AGRICULTURAL CONSERVATION EASEMENTS AND ON-FARM INVESTMENT

by

Conner Jacob McCollum

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ABSTRACT

Land represents the largest asset for farmers to use in securing collateral-based loans. Traditional lending appraisals may or may not take into account the capitalized future development value of the land, particularly in securing operating notes. Conservation easements may offer an alternative to obtaining financial capital while maintaining the agricultural use of the property and retaining access to operating notes through traditional lending channels. We assemble a national panel dataset to measure the relationship between conservation easement enrollment and on-farm investment with the goal of answering the question: "Do conservation easements result in subsequent reinvestment in agricultural operations, and if so, what types of agricultural reinvestment occur?" The results of our study indicate that conservation easements may allow smaller farming operations to persist using a less capitally intensive structure under areas of urban influence. The study contributes to policies regarding the utilization of capital liquidity generated by conservation easements as well as the effectiveness of conservation easements in increasing credit access to smaller farmers. Moreover, our study suggests that agricultural conservation easements may lower barriers to entry in securing farm ownership through both lowering overhead costs in addition to a reduction in the market value of the property.

INTRODUCTION

Land is a fundamental input in agricultural production. The foundation of any farm operation is its land, which allows agricultural producers to build and finance their enterprise. For the 61% of producers who own at least a portion of their operated land, land and other farm real estate is the primary store of producer wealth, representing approximately 81% of farm sector assets on the industry balance sheet (Census of Agriculture, 2017; USDA ERS Farm Wealth Statistics, 2022). Farmland is also often used as collateral by producers in securing operating notes. The market value of the land reflects the net present value of the discounted expected streams of income produced on the land, including the expected development returns produced by the property at some future time. It is unclear of the extent to which future non-agricultural uses are accounted for in agricultural lending appraisals, creating an incentive for producers to free up capital equity embedded in the land through other methods. Conservation easements may offer an alternative to obtaining financial capital while maintaining the current use of the farm operation.

Conservation easements (CEs) have become a popular method of preserving soil and water quality, wildlife habitat, and the amenity values of land and open spaces. Currently, more than 61 million acres of land are under conservation easements in the United States (Land Trust Alliance, 2021). CEs allow landowners to extract the capitalized future difference between the development value and agricultural use value of the property through the donation or sale of development rights. As voluntary contracts that remove the development rights of a property permanently, CEs are most often entered into by agricultural landowners at the rural-urban fringe (or in peri-urban areas) where land values reflect capitalized future development potential. To understand how CEs work, consider the “bundle-of-sticks” metaphor used to describe property ownership in modern legal terms as a collection of rights (Hohfeld, 1917). Landowners hold a “bundle of sticks”, each of which represent an individual right of the property. The right to develop or subdivide the property make up one of these "sticks". CEs remove this particular right from the landowner's bundle, and place it in the hands of an agency or land trust to safeguard against the future development of the property. These easements are designed to attenuate the negative externalities of urban sprawl at a lower cost than outright fee-simple acquisition (Arnold et al., 2013).[1]

As one example of how CEs have been considered from a farm financial standpoint, the Iowa Natural Heritage Foundation proposed the Agricultural Land Trust (ALT) program in the 1985 Farm Bill as a means of utilizing conservation easements to aid farmers and ranchers in debt restructuring. The program was designed with the intent of aiding landowners who were endangered financially, but would also result in a reduction of the downward pressure on land markets during the time, and provide relief to the agricultural finance sector. In addition, the ALT program would provide a public benefit generated by the government, aiding in the betterment of soil, water, and open- space conservation in the United States (Hamilton, 1986). The 1996 Farm Bill broadened the scope of the ALT program through the passage of the Federal Farm and Ranch Protection Program (FRPP), a precursor to the current Federal easement program, known as the Agricultural Conservation Easement Program (ACEP) (American Farmland Trust, 2022). ACEP provides financial assistance to land trusts/non-governmental organizations for generation of agricultural land easements, and only provide financial assistance directly to landowners for wetland reserve easements. Therefore, ACEP represents a very small proportion of overall easement holders in the United States . The largest easement holders are nonprofit organizations known as land trusts that actively work to conserve land through the acquisition of conservation easements. Land trusts range in size and scope from local grassroots groups to national organizations (Land Trust Alliance, 2021). For a landowner, apart from the non-monetary benefts of maintaining the rural amenities from their land, the financial benefits of easements can

[1]Urban sprawl refers to excessive low-density development at the urban fringe and consequential spillover effects in rural areas (Nechyba & Walsh, 2004).

take one of three forms, namely income tax deductions, credits, and direct cash influxes. Together, these land trusts and the ACEP present an opportunity for operators (who are often land rich and cash poor) to extract some of the equity tied up in the value of their property, while allowing the landowner to maintain the current agricultural uses of the land.

This paper addresses the following questions: Do CE adoptions result in subsequent reinvestment of physical capital stock among agricultural operations? If so, what types of investment occur? This study contributes the first observational analysis of how easement enrollment influences farm investment decisions. By using a comprehensive national panel dataset on easements and investment, our paper builds on and extends prior work in this area, which studied investment behavior using surveys administered in relatively narrow geographic regions. The longitudinal nature of our data allows us to exploit variation in the timing of easement adoption across counties, while controlling for various unobserved factors correlated with easement enrollment. Using data from the Census of Agriculture, we explore a range of investment margins, including on-farm expenses, machinery asset values, and operation size. Furthermore, the national scope of our data enables us to explore heterogeneity in the effects of interest across various dimensions, including urban pressure, amenity value, and geographic region. The results of the paper illustrate that current levels of conservation easement adoption across the United States may not be large enough to generate county-level investment outcomes. Nevertheless, the study provides the first observational analysis of the relationship between conservation easement adoption and farm investment, and determines that easement enrollment may spur agricultural investment and allow smaller farms to persist using a less capitally intensive structure, particularly in areas of increasing urban influence.

Adverse incentives and selection effects may cause banks to impose interest rate restrictions and ration small farms out of the credit market, resulting in a market failure in agricultural lending operations (Carter, 1988). Organizations and agencies committed to land conservation projects may provide an opportunity to atone for this market failure through the acquisition of conservation easements. The existence of imperfect farm credit markets paired with the potential for credit constraints to some agricultural landowners implies that conservation easements may act as an alternative in accessing this constrained capital. Agricultural landowners that are best incentivized to dissolve their development rights and enroll their property into a conservation easement are those that are constrained by some credit access availability and where their land has development potential. Briggeman et al. (2009) describe credit constraints as imperfections in capital markets wherein select borrowers cannot access capital at the current interest rate, access less than they would optimally choose (credit rationing), or do not even apply for credit because they anticipate denial. Capital markets have a bearing on the macro-economic environment surrounding the agricultural sector, including impacting technology adoption and the rate of return guaranteed by investments. At the individual level, credit constraints offer an explanation of the economic decisions of the operator/owner and how they allocate scarce financial resources (Briggeman et al., 2009).

Utilization of capital liquidity generated by CE program enrollment has largely been examined with original survey work at a micro-level, with a variation in findings/implications due to differences in the populations surveyed, survey design, and the objectives of the studies conducted. A number of papers survey CE participants in a single state (Maynard et al., 1998; Duke and Ilvento, 2004; Lynch et al., 2007) and a couple of papers have surveyed CE participants across multiple states (Esseks et al., 2013, Duke et al., 2016). The results of these papers are varied, but each found evidence that landowners enrolled in CEs were more often owner-operators of much larger farms. Liquidity generated by CE enrollment was notably used for personal needs, debt service, and reinvestment in agricultural operations.

This paper proceeds as follows. In the first section, we provide a descriptive overview of how conservation easements work and how they are used in practice in addition to the benefits of agricultural investment. We detail prior literature in the second section, examining CE enrollment, farmland amenity valuation, CE program effects, and CE payment use. The third section examines the conceptual theory behind on-farm investment patterns, and motivates the connection we make with conservation easement enrollment in the third section of the paper. We further examine the data available in the fourth section and describe the methodology and empirical strategy of the study in detail in the fifth section, concluding with a review of the model specification used. The sixth section examines the results of our question, across various model specifications and robustness checks. Concluding remarks, including a discussion of policy implications and avenues for future research, are provided in the final section.

BACKGROUND

Easements are, in general, a collection of one or more rights held by an individual entity with respect to another individual entity's property. The landowner maintains ownership of the property, while the secondary party will purchase or maintain certain rights associated with the parcel. Easements can be affirmative, allowing an individual access or use of another individual's property, or negative, which forbids the allowance or use of another individual's property. Easements represent an agreement between one entity and another. The agreement can be a simple handshake between neighbors, or it can be more formalized through the use of a legal contract. The former is typically a transitory agreement that lasts only as long as the original parties involved wish, whereas the latter can be either transitory or permanent. Permanent easements "run with the land", or remain tied to the parcel, rather than the owner of the parcel. If the original owner decides to sell their property, the property is sold in a market for restricted land, and is often marketed as "under contract" (Clark, 1928).

Conservation easements (CEs) are a type of negative easement that restricts the landowner's right to develop the property in order to protect its environmental value. This acts as a private and voluntary form of land use zoning (Parker & Thurman, 2018). Conservation easements are typically formalized through a written contract between a landowner and a land trust or governmental agency. Although there are transitory conservation easements in the United States, most conservation easements are permanent contracts. This is due in part to the incentives present for enrolling land in easements, as well as to the permanent nature of the environmental value of the property. The contractual agreement between the landowner and the easement holder results in a forfeiture of some or all of the development rights of the property. However, further restrictions can be agreed upon by the landowner and the contractual body, and specific allowances are also permissible (e.g., such as low-density rural residential housing).

CE programs take one of two basic forms, either the purchase of development rights/purchase of agricultural conservation easements (PDR/PACE) or the transfer of development rights (TDR) (Lynch et. al., 2007). Purchases of development rights result in a net cash value to the landowner, whereas donated easements result in income tax deductions or credits roughly equivalent to the cash value received for PDR contracts. Landowners can enter these contracts by voluntarily agreeing to either donate (through a TDR) or sell (through a PDR or PACE) the rights to develop their property, and a private organization or public agency will act as the contractual agency, maintaining the development rights under these contracts.

Agricultural conservation easements represent the sector's most commonly used tool for preserving farmland (Squires & Gustanski, 2000). Today, more than 6.5 million acres of farmland are protected from development by agricultural conservation easements (American Farmland Trust, 2022). CEs offer an opportunity for landowners to extract the developmental value while maintaining the agricultural use of the property. This can act as an influx of capital for landowners who are often highly leveraged with much of their net worth tied up in depreciable assets and the land itself, without affecting their ability to secure future operating notes. The capital generated by these contracts may be related to the efficiency of the farm economy as a whole, enhancing some farmer's ability to adopt new technologies, re-invest in their agricultural enterprises, and adjust their operations to remain competitive (Duke et. al., 2016).

The Farmland Protection Policy Act of 1981 gave the federal government the first opportunity in preventing the conversion of agricultural land, and the farm bills of 1990, 1996, and 2002 authorized additional funding in the purchase of agricultural conservation easements (American Farmland Trust, 2022). Conservation programs generated under this legislation include the Conservation Reserve Program (CRP), the Wetlands Reserve Program (WRP), Grassland Reserve Program (GRP), Forest Legacy Program (FLP), and the Farm and Ranch Lands Protection Program (FRPP). The FLP and FRPP act as the agricultural easement arm of the federal government. The FLP is made up of approximately one million acres, while the FRPP is made up of 500,000 acres. However, it is important to note that the 2002 Farm Bill authorized the transfer of federal funds to

NGOs for easement purchases (American Farmland Trust, 2022). Therefore, the Farm and Ranch Lands Protection Program is likely a large contributor to the continued success of state government and non-governmental organization efforts. Non-governmental organizations (NGOs) make up the largest portion of conservation easement holders in the United States (NCED, 2021). NGOs are non-profit groups that function independently of any government, and include high-profile organizations such as Greenpeace, the Nature Conservancy and Nature Friends International. There are 1,281 active land trusts currently operating in the United States (Land Trust Alliance, 2021).

Enrollment in CE contracts offer a number of advantages to landowners besides the promise of maintaining the ecological or farming/ranching landscape for generations to come, primarily through capital payments and tax advantages. The most obvious concession for enrollment in a CE contract is a lump sum cash payment, wherein the landowner sells their development rights to a private organization or public agency through a PDR or PACE. The value of this lump sum payment represents the difference between the agricultural land use value and the appraised market value of the land including developmental value. However, PDR/PACE represent a small percentage of the total easement contracts in the country. Non-profit organizations and public agencies are often restricted by budgetary constraints, which limits the total acreage of easements enrolled through PDR/PACE. If the landowner donates their development rights, the donation is considered a tax-deductible charitable donation by the IRS and qualifies for a reduction in federal and (sometimes) state taxes (Internal Revenue Service, 2017).

Federal income tax deductions for easements received statutory grant of authority in 1976. Prior to 2006, the income tax benefits of charitable deductions were capped to 30% of the taxpayers adjusted gross income (AGI) and the carryover period of the tax advantage was capped at 6 years. The carryover provision, specified by the IRS regarding charitable contributions, allows a landowner to utilize tax advantages following enrollment in subsequent years up to the expiration of the carryover period. This cap has since increased to 15 years with an allowable deduction ranging from 30% to 50%, and as much as 100% of AGI for qualifying farmers. Both PDR and TDR contracts result in the forfeiture of the development rights of the parcel, effectively lowering the market value of the property. This results in lower estate taxes and property taxes for the property if their property is assessed at market value. Provided the value of the property is properly assessed at use-value, there would be a null effect of conservation easement enrollment on the property value and subsequent property taxes on the parcel. However, conservation easements have been shown to increase the property values surrounding the parcel, potentially increasing the property taxes of the county or area as a whole (Engle et al., 1992; King and Anderson, 2004; Geoghegan et. al., 2003).

In addition to the federal tax policies enacted through congress related to the treatment of conservation easements, there are a number of state-level tax policies that act as supplementary incentives for conserving agricultural land. Typically, these policies result in an additional state tax credit above and beyond the federal tax credit offered through the Internal Revenue Service to use as a dollar match credit towards the payment of state income taxes. States offering income tax credits include: Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Iowa, Maryland, Massachusetts, Mississippi, New Mexico, New York, South Carolina, and Virginia (State Tax Credits for Donation of a Conservation Easement, 2019). Credits offered range from 25% of fair market value to 50% of fair market value, usually capped from $50,000 to $375,000 per easement. The transferability and the carry-forward period of these policies is heterogeneous across states. Some states, including Colorado, Georgia,Virginia and New Mexico, offer transferable income tax treatments. This means that a taxpayer with a low AGI can sell the tax credits to a non-donating taxpayer with a higher AGI to reap the total tax benefits of the easement. This effectively undoes the AGI limits imposed by the IRS. Moreover, while most states offer a carry-forward period on the tax credits unused of 5 to 15 years, South Carolina offers an indefinite carry-forward period.

Ivashina et al., (2021) describe four main ways to secure capital through lending, (i) asset-based loans, (ii) cash-flow loans, (iii) trade finance agreements, and (iv) leases. Each are defined by the net recovery from the sale of collateral that is presented by the borrower. Asset-based loans, as their name suggests, are created through a borrower's pledge of specific assets on their operation as a way to secure the loan. Cash-based loans, on the other hand, generate a senior claim on the proceeds from asset liquidations of the operator. Oftentimes, the collateral of cash flow loans are considered to be less durable, have lower liquidation value, and have lower pledgeability than that of asset based loans (Ivashina et. al., 2021). Thus, agricultural lending for property is often secured through asset-based loans, which rely heavily on the initial wealth of the proprietor.

The initial wealth of an agricultural proprietor is often primarily made up of the equity position on the land that they own. Land wealth, then, serves as the main type of collateral used in agricultural asset-based loans. Increases in the equity position of their land holdings, either through paying down debt or through unrealized capital gain from land appreciation, offer an increase in the collateral value available to the landowner when approaching a lender (Weber and Key, 2015). The increase in collateral represents a decrease in the risk of default to the banker, and a decrease in the cost of borrowing to the borrower. CEs provide an opportunity for a landowner to extract the developmental value of the property while maintaining access to traditional operating notes if the property was appraised at use-value. The value of the collateral would not differ between properties with and without a conservation easement provided the property was appraised at agricultural use-value.

LITERATURE REVIEW

This review of the economics literature surrounding conservation easements focuses on five major areas: (1) motivations for conservation easement contracts, (2) CE payment/tax credit uses, (3) farmland amenity valuation, (4) the effects of conservation easements on agricultural and non agricultural land values, farmland retention, and property taxes, and (5) CE program efficiency.

Motivations for Conservation Easements

The theoretical discussions surrounding the theory of voluntary provisions of public goods are numerous, and since Becker's (1974) paper entitled "A Theory of Social Interactions", economists have examined the social and fiscal implications of charitable giving (Becker, 1974). Although charitable giving is often considered to be motivated through altruism, there are numerous private benefits that influence the decision to give in the first place, including a private enjoyment in the actual act (Kamien Schwartz, 1970; Taussig, 1967; Becker, 1981; Andreoni, 1985; Bergstrom et al., 1986; Auten et al., 2002).

