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VALUING CHANGES IN THE PROVISION OF A PUBLIC GOOD: EMPIRICAL APPLICATIONS IN ENVIRONMENTAL AND HEALTH ECONOMICS

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VALUING CHANGES IN THE PROVISION OF A PUBLIC GOOD: EMPIRICAL APPLICATIONS IN ENVIRONMENTAL AND HEALTH ECONOMICS

BY

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DISSERTATION

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DEDICATION

To my beautiful wife, Luciana Zilberman, and amazing son, Ari Z. Izón, without whom this would not have been possible.

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ABSTRACT

This work applies revealed and stated preference methods for valuing changes in the provision of environmental and health care goods. It estimates non-market benefits to society from protecting forest lands from commercial activities and elicits individuals' preference (e.g., willingness to pay) for expanding health care coverage to the uninsured. Health care provision policies can save lives but also increase costs, and may work best when done in combination with behavioral and health interventions that promote healthy life styles such as protecting public forest lands.

Chapters 2 and 3 apply the hedonic pricing empirical framework to investigate whether protecting public forest lands generate economic values that capitalize in the labor and housing market. Chapter 2 investigates the role of natural amenities, in the form of Inventoried Roadless Areas (IRAs), in the Southwest United States (US). IRAs are defined as Public Forest or Grasslands exceeding 5,000 acres that are undeveloped areas with little or no timber harvest and no human construction (USDA 2001a). In light of the current legal debate over whether to open IRAs to commercial activities or to maintain

them in their pristine status, a better understanding is needed about the values that these lands in particular may have within a regional economic context, as observed in housing and labor markets. Based on this motivation, these chapters distinguish between congressionally-protected lands also called wilderness areas, IRAs, and the all inclusive open space definition of a public land (e.g., public forest areas in the National Forest System) to estimate the implicit values that individuals have for these lands (e.g., off-site benefits). After accounting for the presence of spatial dependence (e.g., spatial lag and spatial error models) these chapters show significant off-site benefits for living in proximity or in areas with high percentage of IRAs. Scale and zoning effects (e.g., ecological fallacy, Doll et al. 2004) due to the aggregation of data into predefined administrative boundaries (such as Census tracts) are addressed in chapter 3 by using micro-data with a sample of matched wage-earner housing units.

Chapter 4 uses survey-based data to address changes the in provision of a different good with public attributes: expanding health care coverage to the uninsured in New Mexico. One year after Affordable Care Act (ACA) became law public support for such a reform is still significantly divided (42% in favor and 46% against, The Kaiser Family Foundation, 2011). Given the desire to provide universal health coverage but the reluctance to pay higher taxes at the national level, would a state-based reform receive a majority support from New Mexicans? While New Mexican may widely express support for health care reform, they may be collectively and politically unwilling to finance expansion to all the uninsured, with either higher taxes or increased premiums. As such, the results also suggest that an incremental approach, in the search for majority support (and presumably more political support), might be to expand health care coverage to specific segments of the population such as individuals with chronic conditions.

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Chapter 1

Introduction: Non-market benefits, positive externalities, and the allocation and value of resources with public good attributes.

In a market system, the allocation of resources is determined by the equilibrium price and quantity resulting from the interaction of buyers and sellers. This system allocates resources such that people who value goods the most receive them and firms that can produce goods at the least cost produce them. Given this outcome, nobody can be better off without making somebody worse off if a different allocation were chosen. (e.g., Pareto optimal allocation). However, depending on the nature of the good and the presence of externalities, the allocation of goods based on this system may not be socially optimal (e.g., resources are not allocated to their highest and best use). This is the case for resources that generate economic benefits that are not entirely captured by their market price or that have public good attributes (e.g., non-rival and non-excludable). A plausible mechanism to correct or minimize this market failure is for the allocation to be determined or facilitated by the government. Nevertheless, this requires policymakers to quantify the values of increments or decrements to the quantity or quality that the public good in question offers to its passive and active users. In this work, the social allocation of two types of goods that have public good attributes is analyzed: management of forest lands and the provision of health care coverage in the United States (US). More specifically, this work assesses monetary values for changes in the provision of protected forest areas and public health insurance.

The management process that should govern forest lands in the US has been the center of an ongoing debate (Aarons 2011). The increase in productivity experienced in the extractive industry as a result of technological improvements, such as in timber and mining activities, has allowed significant expansion of the supply of these materials (Loomis 2003). However, higher productivity for commercial purposes has been historically in conflict with other benefits that these lands may provide, including recreational opportunities and ecosystem services (e.g., carbon sequestration and clean air). These competing uses of public lands became more noticeable at the end of the 1960s when the US Congress passed three legislative actions concerning the management process of these lands: The Wilderness Act of 1964, the Wild and Scenic Rivers Act of 1968, and the National Environmental Policy Act of 1969 (Loomis 2003). These Acts introduced a legal process under which the allocation of these resources would be determined based on the evaluation of costs and benefits generated by the different end users (Loomis 2003). In the case of the Wilderness Act, the policy debate has been focused on preservation versus development of public lands. Under this Act, a public land can be declared a congressionally-protected area by prohibiting commercial activities or any type of human intrusion (e.g., construction of properties), if the benefits in its preserved status are deemed to be higher than what society must give up to enjoy such a resource allocation (USDA 1964). This Act rests on the argument that since forest lands generate both commercial and non-commercial benefits to society, markets cannot be relied upon to provide accurate measures of non-market values.

Non-market benefits refer to economic (e.g., and non-economic values (e.g., ecosystem services) that open spaces provide to society by keeping them in their preserved status (e.g., undeveloped and pristine status). Since some of the services provided by public forests do not have an observable demand function, the values that these resources provide to society may not fully capture the importance that they have as non-market resources. Thus, ignoring non-market benefits may result in a resource misallocation, thereby reducing both the efficiency of public policy and net social welfare.

Market failure may also result from the presence of externalities that arise when the choice of production or consumption of some individuals affects the welfare of other individuals. In this case, the market price does not fully capture the value of a good since, for instance, an individual consuming a good may increase not only his utility but also the utility of individuals around him. As a result, the social marginal benefit would exceed the private marginal benefit and the market system would provide a quantity level that is less than what is socially optimal.

The presence of positive externalities has been at the center of the debate over whether universal health care is a socially optimal provision of health coverage. The need to address the problem of an increasing uninsured rate has been shared by past and present administrations (The Kaiser Family Foundation (KFF) 2009). In the 1990s and early 2000s, the public debate over "unmet needs"- gaps in health care insurance coverage- at the federal and state level has been extensive (KFF 2009). Those supporting a government intervention in expanding health coverage to the uninsured view health care as a right that all citizens should have regardless of ability to pay. Since the market fails at achieving such provision, a redistribution mechanism is needed in order to extend coverage to those individuals left out of the market. Implicit in this argument is the idea that individuals may recognize that health care produces positive externalities, and thus support programs out of self-interest (Mooney 2009; Case et al. 2009). In this case, the government may intervene by introducing a “corrective” subsidy. Thus, correcting the market provision of a good with positive externalities entails providing public good or quasi-public good. However, this requires a redistribution of resources and utility from the insured individuals to the uninsured. Funding the subsidy requires an increase in taxes which shifts individuals’ budget constraint and utility down.

One way to address the allocation problem that these two goods present to policymakers is to implement methods for valuing changes in the provision of public lands and health care coverage. A plausible approach is to measure non-market values in terms of consumers’ willingness to pay (WTP), which can be an important information input to social benefit cost analysis. This approach is based on the hypothesis that individuals’ WTP can be either elicited via a survey or can be indirectly estimated based on observable or behavioral patterns (e.g., expenditures for other goods or decomposable variation in observed market prices). There are two sets of basic approaches that have been widely used to measure such benefits: the stated preference and the revealed preference approaches. These methods are used to value willingness to pay (or willingness to be paid) for changing the provision of a public good, assuming that an individual’s utility is a function of private and non-market goods (Mitchell and Carson, 1995).

The stated preference method is a survey based approach that elicits people’s preferences or values for changes in the provision of a good. In this case, two types of survey instruments are used: discrete choice and stated choice valuation techniques (Freeman 2003). The latter presents respondents different alternatives being considered and asks the respondents to rank them in order of preference. This information allows a researcher to estimate the value that respondents may have for a specific attribute (e.g., marginal rate of substitution). The discrete choice valuation instrument elicits monetary values for a specific change in the provision of a good and can provide two types of WTP measures: single bounded and double-bounded amounts. In the first case, respondents are asked whether he or she would be willing to pay a specific dollar amount. A “yes” response would indicate that the amount asked is the least the individual would pay for such a change. Additional information can also be elicited with the inclusion of follow-up questions depending on whether a respondent answers a “yes” or a “no” to the first choice question. A higher amount is asked if a “yes” response is given and a lower amount is asked in the case of a “no” to the first amount. This type of question is referred to as the double-bounded valuation instrument. Since the reliability and validity of discrete choice results depend in part on how questions are presented and asked, a major concern with this approach is the degree of bias in the responses (Champ et al. 2009; Little and Berrens, 2004). Since discrete choice questions are non-binding (e.g., only hypothetical scenarios are presented) respondents may overstate their true WTP by ignoring their budget constraints, which is referred to as hypothetical bias (Vossler et al. 2003; Champ et al. 2009). This bias refers to estimating WTP amounts larger than what respondents would pay if the change of provision were to take place. Several calibration methods have been used to account for this bias including follow up questions based on a numerical scale.[1]

[1] Berrens et al. 2002; Norwood et al. 2008; Li et al. 2009; Vasquez et al. 2009

1.1 Empirical Developments in the Stated Preference Method

In the last forty years, the Contingent Valuation (CV) method has been used extensively to elicit public preferences and values for changes in the provision of environmental goods (Carson and Mitchell 1995). One of the first versions of the stated preference method was introduced by Ciriacy-Wantrup (1947), a strong supporter of "direct interview method" for "collective, extra-market goods". He hypothesized that public goods generated benefits that were not captured by market transactions.

While this technique was originally developed to estimate recreational use values (Davis 1963), there was an increasing concern that individuals may care about environmental resources regardless of their desire to use them.[2] This concept, initially coined existence value (Krutilla 1967) later became known as passive-use values. During the late 1970s and 1980s the number of studies estimating passive-use values significantly increased. These included benefits of reclaiming coal mining areas (Randall et al. 1978), protection of endangered species (Samples et al. 1985), preservation of wild and scenic rivers (Walsh et al. 1983), existence value of endangered species (Brookshire et al. 1983) and the value of wilderness (Walsh el al. 1984).

The increase in CV studies was partially due to the enactment of U.S. laws that allowed nonuse benefits to be included for estimating punitive damages (e.g., U.S. District Court : Ohio v. Department of Interior 1989). The 1989 Exxon Valdez oil spill

[2] Early CV empirical applications primarily focused on assessing monetary values in for changes in access to outdoor recreation. The need to better understand public attitudes towards access to forest lands and water based recreation was the major driver for recreation-based studies (Carson and Hanemann 2005).

court case sparked an intense debate over the validity of stated preference method to estimate passive use values.[3] In light of this debate, the National Oceanic and Atmospheric Administration (NOAA) convened a blue ribbon panel headed by two Nobel Prize Laureates to evaluate the application of this technique to estimate nonuse values (Arrow et al. 1993). This state-of-the-art assessment concluded that the use of the stated preference method in judicial and administrative decision-making was valid as long as the studies follow specific guidelines (see Arrow et al. 1993).[4]

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[3] Passive use values represented a significant percentage of Alaska's total economic damages assessment (Carson et al. 2003).

[4] An important suggestion by the NOAA Panel was on the type of elicitation format for asking valuation questions. In particular, the Panel recommended the use of the dichotomous choice (DC) format in which respondents have to give a Yes or No vote to a hypothetical referendum scenario with a specific payment amount. Since different payment amounts are randomly assigned to each respondent, the estimation of the WTP function is feasible. This elicitation format for asking valuation questions has desirable communication and incentive compatibility properties (Hoehn and Randall 1987; Mitchell and Carson 1989). As opposed to an open-ended (OE) format in which respondents must state a dollar amount, in a hypothetical referendum valuation question a respondent either takes or leaves a specific dollar amount much like many private and political market decisions.

Following the 1993 NOAA report, the number of empirical papers applying the stated preference method significantly increased. In 2005, the production of CV applications totaled 742 studies compared to twenty-five in 1974 (Carson and Hanemann 2005).[5]

1.2 CV Applications in Health Care

The growth in the CV literature has been partially driven by the implementation of survey-based studies in areas outside the environmental field. Health is one area where the evaluation of health policies is increasingly relying on the CV method. The main focus of the early papers applying this method was measuring the willingness to pay for reducing mortality risk (see Carson and Hanemann 2005 and Jones-Lee 1974). Yet, health policy decisions were primarily based on cost effectiveness or cost-utility studies, such as maximizing quality adjusted years (QUALY) subject to a budget constraint (Smith and Sach 2010). In the late 1980s, an increasing interest in measuring morbidity effects was one of the main reasons for the unprecedented increase in the number of health studies applying CV methods (Diener et al. 1998; Olsen and Smith 2001).[6] In later years, the range of applications broadened to areas such as discount rates for treatment options (Ganiats et al. 2000), drug therapy options (Johannesson and Fagerberg 1992), and benefits of pharmacy services (Reardon and Pathak 1988).

In particular, health care papers applying the CV method can be divided into two types of studies: (1) *ex post* evaluations of a specific treatment/disease; and (2) *ex ante*

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[5] During the 1994-2000 period, the number of papers applying the CV method averaged between 400 and 500 per year (Carson and Hanemann 2005).

[6] Between 1990 and 2005, the number of CV applications to health related issues increased from three to thirty-eight (Smith and Sach 2010).

evaluations of probable changes in health status. Since the individuals participating in an *ex post* evaluation survey are either experiencing or have experienced the disease in question, the valuation question elicits used values. In the *ex ante* surveys, the valuation in question involves changes in the provision of public goods and respondents are usually selected from the general population.[7] Thus, both used values and non-use or option values may be obtained (Smith and Sach 2010).[8]

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[7] Three types of respondents can be indentified in health studies applying the CV method: users, convenience sample and the general population (Smith and Sach 2010). Since *ex-post* studies evaluate specific treatments, the target population is usually patients and therefore, use values are estimated.

[8] As of 2005, almost 60 percent of CV studies have been conducted to elicit only use values. In an example of an *ex post* CV study, Greenberg et al. (2004) apply a referendum valuation question to a sample of patients with coronary artherosclerosis (n = 1,729) to assess individuals' WTP for treatments that decrease the risk of restenosis and repeat revascularization after undergoing percutaneous coronary intervention (PCI). Pinto-Prades et al. (2007) use both *ex ante* and *ex post* referendum valuation method to estimate WTP for a medicine (Eplerenone) that reduces the risk of death after myocardial infarction. Using a sample of ninety-two patients with type-II diabetes in Germany, Hammerschmidt et al. (2003) use both a dichotomous choice (DC) and payment card elicitation method to estimate WTP for reducing the risk of three diabetic outcomes. Similarly, Whynes et al. (2003) compares WTP for colorectal cancer screening (n = 2,800) under an open-ended (OE) framework and the referendum valuation method.

As the number of studies applying the CV method to elicit public preferences for either a particular treatment (e.g., *ex post*) or for a proposed public program (e.g., *ex ante*) continues to accumulate, careful attention needs to be paid to the study design and estimation methodology. While the NOAA Panel's recommendations have a particular focus on survey-based studies evaluating environmental goods, the CV guidelines to health care applications are still fairly unclear (Smith and Sack 2010). There remains ongoing debate over whether stated preference surveys should be applied to inform policymakers on health-related issues (and for other applications to public good provision), and persistent concern over minimizing potential hypothetical bias (Champ et al. 2009; Little and Berrens 2004). Yet, continued exploration and applications of stated preference approaches can help better understand and systematically elicit patients' and the public's health care preferences (Smith and Sach 2010).

In this work, an *ex ante* evaluation is conducted based on a singled-bounded discrete choice survey instrument to analyze the public support for expanding health care coverage in New Mexico. In this case, the target sample is the general population and the type of benefits measured is non use values. In light of the Affordable Care Act (ACA) signed into law on March 23, 2010, the question becomes, how should the information presented here be used in the current policy debate? This Act is estimated to provide coverage to an additional 32 million uninsured individuals by 2019 (The Kaiser Family Foundation 2011). Two of the most salient aspects of the reform are the requirement that individuals either maintain minimum health insurance coverage or pay a penalty in the form of a tax (e.g., individual mandate) and the expansion of Medicaid to individuals that were previously not eligible. The ACA law requires that nearly all individuals under 65 earning up to 138% of the federal poverty level (FPL) receive health coverage under Medicaid by 2019.

One year after ACA became law public support for such a reform is still significantly divided (e.g., in a June Kaiser Family Foundation (KFF) poll, 42% of the people polled were in favor and 46% were against, KFF 2011). The current economic recession has brought numerous concerns about the feasibility of such a plan. At the forefront is the fiscal impact that ACA may have on state budgets given their current level of deficit. In a 2011 Kaiser Family Foundation report, a five-state analysis shows that the impact of expanding Medicaid eligibility on state budgets ranges from high budgetary costs to low savings. For instance, for the state of Texas (TX) this would increase costs by $27 billion compared to savings of $0.8 billion for Maryland (MD). One of the main reasons cited for these findings is the size of states' uninsured gap (KFF 2011). Being the state with the highest uninsured rate, TX uninsured gap is 11.4 percent of its total population compared to 5.4 percent for MD.

While the state of New Mexico was not included in this analysis, looking at the number of uninsured adults that would become eligible for Medicaid gives an idea of the impact that this may have on its budget. Since about 12.1 percent of the adult population in NM below 138 percent the federal poverty line does not have insurance, NM may not experience any savings by 2019.[9] In light of this, states like NM may have to finance the new net health care costs by increasing state and local taxes. For policymakers, studies like the one presented in chapter 4 may reveal useful information to identify the public's

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[9] In NM, the total number of individuals under 65 earning up to 138% of FPL is 238,200 in 2010. Based on a total population of 1.97 million, this represents 12.1 percent.

willingness to pay for expanding health care coverage in anticipation of potential cost increases as Medicaid eligibility is expanded.

1.3 Revealed Preference Method

Another set of approaches used to measure the impact that a change in the provision of a good would have on individuals' welfare is the revealed preference method. In this case, the value that a non-market good provides to society is inferred by analyzing individuals' purchasing decisions of private goods (Freeman 2003). This technique estimates the marginal implicit prices of the characteristics that differentiate goods in a market (Freeman 2003). In this method, individuals indirectly reveal the willingness to pay for environmental good through surrogate market prices. In this case, a relationship between the demand for the public good and the demand for a private good is determined such that the values society gives to the public good can be estimated.

Ridker and Henning (1967) authored the groundbreaking study using hedonic methods to show empirically that the level of pollution in St. Louis affects housing prices. Their model used data at the Census tract level over individual level observations of housing values. The authors contend that the errors in estimating the values of individual homes will cancel out across the Census Tract assuming they are random. These findings paved the way for future use of housing values to measure the impacts of environmental variables. As an increasing number of studies started to implement the hedonic pricing method, critics claimed that observed relationships between environmental disamenities and home values could be simply spurious correlation. Freeman (1979) responded to these criticisms by explicitly defining the method for estimating the demand for a characteristic of a property as being a two step method.[10] In this paper, Freeman explicitly draws out the econometric consequences of developing implicit prices for attributes of a good. Building upon this framework, Roback (1982) presented an econometric framework that combines hedonic property value and wage compensations. Prior to this paper, the preceding hedonic approaches to valuing environmental improvements were viewed as alternative approaches. Since then the number of papers applying the hedonic framework significantly increased and the scope of the good being studied broadened considerably.[11]

In this work, these hedonic pricing methods are used to estimate the implicit prices of public forest lands by linking them with house prices and wages. For instance, it is assumed that the price of a house is a function of not only its size and year built but also of environmental quality such the distance to a natural amenity. The hypothesis is that if public forest lands provide non-market benefits, individuals would be willing to pay a higher house price and receive a lower wage the closer the house is located to a public land.

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[10] In the first stage, hedonic pricing methods are used to obtain the implicit pride of the characteristic. In the second stage, the implicit price is used along with the actual observed quantities and individual characteristics to estimate the demand.

[11] Viscusi and Aldy (2003) review sixty studies while Mrozek and Taylor (2032) provide a meta-analysis of over 40 studies that apply the hedonic method to estimate the value individuals place on small changes in the probability of death between 1973 and 2002 (e.g., the Value of a Statistical Life).

1.4 Objectives and Empirical Approaches

This work applies non-market valuation techniques for valuing changes in the provision of public lands protection and health care coverage in the Southwestern US. The objective of this dissertation includes investigating the hypotheses that public forest lands generate service flows that extend beyond input of production and whether there is public support for expanding health care coverage.

Chapters 2 and 3 apply the hedonic pricing empirical framework to investigate the role of Inventoried Roadless Areas (IRAs) in the Southwest. Previous studies have shown that people are willing to pay higher prices to live in proximity to forest amenities. However, IRAs were intentionally or unintentionally part of a broader definition of open space such as forest lands. In light of the current legal debate (e.g., see Aaron 2011) over whether to open IRAs to commercial activities or to maintain them in their pristine status, a better understanding is needed about the values that protecting these lands in particular may have within a regional economics context, as observed in housing and labor markets. Based on this motivation, these chapters distinguish between wilderness areas which are managed as congressionally-protected lands (e.g., human construction or commercial activities are prohibited), IRAs which do not yet have legislative protection, and the all inclusive open space definition of a public land (e.g., forest) in an attempt to estimate off-site benefits of only IRAs (Glicksman 2004). Spatial variations in wage and housing prices partially due to proximity or percentage of forest amenities would further support the New West growth story hypothesis presented by other authors. This West growth story is based on the idea that the preservation of natural amenities is strongly correlated to the rapid economic growth in the American West during the 1990s (Schmidt and Courant 2003).

Each chapter addresses this open empirical question based on a different scale of observation, from a representative agent-based analysis (chapter 2), to the observation of micro-level individual houses and wage earners (chapter 3). Chapter 2 presents a spatial lag hedonic model based on 456 observations to investigate whether one type of benefit – off-site benefits accruing to homeowners in proximity to IRAs – is observable as a hedonic premium paid for in housing prices in New Mexico, using aggregated Census tract-level data. Scale and zoning effects (e.g., ecological fallacy, Doll et al. 2004) due to the aggregation of data into predefined administrative boundaries (such as Census tracts) are addressed in chapter 3 by using micro-level individual data with a sample of matched wage-earner housing units equaled to 1,014 observations. Following Roback's (1982) hedonic framework, this chapter considers interactions between the housing and labor markets in the state of Arizona, using a seemingly unrelated regression econometric approach with two spatial processes (e.g., spatial lag and spatial error correlation).

These two chapters report substantial benefits for living in the proximity or in areas with high percentage of natural public forest areas. However, it is important to note that these off-site benefits are components of the larger bundle of ecosystem services and non-market benefits that protected lands may offer (Loomis and Richardson 2000; Berrens et al. 2006). Thus, these chapters report estimates for a portion of the total economic value (TEV) of these protected areas. Outside mainstream environmental economics, an increasing number of papers argue that land use policies, such as protection of public lands, that promote healthy lifestyles can help curb increasing health care costs (Wernham 2011, Bhatia and Wernham 2008). Recent health care coverage simulations show that expanding health insurance and care saves lives, but can increase costs, and may work best when done in combination with behavioral and health interventions that promote healthy life styles (Wernham 2011). This has particularly impacted New Mexico (NM), which has the second highest uninsured rate in the nation behind Texas. The expansion of health care coverage is addressed in chapter 4 based on a contingent valuation survey.

Chapter 4 uses survey-based data to address changes the in provision of a different good with public attributes: expanding health care coverage to the uninsured in New Mexico. While national opinion polls show a consensus in the general public for some type of national health insurance, some studies show that this support significantly decreases when asked to pay higher taxes to finance such a reform (Kessler and Brady 2009). Given the desire to provide universal health coverage but the reluctance to pay higher taxes at the national level, would a state-based reform receive a majority support from New Mexicans? To address this question, Chapter 4 uses data from a statewide random-digital telephone survey sample. The survey was conducted between October 12 and December 13, 2007, and included 1,076 complete and 182 partial interviews. The experimental design includes split-sample treatments for evaluating: two alternative payment vehicles (increases in either state and local taxes or insurance premiums); and two categorically nested goods (basic health care [the inclusive good] or primary health care [the subset good]).

Chapter 5 presents the summary, conclusions, and limitations of this work as well as suggestions for future research.

Chapter 2

The Economic Value of Protecting Inventoried Roadless Areas: A Spatial Hedonic Price Study in New Mexico

2.1 Introduction

Undeveloped, open-space lands, such as Inventoried Roadless Areas (IRAs) and Congressionally-designated Wilderness Areas (WAs) provide a number of non-market benefits to society, which may not be fully accounted for in land management decisions. While the status of WAs is relatively certain as congressionally-protected lands, the status of IRA lands is tied to Federal agency rulemaking and a protracted political and legal debate, which makes their condition highly uncertain. IRAs are defined as Public Forest or Grasslands exceeding 5,000 acres that meet the minimum criteria for wilderness consideration under the Wilderness Act of 1964 (USDA 2001a) but are not categorized or managed as wilderness areas.[12] The 58.5 million acres of IRA lands represent about 7 percent of all forested lands (Berrens et al. 2006), and 30 percent of all National Forest lands in the U.S.; they are often located on the fringe or buffer of many WAs lands (USDA 2001a).[13] The policy debate over the fate of IRAs centers on whether to manage them consistent with Wilderness designation. Given the difficulties of measuring the

[12] Wilderness Areas (WAs) total 35 million acres and are managed as congressionally protected areas, representing 18 percent all National Forest land in the U.S. (USDA 2001a)

benefits of protecting IRA lands, and the changes that the federal regulations governing IRAs have experienced in the last 15 years, this debate is far from over.

As of this writing, a State Petition Rule allows each state to petition the protection of these areas to the United States Department of Agriculture (USDA 2005).[14] In New Mexico (NM), Governor Bill Richardson filed a petition in May, 2006, to protect all 1.6 million acres of IRAs in NM (and an additional 100,000 acres in the Valle Vidal unit of the Carson National Forest). This petition and other similar protection-oriented petitions from other states with IRAs rest on the arguments that these lands provide various ecosystem and amenity services, recreation values, and cultural significance, both on-site and off-site on proximal lands, and further that these values would be lost or significantly degraded if commercial activities were allowed on these lands.

Nationwide, the IRA policy debate involves questions about the relative values of protection versus development. The state of New Mexico has submitted a petition based largely on the non-market environmental benefits that IRAs provide in the state. The main thrust of this paper is to examine whether off-site benefits accruing to homeowners in proximity to IRAs is observable as a hedonic premium paid for in housing prices in New Mexico. While an increasing number of papers have shown that people are willing to pay higher prices to live in proximity to forest amenities (Hand et al. 2008; Schmidt and Courant 2003), IRAs have not been included as an explanatory variable. In most cases, IRAs were intentionally or unintentionally part of a broader definition of open

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[14] These petitions are reviewed by a National Roadless Area Conservation Advisory Committee (RACAC) that makes recommendations to the USDA as to whether or not the petitions should be accepted (36 C.F.R. § 294.12).

space such as forest. In light of the current legal debate over whether to open IRAs to commercial activities or to maintain them in their pristine status, a better understanding is needed about the impact that these lands in particular may have on an economy. Based on this motivation, this paper distinguishes between congressionally-protected lands (e.g., WAs), IRAs, and the all inclusive open space definition of a public land (e.g., forest) in an attempt to estimate off-site benefits of only IRAs. Since there are other potential benefits (e.g., on-site recreation values, and non-use values) derived from protecting IRAs and WAs (Morton 1999), the estimated off-site benefits to homeowners may only represent a small portion of the total economic value of these lands (e.g., see Loomis 1996). As a state that is becoming relatively more dependent on role of natural landscapes and amenities, including protected forests and grasslands, within the regional economy (e.g., Berrens et al. 2006; Hand et al. 2008a and b; Rasker et al. 2008), the importance of the 1.6 million acres of IRAs may plausibly lie in their role as protected open spaces. If IRAs provide non-market benefits, as argued nationally (Loomis and Richardson 2000), then NM is a place where they should be observable.

Since the benefits provided by IRAs do not have explicit market prices associated with them, testing the validity of this argument requires the application of non-market methods (Champ et al. 2003). This study applies a hedonic pricing framework to NM residential housing values by combining the 2000 Decennial Census data with available Geographic Information Systems (GIS) data. Spatial hedonic models are estimated to determine if the density of IRAs has a positive and statistically significant effect on the median price of a home in NM. Results indicate that there is a 5.6% gain in the price of a house from being located in or adjacent to a Census tract with IRAs. In the aggregate, this gain represents 3.5 percent of the value of owner-occupied units in New Mexico ($1.9 billion in capitalized value or an annualized value in perpetuity of $95 million, assuming a 5 percent interest rate).

2.2 Current Policy Debate

The final Roadless Area Conservation Rule, which was designed to protect 58.5 million acres of National Forest land from further road construction and development, was published in the Federal Register before the Clinton administration left office in January, 2001 (USDA 2001a). Shortly thereafter, the Bush administration set aside the rule for further study as part of a White House moratorium on all Federal rules not yet in effect (USDA 2001b). In 2005, the Bush administration published a rule to replace the original Roadless Rule of 2001 (USDA 2005). This replacement rule used existing individual forest plans as the baseline for managing IRAs, with a mechanism for states to petition the U.S. Department of Agriculture (USDA) for state-specific IRA management. Several states submitted or prepared petitions for state-specific IRA rule making.[15] During the petitioning period a Federal district judge, in a 2006 lawsuit brought by the states of California, New Mexico, and Oregon, found that the 2005 rule was invalid, thus

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[15] Virginia, South Carolina, and North Carolina submitted petitions that were accepted by the Secretary of Agriculture (Warner 2005; Sanford 2006; Easley 2006). New Mexico, California, and Colorado prepared petitions, but they have been either not submitted or not considered due to legal uncertainty about the original 2001 rule. Idaho prepared a petition that it planned to submit under the Administrative Procedures Act (Risch 2006).

reinstating the original 2001 Roadless rule (U.S. District Court Northern District of California 2006).

On August 12, 2008, Judge Brimmer invalidated the 2001 Roadless Area Conservation Rule for the second time, without making any reference to the State Petition rule (U.S. District Court for the District of Wyoming 2008). As a result, the Forest Service has now been directed by Federal courts in different districts to both follow and also not follow the original 2001 Roadless Area Conservation Rule. A new appeal of this decision is pending in the U.S. District Court for the Northern District of California (U.S. District Court Northern District of California 2008). Clearly, the legal debate over the status of IRAs is far from over.

Aside from the legal debates relating to the Roadless Rule of 2001, there is evidence of an economic debate about the role of IRAs in local, state, and regional economies. In a 2001 report to Congress, the Office of Management and Budget (OMB) concluded that prohibiting timber harvest and mining on all IRA lands nationally would cost about $184 million compared to just $219,000 in annual benefits, attributed only to the avoided costs of road building (OMB 2002). Similarly, a study from the U.S. Forest Service reported that costs from the IRA rule would total about $262 million annually and 4,559 lost jobs, but no economic benefits were quantified (USFS 2000). As stated in a law review article (and see discussion in Berrens et al. 2006), Heinzerling and Ackerman (2004, p. 7) note:

> "How did a rule protecting 60 million acres of publicly owned lands, containing fragile and precious sources of water, wildlife, and plant species, come to look so bad in economic terms? The answer is simple: just ignore most of the good things one wants to protect forests for – both the good things that could comfortably be stated in dollar terms (such as the economic value of a forest for tourism) and the good things that money cannot buy (such as the knowledge that pristine forests are being protected in perpetuity)."

