 2.73$$

The ratio 2.73 was used to simulate property tax rates from 1982-2007. For example, the property tax burden to per capita income was 7.6 and the property tax rate in year 2001 was calculated as follows:

$$Property\ Tax\ Rate_{2001} = Property\ Tax\ Burden\ per\ Capita\ Income_{2001} * 2.73$$
$$Property\ Tax\ Rate_{2001} = 7.6 * 2.73 = 20.75$$

Similar calculations were done for all the states for the years 1982-2007. The above tax simulations were done due to the unavailability of full value property tax rates

[12] http://taxfoundation.org/article/state-and-local-tax-burdens-all-years-one-state-1977-2010

at the state level. With a simulation study, the reliability of data used in the research could be challenged. In order to compare the reliability of the tax simulation study, I compared my simulated property tax data to actual property tax rate data from New Hampshire for the years 1995-2009 (see figure 4.1). If more property tax data were available, the above comparison could have been done for more states to check the accuracy of the simulated data. Table 4.2 summarizes the property tax burden information and simulated property tax rates across states.

I continued my analysis using the above simulation of state averages of property tax rates. However, the above property tax rate simulation could add some bias to my study. As shown in figure 4.1, property tax burden per capita income has been constant over the years (7.3-9.4), which suggests that property tax rates have been adjusted according to market conditions. For example, property tax rates have been low during economic downturns and have gone up during economic booms, which has led to fewer variations in property tax burden compared to per capita income. Therefore, using property tax burden data might add some bias in property tax simulations.

CU Value Calculation: Although the market value of a property is considered as the standard value of assessment for property tax purposes, some states do not consider the full value of the property in tax calculations. Rather, such states use an assessment ratio or a partial assessed value based on the class of the property when property taxes are calculated. Assessment ratios for this paper are from the Lincoln Institute of Land Policy. For the state level analysis, the amount of property tax charged was calculated by multiplying the simulated property tax rates and assessed value of agricultural land for the years 1987-2007. In order to calculate property tax savings when enrolling a land parcel in a CU program, property taxes based on CU value is required. To compute capitalization rates by states, I considered the state level average rent[13]-to-land value ratio (England, 2011) over the period 1987-2007. The value of agricultural land, like other income producing assets, can be derived from the expected flow of income. Using per acre net farm income and the above simulated capitalization rates, use values are calculated as follows: $\frac{Net\ Income\ from\ Agriculture}{Capitalization\ Rate}$. Then the CU property taxes on an acre of agricultural land were calculated for all the states.

<u>CU Penalty Calculation:</u> Assuming a land was initially enrolled in 1987, I calculated the tax savings a landowner receives by enrolling an acre of land in the CU program and penalties in case of withdrawal for all 30 states for the years 1987-2007. Calculations done for an acre of land in California and Georgia are shown in table 4.3. As shown, the average value of an acre of agricultural land in California has increased from $1,550 to $5,960 over the years. In California, taxes are applied to 100% of the market value. Therefore, if land is not enrolled in the CU program, the assessed value for tax purposes is the same as the market value of land. Property tax savings from enrolling an acre of land in a CU program are about $106 in 1987 and $444 in 2007. However, if a landowner in California decides to withdraw the land from CU designation, a CU withdrawal penalty is applied. In California, the CU penalty is 12.5% of the market value

[13] Rents are generally considered a short run indicator of the return to a landowner's investment in the land

at the time of withdrawal. Therefore, if an acre of land is withdrawn, the penalty in the first year would be $194 per acre, whereas the penalty would be $745 in 2007. According to this calculation, a landowner with CU designated land in California may face a withdrawal penalty despite the length of the enrollment. In contrast, a landowner in Georgia will face declining penalties (see table 4.3). Similar calculations were done for all the states used for this analysis. Above penalty calculations are used for further analysis of this chapter.

Internal Rate of Return (IRR) Calculation: According to Berry (1993), IRR of the CU program compares the abated taxes per acre and the taxes paid per acre following withdrawal (Berry, 1993). The IRR calculation formula can be given as:

$$\sum \frac{-TA}{(1+i)^n} + \frac{LUC}{(1+i)^{X+1}} = 0 \qquad (4.3)$$

where, TA is the amount of abated taxes, LUC is the land use change tax (i.e. CU withdrawal penalty) and n goes from 0 years to X years. The IRR signifies the degree to which the withdrawal penalty offsets the abated property taxes resulting from enrollment in the program. For example, a zero IRR means that the penalty completely offsets the abated taxes with no net gain to either the property owner or the town. An IRR greater than zero means that the penalty was larger than the tax savings incurred, so there is net gain to the town. If it is negative, then the penalty is not large enough to offset the tax savings, and, therefore, the landowner receives a financial gain by enrolling the land. This paper includes a dummy variable (D=1) if a landowner gains by enrolling a land, i.e. if IRR is negative.

Empirical Models Used in Analyses: In determining the factors that could lead to land development across the states, I estimate the following model:

$$Y_{it} = f(X_{it}^{CU}, X_{it}^{Land}, X_{it}^{Agricu}, X_{i}^{Other}, X_{it}^{Socecon}) + \varepsilon_{it} \qquad (4.4)$$

In equation 4.4, Y_{it} represents percentage rise in developed land compared to state's land total. In equation (4.4), X_{it}^{CU} is a vector of time dependent variables that are related to the CU program. The variables considered are calculated CU penalties, property tax savings, severity of penalty (compared to market value of land) and IRR.

As discussed in chapter 3, I classified CU withdrawal penalties into six major categories. However, within each penalty category, states' CU penalty can differ depending on the number of years of recapture penalty and in the percentage charged as market-value penalty etc. The differences in market value and CU value across states also vary. Therefore a landowner in a state with a higher difference between CU value and market value will be paying a higher roll-back penalty compared to a landowner in a state with a lower difference between CU value and market value, even when the number of years of recapture is the same. To introduce the differences in severity of CU penalty, I used a categorical variable – severity of penalty. The ranking of the severity of penalties depends on the ratio of penalty to accumulated tax savings. Depending on the above ratio, I categorized severity of penalties into six groups. The severity ratio 0 is given for states with no CU penalty. Other penalty severity categories are >0-25, >25-50, > 50-75, >75-100 and >100.

The vector X_{i}^{Land} includes several land characteristics relevant in predicting the rate of land development. The variables are percentage of federal land, percentage of developed land in the previous year and the percentage of rural transportation land. The vector X_i^{Agricu} includes farm dependency index (FDI)[14] and agricultural land value per acre. The vector X_i^{Other} includes three dummy variables to introduce other land conservation programs, including conservation reserve program (CRP), conservation easement and income tax credit program on land conservation. $X_{it}^{Soc.eco}$ includes population change over the period of analysis. In estimating equation 4.4, I used data from 46 states for the years 1987-2007. Michigan, Alaska, Hawaii and Wisconsin are not included in the analysis. Michigan was excluded from the analysis because there is no CU program in the state. Alaska and Hawaii were not included due to some missing information. Wisconsin is also not included since the CU law in Wisconsin was not enacted until 1995, although the law was passed in 1974. Random effect panel data regression was used to estimate equation 4.4.