Although conservation easements are generally considered to be a charitable gift, tax incentives may play a larger role in the decision to enroll than private utility benefits from knowing the land will stay in agriculture. The literature provides evidence of differing motivations generated by offsetting incentives and informational asymmetries across states, individuals, and at different points in time between predictions and economic theory. We will examine (1) land preservation and (2) tax incentives as the primary motives for determining enrollment of a parcel in an easement. Studies examining land preservation examine why individuals give in the first place, what their utility function looks like, and how this impacts social welfare. Studies examining tax incentives, on the other hand, examine personal and business debt, farm size, and relative access to financial aid programs for landowners.

Conservation easements make up the single largest charitable gift on a per-donation basis in the United States (Parker & Thurman, 2018). Although we are unable to exactly specify an individual's reasons for enrolling land into an easement, it seems reasonable to assume that, on average, the decision represents an interaction between altruistic tendencies and private benefits. On one hand, there are a number of studies illustrating the motives present due to the conservation benefits of the easement, particularly for landowners who derive some utility out of maintaining ownership of their land across multiple generations. Lynch & Lovell (2003) determined that participation in conservation easement programs was influenced positively with farm size, growing crops, if a child plans to continue farming, eligibility, and the share of income from farming. Distance to city center was a negative influence on likelihood of enrollment (Lynch & Lovell, 2003). This suggests that participation was determined less by financial motivations, and more by a connection to the land and the protection of the property from development. Moreover, Farmer et al. (2011) utilized a survey approach in the Midwest, questioning landowners on motivations for enrollment, including: place attachment, environmental, witnessing land development, societal, open-space protection, family heritage or legacy, culture, community, and financial incentives. Place attachment was determined to be the most significant reason for conservation, and financial incentives were deemed to be lowest ranking as reason for enrollment. Furthermore, the results of the paper imply that a landowner's relationship with giving underlaid several of the strongest motivational factors for participation. However, 23% of survey responders indicated that they would not have adopted the easement without the financial incentive (Farmer et al., 2011).

The primary fiscal advantage of conservation easement enrollment is the charitable donation incentives embedded in the United States income tax code. The incentive was first introduced in 1976 as a step in converging towards a more decentralized, incentive-based approach of protecting land from development. Parker & Thurman (2018) offer a framework for understanding the recent rise in easements and land trusts, including an analysis of the current treatment of easements in the tax code. The framework emphasizes measurement and monitoring costs, developed from Ronald Coase, Oliver Williamson, and Yoram Barzel, faced by stakeholders under current policy arrangements. They provide the most recent examination of price elasticities with regards to state-level easements, indicating that tax incentives are a motivating factor behind conservation, rather than an additional contribution to conservation. The results of their study provided significantly large elasticity estimates, ranging from -2.4 to -6.1, implying tax incentives have considerable effects on conservation easement enrollment outcomes (Parker & Thurman, 2018). This follows from earlier research detailing individual decisions of charitable giving under tax law. For example, Randolph (1995) estimated an econometric model of charitable giving across a ten year panel of tax data. The results of his paper imply that intertemporal income variations combined with progressive marginal tax rates influence the way people plan their charitable donations. In addition, the paper determines that giving itself is much less price elastic than it is income elastic (Randolph, 1995). In other words, individuals tend to increase their charitable giving to take advantage of unusually high transitory tax rates. Furthermore, Auten et al. (2002) examined the differing effects of transitory and permanent income on charitable giving. The results of the paper imply that transitory income effects have a substantially reduced effect on charitable giving than persistent income shocks (Auten et. al., 2002). Backus & Grant (2016) determined the existence of significant downward bias in the estimate of price elasticity using survey data. The results of the paper suggest that estimates of price elasticity have been systematically overestimated by more than -1. They established that there exists an inelastic tax-price elasticity for the average taxpayer (whom are often unaware of marginal changes in tax treatments of charitable gifts) (Backus & Grant, 2016).

Although there are conflicting theories regarding land preservation and tax incentives as the main driver for land conservation through agricultural easements, the mechanism for why some landowners would enroll their property in an easement for the tax incentives present is described in Carter (1988). The paper describes that even under an unrestricted setting, adverse incentives and selection effects may cause banks to impose interest rate restrictions that ration smaller farms out of the credit market. Carter describes that a credit market equilibrium may arise in which farms with equal productivity and risk characteristics are offered different loan contracts depending on the size of the operation. The paper references that banks may "statistically discriminate" against smaller operations when they rely on farm size as an imperfect method of determining credit worthiness (Carter, 1988). This leads to the motivation that some landowners, particularly of smaller farms, may turn to conservation easements as a way of extracting equity out of their operation. However, Duke (2004) developed a trivariate probit model and found that small parcel owners faced by development pressures were more likely to enroll in commodity programs instead of preservation programs, particularly if the parcel was of relatively low environmental quality (Duke, 2004). Owners of small parcels with low levels of environmental quality and high levels of development pressure will no doubt find it advantageous to delay enrollment with the expectation of receiving the full developed value of the property in a lump sum when the city perimeter moves outward.

Landowner motivations for enrolling in CE contracts is a significantly larger area of research than land trust motivations. Bastian et. al. (2017) examined differing preferences for conservation easements among landowners, enrolling agencies, and land trust professionals. Both landowners and land trusts were more likely to choose CE programs that were permanent, were positively motivated by community or place attachment, and were positively affected by conservation of wildlife habitat. However, public access was negatively associated with landowner choice, control of agricultural operations was positively associated with land trust choice, and higher offered benefits were associated with an increase in likelihood to accept by the landowner, and a decrease among land trusts. Informational asymmetries between landowners and land trusts have generated significant costs to efficiency in likelihoods of enrolling ground into CE programs (Bastian et al., 2017). In addition, land trust characteristics and preferences vary across the location and goals of the local programs. Cropper et al., (2012) determined from stated-choice survey's sent to land trust agents across the Intermountain West that preferences for contract length, protection of wildlife habitat, and land trust control over production practice decisions is positively associated with all land trust preferences, but public access and growth pressure is negatively significant for ecosystem oriented land trusts (Cropper et al., 2012).

The easements enrolled in the United States reflect the preferences of the landowner and the land trust simultaneously. For example, Rissman et al (2007) surveyed The Nature Conservancy staff responsible for nearly 120 conservation easements between 1985 and 2004. Most easements were designed to provide core habitat and/or reduce development. Some further development was permitted on 85% of sampled conservation easements, including over half of the easements allowing additional buildings (although under a restriction to size or building area). Furthermore, working landscape easements, such as those held under ranching, forestry, or farming made up nearly half of the properties sampled (Rissman et al., 2007). It appears that the design of the easement was associated with protecting habitat and reducing development, as long as the property remained unrestricted in its initial land use value.

CE Payment/Tax Credit Uses

Investments in agriculture can result in direct productivity improvements for farmers and ranchers across the agricultural economy (Zepeda and Food And Agriculture Organization Of The United Nations, 2001). Although the relative importance of the agricultural economy diminishes with the development of a country, the U.S. agriculture sector extends beyond the farm business to include a range of industries including food service and food manufacturing. The USDA Economic Research Service indicates that agriculture and its related sectors, including food, food service, and food manufacturing contributed $1.109 trillion to GDP in the U.S. in 2019, with $136.1 billion of this being made up of the initial agricultural output. These numbers represent over 5 percent of overall gross domestic product in the United States and are biased downward, as they do not consider sectors related to the agricultural industry that rely heavily on agricultural inputs in order to contribute added value to the economy (i.e., food stores, textile and apparel, etc...) (USDA ERS - Ag and Food Sectors and the Economy, 2017). Moreover, agriculture and its related industries contributed 19.7 million jobs in 2020, 10.3 percent of U.S. employment and in 2019, 13 percent of American household's expenditures were spent on food, the third largest category in American spending (USDA ERS - Ag and Food Sectors and the Economy, 2017).

As stated previously, there is motivation for conservation easements being used to access capital initially tied up in the asset value of the operation. The capital that is realized from this endeavor could be used as investment towards the operation, driving productivity and revenue. The most precise economic definition of investment is a change in the physical capital stock or physical inputs that have a useful life of one year or longer. These inputs include land, equipment, machinery, storage facilities, and livestock. Put simply, investment is a change in the fixed inputs used in the production process. The FAO describes that a key characteristic of investment is its irreversibility, or asymmetry. Investments in agriculture are often considered sunk costs, and result in acceptance of an asset whose value fluctuates. Under uncertainty, investment will be less than the expected present value of investment, the difference being attributable to the irreversibility of industry-specific investments. These asymmetries are exacerbated by agro-climatic factors in agriculture, particularly when land can only be used for one crop. Physical capital stock, excluding land, employed for farming and ranching have few other alternative uses besides agriculture, and are relatively unavailable to transfer when compared to other forms of capital. Farmers are often reluctant to invest in equipment and other improvements because of this added uncertainty (Zepeda and Food And Agriculture Organization Of The United Nations, 2001). Fixed asset theory hypothesizes that it is more difficult to dispose of capital specific to agricultural production than to add to the stock of specialized capital (Nelson et al., 1989). Thus, we expect to see greater periods of depreciation as compared to investment in agriculture, resulting in net negative agricultural investment in any given year. Consequently, farmers and ranchers are likely only to invest in years of abnormally high profit or when borrowing costs are low (Zepeda and Food And Agriculture Organization Of The United Nations, 2001).

Weber and Key (2015) examined increases in wealth due to rapid appreciations in agricultural land and their resulting effects on farm-level decisions associated with borrowing and expansion.

The results of the paper indicate that real-estate secured borrowing is inelastic with respect to increases in wealth, with an average of 48 cents borrowed on real property for every one dollar increase in wealth for younger farmers. Older farmers, on the other hand, were associated with a weak negative effect between wealth and interest expenses (the causal variable associated with debt) (Weber and Key, 2015). Real increases in wealth may be more readily associated with decreases in borrowing and increases in investment. This lends itself to a mechanism of conservation easement payments and tax advantages being used for investment in agricultural operations. Adverse incentives and selection effects may cause banks to endogenously impose interest rate restrictions and ration small farms out of the credit market (Carter, 1988). Thus, smaller farms may utilize conservation easements as a way to generate capital necessary for remaining competitive and investing in technology that bolsters productivity.

There is a significant amount of research regarding the use of payments or tax credits generated by conservation easements. These studies have, for the most part, been conducted on a micro level with original survey work. For example, Maynard et al. (1998) examined a survey of agricultural CE participants in Pennsylvania with the goal of investigating the heterogeneity of the initial easement program participants. They found that debt reduction was the largest use of easement sale proceeds, followed by savings and farm capital purchases (Maynard et al., 1998). Moreover, Duke & Ilvento (2004) surveyed conservation easement owners in Delaware and determined that 65% of owners reinvested in their operation. Half of owners stated that the CE program "provided critical funding to improve the financial viability of the operation" (Duke & Ilvento, 2004). Lynch et al. (2007) surveyed landowners both enrolled and not enrolled in CE's in Maryland and found that 42% who enrolled in a conservation easement did so to reinvest in their farming operation (Lynch et al., 2007). Esseks et al. (2013) surveyed 506 owners across many states that received benefits from CE's from the Federal Farm and Ranch Lands Protection Program (FRLPP), 84% of FRLPP survey respondents allocated some of the benefits to agricultural purposes (Esseks et al., 2013). Furthermore, Duke et al. (2016) conducted a state wide study of

Delaware, Maryland, and New Jersey and determined systematic patterns of investment among landowners in terms of farm profitability and other characteristics. Their results suggest that profitable owners and non-operators are more likely to use CE payments for needs outside of their agricultural enterprise. In contrast, non-profitable owners and operators reportedly tended to reinvest in the agricultural operation (Duke et al., 2016). The consensus in the literature is that although some farm owners are using this liquidity to fund personal needs, many are reinvesting to improve the financial health of their farming enterprise.

Farmland Amenity Valuation

The valuation of conservation easement land is inherently based on a counterfactual scenario of the parcel being developed, which is unobserved by easement value appraisers. Plantinga (2007) describe the three commonly used methods for valuation of conservation easements as: (1) the comparable sales method, (2) the before-and-after method, and (3) the income approach (Wiebe, Tegene, and Kuhn, 1996). The comparable sales method uses similar conservation easement sales to determine the value of the easement. This is what the IRS deems as their method of determining the value of the charitable contribution. However, the IRS requires a "substantial record" of comparable easements both regarding location and easement terms. The before-and-after method compares the value of unrestricted parcels to those restricted by similar conservation easements. It is worth noting that the before-and-after method builds on the comparable sales method, which is necessary to determine the before valuation of the property. The restricted parcel can be valued by a zoning classification method, a hedonic pricing equation using sales prices and the attributes of the property, or else by determining the present value of income from the property in its restricted setting. The income approach is accomplished by directly estimating and comparing the net present value of the discounted income streams associated with the restricted and unencumbered parcels. The comparable sales approach is a more practical approach to valuing unencumbered property, whereas determining the net present value of discounted income streams from a property that is restricted purely to agricultural use (as after the placement of an easement) is somewhat more straightforward (Plantinga, 2007).

Although the majority of the valuation is made up of the developmental value of the parcel, there are a number of positive externalities that should be considered when the value of an easement is determined. A large number of studies have been conducted in North America measuring amenity values generated by farmland. Bergstom & Ready (2009) summarize the results of these studies in detail. The consensus of these studies points to acreage, regional scarcity, alternative land uses, public accessibility, productivity quality, human food plants, active farming, and intensive agriculture as the main drivers of impacting farmland amenity valuation. Furthermore, there is somewhat inconclusive evidence regarding distance, agricultural land use, unique landscape features, property rights, and non farmland amenity substitutes to farmland amenity valuation (Bergstrom & Ready, 2009).

CE Effects

There are a number of studies that have examined the effects of conservation easement programs on the agricultural economy. The most prevalent of these studies have examined effects among farmland prices, farmland retention, and property taxes.

Farmland Prices

Economic theory predicts that sale prices for preserved parcels should be lower than unpreserved parcels, ceteris paribus, given that a reduction in the rights accompanying the parcel's sale would be associated with less value. Expectations of farmland price reductions resulting from enrollment in these programs grounded in economic theory are not always observed. In fact, conclusions generated regarding the effects of conservation easement enrollment on farmland prices are somewhat inconsistent.

Analyses of impacts on farmland prices, primarily using hedonic analysis with selection effects are most prevalent. Nickerson & Lynch (2001) tested the effect of development restrictions imposed by conservation easements on farmland prices in Maryland using a hedonic approach. Although they find that the preserved parcels' actual land values are lower, they note that the effects are generally insignificant. Their methodology is based on the Heckman selection model, which assumes a particular functional form for the price equation. Their results imply that agencies may have a basis for reducing easement payments, as land values are not reduced by the full value of development rights. Furthermore, they find that preservation agencies favor larger parcels over smaller ones and parcels near preserved parcels in assessing conservation values (Nickerson & Lynch, 2001). Lynch et al. (2007) re-examined the impact on sales prices using a significantly larger data-set in Maryland using both a hedonic regression and propensity score approaches. The results of their hedonic approach established significant reductions in prices for preserved parcels over unpreserved parcels, ranging from an 11.4% to 16.9% decline in value. However, the results of their propensity score approach take advantage of the distance to the closest preserved parcel, and find that the estimated impacts on farmland values diminish in magnitude approaching preserved parcels. Landowners are not enrolling in preservation programs where the land values are likely to become high (Lynch et al., 2007). In other words, high land valuation driven by developmental pressures are likely disincentivizing landowners from enrolling in conservation easements.

Schilling et al., (2013) provide some explanation for the somewhat incongruous results developed by Nickerson and Lynch (2001) and Lynch et al. (2007). Schilling et al., (2013) developed a hedonic model for the preserved farms of New Jersey, and determined that residual development options retained under farmland deeds of easements have significant and positive effects on preserved farmland prices. Their results suggest (1) land enrolled in easements are considered to be roughly the same value as an identical parcel that is undeveloped and (2) that agricultural easements are over-valued, suggesting that the appraisal process is flawed in assuming CE enrollment lowers the farmland value to the capitalized agricultural rents in areas of urban influence (Schilling et. al., 2013). Lawley and Towe (2014) considered the southwestern region of Manitoba using a propensity score approach and found a significant decrease of $86 per acre discount in the value of preserved parcels over non-preserved parcels. Their results further indicate that landowner's received a premium of roughly 16% over the developmental value of their parcel when enrolling in an easement (Lawley and Towe, 2014). This supports the theory that conservation easements may not lower the value of a parcel to the capitalized agricultural rents, and that the CE appraisal process may be somewhat flawed in determining the development value of an agricultural parcel under urban influence.

An additional section of research examines the effects of conservation easements on the value of parcels close to the land preserved through these easements. For example, Irwin (2002) estimated the effect of open space on residential values using an instrumental variables approach. The instruments used in this study were (1) an indicator variable of the steepness of a parcel's slope, (2) an indicator variable of the drainage potential of the soil, (3) an indicator variable for prime agricultural soils, and (4) distance from two urban centers. The results of the study indicate that farmland preservation programs are associated with a premium for residential property values and support the hypothesis that open space is most valued for providing an absence of development over the value of open space amenities (Irwin, 2002).