The often-contentious debates over public land management in the West are clearly visible in the history of the Roadless rule. For example, the states' petitions to the USDA for state-specific IRA management indicate the differing role that IRAs are perceived to play in the economies of each state. Idaho, which petitioned to exempt millions of acres from a prohibition on road building, seeks to strike a "careful balance between all of the needs of those who depend on and enjoy IRAs," (Risch 2006, p. 59). This balance includes classifying a portion of IRAs under a "General Forest" management theme, which allows road building, timber harvesting, and minerals extraction as appropriate activities. Under this management theme, "fish, wildlife, and ecosystem restoration are not necessarily the driving force behind management activities" (Risch 2006, p. 67).

Other states, including New Mexico, make an appeal to the importance of tourism and recreation in their states' economies, the importance of unique natural features that people value, and of the role of IRAs in generating certain ecosystem services. The New Mexico IRA petition, which seeks to manage the state's IRA lands consistent with the 2001 rule, notes that IRAs "protect watershed health, increase and conserve biodiversity, [and] provide opportunities for outdoor recreation and personal renewal," (Richardson 2006, p. 6). According to New Mexico's petition, *inter alia*, the cost of protecting the $1 billion of wildlife-related spending in the economy outweighs the small (if any) negative impact on the forestry sector (Richardson 2006).

New Mexico's and other states' petitions suggest that the states have to some degree engaged in a kind of rough benefit-cost analysis of IRA protection in their state, and have taken regulatory and legal action based in part on that analysis. For example, California's petition claims that preservation "protects both economic and intrinsic values for current and future generations," (Schwartzenegger 2006, p. 1). Virginia's petition came down on the side of IRA preservation with a clear appeal to notions of benefit-cost analysis: "economic reasons for prohibiting development activities in roadless areas far outweigh arguments against such a ban," (Warner 2006, sec. 3.f). Colorado's petition seeks to exempt ski areas from IRA protection, indicative of the relatively important role of ski areas in Colorado's tourism economy (Owens 2006). And Idaho's proposed exemption of 6 million acres (of Idaho's total 9.3 million acres of IRAs) from road-building prohibitions may reflect a greater dependence on the wood products industry in that state (Risch 2006). This poses the question of whether these apparent benefit-cost analyses or trade-off considerations, and thus the conclusions based on them, are accurate representations of the states' public preferences.

While a number of studies applying hedonic price models have shown that proximity to open-space amenities is capitalized in the real estate market (e.g., Hand et al. 2008a; Schmidt and Courant 2006; Kim and Wells 2005; Phillips 2004; Kim and Johnson 2002; Shultz and King 2001; Phillips 1999; Doss and Taff 1996), little is known about the economic benefits of protecting IRA lands, aside from some "back of the envelope" estimates of the non-market values of IRAs (Loomis and Richardson 2000; and Berrens et al. 2006). Both of these studies apply a benefit transfer technique based on Phillips' (1999) findings to estimate the impact of IRAs on housing values at a national level (Loomis and Richardson 2000) and in NM (Berrens et al. 2006) [16]. Loomis and

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[16] In Phillips (1999), a hedonic price analysis was applied to over 6,148 land sales to isolate the value of parcels near designated Wilderness areas in Vermont. Results indicate that proximal parcels sold at prices 13 percent higher than otherwise, with a price

Richardson (2000) estimated that the gain in real local property values is 13 percent compared to 6 percent for NM (Berrens et al. 2006).

To provide background for the case of New Mexico, Table 2.1 presents selected measures of economic performance for New Mexico counties with significant IRAs, and counties with little or no IRAs. High-IRA counties appear to be doing well economically, keeping up with and in some cases surpassing non-IRA counties. Growth in real income per capita, non-farm employment, and real earnings per job was faster in IRA counties as compared to non-IRA counties. And while natural resource extraction is relatively more important in IRA counties, growth in employment in service industries was faster in IRA counties.

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decrease of 0.8 percent per acre for each kilometer of distance from the wilderness area (Phillips 1999; Loomis and Richardson 2000; and Berrens et al. 2006). To estimate the off-site benefits of IRAs on a national level, Loomis and Richardson (2000) used the Phillips (1999) findings by assuming that the 13 percent estimated for designated Wilderness areas can be applied to other natural areas, such as IRA lands. Berrens et al. (2006) adjust this estimate to a 6 percent gain in local ranch properties for NM based on the relative scarcity of protected areas in the Eastern U.S. compared to the Western region. More recently, Phillips (2004) updated his original study to cover all property sales in the area from 1987-2002, covering more than 12,000 transactions and 82 towns across southern and central Vermont within 14 kilometers of the NF boundary. A key finding is that towns with adjacency -- designated Wilderness Area acreage within their borders – had a 19 percent higher per acre price than those without.

Roadless areas may also play a role in the larger regional economy if the economic performance of one county influences nearby counties (see Khan et al. 2001; Wheeler 2001). In New Mexico, counties with large tracts of roadless land, which are predominately rural and sparsely populated, appear to be increasingly tied to the economy and labor markets of nearby urban areas (Hand et al. 2008a). Earnings flows measure the amount of wages and salaries that are earned in a county that is different from where a worker resides. As shown in Table 2.1, net earnings flows in IRA counties are positive, about $511 million in 2005, and have increased by about 27 percent since 2001. This suggests that New Mexicans increasingly live in more rural, IRA-dominated counties and commute to proximal urban areas for access to employment opportunities.

These descriptive data support a *prima facie* case that New Mexico's petition is based on a plausible accounting of the benefits and costs of developing IRAs. However, it remains unclear whether people value IRA-derived benefits to the degree that some Western governors suggest, or whether we can observe any empirical signals of those values.[17] The remainder of this paper focuses on a piece of this larger benefit-cost analysis question and a particular category of benefit, by investigating whether off-site

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[17] Rather than reflecting solely an accounting of public preferences, it is possible that the petitions represent some other kind of safety perspective, such as a Safe Minimum Standard (SMS) approach to conservation. Randall and Farmer's (1995, pp 3) "circumstantial" case for conservation suggests that conservation policy be made "on the basis of benefits and costs, but subject always to the constraint that actions we fear we (or future generations of people we care about) will regret are forbidden,". In this policy framework, benefit-cost analysis plays a role, but not necessarily a decisive role.

benefits accruing to homeowners in proximity of IRAs are being capitalized in the New Mexico housing market. By distinguishing between IRAs and WAs, this paper intends to inform the current debate on whether managing IRAs as WAs generates benefits that are not explicitly capture in the market.

2.3 Hedonic Empirical Framework

In this section, the hedonic framework and a theoretical discussion on spatial-dependence relationships are presented to inform the empirical approach. In hedonic price studies, the hypothesis is that visual or proximal access to some set of environmental amenity and disamenity characteristics gets capitalized into the sales price of the property. The hedonic pricing method decomposes the statistical variation in prices for a heterogeneous good (e.g., residential real estate) to isolate the contribution of individual attributes or characteristics of the good (Taylor 2003).

An important feature of the empirical framework pursued here is that the hedonic analysis is carried out on observations of representative households. Due to housing price disclosure limitations in New Mexico (see Berrens and McKee 2004), the median characteristics of each Census tract are assumed to be representative of the housing stock in that location.[18] It is important to note that while it is a common practice in hedonic studies to assume participants have full information, it may not be realistic to extend this assumption to the relevant natural resource characteristics. It may be the case that an

[18] See Chay and Greenstone (2004) and Greenstone and Gallagher (2008) for examples using median housing values at the census tract level and relying on a "natural experiment" framework to estimate the benefits of environmental regulations and policies.

owner of a house is aware that a forest is located in close proximity but does not know the type of open space in question. However, we adopt two other conventional assumptions for hedonic models: that the housing market is in equilibrium (Blomquist 2008) and that the state of New Mexico represents a single composite housing market. It should be noted that market equilibrium is based on the assumption that utility differences between locations have already been eliminated.[19]

Following Freeman's (2003) theoretical hedonic price framework and using a vector notation, a household's utility function depends on goods consumed **C**, housing characteristics **S**, neighborhood characteristics **N** and location-specific environmental amenities **Q**. In particular, the purpose of this paper is to econometrically estimate the housing price function, which is derived from the utility maximization problem (Freeman 2003):

$$P_{hj} = p(S_{hj}, N_j, Q_j), \qquad (2.1)$$

where *h* represents an individual house with location *j*.

In the context of this study, the environmental amenity vector **Q** includes the percentage of IRAs and Wilderness Areas within a Census tract. In this setting, it is assumed that a household in location *j* faces tradeoffs when choosing the level of, for instance, IRA lands as given by the first order condition:

[19] This is also referred to as spatial equilibrium. This assumption is widely used in urban economics and states that total utility or level of well-being across regions should be the same if the market is at equilibrium (Blomquist 2006). This implies that there is no gain by moving from one market to another since combinations of local amenity bundles, wages, and housing prices are equally attractive.

$$\frac{\partial u / \partial Q_{IRAs}}{\partial u / \partial C} = \frac{\partial p_j}{\partial Q_{IRAs,j}} \quad (2.2)$$

In this study, location *j* corresponds to a Census tract *j* and since each observation corresponds to a Census tract with a representative house, the *h* subscript is dropped. The econometric equivalent of equation (2.1), assuming a log-linear specification,[20] is:

$$\ln P = \alpha_0 + \beta S_j + \phi N_j + \eta Q_j + \varepsilon, \quad (2.3)$$

where $\varepsilon \sim N(0,\Omega)$, and β, φ, and η are the coefficients to be estimated.

2.31 Spatial Econometrics

The model specification in equation (2.3) is perhaps still the most common in applied hedonic studies. However, equation (2.3) does not address spatially-dependent relationships that emerge when using geographic data (Anselin 1988). The econometric model in equation (2.3) implicitly assumes that there is no interdependence of homeowner's home pricing decisions. In this case, interdependence refers to a situation in which the asking price that a homeowner chooses may affect the prices asked by neighboring proprietor. This spatial relationship can be interpreted as a measure of the degree of product substitution in the real estate market and assumes that houses in closer proximity are closer substitutes than those more distant. Spatial dependence may also be observed if similar behavioral responses arise due to a common neighborhood effect. For instance, opening an IRAs for development in Census tract *j* may affect home prices in

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[20] Other model specifications were tested but due to high degree of multicollinearity (e.g., a condition number > 30), they are not reported in this paper.

that location which in turn affects home values in neighboring census tracts. In the context of this paper, spatial dependence arises when the value of a house located in Census tract *j* is determined by both its own housing and environmental characteristics and the values and characteristics of homes located in neighboring Census tracts. In many instances, this arises due to random specifications of geographic units, such as census tracts or county boundaries, which may not accurately reflect the extent to which the phenomenon in question behaves in space (Anselin 1988). Another reason is that regardless of whether data corresponds to individual spatial units or aggregated units, diffusion processes (e.g., spillover effects) result in spatial autocorrelation between different spatial units depending on location and distance. For instance, in Hand et al. (2008) the approach used to control for spatial dependence was to include an independent variable that measures average forest and wilderness areas in contiguous Public Use Microdata Areas (PUMAs). Since the data used was the 2000 Public Use Microdata Series (PUMs), the effect of forest lands or wilderness areas had to be aggregated to geographic areas called PUMAs.[21] The hypothesis was that the natural characteristics of nearby places also affect housing prices and wages in a particular PUMA.[22]

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[21] While PUMs provides individual-level data, each individual is identified to a PUMAs with a population of at least 100,000. In Hand et al. (2008), PUMAs were used as the level of observation to calculate the percentage of forest or wilderness lands. Therefore, the same percentage of forest area was assigned to individual locations that belong to the same PUMA. In total there are 36 PUMAs in Arizona and 15 in New Mexico.

[22] In Hand et al. (2008), results show that the average percentage of wilderness areas in contiguous PUMAs has a much stronger and statistically significant effect on both the

A shortcoming of this approach is that the coefficient of an independent variable may be accounting not only for direct marginal effects but also for spillover effects. For instance, it implicitly assumes that a change in the price of a neighboring home due to a change in the percentage of forest lands does not affect housing prices in a particular PUMA. If there is spatial autocorrelation in the data, the coefficients of the explanatory variables would be biased upwards as they would fail to separate the marginal effects from the spillover effects of the explanatory variable on housing prices. In this case, $E[P|X] = X\beta_{OLS}$ and $\beta_{OLS} > \beta$, where X is a vector of independent variables and β is a column vector of parameters.

Building upon this hypothesis, this paper implements an econometric model that accounts for these spatial interactions as described below. The simultaneity and non-linearity of these spillovers is captured in the spatial lag model specification and estimation.

At present, a small but growing number of empirical papers applying the hedonic pricing framework have tested for the presence of spatial-autocorrelation (Kim et al. 2003; Pace and Gilley 1997; Anselin and Lozano-Garcia 2008; Huang et al. 2006; and Brasington and Hite 2005). As one example, Kim et al. (2003) apply spatial hedonic models (e.g. equations 2.4 and 2.6, presented below) to estimate the benefits of air quality improvement in Seoul, South Korea and to test for the presence of spatial-autocorrelation. The authors find that the OLS coefficient on nitrogen oxides overestimated the effect of

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housing labor market of a particular PUMA than the percentage of wilderness areas in the PUMA in question. These findings suggest that omitting spatial dependence would deliver biased results.

this pollutant on the housing value in the presence of spatial dependence. Moreover, Kim et al. (2003) show that the model that accounts for spatial autocorrelation is preferred to the OLS specification.[23]

As a second example, Pace and Gilley (1997) draw upon Harrison and Rubinfeld's (1978) applied-hedonic study for the housing market in Boston to empirically demonstrate the implications of ignoring spatial autocorrelation. Based on a spatial autorregresive model, Pace and Gilley (1997) find that the estimated sum-of-squares errors fall by 44 percent compared to the OLS results estimated in Harrison and Rubinfeld (1978). Moreover, the effect of nitrogen oxides (NO_x) levels on housing prices, the variable of interest in the paper, decreases by 38 percent when using a spatial autorregresive model as opposed to a log-linear model. These two papers empirically show that accounting for spatial autocorrelation improves the estimated coefficients and overall results of the respective study.

In this paper, spatial dependence is addressed by estimating two different models: a spatial lag model, and a mixed spatial lag model. The first model is estimated using both a Maximum Likelihood (ML) and a 2-SLS robust approach. The mixed spatial lag model is estimated using the ML technique. In the first spatial model, a vector of house prices

[23] Kim et al. (2003) estimate that the marginal willingness to pay (MWTP) for a 4 percent reduction in SO_2 concentration is $2,333 or 1.4 percent of the mean housing price, using a 2-SLS Robust approach to estimate the spatial hedonic model.

observed at other locations is included on the right hand side of the hedonic model, according to (Anselin 1988)[24]

$$\ln P = \alpha_0 + \rho_{price} W \ln P + S\beta + N\phi + Q\eta + \varepsilon, \qquad (2.4)$$

where and **W** is an *nxn* matrix that describes the contiguity relationship between spatial units and has non-zero elements w_{ji} in each row *j* for those columns *i* that are neighbors of location *j*. For a particular location, this model is represented by the following expression: $\ln p_1 = \rho\ (w_{11}\ p_1 + w_{12}\ p_2 + w_{13}\ p_3 ... + w_{1n}\ p_n) + X_1\beta + \varepsilon_1$, where $w_{11} = 0$ and $\rho_{price} \in [-1,1]$ is the spatial autoreggresive coefficient to be estimated and represents the effect of housing prices in neighboring Census tracts on the median price in location *j*. This spatial lag model specification explicitly distinguishes between direct or marginal effects and spillover effects. For instance, the effect of changing the status of WAs to unprotected lands would change the price of a house in the same Census tract (e.g., coefficient η in equation 2.4) as well as prices on neighboring Census tracts (e.g., spillover effects captured by the ρ_{price} coefficient). Therefore, the OLS coefficients in equation (2.3) would be inconsistent as they would incorrectly include both the marginal effect and the spillover effects.

In other words, equation (2.4) is the analogue of equation (2.3) but ρ_{price} is not assumed to be equal to zero.

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[24] While use of a more flexible functional form such as a Box-Cox transformation may be more appropriate, estimation in the presence of spatial dependence raises a number of methodological issues, which we leave to future research and investigation.

In (2.4), the direct effects that structural, neighborhood and environmental characteristics in neighboring Census tract *i* may have on the price of a house in Census tract *j* are assumed to be zero. A more general model that introduces these types of spatial correlations is (Anselin 1988):

$$\ln P = \alpha_0 + \rho_{price} W \ln P + S\beta + N\phi + Q\eta + \rho_S WS + \rho_N WN + \rho_Q WQ + \varepsilon, \qquad (2.5)$$

where ρ_i (for i = S, N, and Q) is the autoregressive coefficient that corresponds to each explanatory variable and represents the effect of, for instance, housing characteristics (**S**) in neighboring Census tracts on the median price in location *j*. The presence of significant spatial lagged coefficients (e.g., ρ_{price}) means that the estimated OLS coefficients in equation (2.3) would be biased and inefficient due to correlation or endogeneity problems between the lagged dependent variable (WP) and the error term (Anselin 1988), which underlines the importance of testing spatial lag dependence.

To correct for this problem, a common solution is to implement an ML or a 2-SLS approach. An important assumption made when using the ML method to estimate equations (2.4) and (2.5) is that the error term is normally distributed. A plausible alternative that addresses this potential issue is a 2-SLS method. Since a 2-SLS approach uses an OLS estimation technique, the probability distribution function of the error term is not required, which suggests that the distribution of the error term is not an issue. Moreover, the existence of endogeneity is solved by finding the instruments for the vector of prices on the right hand side of equations (2.4) and (2.5). In the empirical literature, it is common practice to use the spatially lagged explanatory variables (e.g., **WX**), as instruments (Anselin 1988). Given the specific empirical application of this paper, equation (2.4) can be written in the following way:

$$\ln P = \alpha_0 + \rho_{price} W \widehat{\ln P} + S\beta + N\phi + Q\eta + v, \qquad (2.6)$$

In this equation, $W \widehat{\ln P}$ is obtained by using **WX** as instruments for **W lnP**, where **WX** = [**WS WN WQ**] (Anselin 1988). As a result, including the spatial lags of the explanatory variables on the right hand side of equation (2.6) would result in a misspecification of the 2-SLS model.[25] Based on these models, two marginal effects of interest are estimated: the marginal effect of a 1 percent change in IRAs and a 1 percent change in WAs on housing prices. These effects can be mathematically expressed as:

$$\text{Log-linear: } \frac{\partial P}{\partial Q_{IRAs,j}} = Q_{IRAs,j} P\,, \qquad (2.7)$$

$$\text{Spatial lag: } \frac{\partial P}{\partial Q_{IRAs,j}} = Q_{IRAs,j} [\frac{1}{1-\rho_{PRICE}}]\ P, \qquad (2.8)$$

[25] In the 2-SLS approach, the instruments used to correct the endogeneity problem are the spatially lagged explanatory variables. In this case, the econometric estimation is divided into two stages. In the first stage, **WP** is regressed using the instruments mentioned above to obtain $\widehat{WP}$. In this second stage, equation (4) is estimated after substituting $\widehat{WP}$ for **WP** to solve the endogeneity problem arising from housing price effects. Mathematically this can be represented as follow:

1st Stage: **WP** = ρ_s**WS** + ρ_N**WN** + ρ_Q**WQ** + ε.

2nd Stage: **P** $= \alpha_0 + \rho_{price} \widehat{WP} + \beta S + \phi N + \eta Q + v.$

From the 1st stage estimation, WP = $\widehat{WP} + \varepsilon$. After substituting this right hand side expression for WP in equation (4) and simplifying notation, the equation estimated in the 2nd stage is equivalent to equation (6).

$$\text{Mixed Spatial lag: } \frac{\partial P}{\partial Q_{IRAs,j}} = Q_{IRAs,j}[\frac{1}{1-\rho_{price}}]P + [\frac{1}{1-\rho_{price}}]\rho_{Q\,IRAS,j}. \quad (2.9)$$

Equation (2.7) estimates the direct-contemporaneous effect ($Q_{IRAs,j}$) of a 1 percent change in IRAs located in Census tract j on house prices located in census tract *j*. This marginal change affects prices of houses located in Census tract *j*, assuming that housing prices in the other Census tracts remain constant. In equation (2.8), this assumption is relaxed and two types of effects are estimated: the direct-contemporaneous effect and indirect effects. The latter represents the effect on home prices in Census tract *j* of a 1 percent change IRAs in neighboring Census tracts through an intermediate channel such as neighboring Census tract home prices (represented by ρ_{price}). In this hedonic framework, the marginal or contemporaneous impact is the change in own home prices holding all others' prices constant. The total derivative would be the combined effect of all housing price changing simultaneously. In this case, this total change is given by the spatial multiplier process (1/(1-ρ)) which measures how the average effect of a change in Q_{IRAs} is multiplied by the spillovers in the spatial system (Anselin 2003). This process captures both the direct-contemporaneous and indirect (spillover) effects of neighborhood's IRAs lands on housing prices. A shock in the explanatory variable Q_{IRAs} in census tract *i* (e.g., an increase in the percentage of IRAs opened to development) would simultaneously affect home values in neighboring Census tracts. This spillover effect is a function of the spatial process (e.g., in this case is the spatial lag), the specification of the weight matrix (e.g., weighted average effect of housing prices in neighboring units) and the value of the spatial autoregressive coefficient. Thus, the full effect of a change in Q_{IRAs} on housing prices can be interpreted as a multiple of the marginal direct effect (represented by the coefficient η_{IRAS}) of a change in Q_{IRAs} given (Anselin 2003).

In equation (2.9) three effects are estimated: the direct-contemporaneous, the indirect, and direct spatial-spillover effects (ρQIRAS,j). A direct spatial-spillover represents the effect on home prices in Census tract j of a 1 percent change in IRAs in neighboring Census tracts on own-tract home prices; the effect is direct in the sense that the nearby IRAs are directly affecting home prices, but it is a spatial spillover (i.e., it is not spatially contemporaneous). A positive and statistically significant QIRAs,j would mean that houses in Census tracts with a higher density of undeveloped IRAs would have a higher market value as compared to houses with lower or no IRAs, ceteris paribus. The ρprice coefficient is estimated in equations (2.4)-(2.6), and signifies spatial autocorrelation.

The results obtained in the log-linear model (equation 2.3) that ignores any type of spatial autocorrelation are compared to those of the three spatial-lag model specifications presented above. The spatial weight matrix, **W**, is constructed using a five-closest neighbors criterion. The five Census tracts nearest to location *j* are defined as neighbors, for which the average distance is 2.64 miles.[26]

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[26] The weight matrix was constructed using the X-Y coordinates of each Census tract. The distance between the different Census tracts was calculated using GeoDa software. Other specifications of the weight matrix were computed (i.e. 3, 4, and 6-nearest neighbors) but the estimated coefficients were not significantly different from the spatial lag model based on the 5-nearest neighbors criterion. Other alternatives for constructing a weight matrix includes rook criterion (locations sharing a boundary), queen criterion (locations sharing a vertex), and threshold distance. A k-nearest neighbor's criterion has the advantage of ensuring that each Census tract has an equal number of neighbors.

2.4 Data and Hypotheses

In order to estimate equations (2.3), (2.4), (2.5), and (2.6) we use the 2000 U.S. Census of Population and Housing Information for the state of New Mexico at the Census tract level for the structural and neighborhood variables. A Census tract is a relatively permanent statistical subdivision of a county delineated by a local committee of Census data users. Census tracts average about 4,000 inhabitants and are designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions at the time of establishment (U.S. Department of Commerce 2000).

The data provides median values for various variables for each Census tract, based on responses that individuals gave to the 2000 Decennial Census. For each Census tract the median value for income, number of rooms, house age, number of houses, and house value is reported. In the 2000 Decennial Census a house value is obtained by asking the house owner to state his perceived price at which the house would be sold if it were in the market (Freeman 2003).[27] In all, there are 456 Census tracts in New Mexico, which is our number of observations since each location j corresponds to a representative house and a Census tract.

The reason for using U.S. Census data relates to New Mexico's housing sales disclosure laws. New Mexico is one of the few states that do not publicly disclose actual housing market price transactions. Despite a 2004 a law requiring real estate transactions

[27] Kiel and Zabel (1999) tested the accuracy of this methodology by comparing the actual market sale price of a house with the price estimated by the owner of that house. The study shows that using Census data to estimate hedonic price functions yield unbiased coefficients.

to be filed with the county assessor's office, this information has yet to be publicly accessible (Berrens and McKee 2004, p. 510). Given this restriction, the U.S. Census is the best publicly available source to estimate the effects of open-space amenities on NM housing values. A possible shortcoming of using data aggregated at the Census tract level is that the variables represent a broad description of the stock of housing in the Census tract, rather than individual homes and market transactions.

The dependent variable is LNHVALUE, which is the natural logarithm of the median price of owner-occupied homes in each Census tract .The open-space variables, IRAs and WAs, were constructed using GIS and represent the percentage of such lands in a Census tract. For each Census tract, the number of acres of IRAs and WAs are separately divided by the total size of the Census tract to obtain the percentage of inventoried roadless areas (IRAs) and wilderness areas (WAs) within a Census tract. The size of IRA lands in a Census tract ranges from 2 to 423,100 acres and that of WAs ranges from 2 to 498,600 acres. In percentage terms, IRA values ranges from 58 percent to 0.0033 percent, and WA values from 68 percent to 0.003 percent for a given Census tract.[28]

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[28] For both IRAs and WAs, the lands in question were identified several years before the Census data was collected in 2000. In the case of IRAs, the land identified in the GIS data is based on an evaluation dating from 1979 (RARE II, see below). Almost all WAs in NM were designated prior to 1987. The use of RARE II as the basis of the current IRAs is mentioned in the 2001 Roadles Rule: Federal Register, January 12, 2001, Vol. 66, No. 9, pg. 3246 (http://roadless.fs.fed.us/documents/rule/index.shtml). A listing of all WAs designations through 1999 is published at: http://www.fs.fed.us/rm/pubs/rmrs_gtr018.html.

The distribution of IRAs and WAs values in the data indicate a high degree of heterogeneity across Census tracts (Figure 1). However, there are also underlying differences in Census tract size and area of IRAs and WAs. For example, the largest percentage value of IRAs is located in a Census tract in Santa Fe county (58 percent), but contains only 4,727 acres of IRA land. In contrast, a Census tract located in Eddy county has an IRAs percentage value of 2, but its total IRA area is 32,232 acres. To address this issue, an independent variable representing census size in acres (DCENSIZE) is included in the models.

In terms of the geographical distribution of IRAs and WAs in New Mexico, fourty-three of the 456 Census tracts have IRAs, representing 2 percent of the total land and 17 percent of the national forest land in the state (USDA 2000).[29] Figure 2.1 shows the spatial distribution of the areas in NM. The largest portion of both IRAs and WAs lands is located in the southwest of NW and is part of the Gila National Forest (north of Silver city). This National Forest accounts for almost 50 percent of IRAs and WAs in New Mexico. Census tracts that contain IRAs tend to be more rural and larger than other Census tracts; the average size of census tracts with IRAs is 778,143 acres compared to 110,653 acres for those without IRAs.

An advantage of measuring IRAs and WAs as a percentage of a Census tract's total size is that it can be interpreted as a relative measure of open-space access. For instance, while the size of IRA lands in acres in Census tract *j* is much smaller than that of Census

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[29] New Mexico counties with IRA lands are Catron, Cibola, Eddy, Grant, Harding, Hidalgo, Lincoln, Los Alamos, McKinley, Mora, Otero, Rio Arriba, Sandoval, San Miguel, Santa Fe, Sierra, Socorro, and Taos (USDA 2000).

tract *i*, its size as a percentage of the Census tract's total size may be larger which implies that the access to such lands would require, on average, lower traveled distance compared to Census tract *i*. A disadvantage of these measures is that a small tract may have the same percentage value as a large tract, even though the accessible amount of IRAs may be different in absolute terms.

Table 2.2 lists the summary statistics and descriptions of the dependent and independent variables used to estimate the models presented above. The open-space variables included in the models are IRA lands and Wilderness Areas (WAs). The structural variable **S** is a vector that includes number of rooms coded as a dummy variable (coded 1 for houses that have number of rooms greater than the average number of rooms in the sample; and 0 otherwise), and age of a house (2000-year a house was built); **N** is a vector that represents median income level coded as a dummy variable (coded 1 for houses that are located in Census tracts that have income levels higher than the average income level in the sample; and 0 otherwise), number of houses per acre, and size of a Census tract in acres also coded as a dummy variable (coded 1 for Census tracts whose sizes in acres are higher than the average Census size in the sample; and 0 otherwise); and **Q** is a vector that includes percentage of IRAs and percentage of WAs within a Census tract.

We use the empirical models to test several hypotheses about the impact of open space and spatial relationships on housing prices. These hypotheses can formally be expressed as:

H_1: H_0: $\eta_{IRAs} = 0$ and H_A: $\eta_{IRAs} > 0$.

H_2: H_0: $\eta_{WAs} = 0$ and H_A: $\eta_{WAs} > 0$.

H_3: H_0: $\eta_{WAs} \geq \eta_{IRA}$ and H_A: $\eta_{WAs} \leq \eta_{IRA}$

H_4: H_0: $\rho_{PRICE} = 0$ and H_A: $\rho_{PRICE} \neq 0$.

H_5: H_0: $\rho_{IRA} = 0$ and H_A: $\rho_{IRA} \neq 0$.

H_6: H_0: $\rho_{WAs} = 0$ and H_A: $\rho_{WAs} \neq 0$.

The hypotheses in H_1 and H_2 pertain to the effect that IRAs and WAs in Census tract *j* have on the price of houses located in the same Census tract. In particular, the alternative hypotheses in H_1 and H_2 suggest that IRAs and WAs in Census tract *j* have a positive and statistically significant effect on the median price of a home located within the same Census tract. Failing to reject these alternative hypotheses would mean that benefits from IRAs and WAs are being capitalized in the price of houses in NM. This finding would provide a measure of support for efforts in New Mexico to manage these lands consistent with wilderness designation and counter arguments that the value of such benefits are near zero (e.g. OMB 2002 report and USFS 2000 report). Hypothesis H_3 relates to the geographic location of IRAs relative to WAs. IRA lands are often located on the periphery of WAs (e.g., a prominent example of this is in the Gila National Forest located in the Southwest of NM). This suggests that IRA lands are commonly the more immediate open-space that a house faces. As a consequence, the ex-ante expectation is for the magnitude of the coefficient on the IRA variable to be larger than that of the wilderness variable. This means that the effect that IRAs have on the housing value is expected to be higher than that of WAs.

Hypotheses H_4-H_6 relate to the effect that changes in housing prices, IRAs, and WAs lands in neighboring Census tracts have on the price of houses located in Census tract *j*. For instance, failing to reject the alternative hypothesis in H_4 would mean that the price of a house located in a Census tract *j* is affected by changes in prices of houses located in neighboring Census tracts.

It is important to note that the first three hypotheses are empirically tested based on one-tailed tests while the last three are based on two-tailed tests. The significance level of the one-tailed tests is calculated by dividing the p-value of the two-tailed test by 2 (Green 2000).

Since in these models IRAs and WAs areas are two different explanatory variables, the impact of IRAs on the housing market can be isolated. Furthermore, since these coefficients allow us to monetarily quantify the additional price that the representative homeowner pays for being close to IRAs and WAs, this study estimates the value that these areas provide to the local communities, separately.

2.5 Empirical Results

The estimates of equations (2.3) – (2.6) tend to support the general hypothesis that open space measures (IRA and WAs) represent amenities that have a positive impact on median housing prices. Table 2.3 reports the results for the log-linear and the spatial lag models estimated to test the hypotheses H_1 through H_5.