In determining whether states with penalties increasing over time have any differences in the amount of land development compared to the states with declining or constant penalties, I estimate the following model:

$$Y_{it} = f(X_{it}^{CU'}, X_i^{CU}, X_{it}^{Land}, X_{it}^{Agricu}, X_i^{Other}, X_{it}^{Soc.eco}) + \varepsilon_{it} \qquad (4.5)$$

Compared to equation 4.4, equation 4.5 includes a dummy variable (X_i^{CU}) to indicate CU penalties that have risen compared to the previous year. In equation 4.5, $X_{it}^{CU'}$ includes CU property tax savings and internal rate of returns (IRR). All other variables in 4.5 are the same as described in equation 4.4. In estimating 4.5, I used all the 30 states with any sort of a CU withdrawal penalty. Wisconsin is the only state with a CU

[14] FDI_{it}= Agricultural income/Total income

withdrawal penalty that was omitted in estimating equation 4.5. A random effect panel data regression was used to estimate equation 4.5.

In determining whether rates of residential development are influenced by the amount of CU acres in New Hampshire, I estimate the following model:

$$Y_{it} = f(X_{it}^{CU}, X_i^{CBD}, X_{it}^{Socio-econ}) + \varepsilon_{it} \qquad (4.6)$$

In equation 4.6, Y_{it} represents the number of residential permits issued by each town in New Hampshire. In equation 4.6, X_{it}^{CU} is a vector of time dependent CU characteristics. The variables related to the CU program are percentage of CU land enrolled and CU penalties per acre, if land is withdrawn. $X_i^{Socio-econ}$ is a vector containing population change (per 1,000) in each year and average annual daily traffic data (AADT). The vector X_i^{CBD} contains two dummy variables introducing towns located within 50 miles from Boston, MA and Manchester, NH. In estimating equation 4.6, I used town level data from 231 New Hampshire towns for the years 1999-2011. Equation 4.6 was estimated using random effect panel data technique.

4.4 Results and Discussion

This section presents the results from two studies carried out for this chapter. First, I present the descriptive statistics for the state level comparison study on land development rates. Then, I present the random effect regression analysis results of the state level land development comparison study and the residential development study of New Hampshire.

4.4.1 <u>Descriptive Statistics</u>

Detailed summary statistics for the years 1987 and 2007 are shown in tables 4.4 and 4.5. As shown, the mean FDI has declined from 2.39 in 1987 to 1.15 by the year 2007, indicating a proportional reduction of farm income compared to total income in a state. Similarly, the percentage of cropland has decreased to 21 percent in 2007, compared to 25 percent in 1987. In contrast, the percentage of urban land has increased to 7 percent, compared to 5.7 percent in 1987.

Figure 4.2 shows the changes in severity of penalty during the years 1987-2007. As shown, in most of the states the severity of penalty has declined over the years. This decline in severity of penalty is mostly observed in states with roll-back penalties. Figure 4.3 and table 4.6 show the number of residential building permits issued by counties in New Hampshire from 1999-2011. As shown, the counties Hillsborough, Rockingham and Strafford have issued a higher number of permits during the period of study. Starting in 2006, the average number of residential permits issued by a town has declined irrespective of the county, reaching an annual average number of permits issued to 10 or below. This sharp decline in the number of residential permits issued can be explained by the 2007 Great Recession experienced by the U.S. economy.

Results of the three random effect panel data regressions (equations 4.4-4.6) are presented in the next section.

4.4.2 Random Effect Panel Data Regression Results

The first objective of this paper is to find the influence of withdrawal penalties on the rate of land development across states. The estimations obtained for the analyses are presented in table 4.7. In models 1 and 2, the dependent variable is the percentage of land developed compared to the total land in the state. The difference between models 1 and 2 is that in model 1 CU penalties are used as an independent variable; in contrast, model 2 uses a dummy variable to represent the states with penalties that rise over time.

As expected, an increase in CU property tax savings results in significantly lower rates of land development (see models 1 and 2). Also the results suggest that states with a higher proportion of federal land have lower rates in land development. As shown in table 4.7, states that are heavily dependent on agricultural income compared to their total income have lower rates in land development (not significant). As expected, states with a conservation reserve program (CRP) have lower rates in land development. The results also suggest, if a state imposes conservation restrictions upon CU enrollment, such states will have lower rates in land development (see table 4.7). As expected, an increase in population results in a significant increase in land developed in a state (model 1).

I hypothesized that CU penalties discourage land development, but rising penalties may encourage farmers to withdraw land from the program for development purposes. As shown in the results of model 1, states with CU penalties have lower rates of land development. However, the effect is highly insignificant. Results from model 2 do not support my hypothesis, the states with rising penalties experience faster development compared to the states with declining penalties. This rise in CU withdrawal penalties could be mainly attributed to a rise in market value of land. Penalties that are based on market value of land at the time of sale are affected by a rise in market value. Penalties that are based on tax savings are influenced by a rising market value, because landowners receive an increase in tax savings by enrolling land.

This chapter also focuses on finding out whether the CU program in New Hampshire has influenced residential development. As suggested by Berry (1993), most of the land withdrawn from the CU program in New Hampshire has been withdrawn for residential development. I extended her analysis for all the towns in New Hampshire. The results of the residential development analysis are shown in table 4.8. The dependent variable for this analysis is the average number of residential permits issued by a town in an year. As expected, an increase in CU land in a town has resulted in a significant decrease in residential permits issued in a year. The results also suggest an increase in property tax savings results in a decline in number of residential permits issued. Also the results indicate higher residential development in towns located within 50 miles of Boston and Manchester. As expected, an increase in population also results in an increase in residential land development.

4.5 Conclusions and Suggestions for Further Research

CU programs have been implemented in the U.S. to provide substantial tax relief to agricultural and forestry landowners. In some states, the landowners with open space land do qualify to receive CU property tax savings. As discussed in chapter 2, the tax relief landowners receive by enrolling land plays a major role in the amount of land enrolled in the CU program. In addition, it is important to explore whether the tax relief received indirectly results in lowering the conversion of undeveloped land to developed uses. Existing literature about the CU program suggests that the program might be helpful in preventing property tax driven development, resulting in lowering the rates of land development. However, no empirical studies relating land development and the CU program are found in the existing literature (to my knowledge). Therefore, this chapter focused on addressing the land development issue focusing on the CU program.