Farmland Retention

Governmental and nongovernmental agencies concerned about urban sprawl, open space, and the value of farmland in the regional economy have implemented development right purchases (PDR) through conservation easements. There are more than 190,000 conservation easements across the United States, covering approximately 32,000,000 acres (NCED, 2021). The question of whether these programs are effective in slowing the loss of farmland across the nation has cropped up time and time again. Liu & Lynch, (2011) employ propensity score matching methods across a sample of Mid-Atlantic states and find strong empirical evidence that these programs have resulted in decreasing an individual county's rate of farmland loss by 40% to 55%, and decreases farmland acres lost per year by 375 to 550 acres. Land prices are observed only when feasible trades of land occur (Liu & Lynch, 2011). Provided that the aggregate quantity of land in agriculture is fixed, those trades must occur among heterogeneous agricultural landowners. Leathers (1992) presented a theory that builds on this fundamental concept by developing a model that examines the interaction between the market for agricultural commodities and the land market in general. He explicitly considers a land market made up of trades among farmers of differing "abilities", and determines that the most important consideration in determining the impact of alternative agricultural programs is whether the cross price effect of output price on supply of land is large relative to the own price effect of land price on land supply. He motivates that if cross price effects are considered to be large, commonly used farm programs including land retirement programs will have the effect of reducing the number of farmers (Leathers, 1992). Yuan et al. (2015) conducted parallel studies in Georgia, Maine, and Ohio to determine heterogeneity in preferences for agricultural easements. Their results suggest that significant heterogeneity exists both between and within study regions, particularly with regards to differences in preferences between urban space and open space. Furthermore, their results suggest that prime farmland is conserved through the use of conservation easements, and that although national level efforts to conserve farmland may provide some aid in conservation, they are subsidiary to state level conservation efforts (Yuan et al., 2015). Overall, farmland conservation through easement programs are generally considered to be effective measures of preserving agricultural land for future generations.

Property Taxes

If agricultural land is valued at use value for assessment purposes, there is no reason to expect a decline in property tax revenue. As a result, fee-simple acquisitions by nontaxable organizations transfer development rights from landowners and out of an otherwise taxable property base. Following Engle et al. (1992), although there is some heterogeneity in the effects of conservation easement enrollment on agricultural land use values, there is an expected immediate decrease in the level of property taxes due among enrolled properties, accompanied with a increase in the property taxes among residential parcels. Provided the public values the easement for its inherent amenity use or the interruption of development, capitalization of open space amenities into property values can result in contradictory tax effects. Overall, the property tax base of a region may be positively or negatively influenced by the enrollment of the easement and the subsequent capitalization of value to residential properties (Engle et al., 1992). King and Anderson (2004) examined marginal property tax effects of conservation easement enrollment in Vermont using an auto-regressive, population weighted, generalized estimating equations (GEE) model. Their results indicate that conservation easements increase taxes in the short run, but are tax-neutral or tax diminishing in the long run (King and Anderson, 2004). Geoghegan et al. (2003) developed a hedonic model to estimate the effects of agricultural preservation programs on nearby residents in three Maryland counties. The research motivates that the positive externalities of open space and amenity use generated by agricultural easement enrollment may be partially enveloped by the owners of parcels neighboring the preserved land. These externalities are motivated to be recaptured through increased property taxes. Their findings show that preserved parcels increases taxable nearby property values and generate increased tax revenue that would be available to use for further easement enrollment in the county or state (Geoghegan et. al., 2003).

Program Efficiency

Agricultural preservation programs are designed to retard urban and suburban sprawl, particularly at the urban fringe. State, county, and private programs abound associated with limiting the resulting effects on farmland conversion with the purchase of development rights to apply conservation easements on land parcels. The cost efficiencies of these programs are an important consideration for policy and literature surrounding this topic area is fairly extensive.

Economic efficiency and expenditures of CE transactions

Lynch and Musser (2001) utilized a Farrell efficiency analysis approach in four Maryland counties, determining that parcel size and productivity measures were the most likely to affect efficiency measures. The efficiency analysis determines whether the marginal productivity of an additional acre of conserved land achieves the same marginal advantage as more than one acre of non-conserved land. They determined, among other things, that proximity to a city center and contiguousness to other preserved parcels did not seem to affect the measures of efficiency as often as measures of acreage and productive farm characteristics (Lynch and Musser, 2001). Lynch (2009) focused on comparing characteristics of parcels enrolled among various institutions, and evaluated the technical and cost efficiencies of differing programs. The results of the paper indicated that prime soil and percentage of crop land had the most influence on cost and technical efficiency. Proximity to urban areas and contiguity between preserved parcels were deemed less adequate indicators of efficiency (Lynch, 2009). Mackey and Casey (2007) examined federal, state, and private sources of land conservation spending data across a 10 year period, highlighting the issues surrounding land preservation programs primarily due to the percentage of government efforts used in promoting short term contracts over longer term contracts like conservation easements (Mackey and Casey, 2007).

Bode et al. (2011) examined how organizational behavior and conservation outcomes were affected by the presence of autonomous implementing organizations with differing objectives. This paper uses a game theory model, which examined how cooperation affected an organization's ability to protect the features that mattered to them the most. Altruism is considered a motivation for cooperation, Moreover, the paper examined how an organization's view of cooperation changed as the development and distribution of features across the landscape came to life. Although cooperation generally abounded with greater protection for both organization's features, the results indicated that features with highly correlated spatial distributions may lead to detrimental outcomes across a variety of protection paths. Benefits of cooperative behavior were determined to be most evident when features with distributions of low correlation were sought (Bode et al., 2011). Duke et al. (2013) examined the negative implications of political selection among conservation easement programs, the cost of benefit indices devoid of monetary value, the cost of ignoring development risk or using incomplete cost measures, and the implications of employing cost measures sequentially. The paper draws on relationships between the benefits of CE programs and the complications baked in, such as capitalization and intertemporal planning (Duke et al., 2013).

CE Agreement Effectiveness

Milder et al. (2008) provides an effectiveness measure for conservation and limited development projects (CLDPs).[1] The evaluation method utilized eight indicators that quantify project impacts to the surrounding ecosystem. The results of the paper indicate that CLDPs offer an alternative to conventional development that provides an additional protection of natural resources when conventional conservation techniques (like conservation easements) are too expensive (Milder et al., 2008). Arnold et al. (2013) presented a simple model with asymmetric information, wherein the problems associated with purchasing ecosystem services from privately informed owners when the buyer of said services has a limited budget. They suggest that the search for conservation easement acreage from land trusts results in adverse selection introduced by an informational asymmetry between the buyer and the seller of the particular property. The results of the paper describe that limited budget situations wherein an auction is used to determine development right, the lowest social surplus was achieved. Screening contracts that rely on the government to observe development rights yields the highest social surplus. Moreover, the paper implies that conservation policies aimed at environmental outcomes only succeed in transferring large sums of money from the government and non-profits to landowners, a result of adverse

[1]CLDPs use the revenue generated from a limited development project to finance the protection of land and natural resources (Milder et al., 2008)

selection in the ecosystem services market (Arnold et al., 2013).

THEORY

We assume that the utility of an agricultural landowner is made up of two principal components: an amenity use utility and land profitability utility. Amenity use comprises a combination of the perceived benefits interpreted by the landowner by maintaining its current use and the value to the landowner knowing that the land remain in agriculture or a bequest value. Land profitability reflects the landowner's ability to draw returns from the property in some way. Both of these components are likely weighted in some way that varies across individuals, but we will assume for the time being that agricultural landowners may be motivated to enroll in a CE for many reasons. We will further assume that landowners' utility with respect to land profits is positive and increasing in profit.

Collateral-based lending allows landowners to borrow capital necessary for on-farm operations using their largest asset as collateral, the land. Collateral value has a direct effect on lending behavior, both from the lender's and the borrower's perspective. The effects of collateral value on lending include an alteration in the risk to the bank and a transformation of the borrowers' incentives through a decrease in the risk of default brought on by having more "skin in the game". Expected returns to lending by a bank depends on the probability that the borrower will repay the debt, thus there exists an incentive for the bank to reveal who are "good borrowers" or who are generally less likely to default. The presence of personal and/or real guarantees, such as farm real estate, acts as a signalling device, allowing borrowers to distinguish themselves in the lending market. Real guarantees, in particular, reduce the risk of default to the bank significantly over non-secured loan types (Pozzolo, 2004). Stiglitz and Weiss (1981) is the seminal paper on credit rationing and the existence of credit rationing in market equilibria with imperfect information. They describe that the loan amount and the amount of personal guarantee that a bank demands of borrowers can and will affect the behavior of borrowers in addition to the overall distribution of borrowers in the long run. Assuming that the pool of borrowers has varying degrees of equity, and that all projects require the same investment, wealthy borrowers may be those who have succeeded in risky endeavors. Thus, an adverse selection effect from increasing collateral requirements results both by the average and the marginal borrower being more risky. The bank realizes that raising the amount of collateral required for bank notes may result in lower profits borne by a decrease in the average degree of risk aversion amongst borrowers or an incentive for investors to partake in riskier projects. Thus, credit rationing may persist in markets in equilibrium (Stiglitz and Weiss, 1981).

The persistence of Stiglitz and Weiss's conclusions remains valid throughout any number of principal-agent problems, including agricultural lending practices. Following the methodology employed in Stiglitz & Weiss' paper, agricultural lending markets typically require some value of collateral, say C, in addition to a specified interest rate r, to secure a level of debt D. Different individuals differ in the probability of default. If an individual defaults on his loan, or else is unable to return the value of the debt plus interest, it is evident that they were unable to earn a return on their investment R plus the original debt D to pay back the promised amount. The net return of the borrower can be written as:

$$\pi(R, \hat{r}) = max(R - (1 + \hat{r})D; -C) \tag{4.1}$$

A contract, defined by the collateral value C and the interest rate r, acts as a screening mechanism for the bank. The screening mechanism permits only those with an initial wealth greater than the baseline collateral required by the bank. Decreasing absolute risk aversion among the remaining pool generates the wealthiest individuals in the interval of borrowers.[1] This creates an adverse selection effect borne by wealthier individuals being prone to illicit riskier projects under the same collateral and interest rate requirements. Thus, increasing collateral requirements can lead to both

[1]Decreasing absolute risk aversion refers to a decrease in the percentage decrease in marginal utility, consistent with a greater acceptance of risky situations with greater wealth.

the average and the marginal borrower being riskier (Stiglitz and Weiss, 1981).

Agricultural lending practices typically involve some form of collateral on the farming/ranching operation. Land holdings of an operator make up a significant portion of their overall debt-equity position or a large percentage of their overall net worth. Thus, land holding and correspondingly land values make up the largest collateral value available to the farmer/rancher to distinguish themselves from other borrowers to the bank. In this application, land valuation is determined using a discrete version of the standard undeveloped land value formulation (e.g., Capozza and Helsley, 1989), ignoring conversion costs, to develop our conceptual model for land valuation.[2] Assuming that landowners have perfect foresight, the land market is competitive, and the developed property does not depreciate, land value equals the net present value of anticipated agricultural land rents from $t = 1$ to $t = t^* - 1$ plus the anticipated development returns at time t^* and after. Formally, land values are given as:

$$V_{i,t} = \sum_{t=1}^{t^*} \frac{A_i}{(1+r)^t} + (1+r)^{(1-t^*)} \frac{D_i}{r} \tag{4.2}$$

where V represents the value of parcel i to the landowner, A represents the constant returns from the land from agricultural use, D represents the expected future constant returns from development (due to an irreversible conversion of the parcel from agricultural use), r is the discount rate, and t^* is the optimal time of development.

If agricultural lenders do not fully take into account the net present value of anticipated development returns when determining to whom and how much they will lend, the collateral value

[2]Capozza & Helsley (1989) determined that agricultural land prices and development prices were determined by these measures in addition to the value of agricultural land rent, and motivated further that: land outside of an urban area is characterized purely by agricultural land rent and the value of expected future rent increases (borne by development pressures), land at the urban-rural fringe jumped in price by the cost of conversion, and land inside the urban center was valued with accessibility.

of the property to the landowner is reduced to:

$$V_{i,t} = \sum_{t=1}^{t^*} \frac{A_i}{1+r} + (1+r)^{(1-t^*)}[\frac{A_i}{r} + \gamma(\frac{D_i}{r} - \frac{A_i}{r})] \tag{4.3}$$

where γ falls between 0 and 1 and represents the propensity of normal agricultural lending operations to account for future alternative uses in collateral appraisals. Higher values of γ denote a fuller consideration of non-agricultural use in collateral valuation. Landowners may find that enrolling in a CE contract increases the collateral value of the property, through the means of cash value or tax advantages. Conservation easement enrollment results in a removal of development rights for some value akin to the net present value of anticipated development returns. The value of the easement, whether a cash value or a tax credit, is characterized by the difference between the net present value of future development returns and the net present value of agricultural land rents from t^* onward. Formally, our CE value is

$$CE = \tau(\frac{D_i}{r} - \frac{A_i}{r})(1+r)^{(1-t^*)} \tag{4.4}$$

where τ is a weight of the propensity of easement contract holders(i.e., a land trust NGO) in appraising the full market value of the property. Provided we assume that the contract holder can exactly measure A, D, r, and t^*, τ will equal to 1 and CE enrollment allows the landowner to extract the total net present value of constant discounted expected development returns from the property.

Given that the landowner does not behave in some irrational manner, we will assume enrollment in CE contracts will take place only if τ exceeds γ, or the propensity of conservation easement programs τ exceeds the propensity of ag lending channels γ in determining the net present value of future development returns from the parcel. Furthermore, CEs irreversibly remove development as a future option, but, as γ approaches zero, we know that the landowner can still leverage something close to the same appraisal value in securing future operating loans from traditional agricultural lending channels.

There are numerous reasons as to why we might expect $\gamma < \tau$. Information on development potential of a property site is not perfect, and agricultural lending channels have a comparative advantage in determining the agricultural value of a property, not the developmental value of a property. However, conservation easement programs rely on determining reliable appraisal values for future development due to their inherent goal of removing land from development pathways over time. Moreover, it may be risky for lenders to take into account the full development potential in an appraisal. Housing markets and development values, in turn, have a certain amount of volatility, and overvaluing a property only to have the borrower default may result in an inability to capture the capital promised through the secured note.

Additionally, agricultural lenders may offer operating notes or farm ownership notes, each of which may be related in differing ways to the total value of the property. We might expect that γ would approach 1 for farm ownership notes, whereas operating notes would be more reliant on the agricultural activities financed by the loan and γ would approach 0. This represents another argument for why γ would be less than τ, as the propensity of an agricultural lender to take into account the developmental value of the property would vary inversely with the activity generated by the loan. Operating notes serviced by the production of agricultural products are determined on an agricultural use value basis because anything more could create a cash flow problem for the lender.

DATA

The data used in this thesis are gathered from a number of sources, including the National Conservation Easement Database (NCED), the National Land Cover Database (NLCD), and the National Agricultural Statistics Service (NASS). The national and historic scope of the NCED data allows us to build a county-level panel dataset of conservation easements, giving us the ability to explore various levels of heterogeneity and exploit variation in the timing of conservation easement adoption across space and through time to address the question of interest. Additionally, the Census of Agriculture conducted by NASS allows us to explore a range of investment margins, and the covariates specified allow us to control for various observed factors that may also drive investment.

National Conservation Easement Database

The NCED represents a novel collaboration between public and private easement holders across the nation. The NCED is the first national database of conservation easement information, compiling records from land trusts and public agencies throughout the United States. This public-private partnership brings together national conservation groups, local and regional land trusts, and local, state and federal agencies around a common objective, to provide accurate and timely data related to the number and the types of conservation easements held throughout the United States. The NCED is an initiative of the U.S. Endowment for Forestry and Communities and the current team managing the database includes Ducks Unlimited and The Trust for Public Land. The NCED team collaborates on data acquisition and standards with the USGS Science Analytics and Synthesis's Protected Areas Database of the United States (PAD-US) and cooperates with agencies and organizations nationwide, including The Nature Conservancy and Land Trust Alliance (National Conservation Easement Database, 2021).

NCED data are available in two forms of download, a spatial dataset including the geospatial location of each and every known easement, and a tabular dataset, providing only the county in which the easement is located. Although the spatial data set provides polygons describing the geospatial extent and location of each individual easement, the outcome variables provided by the Census of Agriculture are only available at the county level, so the NCED data gathered for our study are aggregated at the county level to harmonize the unit of analysis across our two main data sources. Note that the tabular data set includes more easements than the spatial data set, due in part to the willingness of the owner in disclosing the geospatial coordinates to the local land trust or agency that gathered the information, in addition to the discontinuity that exists between the NCED organization and local land trusts due to lack of digital records, contact, and differences in privacy concerns. Moreover, land trust organizations with working land easements that recieve federal funding through the Farm Bill are required to provide location information to the USDA.[1] There are a number of tabular entries that only specify the county, although they describe in full the other information included in the NCED. The remainder of county observations that were not disclosed in the spatial data set are included in the dataset used for this study. All figures and statistics presented here are based on a county-level aggregation of the geospatial and tabular NCED data.

A map of the available conservation easement data, binned into quintiles, is shown at the county level in Figure 5.1. The majority of our observations are located near the Appalachian and Rocky Mountain Ranges as well as the northeast. Moreover, California, Florida, and the lower Mississippi Delta demonstrate large numbers of conservation easement acres.