The coefficients for IRA and WAs are positive and significant at the 1 percent level in all models, suggesting that the null hypotheses in H_1 and H_2 can be rejected. It is worth noting that the significance levels of these coefficients in Table 2.3 are based on two-tailed test. Thus, the p-values for hypotheses H_1 and H_2 are obtained by dividing the p-values of the two-tailed tests by 2. For the IRAs and WAs coefficients, the p-values for the one-tailed tests are lower than 1 percent for all four models.[30] For hypothesis H_3 the estimated IRAs and WAs coefficients from the spatial-lag (2-SLS) robust model were used to determine if these coefficients are statistically different from each other (β_{IRAs} = 1.58 and β_{WAs} = 0.72). In this case, the t-value is 1.67 corresponding to a p-value of 0.17 for a one-tailed test and one degree of freedom (e.g., the only restriction in this case is that the two coefficients are not statistically different). This test indicates that the two coefficients are not statistically different from each other.[31]

The ρ_{price} coefficient, which measures the marginal effect of changes in neighboring house prices on the median house price in a given Census tract, is positive and significant (models 2 – 4). This result indicates that a change in one of the explanatory variables not only affect prices of houses located in the same Census tract (e.g., marginal or direct effects) but also housing prices located in neighboring Census tracts. In this case, the intermediate channel is neighboring Census tract home prices (represented by ρ_{price}). For instance, a change in housing prices in Census tract *j* due to a change in the percentage of

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[30] The degrees of freedom (DF) used to test hypotheses H_1 and H_2 is calculated as follows: DF = n – (p + 1), where n is the number of observations, p is the number of parameters to be estimated plus the constant term. For the OLS model the DF is 448 (456 – (7+1)), spatial lag model (ML) is 447 (456 – (8+1)), mixed spatial lag is 440 (456 – (15+1)), and spatial lag model (2-SLS) is 447 (456 – (8+1)).

[31] Since neither a likelihood ratio test nor a Wald test is feasible with a least squares approach, the formula used to calculate the t-value for hypothesis H_3 is:

$$t = \frac{(\beta_{IRAs} - \beta_{WAs})}{(SE_{IRAs} - SE_{WAs})}.$$

protected IRAs would also affect home values in neighboring Census tracts. Thus, the OLS coefficients are picking up not only the contemporaneous effect but also the indirect or spillover effects. This is the reason why the coefficients of the log-linear model are higher than the other three spatial models. In the empirical results given in Table 2.3, the magnitude of this bias (on average, $1/(1-\rho)$) is illustrated by comparing the OLS and spatial lag models' estimates. This indicates that spatial dependence is an important characteristic of the housing market in New Mexico, thus rejecting the null hypothesis; the evidence supports H_4.

For the log-linear model, the benchmark case, the estimated coefficients for the IRAs and WAs variables are 2.27 and 1.19, respectively. In the spatial-lag models, these estimated coefficients are also positive but their effect on median house price is much smaller compared to the log-linear results. This is due to the inclusion of lag variables, such as ρ_{price}, ρ_{IRA} and ρ_{WAs}, which represent the effect of changes in prices, IRAs, and WAs in neighboring Census tracts on the value of houses in a given Census tract.

Calculating marginal effects of changes in IRA and WAs sheds some light on the magnitude of the coefficients estimated in the models. Table 2.4 displays the marginal WTP for a 1 percent change in the value of IRA and WAs in the log-linear model and the spatial-lag models. The marginal WTP for a 1 percent change in the value of IRAs ranges between $2,194 and $2,943, evaluated at the mean house value, which is equivalent to an annualized WTP of $109.7 and $147.15, respectively (assuming a 5 percent interest rate).

Another important result that relates to the difference between the log-linear model and the spatial models is the overall effect that changes in IRAs and WAs lands have on housing values. In model 2, housing values in a given Census tract can be affected by a change in its own IRAs and by housing values in neighboring Census tracts (via the ρ_{price} coefficient). In model 3, a given Census tract is affected by the value of IRAs in neighboring Census tracts (via the ρ_{IRA} coefficient) and the median housing price in neighboring Census tracts (via the ρ_{price} coefficient). The estimated coefficients in the log-linear model may be upwardly biased because own-tract IRAs and WAs are probably correlated with nearby-tract IRAs and WAs, but may still ignore some of the impact of IRAs and WAs in nearby tracts. In the case of hypotheses H_5 and H_6, estimates of ρ_{IRA} and ρ_{WAs} are not significantly different from zero, which suggests that we cannot reject the null hypotheses; the evidence does not support H_5 and H_6. Results indicate that while marginal changes in neighboring house prices affect the price of the median house in a given Census tract (i.e., null hypothesis is rejected in H_4), marginal changes in IRA and WAs in neighboring Census tracts have no direct-spillover effects on house prices.

In terms of model specification, four statistical tests suggest that the spatial-lag models (models 2 and 3) are preferred to the log-linear model in which it is assumed that there is no spatial autocorrelation. The presence of spatial dependency is statistically significant as evidenced by the Lagrange Multiplier (LM) tests (LM-lag, and LM-error values) and the z-score of the ρ_{price} coefficient (i.e. null hypothesis in H_3 is rejected). The LM-lag test has a χ^2 distribution and tests for the presence of spatial lag dependence in the hedonic OLS model in which the null hypothesis is that $\rho_{price} = 0$ (i.e. there is no spatial lag dependence) and the alternative hypothesis is $\rho_{price} \neq 0$ (Anselin 1988). Another type of spatial autocorrelation is spatial error dependence. In this case the model is: $P = X\beta + \varepsilon$, where $\varepsilon = \lambda W + \mu$. However, based on the spatial diagnostics tests reported in Table 2.3, the estimation of the spatial error model is not necessary. While the

LM-error test is significant in the hedonic OLS model, the spatial error dependence is no longer statistically significant after introducing the spatial effect (e.g., ρ_{price}). A spatial-error model would suggest that there are other unobserved variables that are related in space (across Census tracts) and captured in the error structure. But the LM-error test result, after estimating the spatial-lag model (e.g., LM-error = 0.54), suggests that this is not the case, or at least that the spatially lagged independent variables adequately capture the spatial relationship between Census tracts.[32]

The log-likelihood values reported for each model also suggest that models 2 and 3 are superior specifications to the log-linear model. A likelihood ratio test between models 1 and 2 and models 1 and 3 indicates that the coefficients of the restricted model (e.g, model 1) are significantly different from those of the spatial lag or mixed spatial models.[33] While these two spatial lag models are superior specifications to the OLS

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[32] There may be theoretical arguments for estimating a spatial-lag model instead of a spatial-error model. The error dependence between housing transactions is likely to occur on a small scale, e.g., within neighborhood or at least within Census tracts (Anselin 2002). In the representative household framework, any within-tract error dependence is likely hidden behind the median values obtained for each Census tract.

[33] The formula used to calculate the value of likelihood ratio test (LR) is: $LR = 2*(\text{log-likelihood}_{unrestricted} - \text{log-likelihood}_{restricted})$. In this case, R^2 would not be a valid goodness of fit measure to compare the models, given that for the spatial-lag models a pseudo R^2 measure is reported. Based on this formula, the LR value between models 1 and 2 is 138 and between models 1 and 3 is 156. Both of these values follow a χ^2 distribution and are statistically significant at a 1 percent level.

model, two issues need to still be addressed. Regression diagnostics for heteroskedasticity (e.g., the Breusch-Pagan (BP) test) in the first three models indicate the presence of non-constant variance. Moreover, since the estimates for models 2 and 3 are based on the maximum likelihood approach, it is assumed that the error terms are normally distributed. As an alternative and to address these issues, a robust 2-SLS approach is used to estimate the spatial-lag model. Based on the z-values reported for the 2-SLS coefficients, the evidence supports hypotheses H_1-H_4. In this approach spatial lags of the explanatory variables are used as instruments to achieve robust to non-normality and consistent estimates. As a result, including spatially lagged independent variables on the right hand side of the 2^{nd} stage equation would result in a model misspecification since the instruments would be used twice, first in the estimation of **WP** (1^{st} stage) and then in the 2^{nd} stage (Anselin 1988). This is the preferred model and its coefficients are used in the following thought experiment.

2.51 Aggregate Benefits of IRA Lands in New Mexico

In order to understand the policy implications of the results found in this paper, it is necessary to estimate the total capitalized benefits of IRA lands in the New Mexico housing market. Using the results reported in the 2-SLS robust model (equation 2.6), a thought experiment is proposed where the effect on total housing value of eliminating all IRA lands in NM is estimated. Estimating the impact of such a change allows calculation of the total value of IRAs in their current status of roadless lands.[34] Following the

[34] A back-of-the-envelope calculation would be to use the average level of IRAs (0.008 percent), the implicit price in the 2-SLS model ($2,654) and the average housing value

framework in Kim et al. (2000), an aggregate value of IRAs is estimated. The first step is to write equation (2.4) in its reduced form as follows:

$$P = [I - \rho_{price} W]^{-1} X\beta + [I - \rho_{price} W]^{-1} \varepsilon \,, \qquad (2.4')$$

where, for ease of presentation, the logged price is dropped and the different explanatory variables included in this model are represented by the vector **X**. Letting $v = [I - \rho_{price} W]^{-1} \varepsilon$ and $A = [I - \rho_{price} W]^{-1}$, equation (2.4') becomes:

$$P = AX\beta + v \qquad (2.4'')$$

In matrix form, equation (2.4'') can be written as follows:

$$\begin{pmatrix} P_1 \\ P_2 \\ \vdots \\ P_n \end{pmatrix} = \begin{pmatrix} a_{11}, a_{12}, & \cdots & , a_{1n} \\ a_{21}, a_{22}, & \cdots & , a_{2n} \\ \vdots & \ddots & \vdots \\ a_{n1}, & \cdots & , a_{nn} \end{pmatrix} * \begin{pmatrix} x_{11}, x_{12}, & \cdots & , x_{1k} \\ x_{21}, x_{22}, & \cdots & , x_{2k} \\ \vdots & \ddots & \vdots \\ x_{n1}, & \cdots & , x_{nk} \end{pmatrix} * \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_k \end{pmatrix} + \begin{pmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{pmatrix} \qquad (2.10)$$

Letting X'_{IRAs} be a column vector (n *x* 1) that represents the density of IRAs in the different Census tracts, the derivate of **P** with respect to X'_{IRAs} is defined as follows:

($111,461) to calculate the aggregate value that IRA lands have in the housing market in NM. However, this approach would not take account of differences in the percentage of IRAs, Census tract size, density of housing units, and differences in median home values.

$$\frac{\partial P}{\partial X'_{IRAs}} = \begin{pmatrix} \partial P_1/\partial x_{1,IRAs}, & \partial P_1/\partial x_{2,IRAs}, & \cdots & , \partial P_1/\partial x_{456,IRAs} \\ \partial P_2/\partial x_{1,IRAs}, & \partial P_2/\partial x_{2,IRAs}, & \cdots & , \partial P_2/\partial x_{456,IRAs} \\ \vdots & \vdots & \ddots & \vdots \\ \partial P_{456}/\partial x_{1,IRAs}, & \partial P_{456}/\partial x_{2,IRAs}, & \cdots & , \partial P_{456}/\partial x_{456,IRAs} \end{pmatrix} \quad (2.11)$$

In this matrix, row *j* shows the impact that a marginal change in IRAs density in Census tract *j* (direct-contemporaneous effect) and neighboring Census tracts (indirect effect) has on the housing price with location *j*. This means that the price of a house in Census tract *j* is not only affected by changes of IRAs density in Census *j* but also affected by changes of IRAs density in neighboring Census tracts (due to spatial autocorrelation). For instance, the first row shows the direct-contemporaneous effect on housing prices located in Census tract 1 ($\partial P_1/\partial x_{1,IRAs}$) and the indirect effects on housing prices located in Census tract 1 ($\partial P_1/\partial x_{2,IRAs}, \ldots, \partial P_1/\partial x_{456,IRAs}$). Based on equation (2.11), the marginal effect of a change in IRAs density can be expressed as:

$$\frac{\partial P}{\partial X'_{IRAs}} = \begin{pmatrix} \beta_{IRAs}a_{11}, & \beta_{IRAs}a_{12}, & \cdots & , \beta_{IRAs}a_{1n} \\ \beta_{IRAs}a_{21}, & \beta_{IRAs}a_{22}, & \cdots & , \beta_{IRAs}a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{IRAs}a_{n1}, & \cdots & \cdots & , \beta_{IRAs}a_{nn} \end{pmatrix} = \beta_{IRAs}[I - \rho W]^{-1} \quad (2.11')$$

where **W** is a row-standardized weight matrix, $[I-\rho_{price}W]^{-1} = \dfrac{1}{1-\rho_{price}}$ (Kim et al. 2003), β_{IRA} = 1.58, and ρ_{price}= 0.429 (from the 2-SLS model). In the context of this thought experiment, the direct contemporaneous effect of eliminating IRAs on the value of houses located in Census tract 1 is given by $\beta_{IRAs}a_{11}$, and the aggregate indirect effect is $\sum_{i=2}^{456}\beta_{IRAs}a_{i,IRAs}$.

Note that Census tracts that do not currently have IRAs will have no direct effect on house prices because IRAs are already zero in these locations.

As an example meant to illustrate how we calculate aggregate benefits for the entire state, Table 2.5 shows the effect of eliminating IRAs on houses located in Census tract 360. This Census tract is located in Sierra County in the southwest of NM. Its size is 2.7 million acres, which represents 98 percent of Sierra County's total size. The total number of owner-occupied housing units is 2,014 with a median house value of $108,400. The total number of IRA lands is 128,654 acres, which represents almost 5 percent of the total size of the tract, and they are part of the Gila National Forest.

The direct contemporaneous effect or the marginal direct effect per home in Census tract 360, which assumes that the prices of houses located in neighboring tracts remain constant, is $8,237. This number is the first term in the Jacobian matrix given in (3.12): $\partial P_{360}/\partial IRAs_{360}$. In this example, Census tract 360 has 3 neighbors (376, 391, and 375) that would also be affected if the IRAs in Census tract 360 are completely opened to development. These are the indirect or spillover effects which are given by the following expressions: $\partial P_{375}/\partial IRAs_{360}$ (second term in the first column of the Jacobian matrix),

$P_{376}/\partial IRAs_{360}$ (third term in the first column of the Jacobian matrix), and $P_{391}/\partial IRAs_{360}$ (fourth term in the first column of the Jacobian matrix). In Table 2.5, these numbers are \$895, \$5,919, and \$2,620. In terms of coefficient, there are three ways IRAs can affect home prices in a Census tract: direct-contemporaneous (i.e., IRAs = 1.58); direct spatial-spillover (the ρ_{IRAs} coefficient, which is not significantly different from zero in the mixed-spatial model); and indirect effects (i.e., $\rho_{price} = 0.429$). Since only decreases in IRAs are evaluated in this example, the dollar amounts that appear in Table 2.5 can be interpreted as the marginal willingness to accept (MWTA) to eliminate IRAs in Census tracts 360 and in its neighboring Census tracts.

The marginal direct and indirect effects are aggregated by multiplying these per unit changes by the total number of homes in each Census tract. These aggregated numbers are shown on the fifth column: the aggregated direct-contemporaneous effect is \$16.9 million compared to \$18.9 million for aggregated indirect effects. In the aggregate, such a change would translate into a 16 percent loss in the value of housing in Census tract 360 given that their current total housing value is \$218.3 million ((\$16.9+\$18.9)/\$218.3 = 16.3 percent). The importance of estimating models that account for spatial autocorrelation is supported by these results since indirect effects represent 53 percent of the total effect on house values in Census tract 360, which would have been otherwise ignored.

Table 2.6 shows the aggregate MWTA of eliminating all IRAs in NM. Based on the numbers reported in this table, the aggregate loss in housing value in NM of such a change would represent 3.5 percent of the aggregate value of owner-occupied units. Thirty-four percent of this loss is explained by indirect effects, which highlights the importance of estimating spatial-lag models as opposed to the traditional non-spatial models.[35] This estimated effect of IRAs on the housing market in NM is about one-fourth (27 percent) of the impact that wilderness proximity has on housing values in Vermont in Phillip (1999).[36]

2.6 Conclusions

This paper represents the first attempt to econometrically estimate the value of IRA lands in NM. In light of the ongoing national debate about the future of nearly 60 million acres of IRA lands, this paper provides evidence of the importance of better understanding the monetary benefits of IRAs as they currently exist. Previous studies have shown that people are willing to pay higher prices to live in proximity to forest amenities. However, IRAs were intentionally or unintentionally part of a broader definition of open space such as forest. In light of the current legal debate over whether to open IRAs to commercial activities or to maintain them in their pristine status, a better understanding is needed about the impact that these lands in particular may have on an economy. Based on this motivation, this paper distinguishes between congressionally-

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[35] The estimated models indicate that both direct-contemporaneous and indirect effects are statistically significant, but the direct-spillover effect is insignificant.

[36] This is also roughly consistent with the Loomis and Richardson's (2000) summary findings that various estimates of recreation use values per acre in the Western U.S are typically only about one-fourth of comparable Eastern U.S. value estimates, and that estimated passive use values per acre in the West are only about two-thirds the magnitude of comparable Eastern values.

protected lands (e.g., WAs), IRAs, and the all inclusive open space definition of a public land (e.g., forest) in an attempt to estimate off-site benefits of only IRAs.

After controlling for median housing and neighborhood characteristics, and the separate effect of Wilderness Areas, the percent of IRA lands in a Census tract has a positive and statistically significant effect on median home values in all estimated models. These 1.6 million acres of protected IRA lands provide about 3.5 percent of the total housing value in NM. This result is consistent with recent evidence in the Southwestern U.S of strong amenity effects in the regional economy including in-migration, property value, and labor market outcomes (e.g., Kim 2002, Hand et al. 2008a, 2008b;). In Hand et al. (2008a), the empirical framework developed by Roback (1982) is used to examine the possibility of compensating differentials in the labor and housing markets in Arizona and NM.[37] The forest characteristics used in this paper include U.S. forest Service (USFS) and wilderness areas (WAs). Spatially-dependent relationships are accounted by introducing the average proportion of forest areas in neighboring PUMAs as an independent variable.[38] Results indicate that the percentage of USFS and WAs have a positive marginal implicit values.[39] For the USFS this value ranges between $27 and

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[37] As discussed in Chapter 3, compensating differentials refers to the hypothesis that individuals are willing to earn lower wages and pay higher housing prices for living in proximity to forest amenities.

[38] The authors point out that specifying a spatially-autocorrelated model would not be feasible given the high number of observations used in this study (42,000).

[39] These results are based on a seemingly unrelated regression (SUR) model and data from the 2000 Public Use Microdata Series (PUMs).

$36 per square mile compared to $75-$80 for WAs. Forest areas in contiguous PUMAs are found to have a higher implicit value. The authors reason that it is possible that because both states in question have most of their population concentrated in urban areas surrounded by nearby forested areas, it may be more amenable to live nearby an area with high proportion of forested lands than to actually live in the forested area in this case. However, the implicit price of forest areas in contiguous PUMAs may be picking up the effect that changes in price of homes located in the contiguous PUMAs have on prices in a particular PUMAs. The higher the proportion of forest areas in PUMA *i* the higher the value of homes located PUMAs *i*. As a result, home values in neighboring PUMA *j* may be higher due to both a higher proportion of forest areas in PUMA *i* and due to higher home values in PUMA *i*. As discussed above, these spatial relationships among home values may arise due to random specifications of geographic units, such as census tracts or county boundaries or PUMs, which may not accurately reflect the extent to which the phenomenon in question behaves in space (Anselin 1988). In light of this, the results of this paper provide further evidence on the importance of spatial considerations in non-market valuation techniques such as hedonic price functions. Based on the empirical framework of Anselin (1988), this paper finds that indirect effects represent 34 percent of the total impact, which in the traditional log-linear regression are assumed to be zero.

One important issue that is of importance is the assumption that open spaces are homogenous across space. As it is the case in many papers, in this study it is implicitly assumed that the value that the public has for an acre of IRAs or WAs is the same. This would apply if the characteristics of an open space were the same across the region. However, this may not be always accurate. Strictly concerned with hedonic housing price markets, Kim (2002) examines not only the effects of proximity but also forest management practices. In addition to distance to forest land, the authors also included stand level characteristics from the forest stand closest to the home site, and the visibility of clear-cut areas.[40] This paper concludes that forest management schemes do matter and that individuals do care about how forests are managed, as evidenced by housing values. This suggests that future research should account for this and treat forest areas as heterogeneous open spaces.

Non-market benefit estimates for IRAs, as part of a more comprehensive benefit-cost analysis, can be an important informational input in any major regulatory action (e.g., Arrow et al. 1996), including public lands management (Loomis 2002). As such, these results suggest that not accounting for such benefits (e.g., off-site benefits) would significantly underestimate the value society places on these lands. Off-site benefits are components of the larger bundle of ecosystem services and non-market benefits that protected lands may offer (Loomis and Richardson 2000; Berrens et al. 2006). Thus, this paper reports estimates for a portion of the total economic value (TEV) of these protected areas. For instance, there may also be on-site recreation values, and passive use values that are not captured in house prices. Loomis (1996) reviews evidence from various contingent valuation studies that passive use values may represent a significant percentage, and sometimes a majority proportion, of the TEV associated with protected forest areas in the U.S. This suggests that off-site amenity values to residents, as measured here, might represent just one of several significant components of the TEV.

[40] The study area is McDonald-Dunn Research Forest, Corvallis, Oregon.

Table 2.1: Selected Economic Performance Measures for IRA and non-IRA counties in New Mexico

	NM IRA counties[1]	NM Non-IRA counties	New Mexico, all counties	U.S.
Percent growth, 1990-2005				
Real income per capita[2]	29.7	23.3	25.1	18.4
Non-farm employment	29.8	26.3	27.3	20.1
Real earnings per job[2,3]	21.4	13.2	17.5	20.4
Service industry employment				
Percent of non-farm employment in services, 2000[4]	29.9	31.5	31	32.8
Growth in service employment, 1990-20004	44.1	41.4	42.1	37
Earnings flows				
Net earnings flows, 2005 (thousands of $)[5]	511,793	-240,785	–	–
Change in real net earnings flows, 2001-2005 (thousands of $)[2,5]	110,229	-115,693	–	–

Source: Calculations from Bureau of Economic Analysis, Local Area Personal Income data. Available at http://www.bea.gov/bea/regional/reis/, accessed March 21, 2008.

[1]IRA counties are those with at least 1% of land and 10,000 acres in IRA. Includes Catron, Eddy, Grant, Hidalgo, Lincoln, Otero, Rio Arriba, San Juan, San Miguel, Santa Fe, Sierra, Socorro, and Taos counties.

[2]Real figures are calculated as 2005 constant dollars using the annual CPI for all urban consumers (all items). Source: U.S. Bureau of Labor Statistics.

[3]Real earnings per job calculated as real earnings divided by total wage and salary employment.

[4]Most industry-level data is undisclosed for each county due to the change from SIC to NAICS industry classifications. The old SIC industries used a higher level of aggregation and are reportable by county for the last year data are available, 2000.

[5]Net earnings flows are calculated as the earnings of out-commuters minus the earnings of in-commuters for each county. See notes for BEA table CA91 for a detailed description.

Table 2.2: Descriptive statistics

Variable	Description	Mean	Std. Dev.
HVALUE*	Owner-occupied median property value, $	111,461	62,126
ROOM**	Owner-occupied median number of rooms	5.53	0.787
INCOME**	Median income, $	35,500	14,879
HAGE	Structure age, (2000-year built)	25.88	12.94
HPERACRE	Number of houses per acre in a census tract	1.19	1.55
CENSIZE**	Census tract size, acres	170,669	458,407
IRA	Percent IRA lands in a census tract (GIS), %	0.0079	0.0446
WILD	Percent wilderness lands in a census tract (GIS), %	0.0133	0.0637
W_5 (miles)	Closest 5 neighboring houses from a home in location j	2.64	1.61

*In the models estimated in this chapter, this variable is transformed to its log values.
**In the models estimated in this chapter, these variables are dummy variables (0 or 1)

Table 2.3: Estimation Results

Variables	Log-linear model	Spatial-lag (ML)	Mixed Spatial-lag (ML)	Spatial-lag (2-SLS)
DROOMS	0.185***	0.155***	0.158***	0.131***
	(3.43)[a]	(3.43)[b]	(3.53)[b]	(3.55)[b]
DINCOME	0.409***	0.300***	0.289***	0.324***
	(6.96)	(6.05)	(5.74)	(7.93)
HPERACRE	0.049	0.008	-0.007	0.011
	(2.99)	(0.58)	(0.37)	(1.00)
DCENSIZE	-0.345***	-0.253***	-0.252***	-0.298***
	(5.90)	(5.15)	(4.99)	(4.99)
HAGE	-0.007***	-0.004***	-0.008***	-0.004***
	(3.45)	(2.66)	(4.18)	(2.81)
IRAS	2.270***	1.420***	1.040***	1.580***
	(4.87)	(3.64)	(2.59)	(5.10)
WILD	1.190***	0.641**	0.640**	0.720***
	(3.64)	(2.32)	(2.29)	(3.39)
ρ_{HVALUE}		0.513***	0.545***	0.429***
		(12.14)	(10.77)	(7.14)
ρ_{DROOMS}			-0.017	
			(0.18)	
$\rho_{DINCOME}$			-0.051	
			(0.49)	
$\rho_{HPERACRE}$			0.008	
			(0.29)	
$\rho_{DCENSIZE}$			-0.073	
			(0.70)	
ρ_{HAGE}			0.009***	

Table 2.3: Estimation Results (continued)

Variables	Log-linear model	Spatial-lag (ML)	Mixed Spatial-lag (ML)	Spatial-lag (2-SLS)
			(2.77)	
ρ_{IRAS}			0.355	
			(0.49)	
ρ_{WILD}			0.071	
			(0.13)	
INTERCEPT	11.38	5.52	5.04	6.49
R^2	0.456			
Likelihood value	-263.4	-194.4	-185.8	
Likelihood Ratio-Test	$(138^{***})^c$	$(17.8^{**})^d$	$(152^{***})^e$	
BP-test	49.4 ***	86.2 ***	146.0 ***	
LM-lag	197.1 ***			
LM-error	175.5 ***	0.54	0.16	
N = 456				

*, **, and *** denote 99%, 95%, and 90% confidence levels, respectively.
$( )^a$: t-value
$( )^b$: z-value
$( )^c$: LR test between Log-linear and spatial-lag models
$( )^d$: LR test between spatial-lag and mixed spatial-lag models
$( )^e$: LR test between Log-linear and mixed spatial-lag models

Table 2.4: Implicit Prices ($), WTP for a 1% Change in IRA or WAs

	WTP (for a 1% change)		% of median housing price	
	IRA	WAs	IRA	WAs
Log-linear	$2173 (1727, 2619)	$1147 (832, 1463)	2% (1.8%, 2.7%)	1% (0.9%, 1.5%)
Spatial-lag (ML)	$2787 (2010, 3290)	$1260 (660, 1975)	3% (2.1%, 3.4%)	1% (0.7%, 2.1%)
Mixed spatial-lag (ML)	$2943 (2120, 3567)	$1495 (727, 2215)	3% (2.2%, 3.7%)	2% (0.8%, 2.3%)
2-SLS	$2654 (1930, 3548)	$1194 (761, 1728)	3% (2.0%, 3.7%)	1% (0.8%, 1.8%)

Notes: Implicit prices are calculated for each model using equations (7) through (9). Given that a one unit change in IRAs is equal to 100% of the average census tracts land area for the sample (the average IRA value is about 0.008) this change would bring the value of IRA in the average census tract to 1.008, which is not realistic. To make this analysis reasonable in the context of this paper, the calcualted marginal WTP is divided by 100. As a result, the marginal effect of a 1 percentage point increase in IRAs in the average census tract (which means that average IRAs would increase to 0.018) would be, for instance, $2,654 for the 2-SLS robust approach. The same methodology is applied to the marginal effect for wilderness lands.

Table 2.5: The Impact of Eliminating IRAs in Houses Located in Census Tract 360 ($)

		Direct Effect	Inderect Effect	Total Effect, per housing unit	Direct Effect Aggregated	Indirect Effect Aggregated
	360	8,237	0	8,237	16,590,089	
Census	375	0	895	895	0	1,802,543
Tract	376	0	5,919	5,919	0	11,920,082
	391	0	2,620	2,620	0	5,275,958
					16,590,089	18,998,583

Notes: The aggregate monetary effect of this empirical exercise are calculated using equations (2.8) and (2.9) as follows: $IRA_j * HVALUE_i * \frac{\partial \mathbf{P}_i}{\partial \mathbf{X}_{j,IRA}} * units_i$, where i represents census tract 360 and j represents census tracts 376, 391, and 375. HVALUE$_i$ and units$_i$ are the the median value house and the total number of owner-occupied units in census tract 360, respectively.