The factors emphasized in this chapter are the percentage of land enrolled in the CU program, the penalties imposed if land is withdrawn from the program and whether CU withdrawal penalties are rising, declining or constant within the length of the enrolled period. I used two sets of data to analyze whether the CU program helps to reduce the rates of land development. The first dataset consists of state level information on the CU program. Finding detailed state level information on CU programs was difficult and therefore, with the information that was available, I simulated data on CU penalties and CU savings for further analysis. The simulated dataset is used to understand the influence of CU penalties on state level land development for the period 1987-2007. The second dataset consists of residential land development data from New Hampshire for the years 1999-2011. I used the average number of new residential permits issued by towns as a proxy in land development in New Hampshire.

In contrast to my hypothesis, results suggest that there is no significant effect of CU penalties on the rates of land development across states. It is possible that some of the independent variables of X_{it}^{CU} in equation 4.4 and equation 4.5 suffer from possible endogeneity issues. Variables in a regression can be endogenous for several reasons. Simultaneity (i.e. reverse causation), measurement error and omitted variable bias, are the leading causes of endogeneity (Verbeek, 2008). The two main variables I am interested in in this research could be a perfect example of endogeneity due to reverse causation. It is not clear how states did assign different withdrawal penalties or at least why some states impose CU penalties upon withdrawal, while some states do not impose a penalty. States with high land development potential could lean towards the imposition of a stricter penalty, which, on the other hand, states with increasing penalties could have higher rates of development. This possibility of reverse causation between the percentage rise in developed land compared to state's land total and CU penalties, could lead to inconsistent and biased linear estimates. An instrumental variable approach would be appropriate in case of reverse causation that I suspect in equations 4.4. and 4.5.

As indicated by IRR, if landowners do not get a financial advantage by enrolling in the program (i.e. if penalties are greater than tax savings received by enrolling land), rates of land development in such states are higher (see model 2). Also, the results suggest that the percentage of federal land and the presence of other conservation programs such as the conservation reserve program (CRP) help to lower the rates of land development in the U.S.

The analysis done using residential development information from New Hampshire, suggests that CU savings per acre and amount of CU land in a town influence the residential development in the state. According to the results, an increase in CU land leads to lower issuance of residential permits and, therefore, a slower increase in residential development too. In this essay, I chose only New Hampshire residential development data to study the influence of a CU program on residential land development. Using only one state's data leads to some limitations due to lack of variation in residential development patterns. Using more states to compare residential development with CU programs would provide more insight into CU program features on residential land development across states.

The analyses of this chapter were performed with a great constraint in availability of property tax rates and CU data for all the states. Therefore, I simulated a dataset for further analyses across states to find out whether CU programs influence the reduction of the rates of land development. The property tax rates that were simulated using property tax burden per capita and year 2000 actual property tax rates, may add some bias to my analysis depending on market situations. Property tax burden per capita has been stable in New Hampshire from 1995-2009 (see figure 4.1). This indicates that property tax rates have been adjusted given the market situations, i.e. lower property tax rates in economic slowdowns and higher property tax rates in economic expansions. It is less likely that simulated property tax rates would capture such variations, which is a limitation of my data. If actual property tax rates and CU program data were available for all the states, the analyses done in this chapter would be more accurate and could be extended for detailed analyses. This would open up an important extension to the work done in this chapter: research as to whether CU programs are crowding in or crowding out (Parker & Thurman, 2011) federal land conservation programs.

When considering the substitutability or complementarity of the New Hampshire land conservation and CU programs, results suggest that an increase in CU land results in a reduction of land enrolled in other conservation programs (model 5). In New Hampshire, withdrawal penalties collected from the CU program are partially or fully allocated to conservation funds. For example, in Concord, the allocation of LUCT to conservation funds has ranged between 25%-100% during the study period. On the other hand, Durham and Dover have allocated 100% of LUCT to the conservation funds since 2002 and 2001 respectively (New Hampshire Department of Revenue Administration, 1995-2012). Therefore, it is clear that the success of other land conservation effects does depend on the CU program.

Table 4.1: Summary of Data Sources

Variable	Data Sources
Land data, agricultural land values and net farm income:	U.S. Department of Agriculture (USDA) – Economic Research Service (ERS), National Resources Inventory (NRI) and Natural Resource Conservation Service
Population statistics: Tax revenue data: Tax burden data:	U.S. Census Bureau http://www.census.gov/popest Local Tax Collection Data http://www.census.gov/govs/index.html Tax Foundation www.taxfoundation.org
Assessed value ratios of properties:	Lincoln Institute of Land Policy
New Hampshire CU data	The New Hampshire Department of Revenue Administration (NHDRA)
Residential permit data	U.S. Department of Commerce http://censtats.census.gov/bldg/bldgprmt.shtml?

Table 4.2: Property Tax Burden to per Capita Income and Simulated Property Tax Rates

State	2000 Tax Rate	2000 Tax Burden	Ratio	Property Tax Burdens			Calculated Property Tax Rates		
				1982-1989	1990-1999	2000-2010	1982-1989	1990-1999	2000-2010
Alabama	3.78	8.50	0.44	8.63	8.72	8.52	3.84	3.88	3.79
Alaska	12.44	4.80	2.59	5.69	5.29	5.49	14.74	13.71	14.23
Arizona	7.39	8.60	0.86	9.24	9.42	8.73	7.94	8.09	7.50
Arkansas	7.00	9.00	0.78	8.38	9.00	9.54	6.51	7.00	7.42
California	7.20	10.20	0.71	10.08	10.33	10.57	7.11	7.29	7.46
Colorado	6.52	8.60	0.76	9.24	9.22	8.62	7.00	6.99	6.53
Connecticut	14.33	10.80	1.33	9.85	11.27	11.24	13.07	14.95	14.91
Delaware	6.32	8.40	0.75	9.05	8.81	9.03	6.81	6.63	6.79
Florida	11.71	8.30	1.41	8.06	8.84	8.68	11.37	12.47	12.25
Georgia	8.55	9.10	0.94	9.13	9.43	9.18	8.57	8.86	8.63
Hawaii	3.08	9.50	0.32	9.53	10.13	9.75	3.09	3.28	3.16
Idaho	9.06	9.90	0.92	9.86	10.25	9.69	9.03	9.38	8.87
Illinois	16.07	9.10	1.77	9.66	9.67	9.60	17.06	17.08	16.95
Indiana	9.51	8.20	1.16	8.45	8.75	8.95	9.80	10.15	10.39
Iowa	12.87	9.10	1.41	10.03	10.05	9.20	14.18	14.21	13.01
Kansas	11.56	9.20	1.26	9.08	9.65	9.45	11.40	12.13	11.87
Kentucky	7.24	9.60	0.75	9.19	10.11	9.66	6.93	7.62	7.29
Louisiana	3.59	8.00	0.45	7.50	7.90	8.25	3.37	3.55	3.70
Maine	13.03	10.60	1.23	10.35	10.82	10.55	12.72	13.30	12.96
Maryland	11.21	10.10	1.11	10.26	10.44	10.26	11.39	11.59	11.39
Massachusetts	11.15	9.70	1.15	10.36	10.66	10.05	11.91	12.25	11.56
Michigan	12.36	9.40	1.31	10.03	9.75	9.55	13.18	12.82	12.55
Minnesota	11.47	9.90	1.16	10.60	10.55	10.12	12.28	12.22	11.72
Mississippi	6.18	8.70	0.71	8.54	8.84	8.65	6.06	6.28	6.14