The variables present in the dataset include nine domains including security level, ownership type and easement holding type, easement purpose, public access, and duration. While some of these domains are related to the level of public access available within the dataset, ownership holding type, easement holding type, and purpose are the domains used to filter the NCED for the purposes of our analysis. Moreover, the year of the easement designation is included for each individual easement, which is critical in the construction of our county-level panel dataset.

[1]Rissman et. al (2019) describes the relationships between land trust decisions regarding disclosures of easement information and their intrinsic characteristics (Rissman et. al., 2019).

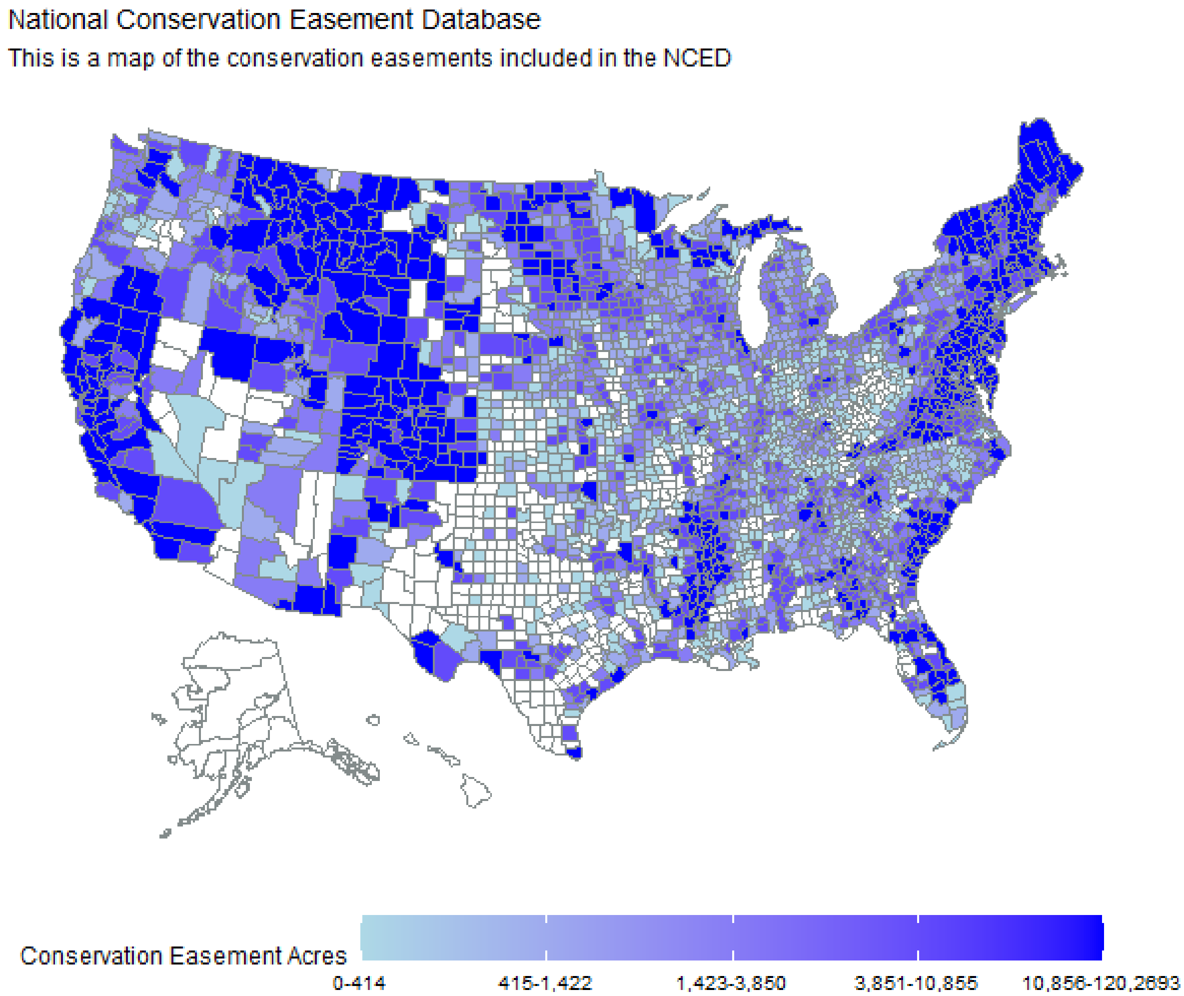

Figure 5.1: NCED Conservation Easements across the United States

Nearly 1.2 million acres are enrolled in conservation easements with the purpose of environmental system conservation. The remaining purposes included are: managed farm lands, managed forest lands, scenic values, managed ranch lands, historic preservation, recreation or education, other and unknown. The purposes that we will be considering for this study will be limited to agricultural conservation, and the final panel will include only purpose types under managed ranch and farm land.

Examine Figure 5.2 for a cross tabulation of the number of easement acreage by ownership

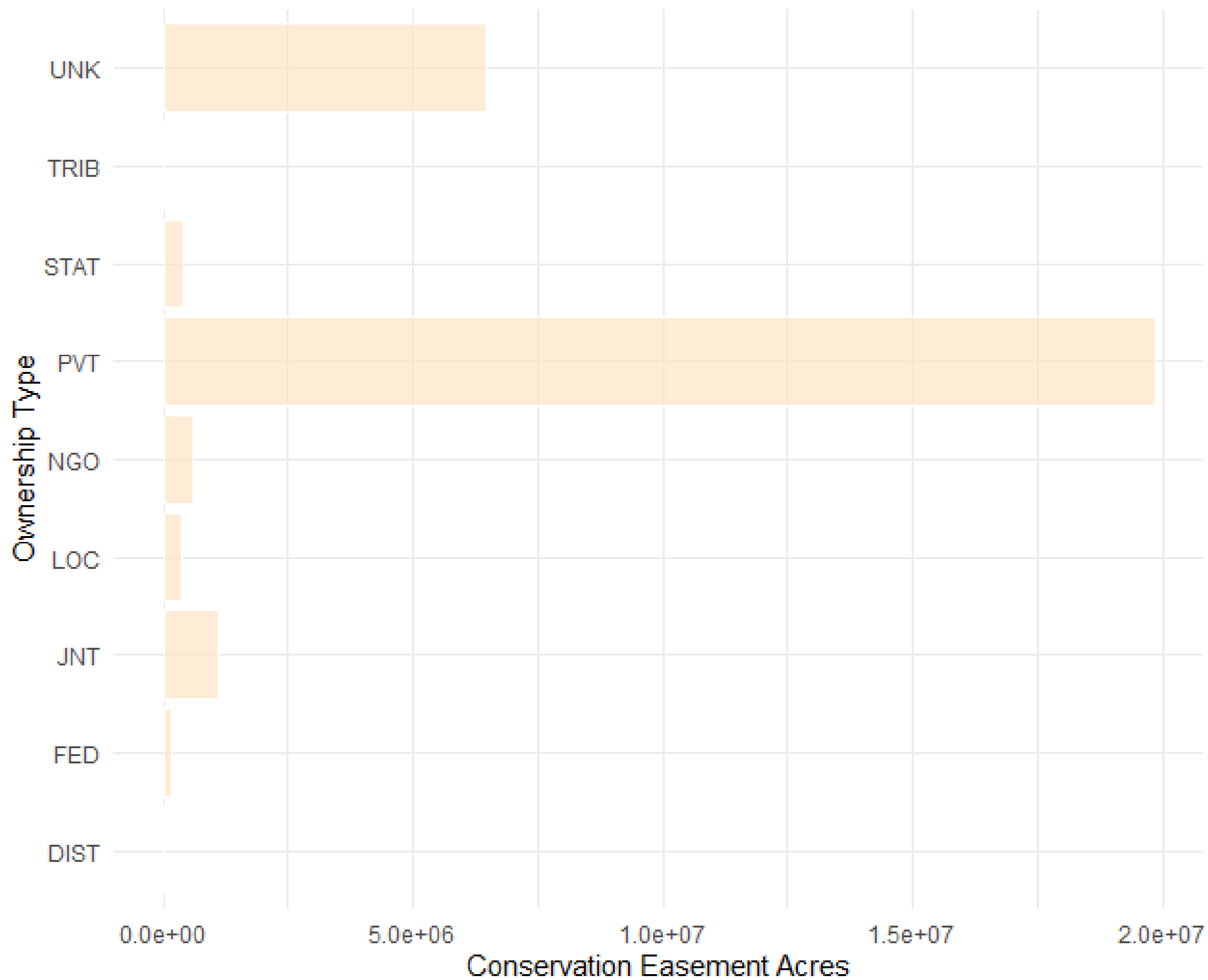

Figure 5.2: Cross Tabulation of Easement Acres by Ownership Type

The categories in this table are: unknown (UNK), tribal (TRIB), state (STAT), private (PVT), non-governmental organization (NGO), local (LOC), joint (JNT), federal (FED), and district (DIST).

type. Private land owners make up the majority of conservation easements. The remaining ownership types included in this data set are: Federal Lands, American Indian Lands, State Lands, Regional Agency Special District, local government, non-governmental organizations, joint private holders, territorial governmental agencies, and unknown owners. Examine Figure 5.3 for a cross tabulation of the number of easement acreage by easement holding type. The largest number of acres under conservation easements are held by NGOs. The remaining easement holding types included in this data set are duplicated from those listed as ownership types: Private, Federal Lands, American Indian Lands, State Lands, Regional Agency Special District, local government, joint private holders, territorial governmental agencies, and unknown holders.

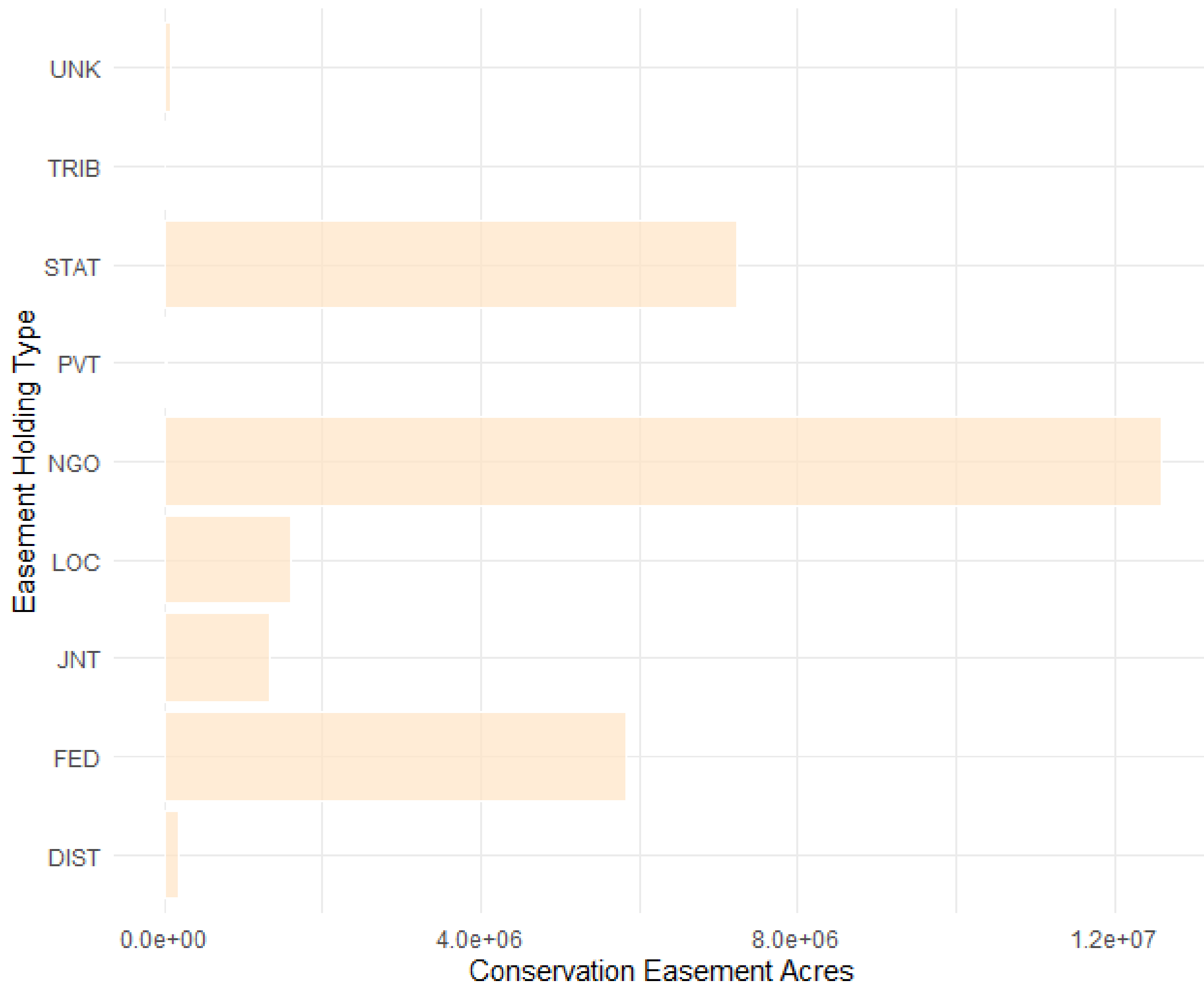

Figure 5.3: Cross Tabulation of Easement Acres by Easement Holding Type

The categories in this table are: unknown (UNK), tribal (TRIB), state (STAT), private (PVT), non-governmental organization (NGO), local (LOC), joint (JNT), federal (FED), and district (DIST).

Notably, the second largest category reported by the NCED in both purpose and ownership type is unknown. Thus, in order to build a more complete database of all easements used for agricultural purposes, we utilize the National Land Cover Database (NLCD) from 2019 as a proxy for assigning a percentage in agriculture variable to each individual easement in the panel. The NLCD is generated from a collection of agencies in the federal government known as the Multi-Resolution Land Characteristics consortium in addition the USGS Earth Resources Observation and Science Center, who use that information to monitor the health of the earth, as well as to inform and motivate research questions and results. Land cover data is generated from decadal Landsat satellite imagery and supplementary data sets. The data set is not faultless, as it is collected using satellite data which may be susceptible to error in distinguishing between residential and agricultural use under forest cover. We create a variable deemed percentage of easement in agriculture by overlaying the NLCD raster on top of the geospatial easement data. (The tabular dataset is not included in this overlay due to the lack of geospatial coordinates.) The resulting variable is used as a proxy for determining whether the unknown acreages are being used for agriculture vs. other uses, and remove easements of an unknown type from the analysis which are described by the NLCD raster as having less than 20% of easement acreage in grassland, pasture, and cultivated crop production.

The NCED is not a complete representation of the total number of easements in the United States. In fact, the NCED is currently only estimated to contain 49% of all publicly held easements and 90% of all non-profit held easements. The completeness of the publicly held easements is based on acreage counts identified by The Trust for Public Land as potential conservation easements from federal, state, and local agencies, departments, and jurisdictions. The completeness of non-profit held easements was judged on estimated easement acres from the 2015 LTA Census, the 2018 NCED Census, and state land trust association censuses (NCED, 2021). Moreover, the NCED has generated a completeness map of the United States at the state level. This allows me to generate multiple sub-samples that focus on areas with more complete easement information available.

The final dataset used in this analysis was filtered to include only private owners who enrolled their acres into a conservation easement agreement for agricultural purposes. The dataset was additionally refined to contain only NGO, federal, and state easement holding types. These changes were to remove any excess variation outside of agricultural easements, which would fall outside the scope of easements that directly affect agricultural investment. The original data set included 136,542 observations. Adding the tabular data set resulted in a total of 188,739 observations. Refining the data set to include only private and joint private owners of conservation acreage removed 63,805 observations. Further filtering the data set to include only state government, federal government, local government and NGO held easements removed an additional 4,430 observations. Moreover, removing all non-agricultural purposes from the dataset removed an additional 55,910 observations. The resulting data set totalled less than 50% of the original; 64,594 observations are left for our study. Examine Figure 5.4 for the resulting agricultural easement dataset, binned into quintiles. The resulting data frame shows similar patterns geographically, however the prevalence of larger easements has been somewhat diminished, particularly on the west coast and along the Appalachian Mountains.

The NCED includes the total acreage of each individual easement, which is used to generate a summary of the county by year growth in NCED acreage. The county by year acreage is used to generate a number of additional independent variables including the cumulative sum of easement acreage in a given county at any given time. We also generate a change variable, which uses the sum of easement acreage added in any given time. Moreover, total agricultural acres was collected from the 1997 Census of Agriculture to generate percentage variables out of each of these independent variables so as to normalize our variables of interest. The variables resulting from this transformation represent the percentage change in the total agricultural acres made up of easements and the easement percentage of total agricultural acres in any given county within any given year.