Table 2.6: Aggregate Benefits of IRAs for the Real Estate Market in the State of New Mexico (thousands of $)

	Direct Effect, Aggregated	Indirect Effect, Aggregated	Total Effect, Aggregated	Agg. Effect as % of Total Housing Value
Bernalillo	-	255	255	0.00%
Catron	15,785	1,929	17,714	16.93%
Chaves	-	3	3	0.00%
Cibola	650	555	1,206	0.31%
Colfax	-	10,337	10,337	3.12%
Curry	-	-	-	-
De Baca	-	-	-	-
Dona Ana	-	852	852	0.02%
Eddy	6,290	2,616	8,906	0.88%
Grant	50,990	60,660	111,650	12.86%
Guadalupe	-	814	814	1.28%
Harding	37	436	473	6.21%
Hidalgo	2,152	423	2,575	2.18%
Lea	-	41	41	0.01%
Lincoln	5,848	3,456	9,305	1.30%
Los Alamos	182,893	84,597	267,490	20.05%
Los Lunas	-	-	-	-
McKinley	13	270	282	0.04%
Mora	1,776	7,931	9,707	7.69%
Otero	30,214	14,878	45,092	3.54%
Quay	-	-	-	-
Rio Arriba	79,903	58,649	138,551	10.20%
Roosevelt	-	-	-	-
San Juan	-	112	112	0.00%
San Miguel	22,164	58,914	81,078	10.49%
Sandoval	6,904	23,229	30,133	0.89%
Santa Fe	710,016	209,982	919,998	11.95%
Sierra	16,590	22,670	39,260	10.14%
Socorro	6,202	6,497	12,699	3.27%
Taos	102,636	75,266	177,902	12.65%
Torrance	-	2,006	2,006	0.46%
Union	-	985	985	1.56%
Valencia	-	-	-	-
Total Effect	1,241,063	648,362	1,889,425	3.51%

Figure 2.1: Spatial Distribution of Inventoried Roadless Areas and Wilderness Areas in NM

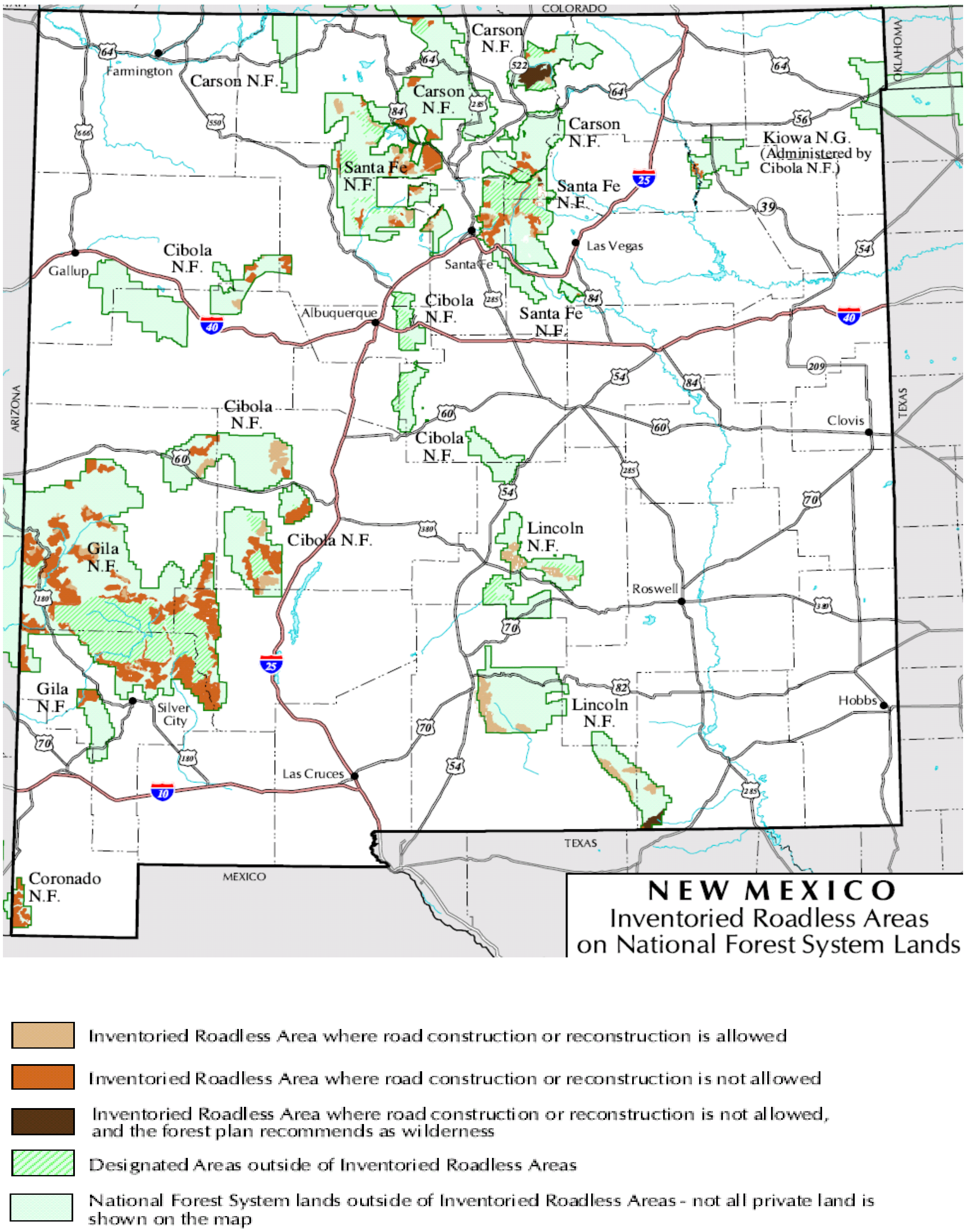
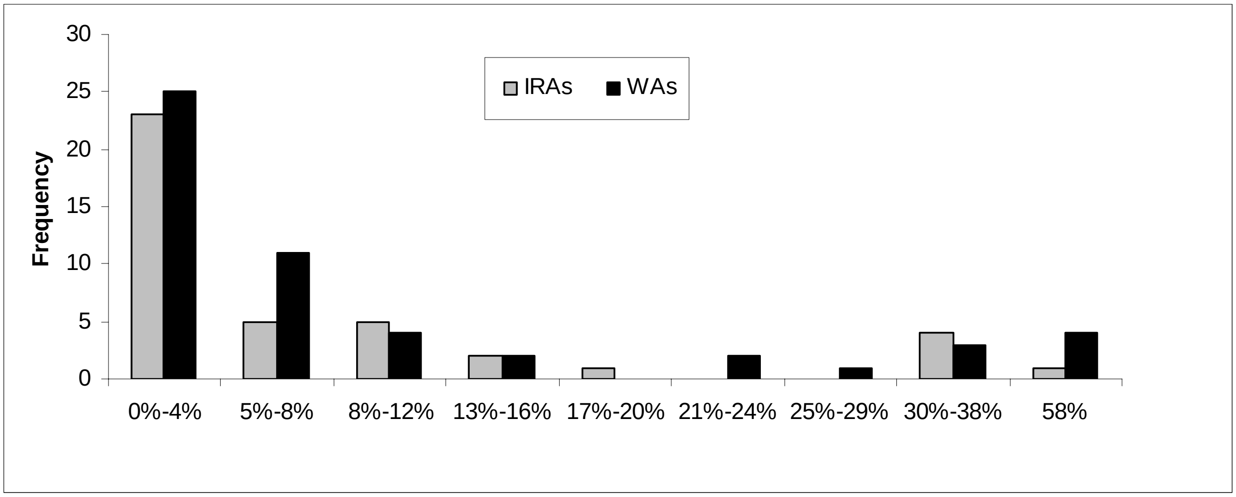


Figure 2.2: Percentage of Land in Census Tracts Covered by IRAs and WAs



Chapter 3

The Role of Forests as Natural Amenities: A Seemingly Unrelated Regression Model with Two Spatial Processes

3.1 Introduction

The classical urban economics model has traditionally explained a household's location decisions based on a tradeoff between residential and commuting costs (Wu and Gopinath, 2008). However, this model has fallen short in explaining the rapid economic expansion some areas, such as in the American West region (Schmidt and Courant, 2006). This shortcoming has given rise to the consideration of new variables to help better understand regional growth. For example, a growing number of papers have looked at natural or environmental amenities to account for persistent differences in wages and housing prices, suggesting that the protection of natural amenities may partially explain the positive economic development in the Southwestern US (Loomis and Richardson, 2000; Schmidt and Courant, 2006; Hand et al., 2008; Izon et al., 2010). These findings suggest that that the traditional view of public lands as inputs in a production process may significantly underestimate the benefits they generate in their pristine status.

Based on the idea of a "second paycheck" derived from the natural landscape (Niemi et al. 1999), Hand et al. (2008) empirically show that congressionally-protected wilderness area (WAs) and US National Forest lands carry implicit prices in the housing and labor markets that range between $27 and $85 per square mile annually in the Southwest United States (Arizona and New Mexico). However, and as it is common in many studies that look at the role of forest amenities (e.g., Schmidt and Courant 2006; Hand et al. 2008; Izon et al. 2010), the aggregated nature of the data raises some methodological issues. Since the geographic data used in these studies pertain to aggregated administrative census boundaries (such as Census tracts and Public Use Microdata Areas, PUMAs), a pressing issue is the possibility of measurement errors due to geographic aggregation bias. This bias refers to differences in empirical results depending on the spatial arrangement of zones or the scale used to estimate the econometric models (Doll et al. 2004).[41] The scale effect arises when the results found using the same data vary as the aggregation level of observation changes (Wrigley et al., 1996). The zone effect occurs when the administrative boundaries are arranged in a different way or zone boundaries are changed. The consequence of these effects is that results based on a particular aggregated administrative boundary may not be generalized to different spatial resolutions or scales. This is also known as ecological fallacy (Cao and Lam, 1997). To address this issue, this study uses micro-level data by matching a sample of wage-earner housing units at the household level.

The objective of this study is examine the role of IRAs on wages and housing prices at the state level in rural and urban areas, selected in Arizona. The major question addresses is whether the findings from the regional study will hold when local data is examined. For this purpose, spatial econometrics in a hedonic empirical framework is applied to investigate spatial variations in wage and housing prices in the presence of IRAs lands. Specifically, the purpose of this paper is to examine whether IRAs generate wage and housing-price differentials in the State of Arizona by estimating a seemingly unrelated model . The 1.1 million acres of IRA lands represent about 10 percent of all

[41] The zone and scale effects are also referred to as the Modifiable Areal Unit problem (MAUP) (Openshaw 1984).

forested lands in the State of Arizona. As it is the case nationwide the policy debate over the fate of these areas centers on whether to manage them consistent with Wilderness designation (Loomis and Richardson 2000; Izon et al. 2010). Assuming that individuals select residential location partially based on proximity to natural amenities, this study follows Rosen (1997) and Roback (1988) general equilibrium framework, looking at wage and housing prices differentials (off-site benefits). Thus, this paper reports estimates for a portion of the total economic value (TEV) of these amenities. For instance, they may also be on-site recreation values and passive values that are not captured in wage or housing prices. In particular, two types of natural amenities are of interest: Wilderness Areas (WAs) and Inventoried Roadless Areas (IRAs). While the status of WAs as congressionally protected areas is relatively certain, the status of IRAs lands is tied to federal agency rulemaking and a protracted and legal debate, making their condition highly uncertain (Aarons 2010; Sanford 2006; Easley 2006; Warner 2005).

Since natural amenities generate multiple beneficial end uses, there have been competing allocation schemes for these resources. This has clearly been the case in the policy debate about WAs and IRAs that centers on the question of how these public lands should be managed and allocated. Since the enactment of the 1964 Wilderness Act (USDA 1964), many input-output models predicted that prohibiting commercial activities (e.g., logging) would have prolonged negative impact on the economies of the affected areas (Schmidt and Courant, 2006). However, the economic performance of this region has been anything but negative.

The policy debate about IRAs centers on whether to manage these lands as wilderness areas. As of today, a State petition rule allows each State to file IRAs petitions for wilderness consideration. While many of the protection-oriented petitions based their argument on the existence of both on-site and off-site benefits, the absence of explicit market prices poses a challenge. Hedonic regressions of housing prices and wages indicate that the average total implicit price for USFS is $1,901 per mile compared to $1,309 for WAs and $694 for IRAs, annually.

3.2 Hedonic Empirical Framework

In order to address the empirical question of whether forest characteristics, such as wilderness lands and inventoried roadless areas are in fact amenities that significantly affect housing-price and wage differentials in Arizona, this paper uses hedonic theory. In this section, hedonic frameworks to analyze households' location decisions in the presence of natural amenities and a theoretical discussion on spatial-dependence relationships are presented to inform the empirical approach. In hedonic price studies, the hypothesis is that visual or proximal access to some set of environmental amenity and disamenity characteristics gets capitalized into the housing and labor markets. The hedonic pricing method decomposes the statistical variation in prices for a heterogeneous good (e.g., home values or wages) to isolate the contribution of individual attributes or characteristics of the good (Taylor 2003).

The underlying model used in this paper for the empirical analysis follows that in Roback (1982). In the context of regional forest, it is assumed that households derive utility over a bundle of characteristics composed of goods consumed (C, a numeraire good), land space (L, sold at price *p*), and location-specific environmental amenities Q. Such a bundle varies across the region depending on where the household lives and works, which gives rise to the hypothesis of compensating differentials in housing and labor markets. Households supply labor to firms in exchange for a wage *w*. In particular, a household in location *j* maximizes utility by choosing C_j and L_j, conditional on natural amenities q_j and subject to the budge constraint, such that:

$$\bar{V} = V(p_j, w_j; Q_j) \text{ for } j = 1,\ldots,J \tag{3.1}$$

where V is the indirect utility function for household in location *j* and $\bar{V}$ is the utility level for the whole region (in this case Arizona) when the labor and housing markets are in equilibrium. Since forest amenities are assumed to be fixed for a particular location, land prices and wages must adjust to equalize utility at $\bar{V}$ in all locations. Since iso-utility curves are upward sloping in the (w, p)-plane, this suggests that for a given level of amenities, a location with higher house prices must also have higher wages to achieve regional equilibrium (Wu and Gopinath 2008).

Firms, the suppliers and producers of good C, are assumed to operate in a perfectly competitive market with a unit cost function that depends on the price of land, wages, and forest characteristics, such that in equilibrium:

$$C(p_j, w_j; Q_j) = 1 \text{ for } j = 1,\ldots,J \tag{3.2}$$

The household equilibrium condition (equation 3.1) and the firms' production cost equality condition (equation 3.2) determine the general equilibrium level of wage and housing prices. Since at equilibrium $\partial C = \partial V = 0$, differentiating equations (3.1) and (3.2) with respect to *Q* and solving for $\partial w / \partial Q$ and $\partial p / \partial Q$ yields the following implicit price expressions:

$$\frac{\partial p}{\partial Q} = \frac{W_W C_Q - V_Q C_W}{\Delta} \tag{3.3}$$

$$\frac{\partial w}{\partial Q} = \frac{V_Q C_P - V_P C_Q}{\Delta} \quad (3.4)$$

where $\Delta = -V_W C_P + V_P C_W < 0$

Equations (3.3) and (3.4) represent the effect of forest amenities on wages (labor market) and housing prices, respectively, and their sign depends on how this natural amenity affects firms' productivity, C_Q (Roback 1982). Let's say that two locations share the same characteristics but one is located closer to forest areas. For a given wage rate and assuming that forest amenities do not affect firms' productivity (e.g., $C_Q = 0$), the utility level is higher for individuals living in the location closer to amenable forest areas (e.g., $V_Q > 0$), and therefore, housing prices in this location should be higher for equation (3.1) to hold (e.g., same utility level ($\bar{V}$)across all locations).[42] In equilibrium, individuals trade proximity to forest areas for lower wages and firms substitute labor for capital, due to lower wages and higher cost of capital (Wu and Gopinath 2008). If firms' costs decrease with proximity to forest areas (e.g., amenity is productive and $C_Q < 0$), $\frac{\partial p}{\partial Q} > 0$ and $\frac{\partial w}{\partial Q} \lesseqgtr 0$. In equilibrium while the housing prices are higher in the location closer to forest amenities, the wage level can be higher or lower depending on the absolute value of the effects proximity to a forest amenity has on individuals' utility level and firms' costs (Wu and Gopinath 2008). On the other hand, if firms' costs increase with

[42]In this analysis, it is assumed that the level of capital accumulation is constant across the state (e.g., differences in wages and housing prices are not a function of accumulated capital).

proximity to forest areas (e.g., amenity is unproductive and $C_Q > 0$), then $\frac{\partial p}{\partial Q} \substack{< \\ >} 0$ and

$\frac{\partial w}{\partial Q} < 0$. In particular, the empirical framework pursued in this paper adopts conventional assumptions for hedonic models: participants in the real estate and labor markets have full information about the relevant natural resource characteristics (Freeman 2003); housing and labor markets are in equilibrium; and the state of Arizona represents a single composite housing market. Since in this study reported household income (defined as HHINC) is used as a proxy for earned wages, HHINC instead of w is used throughout.

A plausible approach to estimate the left hand side of equation (3.3), the implicit marginal housing price of natural amenities, is to apply a hedonic approach. This method decomposes the statistical variation in prices for a heterogeneous good (e.g., residential real estate) to isolate the contribution of individual attributes or characteristics of the good (Taylor 2003). Following Freeman's (2003) theoretical hedonic price framework and using a vector notation, the price of a house depends on housing characteristics **S** (lot size, number of rooms, year built), neighborhood characteristics **N** (school quality, income level) and location-specific amenities **Q** (distance to forest views), such that for a house *i* in location *j*:

$$P_{ij} = P_{ij}(S_i, N_j, Q_{f,j}) \tag{3.5}$$

where the subscript *f* denotes the type of forest included in the model (IRAs, WILD, or FOREST). The vector **Q** includes linear distance to three types of forests: inventoried roadless areas (IRAs), wilderness (WILD), and national forest (FOREST). The coefficient of interest $\theta_f^{'}$ represents the effect of, for instance distance to IRAs on housing prices (e.g., $\theta_{IRAs} = \frac{\partial P_{ij}}{\partial Q_{IRAs,j}}$). In this analysis, a different model is estimated for each forest as opposed to include all three in the same model (e.g., avoids multicollinearity issues between these variables). Without assuming any particular form, such as a Box-Cox transformation or log-linear specification, the econometric equivalent of equation (3.5) is:

$$P_{ij} = \alpha_0 + \beta' S_i + \varphi' N_j + \theta' Q_{f,j} + \varepsilon_i, \tag{3.6}$$

where $\varepsilon_i \sim N(0,\Omega)$, and β, φ, and θ are the coefficient vectors to be estimated. In this setting, while the disturbance ε_i is assumed to be normally distributed, its covariance matrix is of the general form Ω to account for heteroskedasticity and autocorrelation (e.g., off-diagonals are nonzero).

The partial derivative of Equation (3.4) is estimated in a similar manner. Building upon Mincer's (1974) wage equation, annual household income is a function of the household's human capital characteristics **HC** (education level, race, employment status), neighborhood characteristics **N**, and location-specific amenities **Q**, such that:

$$HHINC_{ij} = \gamma_0 + \eta' HC_i + \pi' N_j + \delta'_f\, Q_{f,j} + \mu_i, \tag{3.7}$$

where $HHINC_{ij}$ is the annual income for household *i* in location *j*. It is important to note that since the main focus of this study is the effect of forest amenities on households' income, the *i* subscript represents household income and characteristics as opposed to a particular type of job (e.g., working conditions).

3.21 Spatial Econometrics

The model specification in equations (3.6) and (3.7) has been widely used in applied hedonic studies. However, these equations do not address spatially-dependent relationships that emerge when using randomly distributed geographic data (Anselin 1988). In general, spatial dependence (or spatial autocorrelation) refers to the notion that what happens in one point in space relates to what occurs in other locations.[43] In many instances, this arises due to random specifications of geographic units, such as census tracts or county boundaries, which may not accurately reflect the extent to which the phenomenon in question behaves in space (Anselin 1988). Another reason is that regardless of whether data corresponds to individual spatial units or aggregated units, diffusion processes (e.g., spillover effects) result in spatial autocorrelation between different spatial units depending on location and distance. As stated in Tobler's (1970) first law of geography: "everything is related to everything else, but near things are more related than distant things" (Tobler 1970 pp. 236). In this sense, the presence of spatial autocorrelation is not limited to cases with data collected at an aggregate level but also to point data or individual-level observations, which is the case of this study (Anselin 1988).

Econometrically, spatial dependence can result in non-spherical disturbances (e.g., off-diagonal terms in the variance-covariance matrix of the disturbance vector are not all zero). In the context of this paper and the housing price market, this could be driven by housing prices being spatially correlated (e.g., price of house *i* is a function of changes in

[43] A second type of spatial effect that is not addressed in this model is spatial heterogeneity. This refers to spatial relationships for which the functional form requires parameters to vary with locations.

the price of house *k*) or due to a general correlation of error terms. Two different approaches can be implemented to address this issue: spatial lag and spatial error models. In the first approach, the hypothesis is that housing prices are spatially related and therefore, a vector of house prices observed at other locations is included on the right hand side of the hedonic model and specified as:

$$P_{ij} = \alpha_0 + \rho W_1 P_k + \beta' S_i + \varphi' N_j + \theta' Q_{f,j} + \varepsilon_i, \forall \; i \neq k, \qquad (3.8)$$

where ρ is the spatial lag autoregressive coefficient, ε_i is a vector of spherical disturbance that are normally distributed, and W_1 is an *nxn* weight matrix that indicates how housing prices are related in space (e.g., the effect that a change in the price of house *k* has on the price of house *i*). This weight matrix represents a weighted average effect of housing prices in neighboring units and has non-zero elements w_{ik} when observations *i* and *k* are defined as neighbors. For house *i* in location *j*, this model is represented by the following expression:

$P_{ij} = \rho(w_{i1} p_1 + w_{i2} p_2 + w_{i3} p_3 ... + w_{in} p_n) + \psi' X + v_i$, where $w_{ii} = 0$ and $\rho \in [-1,1]$, $\psi = [\beta, \varphi, \theta_f]$ and $X = [S, N, \theta_f]$. Theoretically, a spatial lag model specification addresses the presence of biased outcomes stemming from spillovers across spatial units that vary with distance and location (Anselin 2001). If spatial dependence arises due to the omission of variables that are related in space, a spatial error model is appropriate (Anselin and Bera 1998). In this case spatial dependence is introduced in the functional form of the error term and the specification of the housing price and wage equations are as follow:

$$P_{ij} = \alpha_0 + \beta' S_i + \varphi' N_j + \theta' Q_{f,j} + \mu_{i,house}, \qquad (3.9)$$

with $\mu_{i,house} = \lambda_{house} W_2 \mu_{k,house} + \xi_{house}$,

$$HHINC_{ij} = \gamma_0 + \eta' HC_i + \pi' N_j + \delta'_f Q_{f,j} + \mu_{i,hhinc} \quad (3.10)$$

with $\mu_{i,hhinc} = \lambda_{hhinc} W_2 \mu_{k,hhinc} + \xi_{hhinc}$,

where λ_{house} and λ_{hhinc} are the spatial error autoregressive coefficients for the housing price and wage equations, respectively, and ξ_{house} and ξ_{hhinc} are vectors of spherical disturbance with zero mean.

Combining both types of lag processes in a single equation results in a more flexible specification to represent spatial relationships and could be appropriate when there is little or no theoretic support as to which spatial process should be introduced to address spatial autocorrelation. In this case, the general specification to represent the housing market is:

$$P_{ij} = \alpha_0 + \rho W_1 P_k + \beta' S_i + \varphi' N_j + \theta' Q_{f,j} + \mu_{i,house}, \quad (3.11)$$

with $\mu_{i,house} = \lambda_{house} W_2 \mu_{k,house} + \xi_{house}$,

where two different weight matrices are specified to address the identification problem that may arise if the same weight matrix is used to represent both spatial processes (Anselin 1980). In this analysis, the implicit marginal housing price (θ_f) and wage (δ_f) are estimated for each type of forest based on equations (3.11) and (3.10), respectively.

A recurring issue in these types of spatial models is the specification of the weight matrix (W). In the majority of the cases, this matrix is not endogenous to the model but pre-defined and arbitrary. The lack of consensus and evidence regarding a suitable weight matrix resulted in a large number of specifications across hedonic spatial studies (Anselin

1988). In light of this, four different row-standardized weight matrices are considered in this study[44]:

1) w_{ik} = 1 if distance between spatial units ≤ 3km, 0 else (defined as 3KM);
2) w_{ik} = 1 if distance between spatial units ≤ 4km, 0 else (defined as 4KM);
3) w_{ik} = 1 if inverse of Euclidean distance, 0 else (defined as IWD);
4) w_{ik} = 1 if inverse of Euclidean distance to the power of 1.5, 0 else (defined as $IWD_{1.5}$).

3.22 Empirical Estimation Process

Two plausible approaches can be used to estimate equations (3.10) and (3.11). One is a fully-simultaneous model in which the structural equations of housing demand, equation (3.11), and labor supply, equation (3.10), are estimated assuming error independence between equations. This restriction may not be appropriate if the error terms are correlated across equations. In this case, using a seemingly unrelated regression (SUR) approach that accounts for unobserved factors that affect the error terms in both equations would be suitable (Greene 2003). This is the approach this paper follows to estimate equations (3.10) and (3.11).

The SUR model with spatial error and lagged autocorrelation in the housing price equation and with a spatial error structure in the wage equation is estimated by applying a spatial Cochrane-Orcutt procedure analogous to that develop for the case with serial correlation in time series (Greene 2003). In the first step an Ordinary Least Square (OLS) and a 2-SLS regression are estimated for equations (3.10) and (3.11),

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[44] These weight matrices were created using RGui software.

respectively, without accounting for spatial error dependence.[45] In the second step, the residuals from the OLS regression $(\hat{\mu}_{1,hhinc}, \hat{\mu}_{2,hhinc}, ..., \hat{\mu}_{n,hhinc})$ are used to estimate λ_{hhinc} (the spatial error autoregressive coefficient of the wage equation) and the variance of the error term $(\sigma^2_{\xi,hhinc})$ using a GMM process outlined in Kelejian and Prucha (1999). In a similar fashion, the residuals from the 2-SLS regression $(\hat{\mu}_{1,house}, \hat{\mu}_{2,house}, ..., \hat{\mu}_{n,house})$ are used to estimate λ_{house} and the variance of the error term $(\sigma^2_{\xi,house})$ following Kelejian and Prucha (2004).[46] Using a general

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[45] The presence of a spatial lagged coefficient (e.g., ρ) means that the estimated OLS coefficients in equation (3.11) would be biased and inefficient due to correlation or endogeneity problems between the lagged dependent variable (W_1P) and the error term (Anselin 1988). For this reason a 2-SLS approach is used with a vector of lagged independent variables (e.g., [WS WN WQ]) as instruments to obtain $\widehat{WP}$ in the first stage.

[46] Since a simultaneous system of equations was used in Kelejian and Prucha (2004), the following adjustments were made to estimate the SUR model: there is no direct dependency between housing prices and wages (e.g., a vector of housing prices is not included on the right hand side of the wage equation and vice versa) and that housing prices are not a function of the spatial lag of the independent variables included in equation (3.11) (e.g., only the spatial lag of other housing prices appears in equation 3.11).

notation, λ_{wage}, $\sigma^2_{\xi,hhinc}$, λ_{house}, and $\sigma^2_{\xi,house}$ are estimated based on the following system of three equations:

$$(\hat{\mu}_{n,m} - \lambda_m W_2 \hat{\mu}_{n,m})'(\hat{\mu}_{n,m} - \lambda_m W_2 \hat{\mu}_{n,m}) - \sigma^2_{\xi,m} = \hat{\Phi}_{1,m}$$

$$\frac{(W_2\hat{\mu}_{n,m} - \lambda_m W_2 W_2 \hat{\mu}_{n,m})'(W_2\hat{\mu}_{n,m} - \lambda_m W_2 W_2 \hat{\mu}_{n,m})}{n} - \frac{1}{n}\sigma^2_{\xi,m} Tr(W_2' W_2) = \hat{\Phi}_{2,m} \quad (3.12)$$

$$\frac{(W_2\hat{\mu}_{n,m} - \lambda_m W_2 W_2 \hat{\mu}_{n,m})'(\hat{\mu}_{n,m} - \lambda_m W_2 \hat{\mu}_{n,m})}{n} = \hat{\Phi}_{3,m}$$

where the subscript *m* refers to "hhinc" for equation (3.10) and "house" for equation (3.11), and $\hat{\Phi}_{1,m}, \hat{\Phi}_{2,m}, \hat{\Phi}_{3,m}$ are regression residuals. In this setting, the GMM estimators of λ_m and $\sigma^2_{\xi,m}$ ($\hat{\lambda}_m$ and $\hat{\sigma}^2_{\xi,m}$) are obtained from the minimization of the sum of the squared residuals or:

$$\min_{\lambda_m, \sigma^2_{1,m}} (\hat{\Phi}_{1,m} + \hat{\Phi}_{2,m} + \hat{\Phi}_{3,m}) \quad (3.13)$$

In the third step, $\hat{\lambda}_m$ allows for the estimation of the coefficients in equations (3.10) and (3.11) to account for spatial error autocorrelation.[47] This is achieved using the following spatial Cochrane-Orcutt transformed regression model[48]:

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[47] In the first step, OLS and 2SLS approaches yield unbiased estimators. However, spatial error correlation within each equation was not taken into account, resulting in a loss of efficiency (Anselin 1988).

[48] Analogous to the case of time series with serial correlation, it can be shown that for this spatial Cochrane-Orcutt procedure the following equalities hold:

$$HHINC^*_{ij} = \gamma^t_0 + \eta''^t HC^*_i + \pi''^t N^*_j + \delta''^t Q^*_{f,j} + \mu^*_{i,hhinc}, \quad (3.14)$$

$$P_{ij} = \alpha^t_0 + \rho W_1 P^*_k + \beta''^t S^*_i + \varphi''^t N^*_j + \theta''^t Q^*_{f,j} + \mu^*_{i,house}, \quad (3.15)$$

where $HHINC^*_{ij} = HHINC_{ij} - \widehat{\lambda}_{hhinc} W_2 HHINC_{ij}$, $P^*_{ij} = P_{ij} - \widehat{\lambda}_{house} W_2 P_{ij}$, and $Z^*_{ij,m} = Z_{ij,m} - \widehat{\lambda}_m W_2 Z_{ij,m}$ for $Z_{ij,m} = [HC_i \; N_{j,m} \; Q_{j,m}]$. Based on this transformation, a SUR model was estimated using the feasible generalized least squares method (Greene 2003). This 3-step process was implemented separately for each type of forest (IRAs, WILD, and FOREST) using different combinations of the weight matrices for spatial lag and error dependencies (since there are four weight matrix specifications, there were twelve possible combinations). The different SUR models for a particular type of forest were compared based on McElroy's (1977) goodness-of-fit measure (McElroy R^2). The pair of weight matrices that yielded the highest McElroy R^2 value was 4KM (spatial lag) and IWD (spatial error).[49] For this reason, results reported in this paper have this weight matrix specification.

3.3 Data

In order to estimate the proposed spatial SUR model a matched sample of wage-earner housing units is used at the household level. In this sample, each observation

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$\eta''^t = \eta', \pi''^t = \pi', \delta''^t = \delta' \;\; \eta''^t = \eta', \pi''^t = \pi', \delta''^t = \delta', \beta''^t = \beta', \varphi''^t = \varphi'$, and $\theta''^t = \theta'$ (Greene 2003).

[49] For this specification, McElroy R^2 was 0.51 compared to 0.32 through 0.50 for the other 11 cases.

includes reported household income (2006$), household characteristics (e.g., race, employment status), home value, and housing characteristics. In particular, the data for the housing and wage equations come from two different sources: 2007 survey for the Southwest Region in the United States titled “Attitudes, Beliefs, and Values towards National Forests and National Forest Management”, referred hereafter as the 2007 Region 3 Survey (McCollum 2008) and housing characteristics purchased from a commercial marketing vendor, PrimeraSource. This housing data was pursued after the final round of the 2007 Region 3 Survey was completed, since the objective was to obtain housing data for those who responded this survey. Thus, a matched sample of wage-earner housing units is used at the household level.

The sample for the wage equation is restricted to wage-earning households between the ages of 18 and 64. The characteristics for these households (e.g., income, education, race, employment status) were obtained from standard demographic questions included in the 2007 Region 3 Survey conducted by the University of New Mexico in conjunction with USDA Forest Service, Rocky Mountain Research Station. Building upon the 1999-2000 USDA Forest Service National Survey on Recreation and the Environment, the 2007 Region 3 Survey was designed to provide input on individuals’ values and objectives regarding land management of large public lands in the Southwestern Region (Arizona (AZ), New Mexico (NM), and small parts of Texas (TX) and Oklahoma, OK). The sampling includes a geographically stratified, random sample (with rural over-sampling for statistical purposes), which allows analysis at both the regional level, and for various sub-regional dis-aggregations (McCollum 2008). This sample is comprised of 6,835 usable responses out of 7,626 received, from a sample frame of 37,804 (31,746) contacts, implying a response rate of 21.53 percent.[50] For the purpose of this paper, this data was subsequently matched with housing data obtained from PrimeraSource. Since only few responses were received from the states of TX and OK and the housing information for NM had significant gaps (NM is a non-disclosure state, Berrens et al. 2006), this paper focuses on the state of AZ.[51] While 3,347 (2,998) usable survey responses were received from AZ, the following three issues did not allow the inclusion of all of them in this study: incomplete household demographic information, lack of housing information, household age higher than 64, household unemployed or homemaker, and no neighboring houses for the weight matrix defined as 3KM (e.g., closest home from house *i* is located further than the 3 kilometer threshold).[52] As a result, the estimates reported in this study are based on 1,014 observations.

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[50] This project involved a large general population sample, multi-mode survey (mail survey mode with a web-based survey mode option), with multiple language options (versions in both English and Spanish). The target population included all households in the Southwest Region (AZ, NM, and small parts of TX and OK). Survey instrument constructed based on five focus groups held in the Economics Department at the University of New Mexico.

[51] The breakdown of total responses received by state is: 3,509 for NM, 2,998 for AZ, 56 for OK, and 272 for TX.

[52] For Arizona, the number of non responses for the demographic section by characteristics are: 55 for gender, 30 for ethnicity (e.g., Hispanic/non-Hispanic), and 35 for years of education, 309 households were at least 65 years of age, and 40 were either unemployed or homemaker. Lack of housing information includes: 268 observations

A key issue in any study that uses survey data is the representativeness of the sample or subsample being used and the ability to weight the responses by known external data or variables to better represent target populations, if any biases are shown to exist (Champ, 2003). To address this issue, this study closely follows the sample weight methodology implemented for the 2007 Region 3 survey.[53] Given the nature of the sample, initial and post-stratification weights are used to ensure estimates that are representative of the population. The initial or survey weights are meant to ensure consistent estimates by reducing imbalances in the data (Dorofeev and Grant 2008). This initial weight is the product of two initial adjustments: a base weight and a non-response adjustment. The base weight is the inverse of the inclusion or selection probability, which is used to adjust survey estimates to reflect the population in the sample frame based on the sample design (Kneipp and Yarandi, 2002). The nonresponse adjustment, can be defined as, the number of responses divided by the sample, and controls for unit nonresponse or failure to achieve a 100% response rate (Lehtonen and Pahkinen, 2004). Therefore, initial weights compensate for unequal sampling rates and unit non-response.