State	2000 Tax Rate	2000 Tax Burden	Ratio	Property Tax Burdens			Calculated Property Tax Rates		
				1982-1989	1990-1999	2000-2010	1982-1989	1990-1999	2000-2010
Missouri	9.22	8.90	1.04	8.79	9.31	9.09	9.10	9.64	9.42
Montana	10.88	8.50	1.28	8.90	9.01	8.59	11.39	11.53	11.00
Nebraska	16.44	9.20	1.79	9.53	9.77	9.73	17.02	17.46	17.38
Nevada	7.92	6.90	1.15	7.36	7.41	7.50	8.45	8.51	8.61
New Hampshire	19.90	7.30	2.73	7.65	8.47	7.65	20.85	23.09	20.84
New Jersey	20.48	10.70	1.91	11.00	11.54	11.46	21.05	22.09	21.94
New Mexico	6.14	9.50	0.65	8.64	9.75	8.83	5.58	6.30	5.71
New York	18.34	11.60	1.58	12.14	12.24	12.03	19.19	19.35	19.02
North Carolina	7.63	9.20	0.83	9.33	9.70	9.70	7.73	8.04	8.04
North Dakota	16.87	9.00	1.87	9.20	9.47	8.85	17.24	17.75	16.60
Ohio	12.05	9.90	1.22	9.50	9.95	10.07	11.56	12.11	12.26
Oklahoma	7.98	9.10	0.88	8.54	9.33	8.91	7.49	8.18	7.81
Oregon	10.45	9.70	1.08	10.76	10.51	17.48	11.59	11.32	18.83
Pennsylvania	15.13	9.50	1.59	9.83	10.03	10.07	15.65	15.97	16.04
Rhode Island	16.72	10.80	1.55	10.59	11.13	10.83	16.39	17.23	16.76
South Carolina	5.49	8.60	0.64	9.00	8.92	8.59	5.75	5.69	5.48
South Dakota	16.10	6.90	2.33	8.00	7.51	7.21	18.67	17.52	16.82
Tennessee	7.63	6.90	1.11	7.46	7.50	7.39	8.25	8.29	8.17
Texas	16.98	7.10	2.39	7.41	7.97	7.55	17.73	19.06	18.07
Utah	6.37	9.90	0.64	10.04	10.13	9.84	6.46	6.52	6.33
Vermont	17.75	9.70	1.83	10.21	10.49	10.16	18.69	19.20	18.60
Virginia	8.91	9.40	0.95	9.29	9.52	9.36	8.80	9.02	8.88
Washington	10.24	8.50	1.20	9.03	9.46	9.08	10.87	11.40	10.94
West Virginia	5.34	9.20	0.58	9.54	9.20	9.37	5.54	5.34	5.44
Wisconsin	18.51	11.10	1.67	11.81	11.59	10.79	19.70	19.33	17.99
Wyoming	5.92	6.30	0.94	6.94	6.34	6.77	6.52	5.96	6.36

Table 4.3: Current Use Assessment - Based on Capitalization Rate or Some Fraction of Fair Market Value

State	Year	Market Value per Acre	Assess Value	CU Value	Prop. Tax Saving Per Acre	Accumulated Tax Savings	Penalty if Withdrawn
California	1987	1553.6	1553.6	90.0	106.4	106.4	194.2
Assess Val: 100%	1989	1742.0	1742.0	92.9	117.6	328.6	217.8
PropTaxRate~7	1991	2077.0	2077.0	31.0	148.8	611.7	259.6
CAP Rate~2-8	1993	2213.0	2213.0	57.9	159.7	929.0	276.6
	1995	2220.0	2220.0	20.5	161.5	1249.1	277.5
	1997	2500.0	2500.0	26.6	178.1	1601.5	312.5
	1999	2800.0	2800.0	41.4	194.7	1981.8	350.0
	2001	3200.0	3200.0	33.8	234.7	2429.8	400.0
	2003	3600.0	3600.0	58.0	255.0	2926.7	450.0
	2005	5050.0	5050.0	89.1	360.7	3557.9	631.3
	2007	5960.0	5960.0	129.3	444.5	4393.9	745.0
Georgia	1987	888.8	266.6	20.8	21.0	21.0	105.1
Assess Val: 30%	1989	1030.0	309.0	34.4	24.0	66.6	96.0
PropTaxRate~8	1991	1095.0	328.5	34.3	26.3	119.7	78.8
CAP Rate~1.5-5.0	1993	1131.0	339.3	40.7	27.2	170.6	54.4
	1995	1260.0	378.0	33.5	30.7	228.0	30.7
	1997	1430.0	429.0	36.9	33.9	294.7	0.0
	1999	1630.0	489.0	57.3	36.9	366.6	0.0
	2001	1900.0	570.0	75.4	42.8	449.0	0.0
	2003	2200.0	660.0	86.9	48.5	544.8	0.0
	2005	3140.0	942.0	126.2	69.8	665.9	0.0
	2007	4350.0	1305.0	152.6	100.7	857.7	0.0

Table 4.4: Summary Statistics – 1987

Variables	Unit of Measurement	Mean	Std. Dev	Min	Max
CU Program Variables					
CU Value	Dollars per acre	39.67	86.30	0.18	456.65
Property Tax Savings	Dollars per acre	99.93	138.27	0.95	655.96
Land Variables					
Agriculture Land Value	Dollars per acre	1040.7	874.22	156.00	3729.00
Agriculture Land Value	Dollars per acre	-121.99	275.80	-583.91	625.88
Crop land	Percentage of total land	24.88	20.55	1.21	78.12
Forest Land	Percentage of total land	38.34	23.42	1.04	87.90
Rural Transportation Land[15]	Percentage of total land	1.56	0.69	0.45	2.99
Urban Land[16]	Percentage of total land	5.70	7.21	0.15	29.53
Federal Land	Percentage of total land	14.24	20.42	0.42	84.48
Developed Land	Percentage of total land	6.64	6.49	0.39	27.37
Rural Land	Percentage of total land	74.88	18.38	14.52	95.78
Rise in Developed Land	Percentage change in developed land	0.59	0.70	0.01	3.95
Socio-Economic Variables					
Farm Dependency Index (FDI)	Index	2.39	3.15	0.16	13.24
Population Change (1982-1987)	Per 1000	38.47	51.81	-58.13	189.37
Net Farm Income (NFI)	Dollars per acre	77.79	104.78	1.37	619.99
Capitalization Rate	Rate per 100	4.80	2.70	0.80	10.30
Property Tax Revenue	Percentage of tax revenue	1.73	3.46	0.00	15.77
Sales Tax Revenue	Percentage of tax revenue	50.94	15.18	13.52	84.53
Income Tax Revenue	Percentage of tax revenue	34.00	16.93	0.00	71.50