The USDA's National Agricultural Statistics Service (NASS) is a statistical agency with

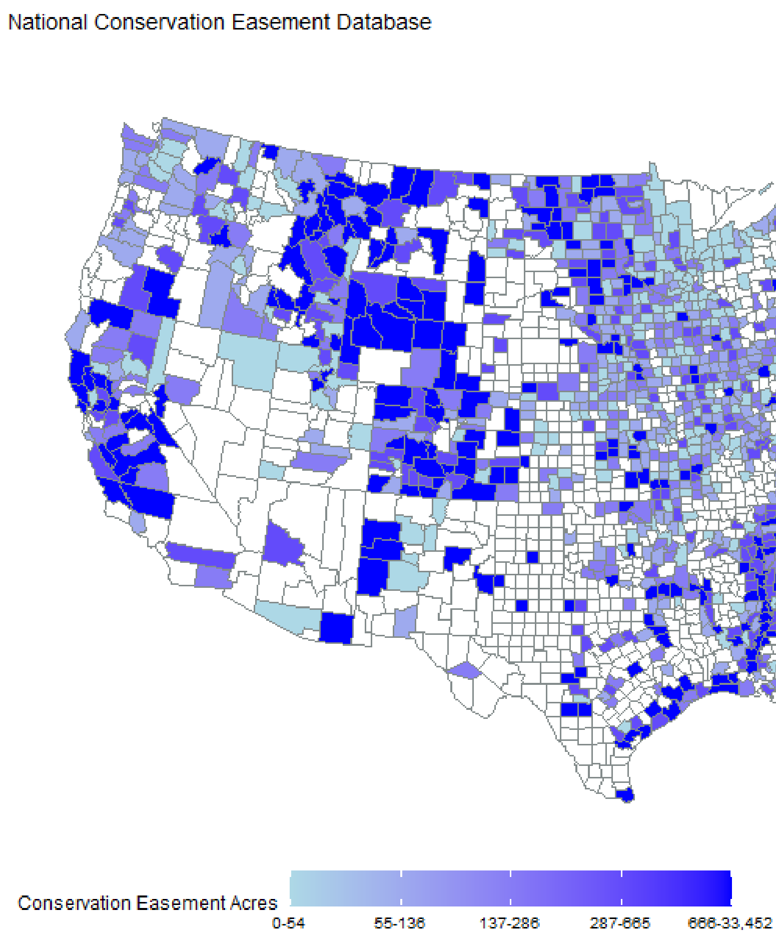

Figure 5.4: Private enrollment in agricultural CE Acres

the goal of gathering information on American agriculture. NASS gathers information through surveys on all aspects of agriculture, including production and supplies of food and fiber, prices paid and received by farmers, farm labor and wages, farm finances, chemical use, and changes in the demographics of U.S. producers. The outcome variables considered in this thesis are derived from the Census of Agriculture and collected from NASS. The Census of Agriculture is collected once every 5 years, the most recent being in 2017.

The goal of this project is to examine investments in physical capital stock, expenses, and debt service, so the NASS data that we use for our outcome variables are related to these outcomes. We consider four major county-level outcome variables: acres per operation, machinery asset value per operation, total operating expense per operation, and total interest expenses per operation. The covariates included in this thesis are operator age and experience, in addition to population density. Moreover, the USDA ERS published a county level amenity scale in 1999 which combined six measures of climate, topography, and water area that reflect the preferences for environmental qualities. Additionally, each outcome variable was further restricted to only include counties that had conservation easement acreage at some point prior to 2020. Table 5.1 provides the summary statistics for the outcome variables of our panel, in addition to the covariates for machinery asset value per operation. The covariates included in models specifying other outcome variables are reflective of the observations contained in their respective categories. The summary statistics reflects differing numbers of observations between our outcome variables due to the number of reporting farms generated by the Census of Agriculture for each outcome variable. The covariates demonstrated are from our largest panel dataset, where machinery asset value per operation was used as an outcome variable. The panel is balanced, so each outcome variable observation is paired with all of our covariates. The outcome variables presented in our summary statistics are represented as a natural log transformation of the values given by NASS.

Table 5.1: Summary Statistics

Statistic	N	Mean	St. Dev.	Source
Acres per operation	10,270	468.87	805.40	NASS
Machinery asset value per operation (USD, ’000’s)	10,355	127.26	89.95	NASS
Total operating expenses per operation(USD, ’000’s)	10,315	151.74	183.73	NASS
Total interest expenses per operation (USD, ’000’s)	9,980	17.85	12.03	NASS
Total land in agriculture (Acres, ’000’s)	10,355	288.14	363.67	NASS
Amenity valuation (Deviation from mean)	10,355	3.41	1.10	ERS
Change in CE acreage (Annual, County-level)	10,355	145.33	745.04	NCED
Total CE acreage (Annual, County-level)	10,355	1,961.60	5,384.40	NCED
45 to 64 years of age proportion	10,355	0.50	0.06	NASS
65 years and older proportion	10,355	0.31	0.07	NASS
Population density (per square mile)	10,355	30.24	252.26	NASS
Average years on operation	10,355	21.93	2.91	NASS

Notes: NASS is the National Agricultural Statistics Service, ERS is the Economic Research Service,and NCED is the National Conservation Easement Database.

EMPIRICAL STRATEGY

This section of the paper examines our empirical strategy for estimating the relationship between conservation easement enrollment and reinvestment in agricultural operations. We will first discuss the mechanism linking conservation easement enrollment to investment decisions, then detail the panel model specification, and will conclude with a discussion of the identification strategy.

Mechanism

We describe the use of easements among landowners as an individual's strategic reinvestment in their agricultural operation as a means of bringing about higher productivity and a larger profit margin. The necessity of this investment varies across individuals, and depends on the financial situation of the enterprise. Agricultural lenders may not fully account for the discounted expected returns from development when appraising a property, and conservation easements may provide an opportunity for these landowners to acquire capital that is inaccessible through traditional lending channels. Moreover, enrollment in an agricultural easement does not hinder a landowner's ability to borrow on the agricultural use value of the property for future operating notes. CE contracts offer capital liquidity while maintaining the current agricultural use of the land. While there is some expectation of CE contracts to be used as a method of paying down debt on highly leveraged new operations, investment in capital stock may also be made with CE-generated financial capital in order for a farm to remain profitable.

We examine four main investment margins including machinery asset value per operation, total acreage per operation, total operating expenses per operation, and total interest expenses per operation. Machinery asset value and total acreage per operation are used as proxies for the total assets held by an operation, the former representing physical capital stock, and the latter being land. We expect that CEs may be used to add machinery, equipment, and land. Total operating expenses proxies for total investment, as a way to explore effects of conservation easement enrollment between farms of different size. The expectation is that landowners may be using CEs to generate efficiency through investment to increase their revenues or to pay down debt so as to diminish overall costs. We use total interest expenses as a proxy for the debt load of an operation. We expect that CE enrollment will be negatively associated with interest expenses if landowners are using capital to settle debts, and positively associated with interest expenses if landowners are using this capital to instead invest in new capital stock that requires some form of debt.

Model Specification

We employ a two-way fixed effects estimator with year and county fixed effects in addition to state-by-year fixed effects to measure the relationship between conservation easement enrollment and on-farm investment. In order to account for the expected delay between capital liquidity through the easement and subsequent reinvestment, we employ a distributed lag (DL) model. This model is represented by the following:

$$\ln(y_{c,t}) = \alpha_0 + \beta_1 \frac{CE_{c,t-\ell}}{agacres_c} + \eta_t X_c + \delta_c + \gamma_t + \theta_{c(s),t} + \varepsilon_{c,t} \tag{6.1}$$

where $y_{c,t}$ represents our investment variables of interest, $CE_{c,t-\ell}$ is the cumulative sum of conservation easement acreage enrolled in a given county in time t lagged ℓ years divided by the total agricultural acres in county c, X_c is our vector of control variables, δ_c are county fixed effects, γ_t are year fixed effects, and $\theta_{c(s),t}$ are state-by-year fixed effects.

Standard errors are clustered at the state level to allow for spatial correlation in the $\varepsilon_{i,t}$ across counties in the same state. We measure our outcome variables with a natural log transformation, in order to account for outliers in the data and to estimate the effect of CE acreage enrollment on the percent change in investment in county c. County and year fixed effects are used to address certain predispositions that are unobservable to our study and are directly related to the level of enrollment in conservation. County fixed effects control for factors that do not change over the course of the study, whereas year fixed effects control for factors that are consistent across all counties in any given year. The state-by-year fixed effects flexibly account for state-specific factors that change over time. Furthermore, we acknowledge that there exist unobservable spatial factors that can lead to spatial and temporal autocorrelation between counties and across years which may affect investment decisions. These are addressed through clustering of the standard errors at the state level. The baseline model is based on the full national sample of NCED and NASS data, and includes any and all counties with conservation easement acreage enrolled at any point in time prior to 2020. We further consider a handful of additional model specifications including an interaction with population density, a non-linear specification, and estimations using different types of easement variables.

Examine model 6.2 for our interaction model specification. Whereas the baseline model specification described population density as being contained to our vector of control variables, our interaction specification includes an interaction between population density and our easement variable. Population density is removed from the vector of covariates described by X in the baseline model and is included as an interaction with our easement variable. Population density is described by the number of people per square mile and is fixed for each county at the population density in 1997. The expectation is that population density will increase the effect of the easement variable through increased easement valuation. Our interaction effect is described by β_3, which measures the reinforcement of our investment effects in areas of higher population density.

$$\ln(y_{c,t}) = \alpha_0 + \beta_1 \frac{CE_{c,t-\ell}}{agacres_c} + \beta_3 \left(\frac{CE_{c,t-\ell}}{agacres_c} \times popdensity_c \right) + \eta_t X_c + \delta_c + \gamma_t + \theta_{c(s),t} + \varepsilon_{c,t} \quad (6.2)$$

Model 6.3 outlines our non-linear model specification. Introduction of a quadratic term to our easement variable allows our effect to vary with our easement variable. The marginal effect of our non-linear specification is described by $\beta_1 + 2\beta_2$.

$$\ln(y_{c,t}) = \alpha_0 + \beta_1 \frac{CE_{c,t-\ell}}{agacres_c} + \beta_2 \left(\frac{CE_{c,t-\ell}}{agacres_c}\right)^2 + \eta_t X_c + \delta_c + \gamma_t + \theta_{c(s),t} + \varepsilon_{c,t} \tag{6.3}$$

The Census of Agriculture is captured quinquennially, so we have observations of the investment outcome variables every 5 years from 1997 to 2017. The outcome variables used in our model specification are: total farmland acres, total operating expenses, total interest expenses, and total machinery asset value in county c in time t. The easement variables of interest are normalized by dividing the total easement acreage in county c in time t by the total agricultural acres in county c in 1997. Moreover, each monetary dependent variable is adjusted for inflation using 2020 dollars. The values of the covariates are fixed at a baseline year equal to the beginning year of the panel by interacting each covariate with a set of year fixed effects. The covariates included are average age of producer as a proportion, population density, and average years on operation. The effect varies over time while the values of the covariates vary across space. This avoids any problems generated by a "bad control", wherein changes in the covariates themselves could be the result of easement adoption.

We consider the natural log of the outcome variables so as to normalize any outliers in our data and to motivate cleaner interpretations of the outcomes generated through easement enrollment. We weight our regressions with the baseline county-level 1997 count of total farm operations so as to get a representative per-farm, county-level estimate. Conservation easement enrollment is hypothesized to generate a capital value that can be used on investment avenues. However, charitable donations are deemed by the IRS to generate tax advantages that have a carryover period of up to 15 years. Thus, we test the sensitivity of our results to alternative lag lengths. Each model specification is estimated using multiple lags, including a 2-year lag, a 4-year lag, and a 6-year lag to account for the discontinuous right hand side as well as the ability to preserve the tax or capital advantage leveraged by the conservation easement.

To address the intermittent structure of our outcome variables, we take the cumulative sum of the CE acreage in county c and match the year of the summation to the year of the investment variable. CEs are not reliant on a census year, so our model specification must take into account that we need to consider CE enrollment for the five years prior to the census. Moreover, a lagged CE enrollment controls for the carryover period of tax advantages leveraged by the IRS and the ability for landowners to utilize cash advantages in subsequent years. As a simple numerical example of what our CE variable resembles, consider 1000 acres enrolled in a conservation easement in a hypothetical county in 1997. Provided that the total agricultural acres in this county were 150,000 acres, our outcome variable was measured in 1997, and we include a 4-year lag, our easement variable would be measured as 0 in 1997 and $\frac{1000}{150{,}000} = 0.0067$ for 2002. The variable represents the cumulative sum of the acreage in the county at any given point in time, so any additional easements enrolled in the county would increase this value over time.

We utilize three sub-samples to examine different regions across the United States due to different levels of easement activity and types of investment. We conduct an analysis of a high-amenity sub-sample of counties described by USDA ERS as having an amenity valuation above the mean across the country, an analysis of the northeastern region of the United States (including Massachusetts, New Hampshire, Connecticut, Rhode Island, Maine, Vermont, New York, New Jersey, Delaware, and Maryland), and an analysis of a mountain west region of the United States (including Montana, Idaho, Wyoming, and Colorado).[1] Sorting our panel on the basis of amenity value gives us a set of estimates generated by counties with notably higher amenities and likely higher easement values. We should expect to see larger effects generated by an increased incentive to use agricultural easements as a method of extracting capital. The mountain west region is associated with above average NCED coverage and the northeastern region is associated with a larger variance in our easements among our sample time period.

Each of these model specifications is estimated using an easement variable described by the

[1] Hecht (2021) described that these four states were considered to have excellent NCED coverage (Hecht, 2021).

percent of agricultural land in easements in time $t - 4$. This model specification allows for a lagged effect of the liquidity generated to be used on our investment outcomes. The estimates are interpreted as a one percent change in the percentage of agricultural land enrolled in easements in time $t - 4$ being correlated with a β_1 percent change in the outcome variable. Moreover, county observations are weighted by the number of operations used in reporting agricultural census numbers. The results are reflective of a full national sample of NCED and NASS data, and includes any and all counties with conservation easement acreage enrolled at any point in time prior to 2020. Our theoretical model predicts that machinery asset value per operation, total acres per operation, and operating expenses per operation should be associated with positive estimates. Interest expenses per operation, on the other hand, can be expected to be positive if landowners are using capital generated by CE contracts as collateral for debt on additional investments, but can be expected to be negatively signed if landowners are using CE enrollment to pay down debt on leveraged accounts.

Identification Strategy

The identification strategy used in this paper employs variation in the timing of conservation easement acres adopted over time and across counties. The county fixed effects absorb unobserved time-invariant heterogeneity at the county level like soil quality and average climate, and the year fixed effects absorb homogeneous time-variant changes across the United States like inflation and interest rates. The state-by-year fixed effects pick up the heterogeneity of each state in each individual year in the dataset, so they are picking up all of the characteristics in each state in each year and controlling for those unobserved and observed characteristics.

Although our two-way fixed effects model exploits within variation in our units, minimizing the potential for unobserved heterogeneity and omitted variable bias, time-varying factors associated differently with each individual county and correlated with easement enrollment will still result in a bias to our estimates. Unobservable factors associated with cash flow which occurs within one year and that does not generate yearly effects may govern enrollment decisions and may not be picked up by the county and year fixed effects nor the state-by-year fixed effects due to the cyclical nature of the cash-flow model of an individual. Moreover, there may be a threat of reverse causality to our estimation strategy. Farm size is one of our primary outcome variables, and we are interested in the result of easement enrollment on farm size. However, smaller farms which are often located closer to urban centers are faced with more distinct differences in the agricultural use value of their property and the high developmental value of the property as the city moves outward. Thus, smaller farms may be more likely to enroll in CEs due to an inherent difference in the average size of an operation. This may allow small farms to push back against consolidation pressure in an urbanizing environment. Furthermore, although we have no control over the sampling of our independent variable, there remains a level of measurement error in the independent variables that have been collected, in addition to the omission of many easements across the country. We also have no way of examining easement enrollment that occurs in one county and investment that occurs across county lines, which may arbitrarily influence our estimates. Taken together, this paper represents an exploratory descriptive work providing estimates that have not yet been put forth in the literature.

RESULTS

This section details the results of the empirical estimation. We first detail the main results of our study, describing the relationship between our baseline easement acreage variable and the natural log of our outcome variables. We then describe the results of our regional analysis, comparing our national sample to three sub-samples that are used as points of comparison. We then detail the results of an interaction between our easement variable and population density with the goal of describing how population density may be a reinforcement of our investment effect. Finally, we introduce a quadratic term to our model specification, which allows for easements to have a non-linear effect on the investment-related outcomes. We cover two main robustness checks, varying both the lag lengths of our easement variable and the structure of our easement variable to examine the sensitivity of our results to alternative specifications.

Examine Table 7.1 for details on the results of our four outcome variables across four model specifications with increasing levels of controls. We consider a pooled OLS model with and without covariates, a county fixed effects model, a two-way fixed effects model, and a two-way fixed effects model with state-by-year fixed effects.