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without any type of housing information, 289 without home values, 14 without year built, 612 without lot size, and 613 without total number of rooms. In addition, 68 observations without neighboring houses as defined by the 3KM weight matrix criterion had to be dropped.

[53] In the 2007 Region 3 survey, weights were constructed at the regional level (sample data was divided in 12 regions) and at the county level. Since the market area studied in this paper is comprised by one state, Arizona, county sample weights are used to adjust the data.

Certain personal or demographic characteristics of the sample are not known until after data is collected, but if known in advance could have led respondent to be further stratified in the sample plan. Post-stratification allows for stratification of the sample after data has been gathered (Cochran, 1977). These demographic characteristics are known after data has been collected. As reported in Table 3.1, both men and high income households tend to be overrepresented in this sample. The mean household age is 54 compared to 43 for the true population. In terms of race, it has a greater proportion of whites than indicated for the population. Based on these comparisons, post-stratification weights were estimated based on four demographic factors: age, race, income and educational attainment. The final weights are the product of initial and post-stratification weights. They control for unequal sampling probabilities and non-response (initial weights) and adjust the data for uneven proportions between sample and population (post-stratification weights). As can be seen in Table 3.1, when using weights, the difference between the sample and the population is significantly reduced. For instance, the weighted proportion of males and whites is 52 percent and 78 percent compared to 50 percent and 82 percent for the population, respectively.

The dependent variables are LNINC, the natural log of annual household income as indicated by respondents in the 2007 Region 3 survey, and LNHVALUE, the natural log of home values. As reported in Table 3.2, the weighted mean household income is $54,621 and the mean home value is $166,019 in 2006$.[54] It is important to note that

[54] The weighted mean value for home values is $177,308. Since the year home values were assessed was in 2008, the price in 2006 dollars is $166,019 given a Consumer Price Index conversion factor of 1.068.

home prices are estimated market values as opposed to values obtained from actual market transactions (e.g., from selling a house). The main reason is that housing data was purchased based on whether the particular household responded the 2007 Region 3 Survey and not on whether the house was sold in 2007.

In terms of the independent variables, the primary interest in the empirical estimates is measures of natural characteristics, and specifically those measures that relate to forest resources. For the purpose of this paper, the site-specific characteristics that have been gathered include linear distance to different measures of forest area, water features, Superfund sites, campground area, and urban characteristics.

The variables that measure forest characteristics are logged distance from house *i* to its closest U.S. Forest Service (USFS) area (LNFOREST, includes the other two open space measures), Congressionally-designated wilderness area (LNWILD), and Inventoried Roadless Area (LNIRAS). All these areas are expected to be an amenity (e.g., $\theta_f < 0$ in the housing equation and $\delta_f > 0$ in the wage equation) but the designation of LNFOREST areas for multiple uses (including recreation and extractive uses) distinguishes USFS area from wilderness and IRAs lands. While Wilderness areas are congressionally protected from any type of human intrusion, such as road construction, IRAs meet the minimum criteria for wilderness consideration under the Wilderness Act of 1964 but do not yet have legislative protection (Aarons 2011). However, all these areas are expected to carry a positive implicit price reflective of recreation, ecosystem services, and passive use values (Phillips 2004). Similarly, the other site-specific natural amenities used in estimation include closest logged distance to lakes (LNLAKES), campgrounds

(LNCAMP), and protected watershed (LNWATERSHED) and logged distance to a Superfund site (LNSPFUND).

The independent variables for the housing-price equation include number of room (ROOMS), structure age (AGE), and property acreage (LOTSIZE). In terms of urban characteristics, the variables included are distance to highway (LNHIGHWAY), distance to school (LNSCHOOL), distance to a railroad (LNRAILROAD), and distance to a golf course (LNGOLF). The wage equation independent variables include categorical variables for employment status, race indicators, gender (MALE) and whether the household's primary wage earners´ job depends directly on natural resources (LIVINGNRE). Table 3.3 describes these variables, and provides descriptive statistics.

3.4 Empirical Results

The presence of both spatial lag and error processes in the housing market as specified in equation (11) may have a number of reasons. Housing prices may not only be determined by its particular characteristics (such as lot size or year built) but also by prices in neighboring houses, resulting in spatial spillover effects that require the inclusion of a spatially lagged dependent variable in the model. Moreover, it is realist to assume that not all the factors affecting housing prices are quantifiable or included in this model. For this reason a spatial error structure may also be needed to obtain reliable results.

Econometrically, these prior beliefs about the nature of spatial dependence can be tested using a series of diagnostics tests. A well known and commonly used test statistic is the Moran's I, which indicates whether or not there is spatial autocorrelation after estimating an OLS regression but does not identify the cause of spatial dependence (Cliff and Ord 1972). An alternative is the Lagrange Multiplier test (LM) derived by Anselin (1988) that allows for testing residual spatial error autocorrelation in the presence of a spatially lagged dependent variable ($LM_{\lambda/\rho}$) and vice versa ($LM_{\rho/\lambda}$). In the first case, a spatial lag model for the housing equation is estimated via a maximum likelihood approach (ML) and the LM test is calculated with the null hypothesis being $\lambda_{house} = 0$ as outlined in Anselin (1998). In a similar manner, the LM test for spatial lag autocorrelation in the presence of spatial error autocorrelation is derived by first estimating a spatial error model (Anselin et al. 1996; Zhou and Kockelman 2009). In this case, the null hypothesis is $\rho = 0$. The LM tests have a chi-squared (χ^2) distribution with one degree of freedom (e.g., the restriction that $\lambda = 0$ or $\rho = 0$).

Tables 3.4 and 3.5 report the $LM_{\lambda/\rho}$ and $LM_{\rho/\lambda}$ values by national forest (IRAS, WILD, and forest). In almost all cases, the χ^2 values are significant at a 99 percent confidence level. For instance, when the pair of weight matrices is IWD (spatial lag) and $IWD_{1.5}$ (spatial error), spatial error autocorrelation is statistically significant after controlling for spatial lag dependence (28.11 for IRAS, 28.78 for WILD, and 30.34 for forest). This is also true for spatial lag autocorrelation after estimating an error model (40.00 for IRAS, 34.98 for WILD, and 35.00 for forest). These findings suggest that in order to obtain reliable estimates, the general specification of spatial dependence defined in equation (3.11) for the housing equation is required.

3.41 SUR Results

To determine the functional form of the dependent and independent variables in the housing equation, a Box-Cox specification was tested and the coefficients by which the variables would have to be transformed were close to zero and statistically insignificant ($\lambda_{IRAS}^{BoxCox} = 0.07, \lambda_{WILD}^{BoxCox} = 0.06,$ and $\lambda_{FOREST}^{BoxCox} = 0.09$). For this reason, a log form was chosen for both the dependent variables (housing prices) and for the natural amenity distance variables. In the case of the wage equation, since many of the independent variables are categorical (e.g., zero or one value), a log form is specified for the dependent variable (household income).

The spatial SUR models for equations (3.10) and (3.11) are estimated and reported in Table 3.6. The residual correlation of 0.12 for IRAS, 0.13 for WILD, and 0.14 for Forest are all statistically significant at a 99 percent confidence level, supporting the use of a SUR approach.

The estimates for the structural characteristics and the household's human characteristics for the housing and wage equations are all statistically significant and have the expected signs. For instance, home values increase with lot size, number of rooms, and year built (e.g., the more recent the house was built the higher its value). Household wages vary significantly depending on years of education, gender (household males tend to earn higher wages compared to females), and race (Whites, the base case, earn significantly higher wages than Blacks and households with two races).

The spatial lag autocorrelation coefficient (ρ) ranges between 0.47 and 0.52 and is statistically significant at across all level models, indicating that home values are positively related. This result underscores the importance of accounting for spatial dependence. However, in this spatial SUR approach, inferences about the significance of the error autocorrelation coefficients (λ_{wage} or λ_{house}) are not possible. Since these coefficients are estimated in step 2 of this 3-step process using GMM, their t-values from the SUR regression (the last step) are not identifiable. While it is not possible to make any conclusions about the joint significance of a spatial lag and error processes in this SUR model, the LM tests reported in Tables 3.4 and 3.5 suggest the need to include both types of spatial dependences.

The coefficients for IRAs, WILD, and FOREST support the hypothesis that these different types of forest areas are amenable to individuals. The negative signs in the housing equation suggest that the closer a home is located to one of these areas the higher its value. In the labor market, individuals are trading wages for forest area as indicated by the positive coefficients for these variables (e.g., the closer a household lives from a forest area, the lower his annual wage). A similar relationship is found for the other natural amenities included in the model. For instance, households are willing to earn a lower wage for living closer to lake areas or protected watersheds and home values increase the closer a house is located from these amenities. The positive sign for RAILROAD indicates that railroads are a disamenity (home prices increase with increasing distant from railroad), possibly due to noise inconvenience. In the case of the other geographic features, mixed results are found for the statistical significance of the estimated coefficients. While LNURBAN (distance to closest urbanized area, defined as a territory with 50,000 or more individuals) has the expected sign for the housing and labor markets, only in the housing equation, LNURBAN is statistically significant, indicating that the closer a house is located from an urbanized area the higher its value. Superfund sites (LNSPFUND) have a statistically significant effect across all the models (negative for housing prices and positive for wages) except for the equation in which the type of forest included is national forest. It is worth noting that conclusions about the effect of each geographic feature on home values and household income based on simply comparing coefficients across equations may lead to inaccurate conclusions. While the absolute values of these coefficients are in most cases higher for the wage equation, the presence of spatial processes requires calculations of total implicit prices to have a proper understanding of their magnitude.[55] By means of this empirical exercise, it is possible to estimate in monetary terms, for instance, how much of the value that individuals have for living in the proximity to forest areas is capitalized in the housing and labor markets (e.g., implicitly paying a higher house price and earning a lower wage). The variables of interest in this analysis are forest areas.

The first step to calculate total implicit prices is to derive the marginal effects for each market separately. Following Freeman's (2003) theoretical hedonic framework, applying total differentiation to the indirect utility function or equation (3.1) gives the following expression, which represents the individuals preference for access to forest areas at the margin:

$$\frac{V_{Q_f}}{V_{HHINC}} = -\frac{V_p}{V_{HHINC}}\frac{dp}{dQ_f} - \frac{dHHINC}{dQ_f} \tag{3.16}$$

where HHINC is used instead of w to reflect the level of income data used in this analysis. In this equation, it is assumed that the market is in equilibrium or $dV = 0$ (e.g., same utility level ($\bar{V}$) across all locations). Since at equilibrium individuals trade

[55] It is also important to note that the housing equation is specified with both spatial processes (spatial lag and error) while only spatial error dependence is included in the wage equation.

proximity to forest areas for wages, $\frac{V_{Q_f}}{V_{HHINC}}$ represents the marginal rate of substitution between the forest variable (Q_f) and the numeraire good (e.g., income spent in all market goods consumed). Assuming that the same individual does not own more than one house and using Roy's identity yield the following total implicit price expression for the Q_f:

$$P_{Q_f} = \frac{dp}{dQ_f} - \frac{dHHINC}{dQ_f} \tag{3.17}$$

where $\frac{dp}{dQ_f}$ and $\frac{dHHINC}{dQ_f}$ are the partial derivates of equations (3.14) and (3.15) that indicate how home prices and household income change with changing proximity to forest areas. Based on the Cochrane-Orcutt transformation in step 3 for estimating the spatial SUR model, equations (3.14) and (3.15) can be rewritten as:

$$(I - \lambda_{house}W_2)(I - \rho W_1)P_{ij} = (I - \lambda_{house}W_2)\beta'^{t}S_j + (I - \lambda_{house}W_2)\varphi'^{t}N_j + \\ + (I - \lambda_{house}W_2)\theta'^{t}Q_{f,j} + \xi^*_{i,house} \tag{3.18}$$

$$(I - \lambda_{house}W_2)HHINC_{ij} = (I - \lambda_{hhinc}W_2)\eta'^{t}HC_j + (I - \lambda_{hhinc}W_2)\pi'^{t}N_j + \\ + (I - \lambda_{hhinc}W_2)\delta'^{t}Q_{f,j} + \xi^*_{i,hhinc} \tag{3.19}$$

Assuming a log form for both dependent variables ,and for the natural amenity distance variables, the right hand side expressions in equation (3.17) are found by taking the partial derivate in the above equations with respect to $Q_{f,j}$ (forest characteristic): IRAs, WILD, or FOREST[56]:

$$\frac{dp}{dQ_f} = (I-\rho)^{-1}\theta'^{t}\frac{Q_{f,j}}{P_{ij}} \tag{3.20}$$

$$\frac{dp}{dQ_f} = \delta'^{t}\frac{Q_{f,j}}{HHINC_{ij}} \tag{3.21}$$

In equation (3.20), two types of effects are estimated: the direct-contemporaneous effect and indirect effects. The first effect refers to how the price of home *i* changes with proximity to a given forest characteristic. Indirect effects represent the impact on home price *i* of changes in the price of neighboring home j due to its distance to, for instance, IRA lands (represented by ρ).

The annualized marginal effect estimates using the above equations are reported in Table 3.6 for the presence of different forest characteristics, lakes and watersheds. Evaluated at the mean house price of $167,651 and mean household income of $46,642, the average home price increases by $620 and the average household income decreases by $74 for moving one mile closer to IRAS, given an initial distance of 38 miles (the mean for the sample). The resulting total implicit price is $694 per mile. When measured by proximity to wilderness areas (WILD) and public forest (FOREST), total implicit prices increase to $1039 and $1901 per mile, respectively.

[56] Since the spatial weight matrices are row-standardized (e.g., each row adds up to one), the partial derivative in equation (3.20) assumes the following equality:

$(I-\rho W_1)^{-1} = (I-\rho)^{-1}$.

Total implicit prices for lakes range between \$9,075 and \$10,537 per mile and for watershed between \$880 and \$900 depending on the type of forest area included in the model. While these features appear to be more "more expensive" on the margin, it is important to note that for a house the average closest distance from a lake or protected watershed is 2.8 and 15.9 miles, respectively, compared to 28.7 through 38.2 for the forest areas. This may partially explain the significant difference in total implicit prices between these geographic features. For instance, assuming a mean house price of \$167,651, household income of \$46,642, and closest distance to a lake of 38 miles, the total implicit value rages between \$670 and \$830. Figure 1 shows how total implicit prices decrease the further away a home is located from these amenities, assuming a constant house price of \$167,651 and household income of \$46,642.

3.5 Conclusion

This study has examined the role of public forest lands as determinants of spatial variations in housing prices and wages for the State of Arizona. The presence of off-site benefits, one type of the total economic value of public forest lands, suggest that invididuals' preferences for housing and labor is partially based on the proximity to these areas and other environmental amenities. These findings are in line with previous studies that have shown that forest amenities cannot longer be tied to only an input good in the production process. However, most of these papers have relied on relatively large geographic scales, such as counties and census tracts, to determine whether people are willing to pay through the housing and labor markets to live close by these areas. These findings can be significant inputs to any management decision process involving public lands to achieve a comprehensive accounting of both market and non-market benefits.

After controlling for housing, neighborhood, household's human capital characteristics and location specific amenities, results show that the average total implicit price for USFS is $1,901 per mile compared to $1,309 for WAs and $694 for IRAs per mile, annually. These findings further evidence that Non-market benefit estimates, as part of a more comprehensive benefit-cost analysis, can be an important informational input in any major regulatory action (e.g., Arrow et al. 1996), including public lands management (Loomis 2002).

The underlying spatial relationships among observations were determined by applying Lagrange Multiplier (LM) tests for the co-existence of spatial lag and spatial error processes. The econometric approach applied in this study follows Kelejian and Prucha (2004) to test the empirical question of whether there are strong amenity effects in the housing and labor markets. The SUR model with spatial error and lagged autocorrelation in the housing price equation and with a spatial error structure in the wage equation is estimated by applying a spatial Cochrane-Orcutt procedure analogous to that develop for the case with serial correlation in time series (Greene 2003). As expected, all spatial lag autocorrelation coefficients are statistically significant and positive, confirming the existence of spatial lag effects. However, while LM tests indicate that spatial error autocorrelation is present after controlling for spatial lag dependence, the significance of the spatial error coefficients (e.g., λ_{house} and λ_{hhinc}) is identifiable in the SUR estimation process.

Using micro-data where households are identified to points on a map allows calculating more precise distances to specific natural amenities and testing for aggregation bias. A possible extension of this study is to test the effect of this bias by estimating a hedonic model where locations are aggregated to match census tract areas and compare the results with those found here. Future studies can relax the assumption that the estimated coefficients are constant in space by introducing spatial heterogeneity. It is important to note that the estimation of the hedonic models assumes spatial equilibrium for the housing and labor markets. Since the presence of natural amenities may in part explain net migration patterns, such an assumption could be too restrictive.

Table 3.1: Weighted and Census Data Comparison

	Survey (unweighted)	Survey (weighted)	US Census
HH Mean Income	$83,799	$46,642	$53,591
Mean Age	51	34	
Gender	Male (72%) Female (28%)	Male (52%) Female (48%)	Male (50%) Female (50%)
Race	White (95%) Asian (1%) Black (1%) American Indian (1%) Native Hawaiian (0.2%) Two or more races(2%)	White (78%) Asian (5%) Black (4%) American Indian (3%) Native Hawaiian (0.2%) Two or more races(3%)	White (82%) Asian (2%) Black (3%) American Indian (4%) Native Hawaiian (0.1%) Two or more races(2%)
Education	High School or Less (11%) Some College (33%) Bachelor Degree (28%) Grad or Prof. Degree (28%)	High School or Less (61%) Some College (23%) Bachelor Degree (12%) Grad or Prof. Degree (4%)	High School or Less (43%) Some College (33%) Bachelor Degree (15%) Grad or Prof. Degree (8%)

Table 3.2: Definitions and Weighted Descriptive Statistics of Geographic Variables

Variable	Definition (source)	Mean	Std. Dev.
LNHIGHWAY	Natural log of distance to nearest highway, meters (GIS, US Department of Commerce)	8.82	0.78
LNSHCOOL	Natural log of distance to nearest schoool, meters (GIS, US Bureau of the Census)	6.69	0.79
LNRAILROAD	Natural log of distance to nearest railroad, meters	8.71	1.13
LNGOLF	Natural log of distance to nearest golf course, meters (GIS, U.S. Bureau of the Census)	8.66	0.78
LNIRAS	Natural log of distance to nearest Inventoried Roadless Area, meters (GIS, USFS)	10.74	0.45
LNWILD	Natural log of distance to nearest Congresionally-designated wilderness area, meters (GIS, USFS)	10.95	0.44
LNFOREST	Natural log of distance to nearest National forest, meters (GIS, USFS)	10.57	0.59
LNSPFUND	Natural log of distance to nearest superfund site, meters (GIS, ADEQ)	8.80	0.83
LNURBAN	Natural log of distance to nearest urbanized area, meters (GIS, US Bureau of the Census)	8.80	0.63
LNLAKES	Natural log of distance to nearest lake, meters (GIS, ADEQ)	8.22	0.69
LNCAMP	Natural log of distance to nearest campground, meters (GIS, U.S. Bureau of the Census)	10.07	0.55
LNWATERSHED	Natural log of distance to nearest watershed, meters (GIS, ADEQ)	9.37	1.71

Sources: USFS: United States Forest Service Southwestern Region, http://www.fs.fed.us/r3/gis/datasets.shtml and http://roadless.fs.fed.us.
ADEQ: Arizona Department of Environmental Quality, US Bureau of the Census, and US Department of Commerce, http://agic.az.gov/portal/dataList.do?sort=theme&dataset=54.

Table 3.3: Definitions and Weighted Descriptive Statistics of Housing and Wage Variables

Variable	Definition	Mean	Std. Dev.	Min	Max
Housing variables					
LNHVALUE	House sale value (2007 $)	11.91	0.47	10.69	13.94
ROOMS	Total number of rooms	5.63	1.28	1.00	14.00
HAGE	Age of a house (2007 - year built)	32.58	17.50	3.00	92.00
LOTSIZE	Size of a house (acres)	0.20	0.30	0.00	20.00
Wage variables					
LNINC	Natural log of Annual Household income (2007 $)	10.55	0.64	9.50	12.25
EDUC	Years of education	5.40	1.69	2	9
WORKPT	Employment status: work part-time, binary	0.11	0.31	0	1
RETIRED	Employment status: retired, binary	0.25	0.43	0	1
HOMEMAKER	Employment status: homemaker, binary	0.20	0.40	0	1
STUDENTFT	Employment status: full-time student, binary	0.03	0.18	0	1
STUDENTPT	Employment status: part-time student, binary	0.001	0.04	0	1
ACTIVEMIL	Employment status: Active duty U S Armed Forces, binary	0.002	0.00	0	1
RESMIL	Employment status: Military Reserve or National Guard, binary	0.003	0.01	0	1
UNEMPL	Employment status: Unemployed looking for a job, binary	0.03	0.17	0	1
TWORACES	Race: Two or more races, binary	0.05	0.22	0	1
ASIAN	Race: Asian/Pacific islander, binary	0.01	0.10	0	1
BLACK	Race: Black, binary	0.001	0.06	0	1
AMERINDIAN	Race: Native American/Alaska Native, binary	0.01	0.10	0	1
HAWAIIAN	Race: Hawaiian, binary	0.002	0.04	0	1
MALE	Gender: Male, binary	0.52	0.50	0	1
LIVINGNRE	Make a living from a job that depends directly on natural resources (e.g., ranching, mining, guiding hunters or recreation users, working in a saw mill), binary	0.05	0.22	0	1

Note: LNHVALUE and LNINC are the dependent variables. The unlog values for the mean housing value and household income are $167,651 and $46,642, respectively.

Table 3.4: Lagrange Multiplier Diagnostics For Housing Equation

	Spatial error autocorrelation in the presence of spatial lag					
Weight Matrix						
Spatial lag	$IWD_{dist1.5}$	$IWD_{dist1.5}$	$IWD_{dist1.5}$	$IWD_{dist1.0}$	$IWD_{dist1.0}$	$IWD_{dist1.0}$
Spatial error	$IWD_{dist1.0}$	4KM	3KM	$IWD_{dist1.5}$	4KM	3KM
Open Space Variable						
IRAS	28.11***	34.10***	22.56***	27.57***	33.12***	21.81***
WILD	28.78***	34.77***	22.57***	28.57***	33.76***	21.83***
Forest	30.34***	34.80***	22.58***	27.73***	33.77***	21.68***

	Spatial error autocorrelation in the presence of spatial lag					
Weight Matrix						
Spatial lag	4KM	4KM	4KM	3KM	3KM	3KM
Spatial error	$IWD_{dist1.5}$	$IWD_{dist1.0}$	3KM	$IWD_{dist1.5}$	$IWD_{dist1.0}$	4KM
Open Space Variable						
IRAS	9.70***	36.34***	13.68***	25.70***	30.77***	3.92**
WILD	28.34***	41.52***	18.71***	10.81***	21.90***	4.56**
Forest	31.33***	26.49***	15.17***	14.75***	35.83***	4.19**

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table 3.5: Lagrange Multiplier Diagnostics For Housing Equation (cont'd)

	Spatial lag autocorrelation in the presence of spatial error					
Weight Matrix						
Spatial lag	$\text{IWD}_{dist1.5}$	$\text{IWD}_{dist1.5}$	$\text{IWD}_{dist1.5}$	$\text{IWD}_{dist1.0}$	$\text{IWD}_{dist1.0}$	$\text{IWD}_{dist1.0}$
Spatial error	$\text{IWD}_{dist1.0}$	4KM	3KM	$\text{IWD}_{dist1.5}$	4KM	3KM
Open Space Variable						
IRAS	40.00***	4.12***	3.67**	14.68***	18.92***	9.12***
WILD	34.98***	3.31***	4.82**	11.45***	4.04**	6.88***
Forest	35.00***	9.60***	3.80**	18.36***	10.86***	4.50**

	Spatial lag autocorrelation in the presence of spatial error					
Weight Matrix						
Spatial lag	4KM	4KM	4KM	3KM	3KM	3KM
Spatial error	$\text{IWD}_{dist1.5}$	$\text{IWD}_{dist1.0}$	3KM	$\text{IWD}_{dist1.5}$	$\text{IWD}_{dist1.0}$	4KM
Open Space Variable						
IRAS	9.73***	8.67***	10.04***	9.38***	3.09*	10.96***
WILD	3.34*	72.57***	23.15***	4.27**	123.77***	13.93***
Forest	12.33***	12.61***	12.33***	14.71***	2.16	12.75***

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table 3.6: Estimation Results, Weighted SUR Models

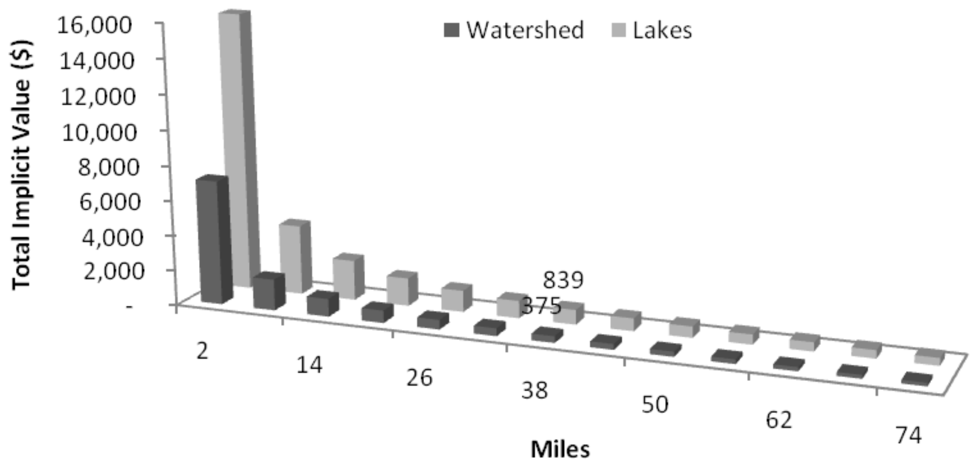
	Housing Equation			HHINC Equation		
ROOMS	0.13***	0.13***	0.13***			
HAGE	-0.01***	-0.01***	-0.01***			
LOTSIZE	0.22***	0.22***	0.22***			
LNHIGHWAY	-0.01	-0.01	-0.02			
LNSHCOOL	-0.01	-0.01	-0.01			
LNRAILROAD	0.04***	0.03***	0.01***			
LNGOLF	-0.01	-0.01	0.01			
EDUC				0.09***	0.09***	0.08***
WORKPT				-0.79***	-0.76***	-0.79***
RETIRED				-0.30***	-0.29***	-0.29***
HOMEMAKER				0.11*	0.13**	0.09
STUDENTFT				-0.16*	-0.13	-0.17*
STUDENTPT				-0.15	-0.19	-0.08
ACTIVEMIL				-0.29	-2.26	0.46
RESMIL				0.34	0.36	0.44
UNEMPL				-0.70***	-0.67***	-0.69***
TWORACES				-0.41**	-0.37**	-0.39**
ASIAN				0.47***	0.47***	0.47***
BLACK				-0.48***	-0.38**	-0.39**
AMERINDIAN				0.40***	0.38***	0.39***
HAWAIIAN				0.19	0.11	0.15
MALE				0.08*	0.07*	0.07*
LIVINGNRE				-0.17***	-0.15**	-0.18**
GROUPMEM				0.05	0.05	0.04
LNIRAS	-0.06**			0.05***		
LNWILD		-0.09***			0.21***	
LNFOREST			-0.14			0.20***
LNSPFUND	-0.03*	-0.02*	-0.01	0.03*	0.04	0.02*
LNURBAN	-0.10***	-0.10***	-0.10	0.01	-0.01	-0.02
LNLAKES	-0.07***	-0.07***	-0.06	0.16***	0.16***	0.15***
LNCAMP	-0.04**	-0.05***	-0.05	-0.03	-0.07	-0.07
LNWATERSHED	-0.02***	-0.02***	-0.03	0.13***	0.15***	0.11***
ρ	0.52***	0.51***	0.47***			
λ	0.36	0.36	0.40	0.37	0.39	0.39
McElroy R^2	0.51	0.51	0.51			
Residu. Corr	0.12**	0.13**	0.14**			
N			1,885,059			

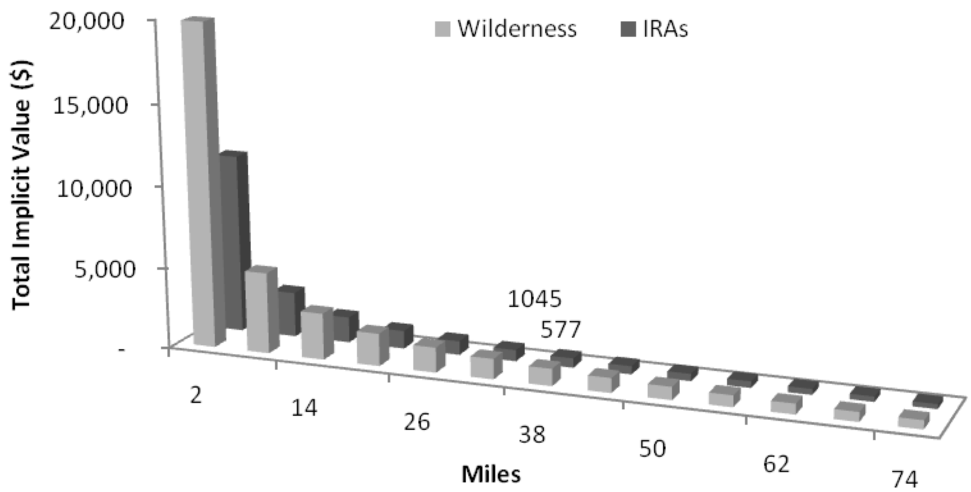
*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table 3.7: Total Implicit Values ($)

		$\partial P/\partial Q$	$\partial HHINC/\partial Q$	Total Implicit Price (P_Q)
IRAs		-620	74	-694
WILD		-777	261	-1,039
FOREST		-1,579	322	-1,901
LAKES	IRAS Model	-8,020	2,517	-10,537
	WILD Model	-8,719	2,652	-11,371
	FOREST Model	-6,508	2,567	9,075
WATERSHED	IRAS Model	-502	396	-896
	WILD Model	-456	444	-900
	FOREST Model	-557	323	-880

Figure 3.1: Change in Total Implicit Prices per Mile





Chapter 4

Public Support for Expanding Health Care Coverage in New Mexico

4.1 Introduction

With the passage of the Affordable Care Act (ACA), states will be tasked with implementing the Act at a time in which their resources have been severely hurt by the current global recession. Consequently, state may need to generate revenue to effectively expand access to health insurance in their borders. This paper examines whether the payment vehicle (e.g., increase in state tax or increase in premiums) for generating revenue from the public has an effect on people´s willingness to pay to expand health care coverage to the uninsured in New Mexico.

The increasing number of individuals lacking health insurance has been one of the most challenging issues facing health policymakers in the United States (U.S.). A growing number of studies have linked the lack of health insurance with negative health outcomes. These studies reveal two general themes: a strong correlation between uninsured status and mortality rates (Wilper et al. 2009), and high rate of community-level uninsurance with negative spillover effects on health care access and unmet medical needs for the insured population (Pauly and Pagan 2007). While the American public shows considerable support to the idea that the first step to overcoming this negative trend is a significant overhaul of the current health care system, the majority of Americans oppose higher taxes or premiums to finance it (The Kaiser Family Foundation 2009a; Kessler and Brady 2009). Not surprisingly, one of the most discussed issues of the current (and past) health care reform debates has been its financial aspects (The Kaiser Family Foundation 2009b; Berenson et al. 2009).