[15] Rural transportation: Highways, roads, and railroad rights-of way, plus airport facilities outside an urban area

[16] Urban area: Densely populated areas with at least 50,000 people ("urbanized areas") and densely populated areas with 2,500 to 50,000 people ("urban clusters")

Table 4.5: Summary Statistics – 2007

Variables	Unit of Measurement	Mean	Std. Dev	Min	Max
CU Program Variables					
CU Value	Dollars per acre	111.00	237.37	-0.78	1411.74
Property Tax Savings	Dollars per acre	383.26	606.36	2.97	2872.47
Land Variables					
Agriculture Land Value	Dollars per acre	3865.22	3832.8	460.00	16400.0
Agriculture Land Value	Dollars per acre	698.36	312.30	294.12	1891.89
Crop land	Percentage of total land	21.19	19.17	1.04	74.76
Forest Land	Percentage of total land	38.50	22.82	1.58	87.86
Rural Transportation Land	Percentage of total land	1.51	0.57	0.51	2.91
Urban Land	Percentage of total land	7.05	10.36	0.18	38.26
Federal Land	Percentage of total land	14.34	20.43	0.43	84.60
Developed Land	Percentage of total land	9.39	8.68	0.82	35.46
Rural Land	Percentage of total land	71.97	18.42	13.96	95.39
Rise in Developed Land	Percentage change in developed land	0.55	0.46	0.01	1.90
Socio-Economic Variables					
Farm Dependency Index (FDI)	Index	1.15	1.56	0.03	7.96
Population Change (2002-2007)	Per 1000	49.32	44.00	-20.14	185.36
Net Farm Income (NFI)	Dollars per acre	127.40	124.49	-0.65	531.22
Capitalization Rate	Rate per 100	3.21	2.47	0.32	12.35
Property Tax Revenue	Percentage of tax revenue	2.75	6.16	0.00	34.68
Sales Tax Revenue	Percentage of tax revenue	46.67	15.91	10.11	81.30
Income Tax Revenue	Percentage of tax revenue	38.94	18.33	0.00	77.51

Table 4.1: Total Residential Permits Issued at County Level in New Hampshire 1999 - 2011

Year	Belknap	Carroll	Cheshire	Coos	Grafton	Hillsborough	Merrimack	Rockingham	Strafford	Sullivan
1999	338	333	271	93	263	1532	631	1690	448	117
2000	437	407	262	109	327	1565	669	1570	562	202
2001	409	496	235	81	390	1475	817	1416	487	147
2002	610	619	319	116	464	1605	947	1321	540	221
2003	598	622	359	110	515	1521	851	1146	581	265
2004	499	703	303	156	584	1570	916	1304	674	287
2005	557	563	337	144	482	1518	814	1133	626	244
2006	388	383	269	132	460	1085	554	790	456	210
2007	359	319	188	87	355	697	424	741	411	159
2008	210	223	124	54	237	404	249	473	214	108
2009	143	129	83	37	144	326	162	379	182	73
2010	150	138	88	44	159	367	176	481	208	68
2011	140	119	67	32	121	334	162	438	181	53

Table 4.7: State Comparison of Current Use Penalties on Land Development

	MODEL 1	MODEL 2
Variable	**Estimate Pr(>|t|)**	**Estimate Pr(>|t|)**
CU Program Variables		
Penalty	-0.001 (0.975)	
Penalty Rise (Dummy)		-0.546 (0.516)
Property Tax Savings ($/Acre)	-0.007*** (0.000)	-0.007** (0.002)
Internal Rate of Return (D=1 if IRR< 0)	0.635 (0.423)	-0.110 (0.933)
Enrollment (Dummy, 1=Automatic)	1.110 (0.300)	0.420 (0.810)
Severity of Penalty (Categories)	0.009 (0.968)	-0.319 (0.430)
Land Variables		
% Federal Land (Compared to Total Land)	-0.046 (0.191)	-0.045 (0.317)
% Developed Land (Lag)	0.845*** (0.000)	0.728*** (0.000)
% Land: Rural Transportation	0.712 (0.483)	0.826 (0.571)
Socio-Economic and other Land Conservation Program Variables		
Pop. Change (per 1,000)	0.021* (0.017)	0.016 (0.200)
Farm Dependency Index	-0.185 (0.353)	-0.207 (0.637)
Change in AGLV ($/Acre)	-0.001 (0.496)	-0.001 (0.702)
CRP (Dummy)	-0.680 (0.438)	-0.270 (0.838)
Conse. Easement (Dummy)	0.105 (0.911)	-1.282 (0.379)
Income Tax Credit (Dummy)	0.108 (0.915)	1.516 (0.363)
Conservation Restriction (Dummy)	-0.237 (0.857)	-1.659 (0.349)
Intercept	-0.172 (0.939)	3.810 (0.358)
R-Squared – overall, between, within	0.639, 0.812, 0.545	0.579, 0.757, 0.085

Table 4.8: Current Use Program Influence on Residential Development in New Hampshire

Variables	
CU Program Variables	
CU Percent	-41.678*** (0.000)
Full Value Tax Rate ($/1000 Value)	-887.396*** (0.000)
CU Tax Savings per Acre ($/Acre)	-0.006*** (0.000)
Socio-Economic Variables	
Average Land Value ($)	1.973 (0.399)
Distance to Boston < 50 miles (D : Yes=1)	22.478*** (0.000)
Distance to Manchester < 50 miles (D : Yes=1)	19.715*** (0.000)
Population Change (per 1000)	80.256*** (0:000)
Average Annual Daily Traffic (AADT)	2.949** (0.006)
Intercept	55.672*** (0.000)
R-Squared – overall, between, within	0.069, 0.014, 0.336

Figure 4.1: Comparison of Simulated Property Tax Rates and Actual Property Tax Rates in New Hampshire