Overall, the results in table 7.1 are not supportive of our hypothesis. Predominantly, estimates generated by this model specification are negatively signed, indicating that there is a negative correlation between each outcome variable and our easement enrollment variable. The OLS specification, with and without covariates, is associated with a positive estimate for operating and interest expenses, although these are not statistically significant, and is associated with a statistically significant negative estimate for total acreage. Interest expenses are associated with negative estimates when using county and year fixed effects and state-by-year fixed effects, which could be considered supportive of our theoretical model on the basis that producers may be using CEs to pay down debt. However, these results are insignificant. Both our county and year fixed effects and state-by-year fixed effects specifications indicate a statistically significant negative

Table 7.1: Baseline Model Specification Results: 4 year CE lag

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
OLS	-0.0695	-2.960***	0.3714	0.1843
	(0.3491)	(0.6094)	(0.9779)	(0.5519)
w/ Covariates	0.3653	-4.238***	1.010	0.3480
	(0.5986)	(0.9176)	(1.069)	(0.5145)
County FE	-0.4266**	-0.1578	-0.6011*	-0.4182
	(0.1547)	(0.1273)	(0.2915)	(0.3275)
County & Year FE	-0.4571**	-0.1385	-0.6173*	-0.4243
	(0.1419)	(0.1391)	(0.2977)	(0.3336)
State x Year Effects	-0.4235*	-0.1308	-0.5862	-0.4456
	(0.1592)	(0.1558)	(0.3090)	(0.3275)
# of Counties	2071	2054	2063	1996
Observations	10,355	10,270	10,315	9,980

Notes: The table above demonstrates the results of our baseline model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable. We utilize a 4 year lag of the cumulative easement acreage proportion in the county as our benchmark. The dependent variables considered in our study are adjusted for inflation. The regression is weighted on the number of observations of each dependent variable in the study. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

correlation between easement enrollment and machinery asset value. The state-by-year fixed effects model with county and year fixed effects specification provides estimates ranging from 0.13% to 0.48% decreases in investment with a 1% increase in the percentage of agricultural land made up by easements.

It could be expected that our national sample may mask potentially important relationships in different regions, and that narrower geographic regions may be better suited to describe the relationship between easement enrollment and investment outcomes. Table 7.2 describes the results of our estimation strategy when we use three separate sub-samples of data in our analysis.

Table 7.2: Regional Analyses Results

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
A. High Amenity Group	(1)	(2)	(3)	(4)
State x Year Effects	-0.3183	-0.5119*	-0.4197	-0.5687
	(0.2990)	(0.2068)	(0.4622)	(0.4098)
# of Counties	830	815	823	780
Observations	4,150	4,075	4,115	3,900
B. Mountain West Region				
State x Year Effects	-1.930	-1.853	-1.801	-1.491
	(0.7699)	(1.512)	(1.166)	(1.553)
# of Counties	143	142	142	133
Observations	715	710	710	665
C. Northeast Region				
State x Year Effects	0.2708	-0.1636	0.3572	0.5084
	(0.1202)	(0.1603)	(0.2205)	(0.3370)
# of Counties	162	159	163	150
Observations	810	795	815	750

Notes: The table above demonstrates the results of our regional model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable for our sub-sample regions. The parameters of each model are equivalent to our full national sample results, although the standard errors for the regional sub-samples are clustered at the agricultural district level. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

An examination of narrower geographic regions generates results that were more supportive of our theoretical model. For example, the northeast region generated estimates ranging from 0.16% decrease in total acreage to a 0.51% increase in interest expenses from a 1% increase in the percentage of agricultural land made up of easements. The mountain west region generated estimates ranging from a 1.93% decrease in machinery asset value per operation to a 1.49% decrease in interest expenses. Our estimates for the group of counties in the United States with an above average amenity value ranged from a 0.56% decrease in interest expenses to a 0.31% decrease in machinery asset values per operation. Although our estimates are positive in some instances, particularly with regards to the northeast region, they are not statistically significant. The regional estimates for the OLS model, county fixed effects model, and two-way fixed effects model are illustrated in the appendix in table A.1.

We might expect each estimate to be reinforced by an interaction with population density. Population density is expected to drive urban pressure, and accordingly, development values. Table 7.3 describes the results associated with including an interaction between population density and our baseline easement variable for each of our model specifications. The three sub-regions in addition to the national sample specification are included in the table.

Interacting our baseline easement variable with population density reinforces the effects generated by our baseline model. Table 7.3 details these results for the state-by-year fixed effects model, which indicates that, for the national sample, a 1 % increase in the percentage of agricultural acres made up of easements is associated with a .54% decrease in machinery asset values per operation, a .13% decrease in average farm size, a .79% decrease in operating expenses per operation, and a .45% decrease in interest expenses per operation. Each of these estimates are negatively signed, which is not altogether supportive of our hypothesis, but the interaction term on these estimates indicates that counties with higher levels of population density are associated with even more negative estimates. That being said, the interaction term for operating expenses per operation is positive, which indicates that areas with more urban influence may be decreasing their operating expenses less than those with less urban influence. The estimate for machinery asset value is negative and statistically significant at the 5% significance level, and is negative and statistically significant at the 10% level for operating expenses. Including population density as an interaction results in a correlation that is more negative.

Although our interaction variable typically reinforces the sign of the estimate overall, the results are not precisely estimated for average farm size or interest expense outcome variables. The regional sub-samples describe somewhat similar results as the national sample, indicating negative estimates with negative interaction terms. However, the northeast region indicates positive estimates for both machinery asset value per operation and interest expenses per operation. The sign of the interaction term additionally seems to vary between specifications, with positive estimates showing up in the high amenity group for operating expenses, as well as in the northeast region for both total acreage and operating expenses.

We further consider a non-linear specification of the baseline model in table 7.4. We include a squared term on our four year lagged easement variable, and examine the results for each of our outcome variables. The parameters used in this model specification do not differ from our baseline model specification in any way besides the addition of our squared term. The regional specifications are additionally included in this table. The addition of a non-linear specification to our baseline model adds the most to our understanding of the relationship between CE enrollment and on-farm investment. The non-linear specifications generated results that were negative for the linear estimate and positive for the squared term, indicating that there exists an increasing, concave function with respect to the percentage of agricultural acres made up of easements in a given county. The marginal effect varies with the percentage of agricultural land in easements. Let's consider, for example, the full national sample machinery asset value model specification. This particular function is described by $ln(f(x)) = -0.9001x + 1.380x^2$ where $x = \left(\frac{CE_{c,t-\ell}}{agacres_c}\right)$, and the marginal effect is determined by the first derivative of the function: $f'(x) = e^{-0.9001+2.760x} - 1$ which is determined by the value of x. So for a county with 10% of its agricultural land in easements, the marginal effect (from this particular function) is equal to $e^{-0.9001+2.760(0.1)} - 1 = -0.4643$ and for a county with 50% of its agricultural land in easements, the marginal effect is equal to $e^{-0.9001+2.760(0.5)} - 1 = 0.6159$.

Figure 7.1 illustrates the marginal effects of each outcome variable in the full national sample based on the percentage of agricultural land in easements. The shaded region of the graph represents the 95% confidence interval of the marginal effect at each percentage of agricultural land in easements, and has been estimated using the delta method.[1] Note that the value of the marginal

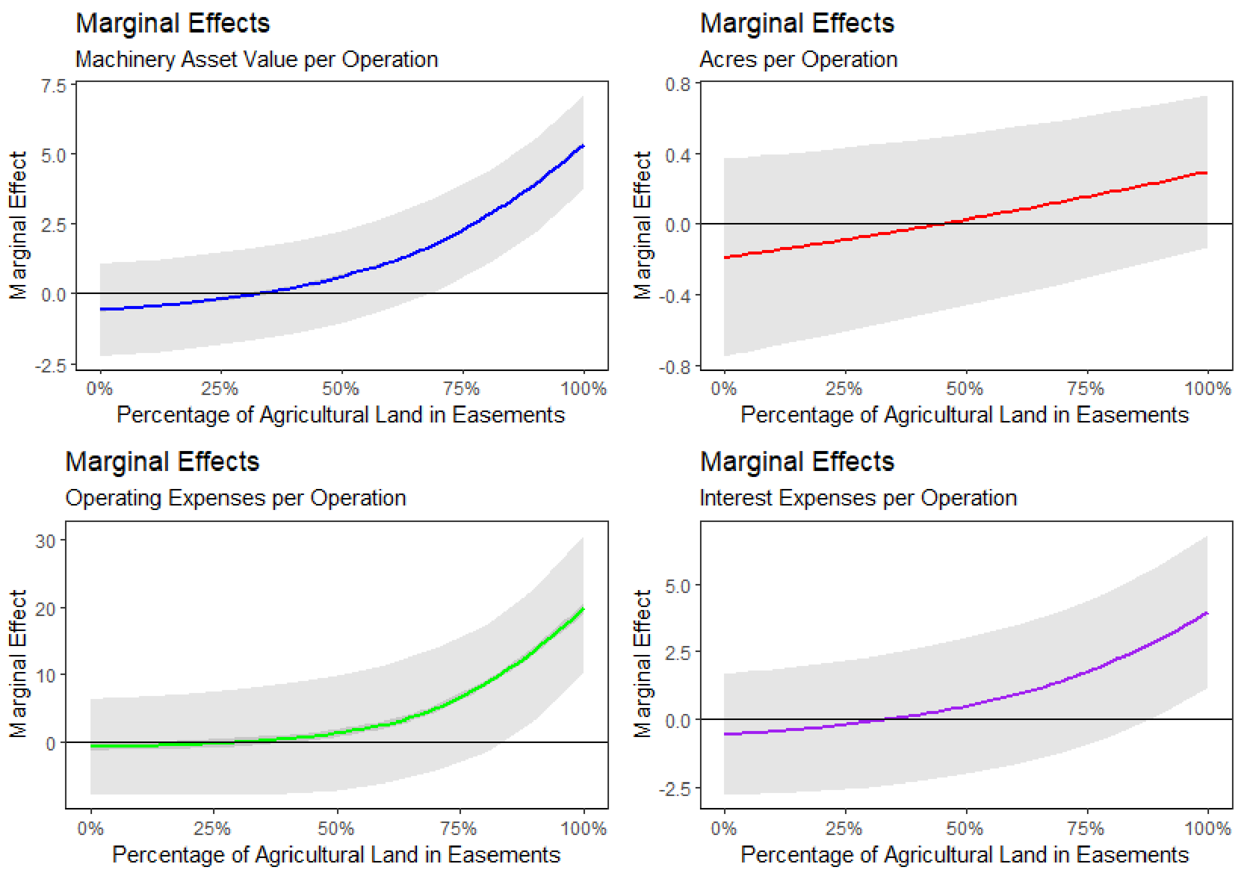

Figure 7.1: Marginal Effect of Percentage of Agricultural Land in Easements on Outcome Variables

effect for each outcome variable becomes positive when between 30% and 40% of the county is enrolled in conservation easements. This represents a large portion of the overall county, and is not representative of the current picture of the United States. The mean percentage of agricultural

[1] The delta method is a useful method for approximating the variance of a function of asymptotically normal random variables with a known variance and which acts as an alternative to bootstrapping.

land in easements in our sample is 1.395%, far below the threshold where our estimates describe a positive relationship between CE enrollment and investment.

Moreover, determining the threshold point at which our estimates are predicted to become positive is a simple solution of determining where the marginal effect is equivalent to zero. For our example, the threshold point can be described as $v = -\frac{\beta_1}{2*\beta_2} = -\frac{-0.9001}{(2*1.380)} = 32.6\%$. Thus, for our current model specification, 32.6% of the county must be enrolled in easements before we can discern positive county level effects.

The estimates generated by the national sample were significant in machinery asset value and operating expenses, whereas the estimates generated by the mountain west region, an area known for above average NCED coverage, were statistically significant between all four outcome variables. Moreover, the threshold at which percentage of agricultural land made up of easements generates positive estimates declines with our mountain west and northeast region. Due to the small number of easements as a proportion of total agricultural acres, the effect sizes that we've determined from our study are not large enough to discern statistically significant results. That being said, the absence of more granular data with respect to investment outcomes leads to the conclusion that we are losing the effects of conservation easement enrollment on our investment outcome variables due to the large number of farms in a given county, most of which are not enrolled in agricultural easements. This seems to be supported by our regional sub-sample of the northeast in table 7.4. The region is known for greater easement support and fewer farms, so we should expect to see larger effects generated at lower percentages of agricultural acres enrolled in easements. The marginal effect generated using machinery asset value per operation as our outcome variable is $f'(x) = e^{-0.0750+1.241x} - 1$, which creates a threshold value v of our conservation easement variable for positive results at $v = -\frac{-0.0750}{1.241} = 6\%$. This differs substantially from the results contained to the national sample, which specify a threshold value of $v = -\frac{-0.9001}{2.760} = 32.6\%$. The same can be said for the mountain west region, which due to its larger sized counties, a percentage increase in the total agricultural land made of easements would generate a large increase in the actual acreage in easements. The results contained by the mountain west region specify a threshold value of $\upsilon = -\frac{-4.129}{46.26} = 8\%$ for machinery asset value, and a threshold value of $\upsilon = -\frac{-4.332}{86.66} = 5\%$ for total interest expenses per operation. These thresholds fall well below the average percent of agricultural acres in easements, but are substantially closer to the average than what was determined from the national sample. This is suggestive of regional heterogeneity induced by familiarity with conservation easements as a tool for on-farm investing. Moreover, disparities between regions of the United States including average county size, number of farms, and knowledge of conservation easements may create contrasting effects between areas.

Figure 7.2 displays the marginal effects of our total acreage per operation specification when applied to the current percentage of agricultural land in easements in each given county in the northeastern region. Counties with marginal effects that are notably positive are described by green shading. It is evident that for most counties, a small enough percentage of agricultural land is in easements as to describe negative effects.

Similar patterns emerge when examining the national sample specification and mountain west sample specification. The northeast specification for machinery asset value and operating expenses describe little variability in marginal effects, and the marginal effects are found to be primarily negative. The northeast specification for interest expenses is positive for most counties, supporting an positive relationship in paying down debt, but is described by little variability in marginal effects. Figure 7.3 demonstrates the marginal effects in the northeast for interest expenses per operation.

Robustness Checks

In addition to examining a four year lag in our easement variable, we further examined smaller and larger lag times with the goal of describing a disparate effect that grows initially with lag time. This is descriptive of a holding of capital generated by easement contracts before being used to invest in agricultural production. The model specifications considered thus far have been reliant

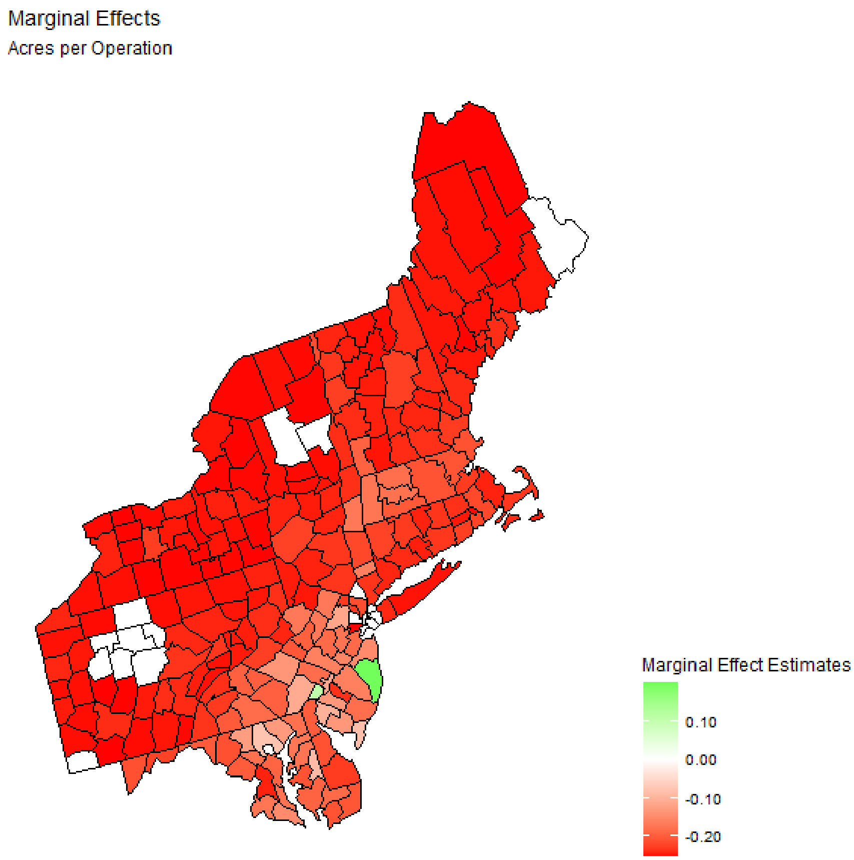

Figure 7.2: Choropleth map of marginal effects of Acres per operation in northeastern region of the United States

on our baseline specification of a four year lag in our easement variable. The IRS stipulates that, in our study period, there is a range on the turnover period of the tax advantage leveraged by the charitable donation from 6 to 15 years. Thus, we consider in table 7.5 the results across a two and six year lag of our independent variable. We expect to encounter an increase in the level of investment across time if landowners are using easement contracts to invest, but are maintaining capital holdings for future use. Overall, the results are indicative of an increase in the absolute value of our estimates when we increase the length of the lag, although there are some exceptions. For example, examining the machinery asset value per operation, a two year lag in our easement variable is correlated with a 0.4428% decrease in the machinery value of an operation, whereas

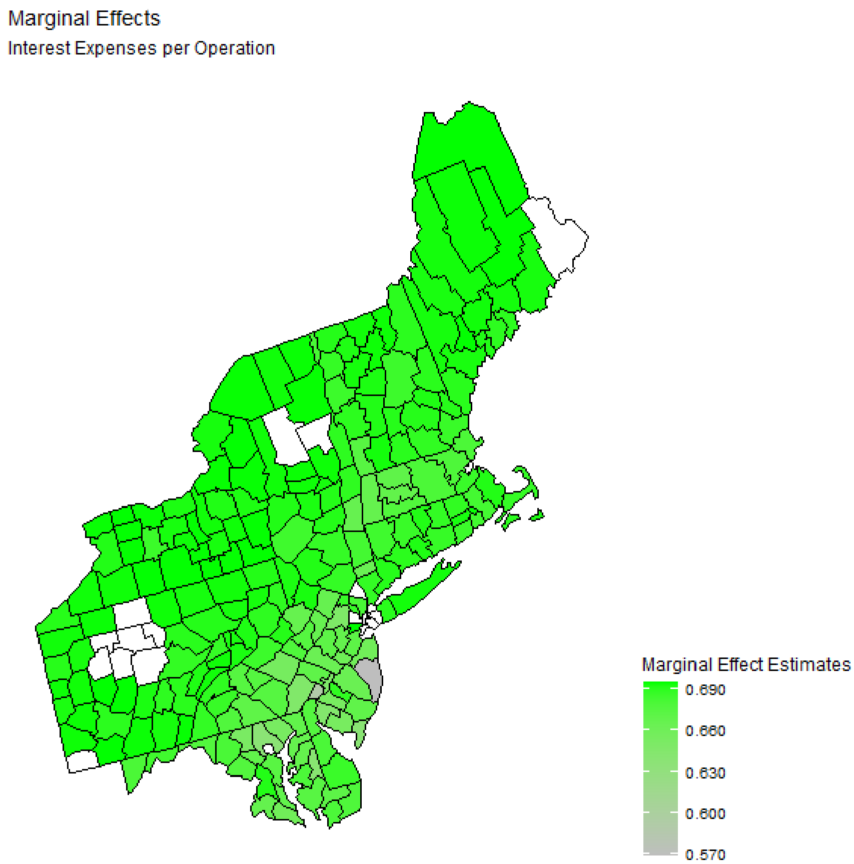

Figure 7.3: Choropleth map of marginal effects for interest expenses per operation in northeastern region of the United States

taking into account the previous 6 years of easement enrollments in the county is associated with a 0.4484% decrease in the machinery asset value of an operation. These results are statistically significant at the 5%, and 10% significance level, respectably. The regional sub-samples of this analysis are contained to tables A.6 through A.8 in the appendix, and are confirmatory of this analysis.