The recent debate that concluded with President Obama signing into law the Affordable Care Act (ACA) has shown the difficulty to come up with a viable strategy for funding comprehensive coverage that achieves majority support.[57] This Act is estimated to provide coverage to an additional 32 million uninsured individuals by 2019 (The Kaiser Family Foundation 2011). Two of the most salient aspects of the reform are the requirement that individuals either maintain minimum health insurance coverage or pay a penalty in the form of a tax (e.g., individual mandate) and the expansion of Medicaid to individuals that were previously not eligible. One year after ACA became law public support for such a reform is still significantly divided (42% in favor and 46% against, The Kaiser Family Foundation, 2011). Nationwide, the debate over the ACA involves questions about the constitutional validity of the act as well as the additional costs that such a reform will impose on states' budgets.

At the forefront is the fiscal impact that ACA may have on state budgets given their current level of deficit. The rapid increase in health care costs in the U.S. in the last thirty

[57] The Affordable Care Act consists of three pieces of legislation that include the Health Care and Education Reconciliation Act of 2010 (H.R. 4872), the Patient Protection and Affordable Care Act, and the Health Care and Education Reconciliation Act of 2010. Together, these laws are commonly known as the Affordable Care Act (ACA).

years has been cited as one of the main reasons for the need to reform the health system.[58] In 2008, total health care expenditure per capita was $7,538, the highest among Organization for Economic Co-operation and Development (OECD) nations.[59] Yet, recent estimates show that the impact of ACA on a state's ability to realize health care savings significantly varies (The Kaiser Family Foundation 2011).[60] One of the main reasons that explain this variation is the size of a states' uninsured gap.[61] While nationally this gap is on average 7.7 percent, it varies widely across states (The Kaiser Family Foundation 2011). At the national level, five different reports show mixed results as to whether the ACA will generate net savings. Two reports show new costs between $20 billion (The Congressional Budget Office (CBO)) and $21.2 billion (Holahan and Headen, Urban Institute) and the other three reports project net savings ranging from $33

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[58] As of 2008, health care spending represented 16 percent of gross domestic product (GDP) or $2.2 trillion compared to 9 percent in 1980 (The Kaiser Family Foundation, 2011).

[59] This number is $2,535 dollars, or 51%, higher than Norway, the next largest per capita spender. The average health care expenditure per capita for the 15 OECD nations is $3,944.

[60]The ACA follows in many aspects the Massachusetts (MA) health care reform law enacted in 2006. Since then, the insured rate in MA has increased to 98 percent. However, this reform has not been able to curb the rise in health care costs in this state, for which it is closely monitored at the national level (SOURCE).

[61] The uninsured gap refers to the percentage of individuals under 65 years old that are uninsured and income eligible under the ACA.

billion (Centers for Medicare and Medicaid Services (CMS) to $106.8 (Lewis Group). As a result, the current economic recession has brought numerous concerns about the feasibility of such a plan as well as lawsuits across the nation.

While the lack of health insurance is a major national issue in the U.S., affecting nearly one-fifth of the adult population, it is not uniformly distributed across the states (Pagan and Pauly 2007). New Mexico (NM) is a "majority minority" state that has relatively low household income and a high rate of health uninsurance.[62] In this state, the uninsured gap is approximately 12.1 percent compared to 7.7 percent for the entire nation.[63] As a result, NM may experience little or no net savings once the ACA is fully implemented.[64] Reductions in necessary payments for uncompensated care may partially offset some of these costs (Dorn and Buettgens 2010). Yet, states like New Mexico may need to find other sources of revenue to cover the costs of increasing enrollment in Medicaid, given its high uninsured gap.

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[62] In 2008, Governor Bill Richardson, unsuccessfully try to secure a majority support in the legislature for his "*Health Solutions New Mexico*" plan to expand insurance coverage to all New Mexicans, largely due to the estimated costs associated with such a reform (Baker 2008). As a result, whether voters would financially support a universal health plan in New Mexico has yet to be determined.

[63] In 2010, the total number of individuals under 65 earning up to 138% of FPL is 238,200. Based on a total population of 1.97 million, this represents 12.1 percent.

[64] Texas, the state with the highest uninsured rate in the nation, has an uninsured gap of 11.4 percent. Given this high gap, this state is estimated to incur new costs of 27 billion (The Kaiser Family Foundation 2011).

In light of this, this study seeks to inform the ongoing health care debate by investigating whether a health care reform to provide health care coverage to all New Mexicans financed with higher taxes or premiums is politically viable in New Mexico. Given the desire to provide universal health coverage but the reluctance to pay higher taxes at the national level, would a state-based reform receive a majority support from New Mexicans?

To address this question, a survey-based stated preference approach, known as the contingent valuation (CV) method, is implemented. This survey-based, stated preference study uses a hypothetical public referendum format for eliciting household voting responses, and estimating willingness to pay (WTP) for expanding health care coverage in NM. The experimental design includes split-sample treatments for evaluating: (i) two alternative payment vehicles (increases in either state and local taxes or insurance premiums); and two categorically nested goods (basic health care [the inclusive good] or primary health care [the subset good]). Basic health care is defined to cover prescription drug coverage, and preventive care including access to the services of a primary care provider, while primary health care is defined to only cover access to the services of a primary care provider. The reason for choosing a health care reform plan in which individuals would get insurance from either the employer or an insurance company as opposed to a government option (e.g., a public option), is to reflect what has been proposed by Governor Richardson (New Mexico Human Services Department, 2007).

With respect to the split-sample treatments, results show: (i) evidence of scope sensitivity (Carson and Mitchell 1995), as a measure of validity; (ii) that the type of payment vehicle matters in this health policy context, as increases in state and local taxes are preferred to higher insurance premiums; (iii) consistent with the accumulating body of evidence from CV meta-analysis (Little and Berrens 2004), WTP results are also shown to be highly sensitive to how response uncertainty is handled; (iv) while results provide evidence that households are willing to pay an important amount for the expansion and provision of health care to the uninsured in NM (annual household median WTP for basic care is $169 and $126 for primary care), a state "universal" health care plan would not achieve majority support among New Mexicans, once response (un)certainty and costs for such a reform are taking into account. These results are broadly consistent with those found at a national level in Kessler and Brady (2009) and The Kaiser Family Foundation Health Tracking Poll.

4.2 Background and Current Policy Debate

On March 23, 2010, President Obama signed into law the Affordable Care Act, one of the most significant health care reform legislation of the last twenty years. There are two main vehicles through which this reform is expected to reduce the number of individuals lacking health insurance: individual mandates and expansion of public programs such as Medicaid. Under this act, the individual mandate clause is termed "minimum essential coverage" and requires U.S. citizens and legal residents to obtain health coverage or pay a tax penalty starting in 2014.[65] In addition, Medicaid eligibility

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[65] The tax penalty is scheduled to be $95 in 2014, $325 in 2015, and $695 in 2016. After 2016, this penalty will be increased annually by the cost-of-living adjustment (The Kaiser Family Foundation 2011).

will be expanded to individuals under the age of 65 (including adults without dependent children) with incomes up to 138 percent of the Federal Poverty Line (FPL).[66]

An intense legal debate has followed the enactment of ACA. A number of states have filed lawsuits mainly focusing on two issues: the constitutional validity of the minimum essential coverage clause and the burden of expanding Medicaid coverage on the states' budgets. As of this writing, twenty separate legal challenges have been filed but in only two cases judges concluded that the individual mandate exceeds constitutional authority.[67] In terms of Medicaid expansion, legal litigations cited that this clause violates the U.S. Spending Clause as the Act "significantly expands and alters the Medicaid program to such an extent [states] cannot afford the newly-imposed costs and burdens" (U.S. District Court for the Northern District of Florida 2011). It is worth noting that under the ACA the costs that the states will incur to enroll newly eligible individuals to the Medicaid program will be 100 percent funded by the federal government from 2014 and 2016. This number will decrease to 95 percent in 2017 and 90 percent in 2020. Both of these reforms will become effective in January 2014.

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[66] While most of the changes will take effect in January 2014, a number of significant provisions have taken place during 2010. These include the prohibition to drop customer with chronic conditions and the requirement to offer coverage to dependents under the age of 26.

[67] On December 13, 2010, Judge Henry E. Hudson of the Eastern District of Virginia ruled that Congress exceeded its powers when it enacted the mandate clause. On January 31, 2011, Judge Roger Vinson of the District Court for the Northern District of Florida also concluded that this requirement is unconstitutional.

While this new federal funding for expanding Medicaid is significant, states may still face high costs after 2020. Based on a 10 year study for the state of Texas (TX) that goes from 2014 to 2023, Bovbjerg et al. (2011) project that this state may not actually experience net savings but additional costs of $27 billion. One of the main reasons is the high uninsured gap that TX will be required to close under the ACA (11.4 percent). Given that the uninsured gap for NM is 12.1 percent, the costs of expanding Medicaid may outweigh the savings.

At 22.8 percent, the state of NM has the second highest uninsured rate in the nation for 2007, lower only than Texas (U.S. Census Bureau 2007). As in other states, in NM health insurance (which does not refer to insurance in the classical sense but a prepayment mechanism) is heavily dependent on salary employment. Of all the New Mexicans with insurance, 54 percent have private health insurance (split as 47.9 percent employer-based and 6.1 percent individual insurance) and 30 percent have public insurance (split as 15.9 Medicaid, 14.1 Medicare and 16 percent other) (NMHPC 2009). However, in a state that has one of the lowest income per capita levels in the nation ($32,091 in 2008) only 51 percent of the firms offer health care benefits (AHRQ 2008; U.S. Bureau of Economic Analysis 2008). As a result, among the adult population (between 19 and 64 years of age) the number of individuals lacking health insurance totaled 346,800 or 29.9 percent in NM compared to 19.7 percent for the U.S. in 2007 (Current Population Survey 2007). In this context, uninsured New Mexicans have relied primarily on private community clinics and public health offices for medical services.

The major source of publicly-financed health care for the uninsured in NM is the County Indigent Funds (CIF) (NMHPC 2009).[68]

In an attempt to address the growing number of uninsured New Mexicans, Governor Bill Richardson made health care reform a continuing priority, including the primary initiative of his 2008 legislative agenda (before the more recent economic downturn). The Health Coverage for New Mexicans Committee (HCNMC), appointed by the Governor, issued a report that highlighted three strategies to achieve health care coverage for all New Mexicans that are a mix of market-based reforms and mandates (New Mexico Human Services Department, 2007).[69] However, his health care reform never achieved majority support in the Democratic-controlled New Mexico Legislature in 2008. Among many reasons, the financial costs for such a reform have been a major obstacle for gaining support (Baker 2008). Consequently, despite being a major focus of the 2008 NM legislative session - health care reform was essentially absent from the 2009 legislative session, even though some changes were made to Medicaid and SCHIP and other public health services programs as a result of this session (Childress 2009). The new health care

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[68] In 2009, total CIF revenues were $91 million (primarily from gross receipt taxes) and expenditures were 86 million (NMHPC 2009).

[69] These comprehensive plans, along with other recommendations by the HCNMC, were presented by Governor Richardson during the 2008 legislative session. Several states have created Health Reform Commissions, appointed by their Governors, that are in charge of evaluating and creating reports on possible coverage expansion plans, including Illinois, Colorado, Louisiana, Maine, North Carolina, New Jersey, Oregon, Vermont, Virginia, and Wisconsin.

federal reform represents a significant boost towards comprehensive coverage. However, there is still a high degree of uncertainty about the final version of the health care law and its impact on states' budgets.

Against this backdrop, improved understanding of the support that an expansion of basic or primary health care would receive from New Mexicans can provide important input to health policymakers in this state, and may offer insights for policy debates in other states.

4.3 Survey Design

There remains ongoing debate over whether stated preference surveys should be applied to inform policymakers on health-related issues (and for other applications to public good provision), and persistent concern over minimizing potential hypothetical bias (Champ et al 2009; Little and Berrens, 2004). Yet, continued exploration and applications of stated preference approaches can help us better understand and systematically elicit patients' and the public's health care preferences (Birch and Donaldson 2001; Smith 2000; Mataria et al. 2004; Weimer et al. 2009). A rapid and growing number of empirical papers have applied survey-based, stated preference approaches, such as the CV method, to estimate willingness to pay (or be paid) measures for changes in health- related goods or policy programs (e.g., Luchini et al. 2003; Olsen and Smith 2001; Smith 2003). While many of these studies have focused on estimating WTP for a specific set of medical treatments or programs (Whynes et al. 2003; Greenberg 2004; Pinto-Prades et al. 2007; Weimer et al. 2009), only a few have attempted to assess WTP for providing extended health care coverage, either in the U.S. and elsewhere. For instance, Kessler and David (2009) in the U.S., Berrens et al. (1999)

in the U.S. (New Mexico), Dror et al. (2007) in India, and Lofgren (2008) in Vietnam provide examples of recent CV studies that assess WTP for health care coverage. Taken generally, these studies provide evidence that households are willing to pay significant amounts for the expansion and provision of health care to the uninsured.

To assess the public's support for expanding health care coverage in NM, the survey included a number of questions that capture the respondent's views on the current state of the health care system in NM and the importance of developing programs to cover unmet needs for health care. The first part of the survey contains attitudinal and general knowledge questions that focus on the problems currently facing the U.S., the role of the government, and the current state of the health care system. The second part focuses on specifics aspects of the health care policy debate and on the valuation component of the survey that addresses the expansion of either basic health care or primary care coverage. This part presents the valuation scenario, the actual advisory referendum question to estimate the respondent support for expanding heath care coverage and a follow up question to address valuation response uncertainty. The final section of the survey included follow up health and demographic questions.

In the valuation component of the survey, a split-sample treatment was used to assess public preferences for health care expansion. Half of the randomly selected respondents were presented with an advisory referendum question and randomly assigned payment amount for expanding basic health care; while the other half were presented with an advisory referendum and randomly assigned payment amount for expanding primary health care. The payment vehicle to fund access to health care coverage in NM was also randomly assigned and took the form of either (i) increased state and local taxes, or (ii) increased insurance premiums. The split-sample design alleviates potential ordering effects (Bateman 2004; Randall et al. 1981).

The valuation section began with these following instructions to the respondent:

> *Regardless of your position on health care reform, I would like to know how much money your family would be willing to pay to cover some of the unmet needs for basic health care in New Mexico. Remember, I am not asking you for money and am not trying to sell you anything. I am only trying to find out whether different households place different values on health care. There are no right or wrong answers to these questions. Your opinions are important and can help set state priorities. Please keep this in mind as you answer the following questions.*
>
> *Also, as you answer the questions, please keep in mind that any dollars your household contributes for expanding public programs to cover some unmet needs for basic health care in New Mexico would not be available to spend on other things that you or your family might otherwise choose, such as charities, environmental programs, groceries, or car payments.*

Then, each respondent was asked the following advisory referendum question (VOTE):

> *If it would cost your household <**$PAY**> dollars per year <**PAYMENT VECHICLE**>, would you vote Yes or No on a state referendum for a program that guaranteed <**HEALTH CARE COVERAGE**> for all New Mexicans?*
> YES________ NO________

Payment vehicle (PAYMENT VEHICLE) refers to an increase in either state and local taxes or increase in premiums while health care coverage (HEALTH CARE COVERAGE) takes the form of either basic health care (inclusive good) or primary care (subset good).[70] Hereafter, the basic care and primary care treatment levels are denoted as BASICARE and PRIMCARE, respectively, for the health care coverage (HCC) good offered. The dollar payment amounts (PAY) were randomly assigned to each respondent

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[70] To review, basic health care is defined to cover prescription drug coverage, and preventive care including access to the services of a primary care provider, while primary health care is defined to only cover access to the services of a primary care provider.

from the following set of values: $PAY Є {10, 25, 50, 75, 100, 150, 200, 250, 500, 750, 900, and 1000}.

After this question, additional follow-up questions were included to assess the certainty level of responses to the valuation question. In particular, survey participants were asked about their level of certainty to the voting response given on the referendum question using a scale from zero to 100, where zero meant that an individual would not vote as stated on the hypothetical referendum and 100 completely certain that the individual would vote as stated on the hypothetical referendum (Berrens et al. 2002). The follow-up (un)certainty question asked was:

> *Suppose that next week a state referendum actually would take place on implementing a program that guaranteed <**HEALTH CARE COVERAGE**> for all New Mexicans at a cost of <**$PAY**> dollars more per year < **PAYMENT VECHICLE** > On a scale from 0 to 100, where 0 means that you are certain that you would not vote <**YES (NO)**> and 100 means you are certain that you would vote <**YES (NO)**>, how certain are you that you would actually vote <**YES (NO)**>?*

Although sometimes scaled differently (e.g., Loomis and Ekstrand 1998), similar questions have been used in a variety of uncertainty response-calibration approaches in a number of recent CV studies (e.g., Berrens et al. 2002; Li et al. 2009; Vasquez et al. 2009; Norwood et al. 2008).

A number of comparisons of hypothetical responses versus real economic behavior provide evidence and support for including a simple follow-up question to assess response (un)certainty (Blumenschein et al. 2008; Blumenschein et al. 2001; Johannesson et. al 1999). Moreover, although there remains uncertainty on the exact threshold level, given a scale from zero to 10, recoding Yes responses based on the condition of at least an eight has been shown to mitigate hypothetical bias (Vossler et al. 2003; Champ et al. 2009).

While there is still much we don't know about controlling for hypothetical bias, in a recent meta-analysis of hypothetical-versus-real comparisons, Little and Berrens (2004) show that use of a public good referendum elicitation format, and controlling for response uncertainty can both significantly reduce potential upward hypothetical bias.

4.4 Theoretical and Empirical Framework

In this section, a utility-theoretic framework is presented for consumer responses to health care coverage expansion in NM. Assuming that V(P, W, HCC, Y) is the indirect utility function, the household's maximum WTP for a change in health care coverage, HCC in NM (e.g., either BASICARE or PRIMCARE) can be shown implicitly as the income adjustments that hold household utility constant at some reference level (e.g., V_0):

$$V_0(P, W, HCC_0, Y) = V_0(P, W, HCC_{BASICARE}, Y\text{-}WTP_{BASICARE}) = V_0(P, W, HCC_{PRIMCARE}, Y\text{-}WTP_{PRIMCARE}) \quad (4.1)$$

where P is a vector of prices for other goods, W represents household characteristics, HCC_0 represents the status quo health care coverage, $HCC_{BASICARE}$ represents increased health care coverage by expanding basic health care, $HC_{PRIMCARE}$ represents increased health care coverage by expanding primary health care, and Y is household income. Therefore, $WTP_{BASICARE}$ and $WTP_{PRIMCARE}$ represent the income adjustment (a decrement in this case) that leaves a household just as well off after the change as before it, for an increment in basic and primary health care, respectively.

In order to obtain the empirical estimates of WTP for expanding health care coverage in New Mexico (e.g., $WTP_{BASICARE}$ and $WTP_{PRIMCARE}$), this study applies Cameron's (1988) censored logistic regression approach. This technique allows for directly estimating WTP models based on referendum voting data. While an individual's vote to a proposed health care expansion plan is not directly observed in the referendum format, it is expected that a YES vote to the referendum question will be given as long as the $LNWTP_{BASICARE}$ or $LNWTP_{PRIMCARE}$ amount is greater or equal to the payment amount in its logarithmic form (LNPAY) presented to the survey participant. If this is not the case, a NO vote is expected to be given (e.g., does not support the proposed health care expansion plan). The individual's voting response can be inferred though a discrete variable Z, such that:

$$Z = 1 \text{ if } LNWTP_{BASICARE} \text{ or } LNWTP_{PRIMCARE} \geq LNPAY\text{; 0 otherwise,} \tag{4.2}$$

where PAY is the randomly assigned payment amount, or censoring threshold, that varies across the different respondents. In this context, referendum data are used to estimate the probability that $LNWTP_{BASICARE}$ or $LNWTP_{PRIMCARE}$ is greater than LNPAY or equivalently, $P(Z = 1) = P(LNWTP_{BASICARE} \text{ or } LNWTP_{PRIMCARE} \geq LNPAY)$ (Cameron 1988). Assuming a standard logistic distribution, equation (4.2) can be rewritten in terms of probability of a YES vote as follows:

$$\begin{aligned} P(Z = 1) &= P(LNWTP_{BASICARE} \text{ or } LNWTP_{PRIMCARE} \geq LNPAY) = \\ &P(X\beta + \varepsilon \geq LNPAY) = P(\varepsilon/K \geq LNPAY/K - X\beta/K) \end{aligned} \tag{4.3}$$

where K is a scaling factor of the logistic function, given by $K = (b\sqrt{3})/\pi$ and b the standard error. The log-likelihood function used to estimate this probability is:

$$\log L = \Sigma(1 - Z)[(LNPAY - X\beta)/K] - \log\{(1 + \exp[(LNPAY - X\beta)/K)] \tag{4.4}$$

A significant advantage of working with referendum data is that a researcher can estimate the β and the K coefficients separately (Cameron 1988).

Alternatively, to account for response uncertainty, the follow-up (un)certainty question included in the survey can also be used to recode the responses to the referendum question (Berrens et al. 2002; Li et al. 2008; Vasquez et al. 2009). In the context of this survey, a respondent had to indicate a certainty level (CERT) to the response given in the referendum question based on a numerical scale that goes from zero to 100, where zero meant that an individual would not vote as stated on the hypothetical referendum and 100 completely certain that the individual would vote as stated on the hypothetical referendum. In particular, if the respondent's certainty level is less than a threshold value of certainty (CERT*), where CERT* Є {70, 75, 80, 85}, then his response is re-coded from a YES vote to a NO vote. Therefore, a variant of equation (4.2) is as follows:

$$Z' = 1 \text{ if } Z = 1 \text{ AND CERT} \geq \text{CERT*}; Z' = 0 \text{ otherwise.} \quad (4.5)$$

With this re-coded data, the log-likelihood function in equation (4.4) can be applied to equation (4.6) by assuming that the error term follows a logistic distribution.

Finally, for the estimation results for the WTP models with and without certainty correction, this paper relies on calculation of a median WTP measure. In addition to its majority rule interpretation in a referendum context, this measure is typically a conservative estimator and more robust than mean WTP estimates, which can be highly sensitive to outliers and the distribution of YES responses (Imber et al. 1993; Harrison and Kristrom 1996).

4.5 Sample Data and Hypotheses

Building from the original survey design used in Berrens et al. (1999), this study uses data from a statewide random-digital telephone survey sample. The survey was conducted between October 12 and December 13, 2007, and included 1,076 complete and 182 partial interviews. The overall survey response rate was 53 percent and the cooperation rate was 63 percent.[71] The University of New Mexico Institute for Public Policy (IPP) Survey Research Center used a computer assisted telephone interview (CATI) system to conduct the telephone surveys.[72] Standard protocols included 10 call attempts per random-digit dialing (RDD) number, respondent appointment tracking and follow-up, and reluctant respondent persuasion where necessary.

Table 4.1 presents definitions and weighted descriptive statistics of the dependent and independent variables used to estimate the WTP model outlined in equations (4.2) and (4.5), for the referendum with no certainty correction and referendum with certainty corrections.[73] The dummy variables CERT70, CERT75, CERT80, and CERT85 are used

71 Cooperation rate is the number of completed interviews divided by the number of contacted eligible respondents. In this case, an eligible household was an individual who was 18 years of age or older. Final disposition rates were calculated using the American Association for Public Opinion Response Rate calculator (AAPOR 2003) using Response and Cooperation Rate 3.

72 The IPP is fully compliant with federal requirements pertaining to human subjects research protections protocols.

73 To account for the presence of potential sample bias in this telephone survey, where only households with phone lines could potentially be selected while the information

to estimate the effect of response (un)certainty on WTP. The effect that a change in the scope of health care expansion has on individuals' WTP is measured by the dummy variable BASICARE (e.g., basic health care [inclusive good] vs primary health care [subset good] proposals). The dummy variable TAXES captures the effect that the payment vehicle through which a health care expansion plan is financed has on WTP (e.g., increase in state and local taxes vs. increase in insurance premiums).

The variables PROGIMP and PROVISION are included to measure the effects of households' perception about the importance of affordable health care programs, and health care provision on WTP for expanding health care. The respondents' characteristics include AGE, AGESQ, INCOME, ethnicity (WHITE, HISP, OTHERACE), employment status (EMPSTAT), political ideology (IDEO), and voting registration status (REGVOTE). To capture the effect that a respondent's health status has on WTP, two variables are included: BMI, PERCEHEALTH. The former (BMI) is used as a proxy for a respondent's actual health condition as opposed to a respondent's perceived health

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from those without phone lines is not gathered, two types of weights are used: adult weight and demographic weights. The adult weight applied to the survey data is:

[7] Adult weight = (Number of adults 18 and over in home i)/ (number of phone lines in home i)

In addition, four different demographic weights are employed to better reflect the population distribution in New Mexico: Ethnicity/race, income, gender, and age.

status (PERCHEALTH) based on a scale ranging from 1 (poor) to 4 (excellent). The dummy variable COVERAGE estimates the effect of having health insurance on WTP.[74]

In addition to estimating WTP of a representative household to expand health care coverage in NM, this paper is structured around four specific hypotheses regarding the household support for such a program. The first hypothesis pertains to the notion that support for expanding health care coverage is conditioned on the dollar amount individuals are faced with paying. In particular, ex-ante the expectation is that the greater the dollar amount the lower the probability of a YES vote, which translates to a positive scale parameter (since K is the negative inverse of the payment amount (PAY) coefficient in a logit model). Against the null hypothesis of no effect, the test is:

H_1: $K > 0$.

The expectation is that the alternative hypothesis (H_1) would be accepted and therefore, that the variable PAY would have a negative effect on the probability of voting YES on the referendum question. This also represents a basic construct validity test for DC or referendum data (Cameron 1988).

The second hypothesis is based on the premise that the type of payment vehicle utilized to expand health care coverage will have a significant effect on the respondents' WTP. In particular, two payment vehicles are considered in the survey: raise state and/or local taxes or increase insurance premiums. In the estimated model, this enters as a dummy variable (TAXES = 1 if increase in state and local taxes; 0 = increase in

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[74] A series of t-tests suggest that there are no statistically significant differences between the independent variables' means for both the basic care and primary care samples.

insurance premiums). The expectation is that WTP amounts under a state and/or local tax increase would be higher than that under an insurance premium increase as evidenced by a recent Health Tracking Poll (The Kaiser Family Foundation 2009a). Against the null hypothesis of no difference between these two payment vehicles, the test is:

H_2: $\beta_{TAXES} > 0$

To further inform the current health care reform debate, this study presents a test of scope sensitivity. Following Bateman et al. (2008), the non-parametric Wilcoxon-Mann-Whitney test is used to assess whether median WTP for the inclusive good (basic health care) is at least equal to that of the subset good (primary care). Standard economic theory suggests that the WTP for the inclusive good (basic care) should be no less (e.g., not necessarily higher) than that of the subset good (primary care) (Bateman et al. 2008). Therefore, the expectation is that respondents are sensitive to the different dimensions of health care expansion being valued:

H_3: $WTP_{BASICARE} \geq WTP_{PRIMCARE}$

A rejection of H_3 would indicate that the WTP values derived by the CV method are inconsistent with economic theory and thus exhibit anomalous preferences (Bateman et al. 2008).

This paper also evaluates the effect that response (un)certainty has on WTP estimates based on the voting response re-coding using the follow-up uncertainty question. In particular, it is expected that the following ordering of the median WTP estimates will hold:

H_4: $WTP_{No\ Certainty\ Correction} > WTP_{CERT70} > WTP_{CERT75} > WTP_{CERT80} > WTP_{CERT85}$

Since the percentage of YES votes decreases with higher certainty threshold levels, WTP is expected to be lower as we move from $WTP_{No\ Certainty\ Correction}$ to WTP_{CERT85}. In this case, we are examining not only whether this ordering holds but also the whether the differences in WTP among these certainty-corrected WTP estimates are statistically significant (Li et al. 2009).

4.6 Empirical Results

Table 4.2 provides a summary profile of the characteristics of the survey respondents, appropriately weighted to account for sample bias that may arise in part due to the survey being conducted via the telephone. Despite the exclusion of households without a telephone, the survey profile corresponds quite well when compared to the 2007 American Community Survey (ACS). The majority of the respondents had an associate or higher degree with a reported median annual household income of $45,000 compared to $42,102 reported in the 2007 ACS, respectively. The majority of the respondents with health insurance were satisfied with their coverage (43 percent “Excellent,” and 42 percent “Good”), which corresponds generally with how most Americans feel about their insurance coverage at a national level (The Kaiser Family Foundation 2009d).

Econometric results for a set of referendum models, with varying levels of (un)certainty recoding are presented in Table 4.3. The five separate WTP models are: referendum WTP with no certainty correction (Model 1); referendum WTP with CERT higher or equal to 70 percent (Model 2); referendum WTP with CERT higher or equal to 75 percent (Model 3); referendum WTP with CERT higher or equal to 80 percent (Model 4); referendum WTP with CERT higher or equal to 85 percent (Model 5). As an indicator of the overall goodness of fit and the validity of the fitted WTP models, the McFadden R^2

values ranges between 0.23 and 0.34. Further, across the set of models, the estimated coefficients on all the significant variables have the expected signs. While the results in Table 4.3 show an important degree of robustness across these models, there are considerable differences in WTP estimates.

A number of significant statistical determinants of WTP can be identified. In terms of explanatory variables, the estimated coefficient on the scale parameter (K) is statistically significant (0.01 level) across the different re-coding levels, implying that respondents are sensitive to the price (Cameron 1988; Whitehead 1995). The positive sign indicates that the support from New Mexican households for expanding heath care services decreases as the payment amount they are required to pay to accomplish this goal increases; thus, the evidence supports hypothesis H_1. The payment vehicle (TAXES) is positive and statistically significant across all the recoding levels. This suggests that the median WTP levels associate with a tax increase is higher than that of an insurance premium increase (e.g., the base case in these models); thus, the evidence supports hypothesis H_2.

A number of other explanatory variables that represent socio-economic status also influence median WTP. The estimated coefficient on the attitudinal variable PROGIMP (respondent's perceived importance that affordable programs be provided to cover unmet needs for health care), is positive and statistically significant (0.01 level). The more important a respondent's belief that affordable programs need to be provided to cover unmet health care needs, the higher the WTP. In particular, results suggest that the top priority includes those individuals with preexisting conditions (COVERPREX) and uninsured children (COVERKIDS). The estimated coefficient on INC, household income level, is positive and statistically significant (0.01 level). This indicates that the expansions in health care coverage evaluated here are normal goods (e.g., the median WTP for both services increases as income increases) (Whitehead, 1995). The AGE variable indicates that the older the individual the lower the dollar amount willing to pay to expand health care coverage. Age squared (AGESQR) shows that the relationship between age and WTP is linear, implying that the decrease in WTP is constant with respect to age.

Further, the political variables have the expected sign: the coefficient on voter registration (VOTEREG) is positive, but only significant in Model 1 (no certainty correction) and Models 2 and 3 (CERT 70 and CERT75). The variable IDEO is negative and significant across the different re-coding levels. Thus, as expected, the more liberal a respondent is the greater the median WTP for a given increment of basic health care or primary care. The effect of race/ethnicity on median WTP is statistically insignificant across all the (un)certainty assumptions. That is, in this "majority minority" state, we observe no race/ethnicity effects for expansion of health care coverage.

The estimated coefficient on CVPOLICY is positive and significant (0.01 level). This indicates that respondents who believe that a CV survey method is a good way for policy makers to inform choices about health care coverage in NM, the higher the annual median WTP for the given increment in basic and primary health care. A strong majority of the sample indicated that asking WTP questions is a suitable instrument to inform NM health care policy (mean value for CVPOLICY is 78 percent). This provides some modicum of support that the hypothetical referendum satisfies Carson et al. (2000) validity criterion of being a "consequential" CV survey question. Thus, respondents are likely to perceive the hypothetical referendum question as a unique opportunity to reveal their preferences, minimizing the probability of strategic behavior.