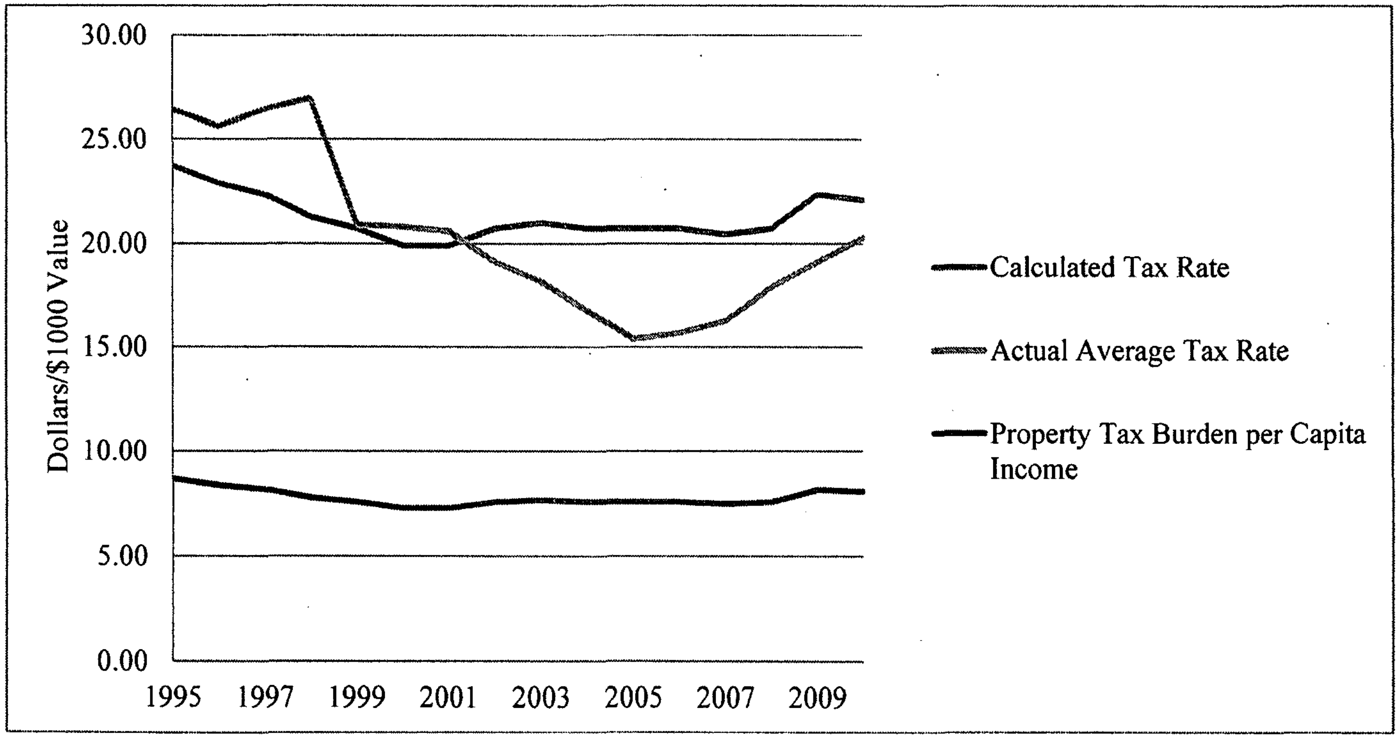


Figure 4.2: Severity of Current Use Withdrawal Penalties from 1987-2007

Severity of Withdrawal Penalty (1987-2007)