Table 7.6 details the results of replacing our baseline easement variable with a change in the number of easements across t years, rather than the cumulative total of easements across years. The change in the number of easements is taken as the annual accrual of easement acres enrolled in a given year, and the variables that we choose in this specification sum across x number of years. As a simple numerical example, consider 100 acres enrolled in 1994, 100 acres enrolled in 1998, and 200 acres enrolled in 2000 in county i. Whereas our cumulative variable would take into account all previous years in that specific county, the change variable we examine here would only take into account x number of years. We utilize a five year and ten year change variable, so we sum across the previous 5 and 10 year periods, respectfully. The result for our numerical example, provided that the county has 100,000 agricultural acres, the easement variable would be measured as $\frac{100+200}{100{,}000} = 0.003$ for our five year change variable measured in 2002 and $\frac{100+100+200}{100{,}000} = 0.004$ for our ten year change variable measured in 2002. Table 7.6 compares a five year change variable to a ten year change, to a five year change in addition to a five year change variable lagged five years.

The results indicated by a different easement variable are on the whole negatively signed. Increasing from a five year change to a ten year change increases the absolute value of our estimates, indicating that there is some evidence that landowners are retaining capital for later use. These results are insignificant. The regional specifications of these models are contained in tables A.9 through A.11 in the appendix.

Table 7.3: Population Density Interaction Results

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
A. National Sample	(1)	(2)	(3)	(4)
State x Year Effects	-0.5433**	-0.1286	-0.7970*	-0.4506
	(0.1829)	(0.2049)	(0.3778)	(0.5538)
Pop. Density Interaction Term	-0.0002*	-0.0002	0.0002	-0.0006
	(9.13e-5)	(0.0003)	(0.0002)	(0.0008)
# of Counties	2071	2054	2063	1996
Observations	10,355	10,270	10,315	9,980
B. High Amenity Group				
State x Year Effects	-0.5028	-0.4944	-0.6608	-0.8499
	(0.3306)	(0.3410)	(0.5630)	(0.6053)
Pop. Density Interaction Term	-0.0001	-0.0001	0.0003	2.27e-5
	(0.0005)	(0.0004)	(0.0006)	(0.0009)
# of Counties	830	815	823	780
Observations	4,150	4,075	4,115	3,900
C. Mountain West Region				
State x Year Effects	-1.236	-0.9828	-1.290	-1.260
	(0.7455)	(0.9389)	(1.090)	(1.283)
Pop. Density Interaction Term	-0.0169**	-0.0217***	-0.0125**	-0.0064
	(0.0050)	(0.0039)	(0.0036)	(0.0062)
# of Counties	143	142	142	133
Observations	715	710	710	665
D. Northeast Region				
State x Year Effects	0.2948	-0.2612	-0.0394	0.5367
	(0.2374)	(0.2146)	(0.3515)	(0.5200)
Pop. Density Interaction Term	-7.43e-5	0.0002	0.0008	-4.42e-5
	(0.0003)	(0.0003)	(0.0005)	(0.0006)
# of Counties	162	159	163	150
Observations	810	795	815	750

Notes: The table above demonstrates the results of our interaction model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable interacted with population density. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table 7.4: Non-linear Specification

	Machinery Asset Value		Total Acreage		Operating Expenses		Interest Expenses	
	4 year lag	4 year lag^2	4 year lag	4 year lag^2	4 year lag	4 year lag^2	4 year lag	4 year lag^2
A. National Sample								
State x Year Effects	-0.9001***	1.380**	-0.2110	0.2358	-1.350**	2.210**	-0.8186	1.216
	(0.2445)	(0.4146)	(0.2545)	(0.4417)	(0.4653)	(0.7727)	(0.4385)	(0.6685)
# of Counties	2071	2071	2054	2054	2063	2063	1996	1996
Observations	10,355	10,355	10,270	10,270	10,315	10,315	9,980	9,980
B. High Amenity Group								
State x Year Effects	-0.8616*	1.375**	-0.65	0.3496	-1.136	1.814*	-0.9420	1.127
	(0.3824)	(0.4884)	(0.3270)	(0.3752)	(0.5798)	(0.6933)	(0.5381)	(0.5628)
# of Counties	830	830	815	815	823	823	780	780
Observations	4,150	4,150	4,075	4,075	4,115	4,115	3,900	3,900
C. Mountain West Region								
State x Year Effects	-4.129**	23.13**	-4.940**	32.42***	-4.428**	27.60**	-4.332*	43.33*
	(1.432)	(8.147)	(1.387)	(6.881)	(1.432)	(8.562)	(2.081)	(16.20)
# of Counties	830	830	815	815	823	823	780	780
Observations	715	715	710	710	710	710	665	665
D. Northeast Region								
State x Year Effects	-0.0750	0.6205*	-0.2912	0.2291	-0.1122	0.8437*	0.5274	-0.0373
	(0.2366)	(0.2480)	(0.2853)	(0.3770)	(0.3491)	(0.3358)	(0.4909)	(0.4829)
# of Counties	162	162	159	159	163	163	150	150
Observations	810	810	795	795	815	815	750	750

Notes: The table above demonstrates the results of our non-linear model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable, included both linearly and squared. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table 7.5: Lag Comparison

	Machinery Asset Value	Total Acreage	Operating Expense	Interest Expenses
	(1)	(2)	(3)	(4)
2 year lag	-0.4428**	-0.1463	-0.5958	-0.4586
	(0.1616)	(0.1589)	(0.3277)	(0.3436)
6 year lag	-0.4484*	-0.1237	-0.5857	-0.4383
	(0.1759)	(0.1615)	(0.3141)	(0.3398)
# of Counties	2071	2054	2063	1996
Observations	10,355	10,270	10,315	9,980

Notes: The table above demonstrates the results of our lag comparisons between a 2 year and 6 year lag in our baseline independent variable. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table 7.6: Change Variables

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
5 year change	-0.3014	-0.1332	-0.1257	-0.4248
	(0.2283)	(0.1571)	(0.2557)	(0.4930)
10 year change	-0.3801	-0.1687	-0.5105	-0.6248
	(0.2140)	(0.1857)	(0.3222)	(0.4327)
5 year change &	-0.3161	-0.1385	-0.1535	-0.4301
	(0.2371)	(0.1648)	(0.2898)	(0.5230)
early 5 year change	-0.4471	-0.2008	-0.8855*	-0.8199
	(0.2711)	(0.2533)	(0.4376)	(0.5174)
# of Counties	2071	2054	2063	1996
Observations	10,355	10,270	10,315	9,980

Notes: The table above demonstrates the results of exchanging our independent variable with the change in easements across time, rather than the cumulative sum of the easements across time. This, just as before, is still representative of the total percentage of all agricultural acres. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

CONCLUSION

Traditional lending operations who rely on collateral-based lending may not take into account the full development value of a property (which is often used for collateral) when securing operating notes. Land typically represents the largest form of collateral available to farmers and ranchers in the United States, but the value of the collateral in the creation of an operating note is equal only to the agricultural use value of the property, and fails to take into account a significant portion of the value of the property encompassed in the future development value. Conservation easements may allow an opportunity for landowners to extract the development value of the property while maintaining access to future operating notes generated by traditional lending operations. We assemble a national panel dataset to measure the relationship between conservation easement enrollment and on-farm investment with the goal of answering the question: "Do CE contracts result in subsequent reinvestment in agricultural operations, and if so, what are the associated effects present in the types of agricultural reinvestment that are observed?" Our results indicate that conservation easement contracts may allow smaller farms to persist using a less capital intensive structure, particularly in areas faced with greater development pressures. Moreover, our results suggest that conservation easement contracts may lower barriers to entry in securing farm ownership through the persistence of less capital intensive operations in addition to a reduction in the market value of the property.

There are a number of limitations to our study, both in modelling choices and in our present data. Our primary modeling limitation is that our empirical strategy fails to take into account time-varying factors associated with each individual county and correlated with easement enrollment. Individual level cash flow factors that are unobservable to our study and which occurs within one year that does not generate yearly effects may govern enrollment decisions and may not be picked up by the county and year fixed effects or the state-by-year fixed effects. An example may be retirement plans that incentivize enrollment in conservation easements due to preferential tax treatment. A secondary modeling limitation is related to reverse causality in our estimation. Smaller farms, which are often located closer to urban centers are faced with more disparate values in their property between the full market value and the agricultural use value. Smaller farms, then, may be more likely to enroll in conservation easements due to an inherent difference in the size of their operation to other, larger operations not under this level of development pressure. Moreover, farm size is related to operating and interest expenses per operation, in addition to total machinery asset value per operation.

Our data generates additional limitations to our study that future data sources may be able to handle more eloquently. First and foremost, our data is associated with measurement error, primarily in our independent variable of interest. The National Conservation Easement Database represents a novel collaboration that is not without error generated both by knowledge barriers between landowners and land trusts, and between land trusts and the collection of these data across the United States. In addition, the dataset itself is an incomplete collection of all of the conservation easements. The accuracy and completeness of the NCED database should improve over time. In addition to measurement error in our independent variable, our data is limited in scale. Although we have geospatial data on easement acreage, we do not yet have access to geospatial data on investment outcomes. We are limited to examining county-level outcomes which are associated with their own set of difficulties. One of these difficulties is associated with spillover effects between counties that are unobservable in our study. For example, a landowner could quite possibly own property in many separate counties, enroll in conservation easements in one or many of those counties, and invest in their farming operation in a different county. This would be especially true for larger farming operations, further exaggerating our estimates towards smaller farming operations.

Transition planning in agriculture in the United States has become more and more of an issue recently. With a large percentage of farmers and ranchers across the country nearing or at retirement age, and with a large percentage of their net worth tied up in the capital on the farm, operator-owners are looking for ways to exit their operations in a financially viable way. Moreover, younger generations are faced by growing barriers to entry in production agriculture, particularly with regards to overhead start up costs. The contribution of this study to agricultural policy is in lowered barriers to entry to younger generations while protecting both the financial viability of the older generation's exit strategy and the future use of the property. For owner-operators who are looking to retire and pass on their operation to their children, conservation easement contracts may satisfy both generations while simultaneously protecting the property from any future development and affirming the older generation that the property will remain in production agriculture. For owner-operators who do not have a transition plan in place for their children, barriers to entry and exit may be diminished on both sides of the incoming and outgoing operator. This premise holds as well for owners of other operations who take on an exiting farmer's operation as a way to grow their current operation. The policy implications of utilizing conservation easement contracts in this way are generally associated with a collaboration between the USDA Farm and Ranch Lands Protection Program (FRPP) and the Farm Service Agency and area extension. Utilizing conservation easement contracts to lower these barriers may simultaneously aid in accomplishing both conservation and farm transition goals across the United States. Moreover, our research indicates that smaller farms with a less capital intensive structure may be able to persist using this method of extracting the capital out of their operation. This has additional ramifications for entering farmers, suggesting that they may be able to operate under less overhead costs so as to remain profitable, particularly in times of lower net farm income.

There are a number of future research questions that would be interesting to explore. First and foremost, our data is generally limited in scale to county-level outcomes. Thus, more granular data, specifically on-farm or geospatial data would be interesting to examine, particularly with regards to spillover effects between counties. Moreover, in relation to farm transitions, there may be a question as to what the adoption of conservation easement contracts do to the total number of farm transitions over time. There may be additional research examining the timing of conservation easement contracts, particularly with regards to the passage of Farm Bills, and to development pressures in years driven by low interest rates. Low interest rates may also incentivize further reinvestment in agricultural operations, lowering the total costs associated with capital purchases financed. Furthermore, examining the timing of investment patterns and their relation to income tax treatment at the federal and state level may further enrich the results we have found in our analysis.

REFERENCES CITED

REFERENCES

[1] Conservation easements — internal revenue service, 2017.

[2] Usda ers - ag and food sectors and the economy, 2017.

[3] State tax credits for donation of a conservation easement, 2019.

[4] Land trust alliance, 2021.

[5] National conservation easement database — nced, 2021.

[6] American farmland trust, 01 2022.

[7] James Andreoni. Giving with impure altruism: Applications to charity and ricardian equivalence. *Journal of Political Economy*, 97:1447–1458, 12 1985.

[8] Michael A. Arnold, Joshua M. Duke, and Kent D. Messer. Adverse selection in reverse auctions for ecosystem services. *Land Economics*, 89:387–412, 2013.

[9] Gerald E. Auten, Holger Sieg, and Charles T. Clotfelter. Charitable giving, income, and taxes: An analysis of panel data. *The American Economic Review*, 92:371–382, 2002.

[10] Peter Backus and Nicky Grant. Economics discussion paper series edp-1606 consistent estimation of the tax-price elasticity of charitable giving with survey data, 2016.

[11] Christopher T. Bastian, Catherine M.H. Keske, Donald M. McLeod, and Dana L. Hoag. Landowner and land trust agent preferences for conservation easements: Implications for sustainable land uses and landscapes. *Landscape and Urban Planning*, 157:1–13, 01 2017.

[12] Gary S. Becker. A theory of social interactions. *Journal of Political Economy*, 82:1063–1093, 11 1974.

[13] Gary S. Becker. Altruism in the family and selfishness in the market place. *Economica*, 48:1, 02 1981.

[14] John C. Bergstrom and Richard C. Ready. What have we learned from over 20 years of farmland amenity valuation research in north america? *Review of Agricultural Economics*, 31:21–49, 03 2009.

[15] Theodore Bergstrom, Lawrence Blume, and Hal Varian. On the private provision of public goods. *Journal of Public Economics*, 29:25–49, 02 1986.

[16] Michael Bode, Will Probert, Will R. Turner, Kerrie A. Wilson, and Oscar Venter. Conservation planning with multiple organizations and objectives. *Conservation Biology*, 25:295–304, 2011.

[17] Brian C. Briggeman, Charles A. Towe, and Mitchell J. Morehart. Credit constraints: Their existence, determinants, and implications for u.s. farm and nonfarm sole proprietorships. *American Journal of Agricultural Economics*, 91:275–289, 2009.

[18] Dennis R. Capozza and Robert W. Helsley. The fundamentals of land prices and urban growth. *Journal of Urban Economics*, 26:295–306, 11 1989.

[19] Michael R. Carter. Equilibrium credit rationing of small farm agriculture. *Journal of Development Economics*, 28:83–103, 02 1988.

[20] Charles E. Clark. The assignability of easements, profits and equitable restrictions. *The Yale Law Journal*, 38:139–164, 1928.

[21] Eric D Cropper, Donald M McLeod, Christopher T Bastian, Catherine M Keske, Dana L Hoag, and Jennifer E Cross. Factors affecting land trust agents' preferences for conservation easements. *Escholarship.org*, 42, 2012.

[22] J Dixon Esseks, Brian Schilling, Alexander Hahn, J Dixon, ; Schilling, Brian Hahn, and Alexander. Impacts of the federal farm and ranch lands protection program: An assessment based on interviews with participating landowners, 2013.

[23] Joshua M Duke. Participation in agricultural land preservation programs: Parcel quality and a complex policy environment, 2004.

[24] Joshua M. Duke, Steven J. Dundas, and Kent D. Messer. Cost-effective conservation planning: Lessons from economics. *Journal of Environmental Management*, 125:126–133, 08 2013.