Using primary health care coverage expansion (e.g., BASICARE = 0) as the base case, the estimated coefficient for BASICARE is positive across all models and statistically significant in Models 3, 4, and 5 (CERT70, CERT80, and CERT85, respectively). This provides evidence for the scope test that $WTP_{BASICARE}$ is higher than $WTP_{PRIMCARE}$ (e.g., hypothesis H3).

Based on these estimated coefficients, the annual median WTP values for each health care coverage expansion with the corresponding 95 percent confidence intervals are reported in Table 4.4. The median WTP values decrease as the (un)certainty threshold level (CERT*) increases, thus evidencing that re-coding provides increasingly conservative estimates of the median WTP for both health care expansions. The highest median WTP estimates, $942 for BASICARE and $819 for PRIMCARE, is observed in Model 1, which does not take account of any preference uncertainty. For the (un)certainty re-coded models, median WTP values for BASICARE ranges from $447 (CERT70) to $128 (CERT85) compared to $320 (CERT70) to $71 (CERT85) for PRIMCARE.[75]

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[75] In the study most closely related to our own (and upon which the current survey builds), Berrens et al. (1999) used a statewide telephone survey in NM (n = 3,179), and a public good referendum format to estimate households' annual WTP to provide increased coverage for basic health care. In particular, nine different health service increments that compose basic health care are evaluated: eye exams, dental services, prescription drug, primary care provider, medical specialists, hospitalization, behavioral health, alternative practitioner, and home health care. Using a CV format and a split-sample design, this

Tables 4.5 and 4.6 present formal tests of hypotheses H_3 (e.g., $WTP_{BASICARE} \geq WTP_{PRIMCARE}$) and H_4 (e.g., WTP decreases as (un)certainty threshold level increases from $WTP_{No\ CertaintyCorrection}$ to WTP_{CERT85}) based on Wilcoxon-Mann-Whitney rank sum test. A number of recent studies (Bateman et al. 2008; Plott and Zeiler 2005; Olsen et al. 2004; Lee et al. 2005) have tested the statistical significance of difference across distributions using the rank-sum test. In particular, this test shows that not only $WTP_{BASICARE}$ is higher than $WTP_{PRIMCARE}$ but this difference is statistically significant across all models; thus, the evidence supports hypothesis H_3 (Table 4.5).

As other CV studies have found (Vossler et al. 2003; Little and Berrens 2004; Vazquez et al. 2009), the rank-sum test also indicates that higher (un)certainty correction criteria corresponds with lower median WTP values and that these values are statistically

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paper provides relative rankings for these nine increments based on estimated household WTP. The results show that primary care services is ranked the highest with a mean WTP of \$279 (in 2007 \$) followed by services of medical specialists (\$270), based on an 80 percent certainty correction (e.g., CERT $\geq$ 80). Based on Model 3 (CERT80), the estimated mean WTP for expanding primary care services is \$406, which represents a 45.5 percent increase in the public's valuation for such an expansion (\$406/\$279). This suggests that not only are households willing to pay for decreasing the number of New Mexicans without primary care coverage, but also that support may have increased in 2007 relative to1999. More cautiously, since there are some differences in specifications, we have no evidence that support for expansion of primary care coverage has declined since 1999 in New Mexico.

different from each other. As Table 4.6 shows, the differences in median WTP corresponds with the order outlined in hypothesis H_4. Thus, the median WTP values reported for each (un)certainty correction criteria comes from different distributions, and the ordering evidence supports hypothesis $H_{4.}$ Uncertainty corrections clearly matter in understanding this stated preference data.

4.61 Political Viability of Universal Health Care in New Mexico

To better understand the policy implications of the case study results, it is useful to assess whether providing basic health care coverage to the adult, non-elderly uninsured population (between 18 and 64 years old) financed with a state tax increase in New Mexico is politically viable (i.e., would it obtain majority support). As Table 4.2 shows, the percentage of YES responses significantly decreases as the (un)certainty threshold level (CERT*) increases. In particular, both health care coverage expansion plans would not achieve a majority support for (un)certainty levels 80 and 85 percent (e.g., CERT80 and CERT85). Using the results reported in Table 4.5 for BASICARE = 1 (e.g., basic care coverage expansion), a thought experiment is proposed where the percentage of YES responses is estimated under three different scenarios: insuring all uninsured New Mexicans, insuring half of the uninsured New Mexicans, and insuring one-quarter of the uninsured New Mexicans. Estimating the percentage of YES votes allows evaluation of whether a majority of New Mexicans (e.g. 50 percent or above) would support such a reform. In this setting, predicted WTP amounts based on equation (4.2) is compared to the tax increase that each respondent would have to sustain to achieve each of the coverage scenarios mentioned above.[76] Conditional on a YES response to the specific amount asked in the survey, a predicted YES vote for individual *i* and scenario *j* can be expressed as follow:

$$\text{Predicted (VOTE)}_{ij} = 1 \text{ if VOTE}_i = 1 \text{ AND TAXINC}_i \leq \hat{WTP_i}\text{; else 0,} \qquad (4.6)$$

where a YES response to the contingent valuation question is recoded to 1 under the different (un)certainty correction criteria, j = insuring all uninsured, insuring half uninsured, and insuring quarter uninsured; TAXINC is the amount that individual *i* would have to pay (in increase taxes) to fully cover the costs under scenario *j*; and $\hat{WTP_i}$ amounts are estimated based on the coefficients reported in Table 4.3. While VOTE_i and $\hat{WTP_i}$ are known from the survey's reported responses and the estimated models, respectively, TAXINC_i has yet to be estimated. Following the methodology in Kessler and Brady (2009), the tax increase for individual *i* is estimated as follows:

$$Tax\_increase_{ij} = \frac{\text{cost of reducing uninsured}_j}{\text{Personal income tax revenues (2006)}} * \text{average tax rate}_i \text{(2006)} * \text{household income}_i \text{(2006)}$$

where personal income tax revenues represent total income taxes collected from individuals in 2006, the *average tax rate*$_i$ is the state income average tax rate that individual *i* has to pay according to the State of New Mexico Taxation and Revenue department and household income levels are those reported by each survey respondent.[77]

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[76] We can also predict YES votes by plugging in the estimated WTP in equation (5) and estimating the percentage of YES responses. However, this would not take into account the "true" tax increase that would be required to achieve such a reform.

[77] In 2006, NM average tax rates by income brackets were:
0.018 if *household income*$_i$ < 10,000
0.033 if 10,000 ≤ *household income*$_i$ ≤ 25,000

While the costs required for extending coverage to the uninsured population in New Mexico are still unclear, this thought experiment uses the New Mexico Human Services Secretary figures presented at the 2008 NM State Legislature session: $30 million in fiscal year 2010 and additional costs of $72 million over the next five years under the Governor's plan.[78] The total costs based on these estimates are $390 million.[79] Figure 1 shows the predicted YES responses based on equation (4.7). As expected, within each coverage scenario, the percentage of YES responses decreases as the (un)certainty response-recoding threshold increases. Moreover, as the expansion coverage plan decreases from 100 percent to 25 percent of uninsured adult New Mexicans, the percentage of YES responses increases significantly. However, a slight majority support (50.7 percent) for providing coverage to all the uninsured adult population is achieved only when no vote recoding is implemented. These results suggest that public support for expanding health care coverage financed with an increase in state taxes is sensitive to

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0.046 if $26{,}000 \leq \textit{household income}_i \leq 96{,}000$
0.053 if $96{,}000 \leq \textit{household income}_i$.

Source: http://www.tax.state.nm.us/forms/year06/2006RATETABLES.pdf. In 2006, personal income tax revenues totaled $1.5 billion (U.S. Census Bureau 2006).

[78] These figures were based on a cost analysis prepared by the Mathematica Policy Research Group. However, earlier in November 2008 significantly higher estimates of $75 million in FY2010 and $333 million over the next five years were presented to the legislature.

[79] In 2006, there were 346,800 individuals between the ages of 18 and 64 without insurance in NM (Current Population Survey 2007).

both the total cost assumed for such a reform and assumption made about response certainty (i.e., threshold for vote recoding). As other studies have found at a national level (Kessler and Brady 2009)[80], this thought experiment suggests that while New Mexicans widely support a health care reform, they appear to lack sufficient political will to support financing it with higher taxes (even if they tend to prefer increased taxes to increased insurance premiums).

However, two important aspects of this analysis may underestimate the public's support for such a reform. First, while in this study the cost of expanding either basic or primary health care coverage falls entirely on the tax payers, there is the possibility that reform can be financed in part through cost savings resulted from the reform (e.g., see Chernow et al. 2009). This may actually lower the estimated cost used in this thought experiment, which would increase the support for such a reform. Second, in the contingent valuation question, respondents are asked WTP amounts to cover all uninsured individuals as opposed to certain groups. While a majority support is not achieved to cover all uninsured New Mexicans, it may be the case that a majority could be achieved if expansion of health care only included individuals with preexisting or chronic conditions. While the aggregate WTP estimate is lower than total costs for expanding coverage to all uninsured individuals, results indicate that top priorities for respondents include broadening coverage for children and for individuals with preexisting conditions. This suggests that a reasonable first step that may achieve

[80] Kessler and David (2009) also found that while Americans support some type of health care reform, they are reluctant to pay higher taxes to finance it.

majority support and reduce the number of uninsured would be to expand health coverage to people with preexisting conditions.

4.7 Conclusions

Beyond just charity motivations, because health care delivery systems may be negatively affected by high uninsurance rates (Pauly and Pagan 2007), it may be in the self interest of all households to be concerned about the most vulnerable populations. This study applied the survey-based CV method to empirically estimate the median WTP per year for expanding health care coverage to the uninsured population in New Mexico. An RDD telephone survey sample with a hypothetical referendum format for asking valuation questions, and an increase in either state and local taxes or insurance premiums as the payment vehicle for expanding health care coverage, was used to evaluate household support for two categorically-nested goods : (i) basic health care; and (ii) primary health care. Since the services offered under basic health care encompass and exceed that of primary health care, standard economic theory suggests that the WTP for the inclusive good, basic care, should be at least no less (but not necessarily higher) than that of the subset good, primary care (Bateman et al. 2008). After carefully controlling for response uncertainty and relying on a robust and conservative median WTP estimator, results how: (i) there is evidence of scope sensitivity (Carson and Mitchell 1995), as a measure of validity; (ii) that the type of payment vehicle matters in this health policy context, as increases in state and local taxes are preferred to higher insurance premiums; (iii) WTP results are highly sensitive to how response uncertainty is handled, consistent with the accumulating body of evidence from CV meta-analysis (Little and Berrens 2004); and (iv) while results provide evidence that households are willing to pay significant positive amounts for the expansion and provision of health care to the uninsured in NM, a state "universal health coverage plan" would not achieve majority support among New Mexicans, once response (un)certainty and costs are accounted for, and no matter which payment vehicle is proposed (higher taxes or increased premiums).

Results indicate that policies aimed at extending coverage to wider segments of the population will garner greater public support if they are aimed at providing residents with basic care. Yet, much of the value (approximately 75%) of extending basic care is based on primary care (i.e., access to a primary care physician), and this additional benefit would have to be considered against incremental program costs in any full benefit-cost analysis. Although clear differences emerge as more restrictive certainty level assumptions are applied, our results suggest that funds generated from increasing taxes or premiums can be rather substantial. For example, the range of the median $WTP_{BASICARE}$ drops from $942 (no certainty correction) to $128 (CERT85, and from $819 (no certainty correction) to $71 (CERT85) for the median $WTP_{PRIMCARE}$. Based on the more conservative CERT85 response re-coding model, the aggregate WTP amounts for expanding basic care and primary care are $177 million and $129 million per year, respectively. However, while such a referendum would appear to pass a benefit-cost analysis (BCA), it might fail to achieve a majority support for passing any public referendum. As other studies have found (Kessler and Brady 2009), this thought experiment suggests that while New Mexican may widely express support for health care reform, they may be collectively and politically unwilling to finance expansion to all the uninsured, with either higher taxes or increased premiums. As such, the results also suggest that an incremental approach, in the search for majority support (and presumably more political support), might be to expand health care coverage to specific segments of the population such as individuals with chronic conditions. It appears that such incremental packages would have to be carefully tailored to achieve majority public support. We leave the evaluation of specific incremental approaches to future research.

Table 4.1: Definitions and Weighted Descriptive Statistics for Variables in the WTP Models

Variable	Descriptions	BASIC +PRIMARY (N=953) Mean	BASIC CARE (N=474) Mean	PRIMARY CARE (N=479) Mean
AGE	Respondent's age	43	42	0.45
AGESQ	Age * Age	2,157	2,065	2,248
MALE	Indicator variable of gender: 0=female, 1=male	0.49	0.49	0.49
EMPSTAT	Employment status of respondent: 1=full-time, else =0	0.66	0.64	0.64
IDEO	Indicator variables of respondent's political ideology varying from 1 to 7, with 1=strongly liberal, 7=strongly conservative	3.84	3.87	3.82
REGVOTE	Indicator variable of respondent's vote registration, 1=registered to vote, else=0	0.84	0.86	0.83
HISP	Indicator variable of race: 1=Hispanic, else =0	0.41	0.42	0.40
WHITE	Indicator variable of race: 1=white non-Hispanic, else =0	0.48	0.46	0.49
OTHERACE	Indicator variable of race: 1=Native America/Black/Asian, else =0	0.11	0.42	0.40
PROGIMP	Repondent's perceived importance that affordable programs be provided to cover unmet needs for health care in NM. 0-10 scale, with 0=not at all important and 10=extremely important	8.36	8.49	8.30
TAXES	Indicator variable of payment vehicle: 1=Taxes, else =0	0.50	0.50	0.51
BASICARE	Randomly assigned health care coverage, 0=primary care provider, 1=basic health care	0.49	1	1
CHILDNUM	Number of children in the household under 17 yearls old: 1 = if children in household, else =0	0.45	0.47	0.45
BMI	Repondent's actual health status based on BMI Index, with underweight=1, obese=4	2.86	2.86	2.84

Table 4.1: Definitions and Weighted Descriptive Statistics for Variables in the WTP Models (cont'd)

Variable	Descriptions	BASIC +PRIMARY (N=953) Mean	BASIC CARE (N=474) Mean	PRIMARY CARE (N=479) Mean
PERCHEALTH	Repondent's perceived health status ranging from 1 to 4, with 1=poor, 4=excellent	3.11	3.08	3.08
CVPOLICY	Repondent's opinion on whether CV is a good way fo decision makers to make policy about NM health care: CVPOLICY = 1 if good way, else = 0	0.78	0.81	0.79
COVERPREX	Repondent's view on whether basic health care coverage should be provided to individuals with high care needs or pre-existing conditions in NM: 1 = strongly disagree, 4 = strongly agree	3.00	3.03	3.00
COVERADULT	Repondent's view on whether basic health care coverage should be provided to the uninsured adult population in NM: 1 = strongly disagree, 4 = strongly agree	2.78	2.74	2.80
COVERKIDS	Repondent's view on whether basic health care coverage should be provided to all uninsured children in NM: 1 = strongly disagree, 4 = strongly agree	3.38	3.40	2.37
COVERUNDOC	Repondent's view on whether basic health care coverage should be provided to undocumented immigrants in NM: 1 = strongly disagree, 4 = strongly agree	2.07	2.06	2.08
COVERUNEM	Repondent's view on whether basic health care coverage should be provided to the unemployed in NM: 1 = strongly disagree, 4 = strongly agree	2.78	2.76	2.78
COVEREGARD	Repondent's view on whether basic health care coverage should be provided regardless of changes in someone's health in NM: 1 = strongly disagree, 4 = strongly agree	3.01	3.04	3.03

Table 4.1: Definitions and Weighted Descriptive Statistics for Variables in the WTP Models (cont'd)

Variable	Descriptions	BASIC +PRIMARY (N=953) Mean	BASIC CARE (N=474) Mean	PRIMARY CARE (N=479) Mean
COVERAGE	Repondent's health care coverage status: 1 = continuous coverage in the past 12 months, else = 0	0.73	0.74	0.75
PAY	Randomly assigned payment amount ($2007 US), from $10 to $1000	324	326	330
VOTE	Indicator variable of respondent's voting for a health program for all New Mexican, 0=No, Yes=1	0.79	0.78	0.79
CERT	Respondent's certainty level on their referendum voting decisin, on a 0-100 scale: 0=absolutely certain to vote NO, 1=absolutely certain to vote YES	76.93	76.64	75.66
CERT70	Indicator variable of respondent's voting decision, 1=YES and CERT $\geq$ 70, else =0	0.58	0.61	0.64
CERT75	Indicator variable of respondent's voting decision, 1=YES and CERT $\geq$ 75, else =0	0.55	0.57	0.58
CERT80	Indicator variable of respondent's voting decision, 1=YES and CERT $\geq$ 80, else =0	0.49	0.49	0.51
CERT85	Indicator variable of respondent's voting decision, 1=YES and CERT $\geq$ 85, else =0	0.42	0.42	0.43
INC[1]	Annual Household Income	5.02	5.18	5.06

[1]Household income, 16 categories in $1,000s: 1=≤10, 2=$10-20, 3=$20-30, 4=$30-40, 5=$40-50, 6=$50-60, 7=$60-70, 8=$70-80, 9=$80-90, 10=$90-100, 11=$100-110, 12=$110-120, 13=$120-130, 14=$130-140, 15=$140-150, 16=≥150.

Table 4.2: Weighted Respondent Profiles

Description	Mean	Std. Dev.
White, Non-Hispanic	48%	0.49
Hispanic	41%	0.50
Other Race	11%	0.31
Associate Degree or Higher	70%	0.48
Annual Household Income ($)	45,000	39,522
Number of Children in the Household	1	1.30
Percentage of Respondents between 18 and 64 of Age	85%	0.36
Part-Time or Full-Time Employment	63%	0.76
Health Insurance (does not include Medicare)	70%	0.46
Health Care Rating (GOOD or Excellent)	85%	0.20

Table 4.3: Estimation Results, Dependent Variable = log(Unobserved WTP)

Variable	Model 1: No Certainty Correction	Model 2: CERT70	Model 3: CERT75	Model 4: CERT80	Model 5: CERT85
AGE	-0.12***	-0.12***	-0.10**	-0.10**	-0.10***
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
AGESQ	0.00***	0.00*	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
MALE	-0.19	-0.45***	-0.50***	-0.83***	-0.30
	(0.21)	(0.17)	(0.17)	(0.16)	(0.17)
EMPSTAT	0.07	-0.11	0.23	0.28	0.46
	(0.26)	(0.22)	(0.21)	(0.21)	(0.22)
INCOME	0.09**	0.25***	0.30***	0.36***	0.27***
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
IDEO	-0.13**	-0.14***	-0.26***	-0.16*	-0.17**
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
REGVOTE	0.54**	0.60*	0.85**	0.21	0.25
	(0.26)	(0.33)	(0.23)	(0.22)	(0.23)
HISP	-0.16	-0.25	-0.24	-0.25	-0.23
	(0.23)	(0.23)	(0.23)	(0.24)	(0.24)
OTHERACE	-0.05	-0.10	-0.11	-0.24	-0.22
	(0.34)	(0.28)	(0.28)	(0.27)	(0.27)
PROGIMP	0.18***	0.19***	0.27***	0.31***	0.37***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
TAXES	0.58***	0.60***	0.81***	1.42***	1.13***
	(0.23)	(0.20)	(0.19)	(0.18)	(0.19)
BASICARE	0.03	0.17	0.37**	0.38**	0.36**
	(0.20)	(0.19)	(0.16)	(0.19)	(0.18)
CHILDNUM	-0.17	-0.50***	-0.92***	-1.16***	-0.62**
	(0.23)	(0.20)	(0.18)	(0.18)	(0.18)
BMI	0.14	0.12	0.11	0.11	0.14
	(0.12)	(0.13)	(0.10)	(0.10)	(0.10)
PERCHEALTH	0.36***	0.37**	0.32**	0.55***	0.25*
	(0.13)	(0.13)	(0.10)	(0.10)	(0.10)
CVPOLICY	0.60**	0.75***	0.74***	0.58***	0.51
	(0.22)	(0.20)	(0.19)	(0.19)	(0.20)
COVERPREX	0.46**	0.67***	0.95***	0.82***	1.07***
	(0.19)	(0.25)	(0.26)	(0.29)	(0.27)
COVERADULTS	0.23	0.00	0.17	0.80***	0.83***

Table 4.3: Estimation Results, Dependent Variable = log(Unobserved WTP) (contd)

Variable	Model 1: No Certainty Correction	Model 2: CERT70	Model 3: CERT75	Model 4: CERT80	Model 5: CERT85
	(0.17)	(0.23)	(0.22)	(0.25)	(0.23)
COVERKIDS	0.16	0.66***	0.53**	0.69***	0.63***
	(0.16)	(0.21)	(0.21)	(0.24)	(0.22)
COVERUNDOC	0.09	0.00	0.14	0.08	-0.02
	(0.14)	(0.17)	(0.17)	(0.18)	(0.16)
COVERUNEM	0.54***	0.21	-0.01	0.39	0.12
	(0.17)	(0.21)	(0.23)	(0.24)	(0.23)
COVEREGARD	0.17	0.06	0.09	-0.16	-0.17
	(0.16)	(0.22)	(0.22)	(0.25)	(0.23)
COVERAGE	-0.25	-0.04	-0.10	0.09	0.14
	(0.27)	(0.21)	(0.21)	(0.20)	(0.20)
INTERCEP	4.85***	2.85**	2.12***	2.75***	2.92***
	(1.22)	(1.22)	(0.91)	(0.90)	(0.92)
k (scale parameter)	0.93***	1.52***	1.60***	1.82***	1.47***
	(0.10)	(0.07)	(0.06)	(0.06)	(0.06)
Pseudo R2	0.34	0.26	0.23	0.23	0.23

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.
( )^{a}: Standard deviation

Table 4.4: Estimated Median WTP ($)

	Median WTP	95% CI Lower Bound	95% CI Upper Bound	Median WTP as Percentage of Median Household Income
Model 1: No Certainty Correction				
BASICARE = 1	942	669	1566	2.09%
BASICARE = 0	819	626	1199	1.82%
Model 2: CERT70				
BASICARE = 1	467	314	795	1.04%
BASICARE = 0	320	221	519	0.71%
Model 3: CERT75				
BASICARE = 1	372	254	601	0.83%
BASICARE = 0	254	174	405	0.56%
Model 4: CERT80				
BASICARE = 1	186	125	285	0.41%
BASICARE = 0	127	75	208	0.28%
Model 5: CERT85				
BASICARE = 1	128	88	183	0.28%
BASICARE = 0	71	44	106	0.16%

Note: 95% confidence intervals based on Krinsky and Robb (1986) procedure with 5,000 simulation draws.

Table 4.5: Median WTP Differences (Hypothesis 3)

	$P(WTP_{\texttt{BASICARE}} > WTP_{\texttt{PRIMCARE}})$
Model 1: No Certanty Correction	$P = 0.70$ ($p_{\texttt{value}} < 0.01$)
Model 2: CERT70	$P = 0.89$ ($p_{\texttt{value}} < 0.01$)
Model 3: CERT75	$P = 0.88$ ($p_{\texttt{value}} < 0.01$)
Model 4: CERT80	$P = 0.89$ ($p_{\texttt{value}} < 0.01$)
Model 5: CERT85	$P = 0.98$ ($p_{\texttt{value}} < 0.01$)

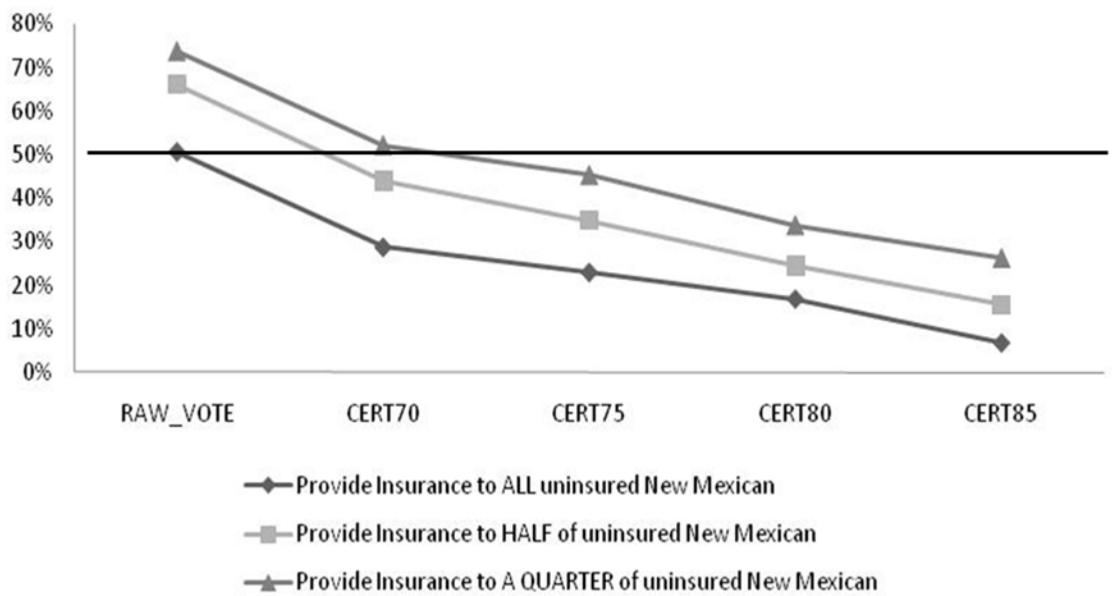
Note: Probabilities based on Wilcoxon-Mann-Whitney Test (Rank-sum test)

Table 4.6: Median WTP Differences (Hypothesis 4)

	BASICARE = 1	BASICARE = 0
$P(WTP_{\texttt{No Certanty Correction}} > WTP_{\texttt{CERT70}})$	$P = 0.98$ ($p_{\texttt{value}} < 0.01$)	$P = 0.99$ ($p_{\texttt{value}} < 0.01$)
$P(WTP_{\texttt{CERT70}} > WTP_{\texttt{CERT75}})$	$P = 0.77$ ($p_{\texttt{value}} < 0.01$)	$P = 0.78$ ($p_{\texttt{value}} < 0.01$)
$P(WTP_{\texttt{CERT75}} > WTP_{\texttt{CERT80}})$	$P = 0.99$ ($p_{\texttt{value}} < 0.01$)	$P = 0.98$ ($p_{\texttt{value}} < 0.01$)
$P(WTP_{\texttt{CERT80}} > WTP_{\texttt{CERT85}})$	$P = 0.92$ ($p_{\texttt{value}} < 0.01$)	$P = 0.96$ ($p_{\texttt{value}} < 0.01$)

Note: Probabilities based on Wilcoxon-Mann-Whitney Test (Rank-sum test)

Figure 4.1: Predicted YES Responses for Expanding Basic Health Care (Cost of Providing Insurance to all non-elderly uninsured New Mexicans: $390 million)



Chapter 5

Summary and Conclusions: Evaluating empirical evidence for allocating resources with public good attributes

The allocation of resources with public good attributes requires a careful accounting of the costs and benefits of the different allocation schemes to achieve their most beneficial and fair use. This has been the case in the policy debate for managing public forest lands and for providing health care coverage in the United States. In both cases, the challenge for policymakers is related to the fact that these goods generate benefits that are beyond those captured in their market prices. For many public lands, such as inventoried roadless areas (IRAs), the debate centers on whether to open them for development or managing them as protected areas. In the case of health care, the policy question is whether the private market results in a level of health care coverage that is lower than the efficient outcome. The presence of positive externalities has been at the center of the debate over whether universal health care is a socially optimal provision of health coverage.

In light of these debates, this work applies two methods for valuing changes in the provision of public lands and health care coverage: revealed preference method and the contingent valuation method (CVM). The former estimates offsite benefits of protecting public lands and the CVM estimates individuals' willingness to pay for expanding health care coverage.

One goal of this work has been to improve the understating of the role that forest lands and other natural amenities play in an economy. The broad hypothesis is that the role of public lands extends beyond the traditional view of inputs of production (e.g., extractive uses). The benefits that these lands may generate in their pristine status (e.g., ecosystem services) require recognition of these values to implement a proper management process of these lands. In light of petitions filed by various U.S. states to maintain the status of IRAs as roadless lands, chapters 2 and 3 report off-site benefits that these land may generate. Since these benefits represent only a portion of IRAs' total economic value (TEV) as protected lands, these values can be interpreted as lower bound estimates (Loomis and Richardson 2000; Berrens et al. 2006).[81] The results in chapters 2 and 3, suggest that the role of public forests, such as IRAs, cannot be limited to inputs of production. Using a utility theory framework, hedonic results support the hypothesis that implicit prices for forest characteristics are paid through the housing and labor markets. This suggests that the presence of natural amenities partially determines housing prices and the amount and distribution of human capital across a region. These implicit price results also provide evidence that where people live and what jobs they have is affected by natural amenities.

[81] These benefits are a component of the larger bundle of ecosystem services and non-market benefits that protected lands may offer. For instance, there may also be on-site recreation values, and passive use values that are not captured in the housing or labor markets. Loomis (1996) reviews evidence from various contingent valuation studies that passive use values may represent a significant percentage, and sometimes a majority proportion, of the TEV associated with protected forest areas in the U.S. This suggests that off-site amenity values to residents, as measured here, might represent just one of several significant components of the TEV.

The results in chapters 2 and 3 also provide further evidence on the importance of spatial considerations in non-market valuation techniques such as hedonic price functions. A recurring issue when using geographic data is the specification of spatial relationship between observations. A common assumption in hedonic analyses is that, for instance, the value of house *j* is determined only by the independent characteristics associated with that house and not the values and characteristics of neighboring homes. Two conceptual models are applied to address spatially-dependent relationships: the spatial lag and the spatial error models. In the context of the housing market, a spatial lag model assumes that one's housing price is explained by that house's structural, locational, and neighborhood characteristics. The hypothesis is that the weighted average of neighborhood's housing values partially explains the price of an individual house. In this case, the presence of a significant spatial lagged coefficient indicates that ignoring this would result in biased and inconsistent estimators. The spatial error model assumes that spatial dependence arises due to the omission of variables that are related in space. Thus, ordinary least square estimators would be unbiased but inefficient.

Chapter 2, using Census tracts as the level of observation, shows that for the State of NM, the higher the percentage of IRA lands in a census tract, the higher the value of the houses. Based on a hypothetical policy experiment, which supposed a decrease of IRA lands as protected areas in NM, on the margin, the total housing value would decrease by 3.5 percent across the state. This would suggest a population shift to other locations that would become relatively more attractive. However, and as it is the case in other studies that looked at the role of forest amenities (e.g., Hand et al. 2008), the nature of the data raise some issues. Since the geographic data used in this study pertain to census tract-defined locations, the possibility of measurement errors due to geographic aggregation bias requires careful interpretation of the econometric results. A spatial-lag model specification partially addresses this bias by allowing spatial effects among houses that go beyond those delineated by the aggregated geographic boundaries (e.g., census tracts). However, given that the size of the census tracts significantly varies upon the location (e.g., rural areas tend to be much larger census tracts compared to urban areas) creating precise distance measures to location-specific amenities would be a difficult task. For instance, disaggregating large census tracts to match smaller census tracts may change the results if the distance measure is related to the size of a census tract.

This issue is addressed in chapter 3 by using micro-level data. In this case, households are identified to points on a map as opposed to a representative agent level of observation. Since each observation represents a particular house in space (e.g., point data), precise linear distance to forest areas are calculated. In this case, the effect of natural amenities on the housing and labor markets is a function of distance instead of a function of percentage of forests. The results show that compensating differentials arise both in the housing market (e.g., the shorter the distance to a forest the higher home prices) and in the labor market (e.g., the shorter the distance to a forest the lower the wage). Given these findings, the presence of forest and other natural amenities may partially determine the amount and characteristics of human capita in an economy. In order to test for aggregation bias, a natural extension of this chapter is to estimate a hedonic model where locations are aggregated to match census tract areas and compare the results with those found here.