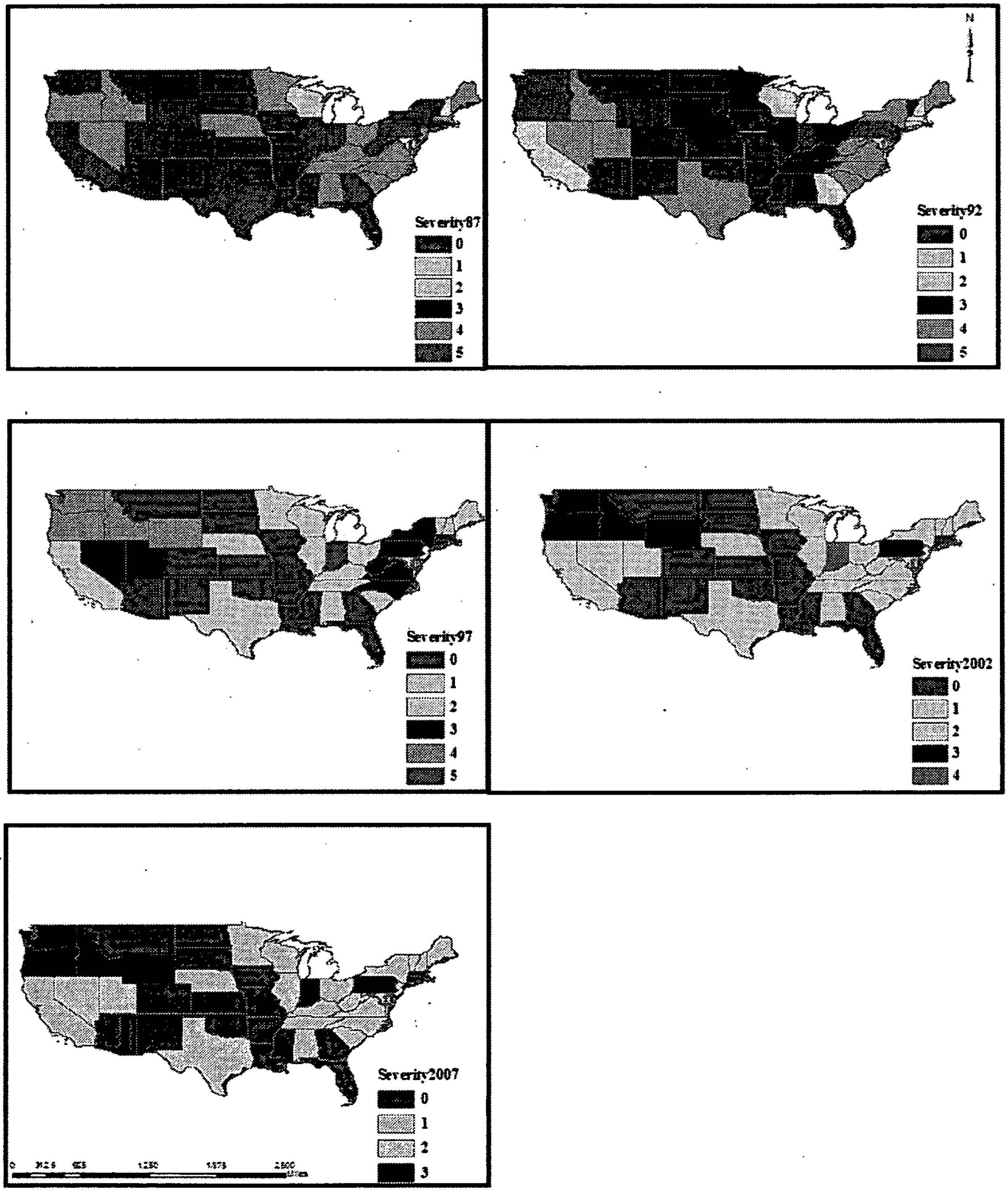
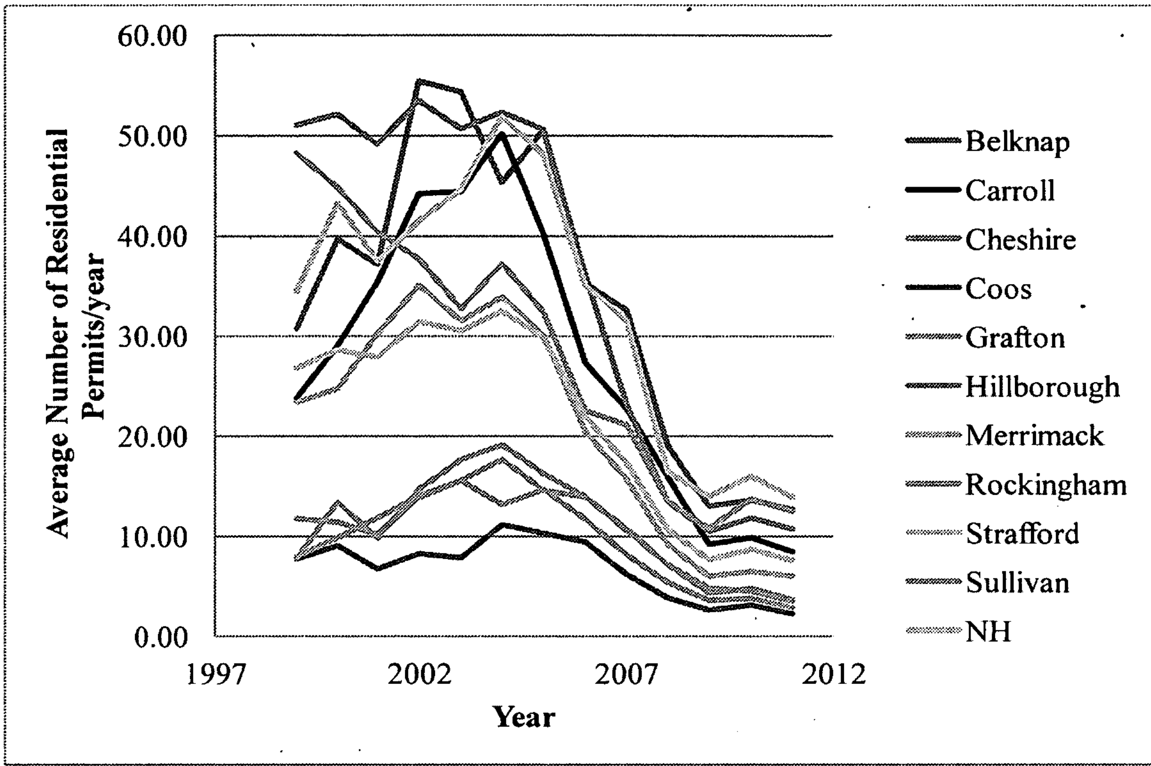


Figure 4.3: Average Number of Residential Building Permits Issued by a Town at County Level



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APPENDIX

A.1 Theoretical Background of Empirical Models Used

This section describes the theoretical background of duration analysis (Danacica & Babucea, 2010; Kiefer, 1988; Klein & Moeschberger, 2005), competing risk regressions and random-effect multinomial logit models used in chapter 3.

A.1.1 Duration Analysis

Duration analysis (also known as event history analysis, hazard analysis or survival analysis) has been used in different fields of study to determine the time periods during which an event is most likely to occur, as well as why the event happened at different periods of time. In logistic regression, the overall probability of an event is considered without regard to the timing of the event. Duration analysis allows for the inclusion of the longitudinal progression of the probability of an event occurrence, considering the timing of the event.

Due to the uncertainty about whether an event could happen before or after the study period, duration analyses are preferred over simple regression or logistic regression (Allison, 1984). Uncertainties regarding the occurrence of an event are known as censoring, in which individuals or jurisdictions of interest have not experienced the event during a period of study or may have experienced the event before the study period. If the end-time is observed beyond the time period, such observations are considered to be right-censored (see figure A.1) and the observations are considered left-censored if the event is observed before the study period (Fox & Andersen, 2005; Kiefer, 1988; Klein & Moeschberger, 2005). Such censoring are due to the lack of control by the researcher over when the event happened or may happen in the future. Right-censored observations are common. Excluding observations of the event from before the study period, known as left truncated, or excluding observations of the event from after the period of study, known as right truncated, would lead to serious sample size reductions. Duration analysis directly deals with such observations, which is advantageous for most of the researchers.

The events that happen could be categorized as discrete versus continuous time events, repeated or non-repeated events and single versus multiple kinds of events. In discrete time events, observations will be grouped or banded into discrete intervals of time, such as for months or years (Allison, 1984; Therneau & Grambsch, 2000). However, the event may happen in continuous time. Unavailability or not reporting of data in continuous time could be the reason for considering continuous time data with discrete events. Considering continuous time data with discrete time analysis is known as interval censoring (Rabe-Hesketh & Skrondal, 2008). In multiple kinds of events, the same individual or the same observations have the possibility of experiencing one event out of multiple events that are studied.

In order to consider various types of data, numerous event history methodologies have been developed in the past. Basic duration model is described in the following section, which expands to describe briefly the Cox proportional hazard model and the survivor function.

In duration analysis, T, a random variable that represents the time of the event, has a cumulative distribution function represented as $P(t) = \Pr(T \leq t)$, where t is the duration of the study. The survivor function, $S(t)$, is the probability that an event has not occurred during the period of study t, and is represented by $S(t) = \Pr(T > t) = 1 - P(\mathrm{t})$. The probability that an event occurred before the time of study is known as cumulative density function and denoted as $F(t) = \Pr(T < t) = 1 - S(t)$. Modeling of duration (survival) data usually employs a hazard function (Kiefer, 1988) or log hazard function. The hazard function, $h(t)$ in general, assesses the risk of an event happening during time t and represented as $h(t) = \Pr(T = t \mid T \geq t)$.