[25] Joshua M. Duke and Thomas W. Ilvento. A conjoint analysis of public preferences for agricultural land preservation. *Agricultural and Resource Economics Review*, 33:209–219, 10 2004.

[26] Joshua M. Duke, Brian J. Schilling, Kevin P. Sullivan, J. Dixon Esseks, Paul D. Gottlieb, and Lori Lynch. Illiquid capital: Are conservation easement payments reinvested in farms? *Applied Economic Perspectives and Policy*, 38:449–473, 07 2016.

[27] Robert Engle, Peter Navarro, and Richard Carson. On the theory of growth controls. *Journal of Urban Economics*, 32:269–283, 11 1992.

[28] James R. Farmer, Doug Knapp, Vicky J. Meretsky, Charles Chancellor, and Burnell C. Fischer. Motivations influencing the adoption of conservation easements. *Conservation Biology*, 25:827–834, 2011.

[29] Jacqueline Geoghegan, Lori Lynch, and Shawn Bucholtz. Capitalization of open spaces into housing values and the residential property tax revenue impacts of agricultural easement programs. *Agricultural and Resource Economics Review*, 32:33–45, 04 2003.

[30] Alice Hecht. Conservation easements in montana, 2021.

[31] Marek Hlavac. *stargazer: Well-Formatted Regression and Summary Statistics Tables*. Social Policy Institute, Bratislava, Slovakia, 2022. R package version 5.2.3.

[32] Elena G. Irwin. The effects of open space on residential property values. *Land Economics*, 78:465–480, 11 2002.

[33] Victoria Ivashina, Luc Laeven, and Enrique Moral-Benito. Loan types and the bank lending channel. *Journal of Monetary Economics*, 11 2021.

[34] Morton I. Kamien and Nancy L. Schwartz. Market structure, elasticity of demand and incentive to invent. *The Journal of Law and Economics*, 13:241–252, 04 1970.

[35] Jonathan R. King and Christopher M. Anderson. Marginal property tax effects of conservation easements: A vermont case study. *American Journal of Agricultural Economics*, 86:919–932, 2004.

[36] Chad Lawley and Charles Towe. Capitalized costs of habitat conservation easements. *American Journal of Agricultural Economics*, 96:657–672, 2014.

[37] Howard D. Leathers. The market for land and the impact of farm programs on farm numbers. *American Journal of Agricultural Economics*, 74:291–298, 05 1992.

[38] Jeff Lerner, Janet Mackey, and Frank Casey. What's in noah's wallet? land conservation spending in the united states. *BioScience*, 57:419–423, 05 2007.

[39] Xiangping Liu and Lori Lynch. Do agricultural land preservation programs reduce farmland loss? evidence from a propensity score matching estimator. *Land Economics*, 87:183–201, 2011.

[40] Lori Lynch. Land preservation programs achieve high levels of efficiency. *American Journal of Agricultural Economics*, 91:1368–1374, 2009.

[41] Lori Lynch, Wayne Gray, and Jacqueline Geoghegan. Are farmland preservation program easement restrictions capitalized into farmland prices? what can a propensity score matching analysis tell us? *Review of Agricultural Economics*, 29:502–509, 2007.

[42] Lori Lynch and Sabrina J. Lovell. Combining spatial and survey data to explain participation in agricultural land preservation programs on jstor. *Land Economics*, 79:259–276, 2003.

[43] Lori Lynch and Wesley N. Musser. A relative efficiency analysis of farmland preservation programs. *Land Economics*, 77:577–594, 2001.

[44] Leigh J Maynard, Timothy W Kelsey, Stanford M Lembeck, and John C Becker. Early experience with pennsylvania's agricultural conservation easement program. *Journal of Soil and Water Conservation*, 53:106–112, 04 1998.

[45] Jeffrey C. Milder, James P. Lassoie, and Barbara L. Bedford. Conserving biodiversity and ecosystem function through limited development: An empirical evaluation. *Conservation Biology*, 22:70–79, 2008.

[46] Carl H. Nelson, John B. Braden, and Jae-Sun Roh. Asset fixity and investment asymmetry in agriculture. *American Journal of Agricultural Economics*, 71:970–979, 11 1989.

[47] Cynthia J. Nickerson and Lori Lynch. The effect of farmland preservation programs on farmland prices. *American Journal of Agricultural Economics*, 83:341–351, 05 2001.

[48] Dominic P. Parker and Walter N. Thurman. Tax incentives and the price of conservation. *Journal of the Association of Environmental and Resource Economists*, 5:331–369, 04 2018.

[49] Andrew. Plantinga. The economics of conservation easements. 2007.

[50] Alberto F. Pozzolo. The role of guarantees in bank lending. *SSRN Electronic Journal*, 2004.

[51] William C. Randolph. Dynamic income, progressive taxes, and the timing of charitable contributions. *Journal of Political Economy*, 103:709–738, 1995.

[52] Adena R. Rissman, Lynn Lozier, Tosha Comendant, Peter Kareiva, Joseph M. Kiesecker, M. Rebecca Shaw, and Adina M. Merenlender. Conservation easements: Biodiversity protection and private use. *Conservation Biology*, 21:709–718, 2007.

[53] Brian Schilling, Kevin Sullivan, and Joshua Duke. Do residual development options increase preserved farmland values? on jstor. *Agricultural and Resource Economics*, 38:327–343, 2013.

[54] R. H. Squires and J. A. Gustanski. Protecting the land: Conservation easements past, present, and future. *Geography, Environment, and Society*, 2000.

[55] Joseph E. Stiglitz and Andrew Weiss. Credit rationing in markets with imperfect information. *The American Economic Review*, 71:393–410, 1981.

[56] Michael K. Taussig. Economic aspects of the personal income tax treatment of charitable contributions. *National Tax Journal*, 20:1–19, 03 1967.

[57] Jeremy G. Weber and Nigel Key. Leveraging wealth from farmland appreciation: Borrowing, land ownership, and farm expansion. *Land Economics*, 91:344–361, 2015.

[58] Keith Wiebe, Abebayehu Tegene, and Betsey Kuhn. Managing public and private land through partial interests. *Contemporary Economic Policy*, 15:35–43, 04 1997.

[59] Yuan Yuan, Kevin Boyle, and Wen Yu. Sample selection, individual heterogeneity, and regional heterogeneity in valuing farmland conservation easements. *Land Economics*, 91:627–649, 2015.

[60] Lydia Zepeda, Food, and Agriculture Organization Of The United Nations. *Agricultural investment and productivity in developing countries*. Fao, 2001.

APPENDIX

APPENDIX: APPENDIX A

Table A.1: Regional Analyses Results: OLS, County FE, Two-way FE Specifications

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
A. High Amenity Group	(1)	(2)	(3)	(4)
OLS	0.0412	-4.106***	-0.7180	-0.5318
	(0.4938)	(0.9453)	(1.273)	(0.8164)
County FE	-0.3101	-0.5484*	-0.4241	-0.4986
	(0.2503)	(0.2128)	(0.4278)	(0.3645)
County & Year FE	-0.3428	-0.5248**	-0.4395	-0.5668
	(0.2842)	(0.1890)	(0.4450)	(0.4048)
# of Counties	830	815	823	780
Observations	4,150	4,075	4,115	3,900
B. Mountain West Region				
OLS	-5.395**	-10.03	-12.41**	-5.470**
	(0.8340)	(5.108)	(1.870)	(0.7562)
County FE	-2.366	-1.295	-1.991	-1.360
	(0.8600)	(1.403)	(1.163)	(1.335)
County & Year FE	-2.247*	-1.278	-2.001	-1.357
	(0.6010)	(1.369)	(0.9309)	(1.310)
# of Counties	143	142	142	133
Observations	715	710	710	665
C. Northeast Region				
OLS	-0.0672	-1.489	0.2691	0.7319
	(0.5477)	(0.6864)	(0.4298)	(0.4104)
County FE	0.2547	-0.1707	0.3355	0.5204
	(0.1647)	(0.1630)	(0.2637)	(0.3223)
County & Year FE	0.2595	-0.1694	0.3347	0.5089
	(0.1566)	(0.1664)	(0.2632)	(0.3395)
# of Counties	162	159	163	150
Observations	810	795	815	750

Notes: The table above demonstrates the results of our baseline model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable. We utilize a 4 year lag of the cumulative easement acreage proportion in the county as our benchmark. The dependent variables considered in our study are adjusted for inflation. The regression is weighted on the number of observations of each dependent variable in the study. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.2: Non-linear Specification: National Sample

	Machinery Asset Value		Total Acreage		Operating Expenses		Interest Expenses	
	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$
OLS	0.1574	-0.7956	-4.144***	4.306	0.6167	-0.8602	0.5180	-1.252
	(0.6098)	(1.039)	(1.060)	(2.344)	(1.509)	(2.067)	(0.9089)	(1.511)
County FE	-0.8677***	1.280**	-0.2634	0.3111	-1.347**	2.164**	-0.7819	1.190
	(0.2191)	(0.3657)	(0.2291)	(0.4496)	(0.4283)	(0.7303)	(0.4349)	(0.6572)
County & Year FE	-0.9406***	1.402**	-0.2203	0.2406	-1.387**	2.230**	-0.7939	1.205
	(0.2159)	(0.4014)	(0.2309)	(0.4317)	(0.4481)	(0.7646)	(0.4488)	(0.6735)
# of Counties	2071	2071	2054	2054	2063	2063	1996	1996
Observations	10,355	10,355	10,270	10,270	10,315	10,315	9,980	9,980

Notes: The table above demonstrates the results of our non-linear model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable, included both linearly and squared. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.3: Non-linear Specification: High Amenity Group

	Machinery Asset Value		Total Acreage		Operating Expenses		Interest Expenses	
	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$	4 year lag	4 year lag$\hat{2}$
OLS	0.3348	-0.8711	-5.980***	5.557**	-0.9319	0.6345	-0.4243	-0.3353
	(0.7672)	(0.9718)	(1.495)	(1.952)	(2.101)	(2.510)	(1.251)	(1.487)
County FE	-0.7942*	1.228**	-0.7169*	0.4278	-1.110*	1.741**	-0.8254	0.9980
	(0.3505)	(0.4410)	(0.3315)	(0.4026)	(0.5325)	(0.6429)	(0.4858)	(0.5196)
County & Year FE	-0.8826*	1.366**	-0.6607*	0.3442	-1.154*	1.807**	-0.9401	1.127
	(0.3536)	(0.4624)	(0.2995)	(0.3605)	(0.5422)	(0.6599)	(0.5319)	(0.5640)
# of Counties	830	830	815	815	823	823	780	780
Observations	4,150	4,150	4,075	4,075	4,115	4,115	3,900	3,900

Notes: The table above demonstrates the results of our non-linear model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable, included both linearly and squared. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.4: Non-linear Specification: Mountain West Region

	Machinery Asset Value		Total Acreage		Operating Expenses		Interest Expenses	
	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂
OLS	-10.72**	59.27*	-18.82	98.08	-21.46**	101.0**	-7.957	37.51
	(3.269)	(21.11)	(11.09)	(64.30)	(5.727)	(35.41)	(4.354)	(43.14)
County FE	-4.447**	21.63**	-4.080*	28.91***	-4.568**	26.77**	-4.300	44.64*
	(1.398)	(6.247)	(1.614)	(7.487)	(1.458)	(7.106)	(2.161)	(17.63)
County & Year FE	-4.418**	22.78*	-4.433*	33.06***	-4.613**	27.36**	-4.271	44.21*
	(1.431)	(8.047)	(1.630)	(7.853)	(1.459)	(8.682)	(2.059)	(16.79)
# of Counties	830	830	815	815	823	823	780	780
Observations	715	715	710	710	710	710	665	665

Notes: The table above demonstrates the results of our non-linear model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable, included both linearly and squared. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.5: Non-linear Specification: Northeastern Region

	Machinery Asset Value		Total Acreage		Operating Expenses		Interest Expenses	
	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂	4 year lag	4 year lag2̂
OLS	0.0032	-0.1785	-2.090*	1.523	0.5172	-0.6301	1.535	-2.052
	(0.8672)	(1.201)	(0.8872)	(1.382)	(1.364)	(1.697)	(0.9255)	(1.219)
County FE	-0.0956	0.6287*	-0.3062	0.2433	-0.1412	0.8571*	0.5580	-0.0737
	(0.2657)	(0.2664)	(0.2967)	(0.3890)	(0.3754)	(0.3744)	(0.4386)	(0.4471)
County & Year FE	-0.0958	0.6380*	-0.3031	0.2403	-0.1536	0.8781*	0.5281	-0.0377
	(0.2650)	(0.2698)	(0.2969)	(0.3858)	(0.3735)	(0.3706)	(0.4681)	(0.4663)
# of Counties	162	162	159	159	163	163	150	150
Observations	810	810	795	795	815	815	750	750

Notes: The table above demonstrates the results of our non-linear model specification examining the relationship between the natural log of each of our outcome variables and our easement acreage variable, included both linearly and squared. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.6: Lagged CE Comparison: High Amenity Group

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
2 year lag	-0.3064	-0.5434*	-0.4473	-0.5327
	(0.3299)	(0.2066)	(0.4882)	(0.4350)
6 year lag	-0.3252	-0.5302*	-0.4718	-0.6641
	(0.2985)	(0.2109)	(0.4832)	(0.4488)
# of Counties	830	815	823	780
Observations	4,150	4,075	4,115	3,900

Notes: The table above demonstrates the results of our lag comparisons between a 2 year and 6 year lag in our baseline independent variable. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.7: Lagged CE Comparison: Mountain West Region

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
2 year lag	-2.749**	-2.640*	-2.439*	-1.198
	(0.8201)	(1.173)	(0.9881)	(1.084)
6 year lag	-1.499*	-1.794*	-1.292	-1.139
	(0.6796)	(0.7142)	(0.7772)	(1.016)
# of Counties	143	142	142	133
Observations	715	710	710	665

Notes: The table above demonstrates the results of our lag comparisons between a 2 year and 6 year lag in our baseline independent variable. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.8: Lagged CE Comparison: Northeast Region

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
2 year lag	0.2873*	-0.1520	0.3798	0.5834*
	(0.1316)	(0.1542)	(0.2451)	(0.2550)
6 year lag	0.2713*	-0.1696	0.3834	0.5507
	(0.1178)	(0.1607)	(0.2227)	(0.2939)
# of Counties	162	159	163	150
Observations	810	795	815	750

Notes: The table above demonstrates the results of our lag comparisons between a 2 year and 6 year lag in our baseline independent variable. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.9: Lagged CE Change Variables: High Amenity Group

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
5 year change	-0.4304	-0.1103	-0.5906*	-1.222
	(0.3293)	(0.2123)	(0.2860)	(0.6445)
10 year change	-0.5795	-0.3173	-0.7865	-1.589**
	(0.3013)	(0.2455)	(0.3927)	(0.5558)
5 year change &	-0.4748	-0.1426	-0.6498	-1.289
	(0.3491)	(0.2367)	(0.3226)	(0.6987)
early 5 year change	-0.6996	-0.5178	-0.9436	-1.912**
	(0.3838)	(0.3597)	(0.5978)	(0.6940)
# of Counties	830	815	823	780
Observations	4,150	4,075	4,115	3,900

Notes: The table above demonstrates the results of exchanging our independent variable with the change in easements across time, rather than the cumulative sum of the easements across time. This, just as before, is still representative of the total percentage of all agricultural acres. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.10: Lagged CE Change Variables: Mountain West Region

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
5 year change	-0.3440	-0.5251	-0.2163	-0.8096
	(0.7747)	(1.054)	(0.5368)	(1.052)
10 year change	-0.6680	-0.9820	-0.8890	-1.569
	(0.7611)	(0.9109)	(0.5307)	(0.8162)
5 year change &	-0.4449	-0.6689	-0.3857	-0.9379
	(0.8287)	(1.094)	(0.5265)	(0.9804)
early 5 year change	-1.110	-1.602	-1.886*	-2.688*
	(0.8727)	(1.168)	(0.8641)	(1.114)
# of Counties	143	142	142	133
Observations	715	710	710	665

Notes: The table above demonstrates the results of exchanging our independent variable with the change in easements across time, rather than the cumulative sum of the easements across time. This, just as before, is still representative of the total percentage of all agricultural acres. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.

Table A.11: Lagged CE Change Variables: Northeast Region

	Machinery Asset Value	Total Acreage	Operating Expenses	Interest Expenses
	(1)	(2)	(3)	(4)
5 year change	-0.6976	-0.0425	-0.4483	-0.0178
	(0.4823)	(0.2685)	(0.6348)	(0.7687)
10 year change	-0.1292	0.0302	0.0328	-0.1809
	(0.3665)	(0.2617)	(0.4743)	(0.5220)
5 year change &	-0.6810	-0.0384	-0.4276	-0.0230
	(0.4661)	(0.2758)	(0.6188)	(0.7667)
early 5 year change	0.4564	0.1031	0.5221	-0.3355
	(0.4112)	(0.3397)	(0.4181)	(0.6240)
# of Counties	162	159	163	150
Observations	810	795	815	750

Notes: The table above demonstrates the results of exchanging our independent variable with the change in easements across time, rather than the cumulative sum of the easements across time. This, just as before, is still representative of the total percentage of all agricultural acres. *,**, and *** are representative of a 10%, 5%, and 1% significance level in our estimates.