Chapter 4 provides further evidence of the importance of applying valuation techniques to measure the social benefits of goods with public attributes. Using a hypothetical public referendum format to elicit household voting responses and estimate willingness to pay (WTP) for expanding health care coverage in New Mexico (NM), results show mixed support for a universal health care system in NM. While such a referendum would appear to pass a benefit-cost analysis (BCA), it might fail to achieve a majority support for passing any public referendum. The suggested though experiment presented in chapter 4 indicates that while New Mexican may widely express support for health care reform, they may be collectively and politically unwilling to finance expansion to all the uninsured, with either higher taxes or increased premiums. As such, the results also suggest that an incremental approach, in the search for majority support (and presumably more political support), might be to expand health care coverage to specific segments of the population such as individuals with chronic conditions. In light of the Affordable Care Act (ACA) signed into law on March 23, 2010, the question becomes, how should the information presented here be used in the current policy debate?

One year after ACA became law public support for such a reform is still significantly divided (42% in favor and 46% against, The Kaiser Family Foundation, 2011). The current economic recession has brought numerous concerns about the feasibility of such a plan. At the forefront is the fiscal impact that ACA may have on state budgets given their current level of deficit. In a 2011 Kaiser Family Foundation (KFF) report, a five-state analysis shows that the impact of expanding Medicaid eligibility on state budgets ranges from high budgetary costs to low savings.[82] For instance, for the state of Texas (TX) this would increase costs by $27 billion compared to savings of $0.8 billion for Maryland (MD). One of the main reasons for these findings is the size of states' uninsured gap (KFF 2011). Being the state with the highest uninsured rate, TX uninsured gap is 11.4 percent of its total population compared to 5.4 percent for MD.

While the state of New Mexico was not included in this analysis, looking at the number of uninsured adults that would become eligible for Medicaid gives an idea of the impact that this may have on its budget. Since about 12.1 percent of its adult population below 138 percent does not have insurance, NM may not experience any savings by 2019.[83] In light of this, states like NM may have to finance the potential raised in budget costs by increasing state and local taxes. For policymakers, studies like the one presented in chapter 4 may reveal useful information to identify the public's willingness to pay for expanding health care coverage in anticipation of potential cost increases as Medicaid eligibility is expanded.

5.1 Limitations and Future Research

One of the main objectives of this work has been to estimate monetary values (e.g., willingness to pay) and public support for changes in the provision of resources with public good attributes. From a policy perspective, values provide a tangible and explicit

[82] The ACA law requires that nearly all individuals under 65 earning up to 138% of the federal poverty level (FPL) receive health coverage under Medicaid by 2019.

[83] In NM, the total number of individuals under 65 years of age who ear up to 138% of FPL is 238,200. Based on a total population of 1.97 million, this represents 12.1 percent.

way to summarize how competing allocation schemes will affect individuals. However, while results show compensating differentials for forest lands and substantial willingness to pay amounts for expanding health care coverage, there are some empirical issues that need special attention.

For instance, the estimation of implicit prices assumes an equilibrium framework. This means that households are completely mobile and migration is costless, thus implying that utility differences between locations have already been eliminated or that the market is at its spatial equilibrium (Blomquist et al. 2007). Since public lands may be endogenously determining where people live and work, such an assumption may be too restrictive. Analyzing migration patterns could indicate that the presence of natural amenities affects migration behavior and thus, that the market is not in equilibrium (Garber-Yonts 2004). Addressing this issue would require additional independent variables which may explain migration such as health status and environmental quality indexes (Rupasingha and Goetz, 2004). A second methodological issue related to the geographic nature of observations refers to spatial heterogeneity. The estimated coefficients in this work are assumed to be constant in space. This implies that reducing the distance between the average house and a public forest area by 1 percent or 0.4 miles, has the same effect on a house value regardless of where the house is located. Spatial heterogeneity addresses this issue by allowing the coefficients to vary in space. Depending on the sample size, an efficient approach could be to disaggregate a market in smaller submarkets and estimate separate spatial models and test whether the estimators are statistically different from each other.

The mixed support for a universal health care system in NM may indicate that redefining the good in question would shed more light to the current debate. Future research should elicit people's willingness to pay (WTP) to expand health care coverage to specific segments of the uninsured population. Building on the work done by Bundorf and Fucks (2006) and Kessler and Brady (2009), a promising route would be to include a contingent valuation scenario to elicit WTP for low-income individuals and for people incurring high medical costs due to preexisting or chronic conditions.

Appendix A: Maximum likelihood estimation

Following Anselin (1988) notation, the maximum likelihood (ML) coefficients presented in chapter 2 are the result of the following log-likelihood function assuming homoscedasticity (e.g., $\Omega = \sigma^2 I$):

$$L = -(N/2)\ln\pi - (N/2)\ln\sigma^2 + \ln|A| - (1/2\sigma^2)(Ay - X\beta)'(Ay - X\beta) \qquad \text{(A.1)}$$

where $A = I - \rho W$

Applying the first order conditions to equation (A.1) yields the following estimator for β:

$$b = (X'X)^{-1}X'y - \rho(X'X)^{-1}X'Wy = b_0 - \rho b_L \qquad \text{(A.2)}$$

Since the estimator b is a function of ρ, the value for the autocorrelation coefficient has to be found for b to be determined. The first step is to run the following two ordinary square estimations to obtain e_0, e_L, and σ^2:

$$e_0 = y - Xb_0 \qquad \text{(A.3)}$$

$$e_L = Wy - Xb_L \qquad \text{(A.4)}$$

$$\sigma^2 = (1/N)(e_0 - \rho e_L)'(e_0 - \rho e_L) \qquad \text{(A.5)}$$

A concentrated likelihood function can be obtained by substituting the estimates for β and σ^2 in equation (A.1):

$$L_C = C - (N/2)\ln[(1/N)(e_0 - \rho e_L)'(e_0 - \rho e_L)] + \ln|I - \rho W| \qquad \text{(A.6)}$$

where C is a constant. Since the likelihood expression in equation (A.6) is a non-linear function of one parameter, ρ, numerical techniques, such as a bisection search, has to be applied to find the value of this parameter. In summary, the ML estimation process used to obtain the results in chapter 2 was based on the following steps:

1) OLS of X on y to obtain b_0
2) OLS of X on Wy to obtain b_L
3) residual e_0 and e_L are calculated
4) ρ is obtained via a non-linear optimization technique
5) b and σ^2 are estimated

Table B.1: Additional Spatial-Lag Models

Variables	Spatial-lag (ML) W_3	W_4	W_6
DROOMS	0.176***	0.175***	0.168***
	(3.87)	(3.89)	(3.72)
DINCOME	0.315***	0.304***	0.303***
	(6.38)	(6.19)	(6.17)
HPERACRE	0.020	0.020	0.018
	(1.45)	(1.40)	(1.29)
DCENSIZE	-0.270***	-0.260	-0.264***
	(5.54)	(5.38)	(5.47)
HAGE	-0.004***	-0.005***	-0.005***
	(2.70)	(2.88)	(2.92)
IRAS	0.981**	0.947**	0.949**
	(2.39)	(2.33)	(2.33)
WILD	0.651**	0.614**	0.593**
	(2.31)	(2.19)	(2.12)
ρ_{HVALUE}	0.337***	0.376***	0.396***
	(8.59)	(9.02)	(8.97)
CONS_	7.409	6.977	6.757
R^2	0.332	0.398	0.381
LK	-198.35	-196.9	-195.7
LM-error	0.232	0.165	0.083

Table C.1: SUR Results for IRAs (Spatial-lag: 3KM and Spatial error: 4KM)

	Weighted Model $3KM_{(lag)}$-$4KM_{(error)}$		Unweighted Model $3KM_{(lag)}$-$4KM_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.14***		0.12***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.24***		0.04***	
LNHIGHWAY	-0.01		-0.03*	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.05***		-0.01*	
LNGOLF	-0.02		-0.01	
EDUC		0.10***		0.09***
WORKPT		-0.83***		-0.13**
RETIRED		-0.36***		-0.31***
HOMEMAKER		0.14**		0.09
STUDENTFT		-0.06		-0.39**
STUDENTPT		-0.31		-0.24
ACTIVEMIL		-12.68**		0.87
RESMIL		-0.20		0.09
UNEMPL		-0.66***		-0.41***
TWORACES		-0.49***		0.03
ASIAN		0.18		0.04
BLACK		-0.22		0.00
AMERINDIAN		0.08		-0.03
HAWAIIAN		0.15		0.24
MALE		0.11***		0.21***
LIVINGNRE		-0.11		-0.08
GROUPMEM		0.07		-0.02
LNIRAS	-0.11***	0.14*	-0.04*	0.03*
LNSPFUND	-0.03*	0.03**	-0.02*	0.07***
LNURBAN	-0.10	0.03	-0.05**	0.03
LNLAKES	-0.04**	0.11***	-0.02**	0.04*
LNCAMP	-0.06**	-0.02	-0.05**	0.06
LNWATERSHED	-0.02***	0.14***	0.01*	0.09**
ρ	0.41***		0.54***	
λ	0.36	0.57	0.31	0.27
McElroy R^2	0.43		0.43	
N	1,885,059		1014	
Residu. Corr	0.12		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.2: SUR Results for IRAs (Spatial-lag: 3KM and Spatial error: IWD)

	Weighted Model $3KM_{(lag)}$_$IWD_{(error)}$		Unweighted Model $3KM_{(lag)}$_$IWD_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.13***		0.12***	
HAGE	-0.01***		-0.00***	
LOTSIZE	0.20***		0.04***	
LNHIGHWAY	-0.01		-0.02**	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.04***		-0.01*	
LNGOLF	-0.01		-0.01	
EDUC		0.10***		0.09***
WORKPT		-0.80***		-0.12**
RETIRED		-0.35***		-0.32***
HOMEMAKER		0.13*		0.08
STUDENTFT		-0.16*		-0.49***
STUDENTPT		-0.20		-0.26
ACTIVEMIL		-0.31		-1.16**
RESMIL		0.34		0.22
UNEMPL		-0.66***		-0.42***
TWORACES		-0.58***		0.02
ASIAN		0.52***		0.10
BLACK		-0.26		0.06
AMERINDIAN		0.33***		0.01
HAWAIIAN		0.27		0.28
MALE		0.12***		0.21***
LIVINGNRE		-0.14*		-0.10
GROUPMEM		0.06		-0.02
LNIRAS	-0.07**	0.05**	-0.03*	0.04*
LNSPFUND	-0.04***	0.05*	-0.02*	0.07***
LNURBAN	-0.10***	0.02	-0.05***	0.02
LNLAKES	-0.06***	0.15***	-0.02*	0.05**
LNCAMP	-0.01***	0.01	-0.05**	0.07**
LNWATERSHED	-0.07***	0.14***	-0.01*	0.09***
ρ	0.50***		0.65***	
λ	0.32	0.37	0.17	0.17
McElroy R^2	0.47		0.47	
N	1,885,059		1014	
Residu. Corr	0.11		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.3: SUR Results for IRAs (Spatial-lag: 3KM and Spatial error: $IWD_{1.5}$)

	Weighted Model $3KM_{(lag)}$_$IWD_{1.5(error)}$		Unweighted Model $3KM_{(lag)}$_$IWD_{1.5(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.13***		0.12***	
HAGE	-0.01***		-0.00***	
LOTSIZE	0.21***		0.04***	
LNHIGHWAY	-0.01		-0.03**	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.05***		-0.01*	
LNGOLF	-0.02		-0.01	
EDUC		0.10***		0.09***
WORKPT		-0.80***		-0.13**
RETIRED		-0.35***		-0.32***
HOMEMAKER		0.13*		0.08
STUDENTFT		-0.17*		-0.48***
STUDENTPT		-0.21		-0.26
ACTIVEMIL		-1.14		1.12
RESMIL		0.29		0.24
UNEMPL		-0.68***		-0.43***
TWORACES		-0.55***		0.03
ASIAN		0.52***		0.10
BLACK		-0.24		0.06
AMERINDIAN		0.33		0.02
HAWAIIAN		0.26		0.27
MALE		0.11***		0.21***
LIVINGNRE		-0.14*		-0.09
GROUPMEM		0.06		-0.02
LNIRAS	-0.07**	0.05**	-0.03*	0.03
LNSPFUND	-0.04**	0.04*	-0.02*	0.07***
LNURBAN	-0.10***	0.02	-0.05***	0.02
LNLAKES	-0.06***	0.15***	-0.02*	0.05**
LNCAMP	-0.06***	0.00	-0.05**	0.07**
LNWATERSHED	-0.02***	0.14***	0.01*	0.09***
ρ	0.48***		0.64***	
λ	0.32	0.35	0.19	0.17
McElroy R^2	0.49		0.49	
N	1,885,059		1014	
Residu. Corr	0.11		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.4: SUR Results for IRAs (Spatial-lag: 4KM and Spatial error: 3KM)

	Weighted Model $4KM_{(lag)}$_$3KM_{(error)}$		Unweighted Model $4KM_{(lag)}$_$3KM_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.14***		0.12***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.25***		0.05***	
LNHIGHWAY	-0.01		-0.02*	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.06***		-0.01*	
LNGOLF	-0.03*		-0.01	
EDUC		0.08***		0.08***
WORKPT		-0.81***		-0.13**
RETIRED		-0.31***		-0.31***
HOMEMAKER		0.07		0.08
STUDENTFT		-0.06		-0.45***
STUDENTPT		-0.14		-0.25
ACTIVEMIL		-0.50		-1.00*
RESMIL		0.03		0.10
UNEMPL		-0.69***		-0.42***
TWORACES		-0.41		0.04
ASIAN		0.12		0.02
BLACK		-0.24		0.00
AMERINDIAN		0.10		-0.02
HAWAIIAN		0.11		0.22
MALE		0.08**		0.21***
LIVINGNRE		-0.11		-0.10*
GROUPMEM		0.07		-0.02
LNIRAS	-0.13***	0.08*	-0.07*	0.03*
LNSPFUND	-0.02*	0.03**	-0.02*	0.07***
LNURBAN	-0.10***	0.03	-0.05***	0.03
LNLAKES	-0.04**	0.11***	-0.02**	0.05**
LNCAMP	-0.04	-0.03	-0.05**	0.06*
LNWATERSHED	-0.02**	0.14***	0.00*	0.09**
ρ	0.37***		0.63***	
λ	0.36	0.47	0.24	0.19
McElroy R^2	0.44		0.44	
N	1,885,059		1014	
Residu. Corr	0.13		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.5: SUR Results for IRAs (Spatial-lag: 4KM and Spatial error: IWD)

	Weighted Model $4KM_{(lag)}\_IWD_{(error)}$		Unweighted Model $4KM_{(lag)}\_IWD_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.13***		0.12***	
HAGE	-0.01***		-0.00***	
LOTSIZE	0.22***		0.04***	
LNHIGHWAY	-0.01		-0.02**	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.04***		-0.02*	
LNGOLF	-0.01		-0.01	
EDUC		0.09***		0.09***
WORKPT		-0.79***		-0.12**
RETIRED		-0.30***		-0.33***
HOMEMAKER		0.11*		0.07
STUDENTFT		-0.16*		-0.47***
STUDENTPT		-0.15		-0.26
ACTIVEMIL		-0.29		-0.98*
RESMIL		0.34		0.21
UNEMPL		-0.70***		-0.43***
TWORACES		-0.41**		-0.11
ASIAN		0.47***		0.05
BLACK		-0.48***		0.05
AMERINDIAN		0.40***		0.06
HAWAIIAN		0.19		0.16
MALE		0.08*		0.21***
LIVINGNRE		-0.17**		-0.10*
GROUPMEM		0.05		-0.02
LNIRAS	-0.06**	0.05**	-0.02**	0.05*
LNSPFUND	-0.03*	0.03*	-0.03**	0.08***
LNURBAN	-0.10***	0.01	-0.05***	0.02
LNLAKES	-0.07***	0.16***	-0.02*	0.05**
LNCAMP	-0.04**	-0.03	-0.05***	0.06**
LNWATERSHED	-0.02***	0.13***	-0.01*	0.10***
ρ	0.52***		0.72***	
λ	0.36	0.37	0.18	0.17
McElroy R^2	0.51		0.51	
N	1,885,059		1014	
Residu. Corr	0.12		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.6: SUR Results for IRAs (Spatial-lag: 4KM and Spatial error: $IWD_{1.5}$)

	Weighted Model $4KM_{(lag)}\_IWD_{1.5(error)}$		Unweighted Model $4KM_{(lag)}\_IWD_{1.5(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.14***		0.12***	
HAGE	-0.01***		-0.00***	
LOTSIZE	0.22***		0.04***	
LNHIGHWAY	-0.01		-0.02*	
LNSHCOOL	-0.01		-0.01	
LNRAILROAD	0.05***		-0.02**	
LNGOLF	-0.02		-0.01	
EDUC		0.10***		0.09***
WORKPT		-0.79***		-0.13**
RETIRED		-0.34***		-0.32***
HOMEMAKER		0.12*		0.07
STUDENTFT		-0.17*		-0.48***
STUDENTPT		-0.20		-0.27
ACTIVEMIL		-1.29		-1.15**
RESMIL		0.29		0.22
UNEMPL		-0.69***		-0.43***
TWORACES		-0.54***		0.02
ASIAN		0.54		0.10
BLACK		-0.23		0.06
AMERINDIAN		0.36**		0.03
HAWAIIAN		0.26		0.26
MALE		0.11***		0.20***
LIVINGNRE		-0.14*		-0.10*
GROUPMEM		0.06		-0.03
LNIRAS	-0.05*	0.03**	-0.02*	0.02*
LNSPFUND	-0.02*	0.04*	0.03***	0.07***
LNURBAN	-0.11***	0.02	-0.05***	0.02
LNLAKES	-0.07***	0.15***	-0.03*	0.05**
LNCAMP	-0.03	0.00	-0.05**	0.06**
LNWATERSHED	-0.02***	0.14***	-0.01*	0.09***
ρ	0.47***		0.70***	
λ	0.37	0.35	0.19	0.17
McElroy R^2	0.49		0.49	
N	1,885,059		1014	
Residu. Corr	0.12		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.7: SUR Results for IRAs (Spatial-lag: IWD and Spatial error: 3KM)

	Weighted Model $IWD_{(lag)}$-$3KM_{(error)}$		Unweighted Model $IWD_{(lag)}$-$3KM_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.15***		0.12***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.22***		0.05***	
LNHIGHWAY	-0.01		-0.04**	
LNSHCOOL	-0.02*		-0.01	
LNRAILROAD	0.10***		0.05***	
LNGOLF	-0.04**		-0.02	
EDUC		0.07***		0.07***
WORKPT		-0.80***		-0.14**
RETIRED		-0.30***		-0.29***
HOMEMAKER		0.02		0.09
STUDENTFT		-0.03		-0.40**
STUDENTPT		-0.10		-0.26
ACTIVEMIL		-0.41		0.81
RESMIL		-0.05		0.11
UNEMPL		-0.70***		-0.42***
TWORACES		-0.38***		0.07
ASIAN		0.07		-0.01
BLACK		-0.18		0.00
AMERINDIAN		0.08		0.01
HAWAIIAN		0.05		0.18
MALE		0.07*		0.20***
LIVINGNRE		-0.08		-0.10*
GROUPMEM		0.08*		-0.01
LNIRAS	-0.12***	0.03**	-0.01**	0.02*
LNSPFUND	0.06***	0.02*	0.01*	0.07**
LNURBAN	-0.09***	0.02	-0.07***	0.04
LNLAKES	-0.01**	0.09**	-0.02**	0.07**
LNCAMP	-0.03	-0.10	-0.07**	0.06
LNWATERSHED	0.00	0.12***	0.03*	0.08*
ρ	0.07**		0.12***	
λ	0.49	0.47	0.53	0.19
McElroy R^2	0.32		0.32	
N	1,885,059		1014	
Residu. Corr	0.14		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.8: SUR Results for IRAs (Spatial-lag: IWD and Spatial error: 4KM)

	Weighted Model $IWD_{(lag)}$-$4KM_{(error)}$		Unweighted Model $IWD_{(lag)}$-$4KM_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.15***		0.13***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.23***		0.05***	
LNHIGHWAY	-0.02		-0.05**	
LNSHCOOL	-0.02*		-0.01	
LNRAILROAD	0.10***		0.05**	
LNGOLF	-0.04**		-0.01	
EDUC		0.09***		0.08***
WORKPT		-0.83***		-0.14**
RETIRED		-0.37***		-0.29***
HOMEMAKER		0.12*		0.09
STUDENTFT		-0.04		-0.33*
STUDENTPT		-0.34		-0.25
ACTIVEMIL		-11.49***		0.66
RESMIL		-0.42		0.05
UNEMPL		-0.66***		-0.40***
TWORACES		-0.47***		0.04
ASIAN		0.14		0.02
BLACK		-0.17		0.00
AMERINDIAN		0.06		-0.01
HAWAIIAN		0.09		0.20
MALE		0.10**		0.20***
LIVINGNRE		-0.08		-0.06
GROUPMEM		0.09*		-0.02
LNIRAS	-0.16***	0.14**	-0.05*	0.03**
LNSPFUND	0.04**	0.01*	0.01*	0.07**
LNURBAN	-0.09***	0.02	-0.06***	0.03
LNLAKES	-0.01**	0.08**	-0.02**	0.04**
LNCAMP	-0.03	-0.07	-0.08**	0.05
LNWATERSHED	-0.01	0.13***	0.03	0.09*
ρ	0.11***		0.12***	
λ	0.52	0.57	0.58	0.27
McElroy R^2	0.33		0.33	
N	1,885,059		1014	
Residu. Corr	0.12		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.9: SUR Results for IRAs (Spatial-lag: IWD and Spatial error: $IWD_{1.5}$)

	Weighted Model $IWD(lag)\_IWD_{1.5(lag)}$		Unweighted Model $IWD(lag)\_IWD_{1.5(lag)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.15***		0.14***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.22***		0.09***	
LNHIGHWAY	0.00		-0.04**	
LNSHCOOL	-0.03*		-0.01	
LNRAILROAD	0.15***		0.08***	
LNGOLF	-0.03**		-0.04**	
EDUC		0.09***		0.08***
WORKPT		-0.78***		-0.13**
RETIRED		-0.34***		-0.31***
HOMEMAKER		0.11		0.09
STUDENTFT		-0.18*		-0.46***
STUDENTPT		-0.19		-0.30
ACTIVEMIL		-0.97		-1.07*
RESMIL		0.30		0.34
UNEMPL		-0.69***		-0.45***
TWORACES		-0.55***		0.03
ASIAN		0.56***		0.14
BLACK		-0.20		0.10
AMERINDIAN		0.40		0.05
HAWAIIAN		0.27		0.21
MALE		0.10**		0.20***
LIVINGNRE		-0.14*		-0.08
GROUPMEM		0.07		-0.03
LNIRAS	-0.17***	0.02**	-0.05*	0.03*
LNSPFUND	0.05***	0.03	0.01**	0.08***
LNURBAN	-0.14***	0.01	-0.12***	0.02
LNLAKES	-0.08***	0.16***	-0.05***	0.05**
LNCAMP	-0.05**	-0.02	-0.10***	0.07*
LNWATERSHED	-0.02***	0.14***	0.02*	0.10***
ρ	0.11***		0.10***	
λ	0.43	0.35	0.34	0.17
McElroy R^2	0.37		0.37	
N	1,885,059		1014	
Residu. Corr	0.13		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.10: SUR Results for IRAs (Spatial-lag: $IWD_{1.5}$ and Spatial error: 3KM)

	Weighted Model $IWD_{1.5(lag)}$_$3KM_{error}$		Unweighted Model $IWD_{1.5(lag)}$_$3KM_{error}$	
	Housing	Wage	Housing	Wage
ROOMS	0.14***		0.12***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.22***		0.05***	
LNHIGHWAY	-0.01		-0.04*	
LNSHCOOL	-0.02		-0.01	
LNRAILROAD	0.09***		0.05**	
LNGOLF	-0.04**		-0.02	
EDUC		0.07***		0.07***
WORKPT		-0.81***		-0.14***
RETIRED		-0.30***		-0.29***
HOMEMAKER		0.04		0.09
STUDENTFT		-0.04		-0.40**
STUDENTPT		-0.11		-0.26
ACTIVEMIL		-0.50		0.83
RESMIL		-0.06		0.09
UNEMPL		-0.70***		-0.42***
TWORACES		-0.39***		0.06
ASIAN		0.07		-0.01
BLACK		-0.19		0.00
AMERINDIAN		0.07		0.00
HAWAIIAN		0.06		0.18
MALE		0.08*		0.21***
LIVINGNRE		-0.09		-0.10
GROUPMEM		0.08*		-0.01
LNIRAS	-0.12***	0.04**	-0.01*	0.02*
LNSPFUND	0.05**	0.02	0.01*	0.07**
LNURBAN	-0.09***	0.02	-0.07***	0.04
LNLAKES	-0.02**	0.10***	-0.02**	0.06*
LNCAMP	-0.03	-0.09	-0.07**	0.06
LNWATERSHED	-0.01*	0.13***	0.03	0.08*
ρ	0.14***		0.18***	
λ	0.47	0.47	0.50	0.19
McElroy R^2	0.33		0.33	
N	1,885,059		1014	
Residu. Corr	0.13		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.11: SUR Results for IRAs (Spatial-lag: $IWD_{1.5}$ and Spatial error: 4KM)

	Weighted Model $IWD_{1.5(lag)}$-4KM		Unweighted Model $IWD_{1.5(lag)}$-4KM	
	Housing	Wage	Housing	Wage
ROOMS	0.15***		0.13***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.23***		0.05***	
LNHIGHWAY	-0.02		-0.05**	
LNSHCOOL	-0.02		-0.01	
LNRAILROAD	0.10***		0.04**	
LNGOLF	-0.04**		-0.01	
EDUC		0.09***		0.08***
WORKPT		-0.83***		-0.14***
RETIRED		-0.37***		-0.30***
HOMEMAKER		0.13**		0.09
STUDENTFT		-0.04		-0.34*
STUDENTPT		-0.34		-0.25
ACTIVEMIL		-11.86***		0.68
RESMIL		-0.41		0.04
UNEMPL		-0.66***		-0.40***
TWORACES		-0.48***		0.04
ASIAN		0.13		0.02
BLACK		-0.17		0.00
AMERINDIAN		0.05		-0.01
HAWAIIAN		0.10		0.20
MALE		0.10**		0.20***
LIVINGNRE		-0.08		-0.06
GROUPMEM		0.09*		-0.01
LNIRAS	-0.15***	0.14**	-0.02*	0.03*
LNSPFUND	0.04*	0.01*	0.00	0.07**
LNURBAN	-0.09***	0.02	-0.06***	0.03
LNLAKES	-0.02**	0.08**	-0.02*	0.04*
LNCAMP	-0.03	-0.06	-0.07**	0.05
LNWATERSHED	-0.01*	0.14***	0.03*	0.09*
ρ	0.19***		0.18***	
λ	0.50	0.57	0.55	0.27
McElroy R^2	0.34		0.34	
N	1,885,059		1014	
Residu. Corr	0.11		0.20	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table C.12: SUR Results for IRAs (Spatial-lag: $IWD_{1.5}$ and Spatial error: IWD)

	Weighted Model $IWD_{1.5(lag)}$_$IWD_{(error)}$		Unweighted Model $IWD_{1.5(lag)}$_$IWD_{(error)}$	
	Housing	Wage	Housing	Wage
ROOMS	0.15***		0.13***	
HAGE	-0.01***		-0.01***	
LOTSIZE	0.22***		0.08***	
LNHIGHWAY	-0.01		0.03*	
LNSHCOOL	-0.02		0.00	
LNRAILROAD	0.11***		0.05***	
LNGOLF	-0.04***		-0.03**	
EDUC		0.10***		0.08***
WORKPT		-0.80***		-0.12***
RETIRED		-0.35***		-0.33***
HOMEMAKER		0.13*		0.09
STUDENTFT		-0.16*		-0.47***
STUDENTPT		-0.20		-0.27
ACTIVEMIL		-0.54		-1.14*
RESMIL		0.33		0.22
UNEMPL		-0.67***		-0.43***
TWORACES		-0.57***		0.02
ASIAN		0.54		0.12
BLACK		-0.25		0.07
AMERINDIAN		0.34**		0.02
HAWAIIAN		0.27		0.25
MALE		0.11***		0.21***
LIVINGNRE		-0.13*		-0.09
GROUPMEM		0.06		-0.02
LNIRAS	-0.06**	0.05*	-0.02*	0.05*
LNSPFUND	0.04***	0.05*	0.00	0.08***
LNURBAN	-0.13***	0.01	-0.10***	0.02
LNLAKES	-0.08***	0.15***	-0.04***	0.05**
LNCAMP	-0.05**	0.00	-0.09***	0.06**
LNWATERSHED	-0.01*	0.14***	-0.01*	0.10***
ρ	0.13***		0.35***	
λ	0.37	0.37	0.21	0.17
McElroy R^2	0.41		0.41	
N	1,885,059		1014	
Residu. Corr	0.13		0.19	

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

Table D.1: Dependent Variable = log(Unobserved WTP)

Variables	Raw vote	CERT70	CERT75	CERT80	CERT85
AGE	-0.12***	-0.12***	-0.10**	-0.10**	-0.10***
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
AGESQ	0.00***	0.00*	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
MALE	-0.19	-0.45***	-0.50***	-0.83***	-0.30
	(0.21)	(0.17)	(0.17)	(0.16)	(0.17)
EMPSTAT	0.07	-0.11	0.23	0.28	0.46
	(0.26)	(0.22)	(0.21)	(0.21)	(0.22)
INCOME	0.09**	0.25***	0.30***	0.36***	0.27***
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
IDEO	-0.13**	-0.14***	-0.26***	-0.16*	-0.17**
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
REGVOTE	0.54**	0.60*	0.85**	0.21	0.25
	(0.26)	(0.33)	(0.23)	(0.22)	(0.23)
HISP	-0.16	-0.25	-0.24	-0.25	-0.23
	(0.23)	(0.23)	(0.23)	(0.24)	(0.24)
OTHERACE	-0.05	-0.10	-0.11	-0.24	-0.22
	(0.34)	(0.28)	(0.28)	(0.27)	(0.27)
PROGIMP	0.18***	0.19***	0.27***	0.31***	0.37***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
TAXES	0.58***	0.60***	0.81***	1.42***	1.13***
	(0.23)	(0.20)	(0.19)	(0.18)	(0.19)
BASICARE	0.03	0.17	0.37	0.38	0.12
	(0.20)	(0.19)	(0.16)	(0.16)	(0.16)
CHILDNUM	-0.17	-0.50***	-0.92***	-1.16***	-0.62**
	(0.23)	(0.20)	(0.18)	(0.18)	(0.18)
BMI	0.14	0.12	0.11	0.11	0.14
	(0.12)	(0.13)	(0.10)	(0.10)	(0.10)
PERCHEALTH	0.36***	0.37**	0.32**	0.55***	0.25*
	(0.13)	(0.13)	(0.10)	(0.10)	(0.10)
CV_POLICY	0.60**	0.75***	0.74***	0.58***	0.51
	(0.22)	(0.20)	(0.19)	(0.19)	(0.20)
PROVISION_INDEX	0.48***	0.41***	0.38	0.73***	0.40
	(0.11)	(0.09)	(0.09)	(0.09)	(0.09)
COVERAGE	-0.25	-0.04	-0.10	0.09	0.14
	(0.27)	(0.21)	(0.21)	(0.20)	(0.20)
INTERCEP	4.85***	2.85**	2.12***	2.75***	2.92***

Table D.1: Dependent Variable = log(Unobserved WTP) (cont'd)

Variables	Raw vote	CERT70	CERT75	CERT80	CERT85
	(1.22)	(1.22)	(0.91)	(0.90)	(0.92)
k (scale parameter)	0.93***	1.52***	1.60***	1.82***	1.47***
	(0.10)	(0.07)	(0.06)	(0.06)	(0.06)
Pseudo R2	0.34	0.26	0.23	0.23	0.23

*, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.
( )[a]: Standard deviation

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