The Cox Proportional Hazards Model: In the duration (survival) analysis, the relationship of survival distribution to its covariates[17] (independent variables of the model) is usually examined. If the covariates $x(t)$ are assumed to be constant over time, the model is referred to as the Cox Proportional Hazard model. The relationship of survival distribution to its covariates is mostly specified as $\log h_i(t) = \alpha(t) + \beta_k x_{i,k}$, where $\alpha(t) = \log h_0(t)$ is the baseline hazard function with the event of interest happening when all the covariates are zero (Allison, 1984; Therneau & Grambsch, 2000). Equivalently, the Cox Hazard model can be represented as $h_i(t) = \alpha(t)\exp(\beta_k x_{i,k})$.

[17] In event history analysis, independent variables are referred to as covariates.

The Survivor Function for the Cox Model: The relative risk or hazard rate (HR) of an event for a binary covariate can be written as:

$$HR = \frac{h_0(t)exp(x_1 \hat{\beta})}{h_0(t)exp(x_0 \hat{\beta})} = exp((x_1 - x_0)\hat{\beta}) = exp(\hat{\beta})$$

Using the above hazard formula, the survivor function for the Cox model can be written as $S(t) = exp(-H(t))$. By writing $H(t)$ in term of $S(t)$:

$$\begin{aligned} S(t) &= exp[-\int_0^t h(u).du] \\ &= exp[-exp(x_i\beta)\int_0^t h_0(u).du] \\ &= exp[-\int_0^t h_0(u).du]^{\exp(x_i\beta)} \\ &= [S_0(t)]^{\exp(x_i\beta)} \end{aligned}$$

A.1.2 Random Effect Multinomial Logit Regression

In many studies, data occur in repeated unordered categorical form. Such repeated measurements may add some correlated errors to the model setting. This section will briefly discuss multinomial logit models, which are used in cross-sectional and longitudinal settings in the presence of unordered categorical dependent variables.

In a cross sectional setting an indirect utility function can be written as $V_{ijt} = \alpha_j + \beta_j x_{it} + \varepsilon_{ij}$, where j represents a unit of observation (hereafter individual) and x_{it} is a set of individual characteristics. ε_{ij} is assumed to be independently and identically distributed (Hartzel, Agresti, & Caffo, 2001; Livote, Ross, & Penrod, 2010). The probability of an individual's choice is:

$$\Pr_{ij} = \frac{\exp(\alpha_j + x_{it}\beta_j)}{\sum_{k=1}^{J}\exp(\alpha_k + x_{it}\beta_k)}, j = 1,2,3.....J.$$

In the case of such longitudinal settings, individual heterogeneity present in an individual is likely to give some correlated errors (Long & Freese, 2006; Rabe-Hesketh, Skrondal, & Pickles, 2004). Including such correlated errors, the above indirect utility function can be written as $V_{ijt} = \alpha_j + u_{ij} + \beta_j x_{it} + \varepsilon_{ij}$, where u_{ij} represents individual heterogeneity. In this random multinomial setting, the probability of choosing an unordered multinomial choice can be written as:

$$\Pr_{ijt} = \frac{\exp(\alpha_j + u_{ij} + x_{it}\beta_j)}{\sum_{k=1}^{J}\exp(\alpha_k + u_{ik} + x_{it}\beta_k)}, j = 1,2,3.....J.$$

A.1.3 <u>Competing Risk Regressions</u>

As discussed in section 3.2.2, standard duration analysis focuses on event-time data that only has a single type of event or failure. In many analyses, treating all the events possible to one outcome would be convenient. However, such aggregation of information will lead to loss of information that is relevant for the analyses. Therefore, distinguishing different possible events or outcomes is important for many researchers. Random effect multinomial logit (RMNL) is one alternative that researchers use to evaluate multinomial dependent variables of interest. Competing risks models are another alternative (Dignam, Zhang, & Kocherginsky, 2012; Sun & Tiwari, 1995; Therneau & Grambsch, 2000). Choosing to use competing risk models over RMNL regression depends on the availability of data and also the type of data available for analyses.

RMNL considers the effect of different independent variables when choosing one alternative over another, without tracking the time of the event. Competing risk models, on the other hand, have the capability to track the time of the event as well as predict the effect of covariates on different alternatives.

Competing risk model is a model used for multiple durations that start at the same time, where the individual or jurisdiction is observed until one of the events being analyzed is occurred. However, we should note that some of the units in the analysis may have also experienced the event before the period of analysis, which we consider as left-censored observations in duration analysis.

One of the common approaches to modeling competing risk models is known as cause-specific or type specific hazard function. In estimating cause-specific competing risk hazard models, the model proposed by Cox in 1972 is widely used (Sun & Tiwari, 1995). In cause-specific models, if the total number of possible events equals *J,* then the probability of an event *j* happening during the time period *t* and $t+\Delta t$ can be written as $P_j(t,t+\Delta t)$. Considering the above probability, the cause-specific hazard rate is written as follows (Allison, 1984; Steele et al., 2004):

$$h_j(t) = \lim_{s\to 0} \Pr_j(t,t+\Delta t)/\Delta t$$

where, each event type has its own hazard function and the overall hazard function $h(t)$ is the summation of all the competing risk functions. The hazard that no event of any type occurs at time t can be given as: $h_0(t) = 1-\sum_{j=1}^{m} h_j(t)$. With covariates ($x_i$), the above hazard rate can also be expressed as:

$$h_j(t,x_i) = \lim_{\Delta t \to 0} \frac{\Pr(t \le T \le t+\Delta t \mid T \ge t, x_i)}{\Delta t}$$

The overall hazard rate is represented by $h(t) = \sum_j h_j(t)$.

Based on the above, the probability of the occurrence of an event j can be given in the following cumulative incidence function (CIF):

$$I_j(t) = \int_0^t h_j(u)du = \Pr(T \le t \text{ and } J = j)$$

Competing risks can be modeled simultaneously using a multinomial logit, or used to consider competing risks separately, treating all other events as censored (Sun & Tiwari, 1995). In estimating competing risk models, two approaches are widely used (Dignam et al., 2012). The approaches are using Cox Proportional Hazards model to obtain cause-specific hazards, and using the Fine and Gray model to obtain cumulative incidence rates.

In the Fine and Gray model, cumulative incidence function (CIF) is considered to be a survival function, and underlying hazard is calculated (Fine & Gray, 1999; Steele et al., 2004). The hazards of the Fine and Gray model are referred to as sub-hazard and denoted as $\bar{h}_j(t,x)$, where $\bar{h}_j(t,x) = -\frac{d}{dt}\log(1 - I_j(t,x)) = \frac{h_j(t)}{1 - I_j(t)}$

$$= \bar{h}_{j0}(t)\exp(x_i\beta_j)$$

$\bar{h}_{j0}$ is the baseline sub-hazard for type j events, and $\exp(x_i\beta_j)$ is the relative risk associated with covariates x.

Figures

Figure A.1: Censoring