

INVESTING IN STABILITY: AN ASSESSMENT OF THE TERTIARY EFFECTS OF OREGON'S SEISMIC
REHABILITATION GRANT PROJECT

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Abstract

Geological scientists have predicted an impending massive earthquake is likely to occur on the North Pacific Coast of the US. In response to the warnings of impending disaster, the State of Oregon has implemented several disaster preparedness measures, including the Seismic Rehabilitation Grant Project (SRGP), a grant dispersed to public school buildings in an effort to mitigate lives lost in the event of large-scale seismic activity. By following the dispersal of this grant, I perform a test the primary hypotheses of Charles Tiebout's "Theory of Local Expenditures," specifically the assertion that public services afforded to an area will increase desirability of the area. This was tested through a longitudinal analysis of home prices in neighborhoods in which the local school has received the SRGP funds, and will be compared to the changes over the same time in house prices of similar neighborhoods. From this test, an average increase in home values of 3.7% was found in areas that contained school buildings that received funds from the SRGP. These findings pose normative questions of how governments ought to act, including variation in differently sized governmental bodies.

Keywords: Seismic Retrofits, Tiebout

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Throughout the Pacific Northwest region of the United States, the likelihood of an impending an earthquake has become a focal point of hazard mitigation policy. Studies from Oregon's Department of Geological Studies (DOGAMI), Oregon State University (OSU), and the Federal Emergence Management Agency (FEMA) have culminated into what has amounted to a certainty that an earthquake of a magnitude greater than 8.5 will occur off the coast of Vancouver, BC which will have huge impacts on the areas from Alaska to Oregon. In Oregon alone, an estimated \$30 B worth of damage to buildings is estimated following the earthquake (Wang, 1998). This piece seeks to examine one of the hazard mitigation policies the State of Oregon has implemented in preparation for the earthquake.

To begin alleviating the effects of the likely earthquake, known as the Cascadia Event, Oregon has implemented a policy of awarding grants to public schools and emergency response buildings to complete seismic retrofits. To complete this assessment, I will be considering a tertiary effect of the grant on the neighborhoods that schools that receive that grant reside in. Capital investments into school infrastructure have been shown to have positive effects on surrounding neighborhoods, especially as measured through home values. These effects, known as Tiebout effects, are largely based on the investments communities make that either attract or repel prospective homebuyers. Through the Tiebout model, a hypothesis of positive neighborhood reactions to capital investments can be developed. This piece will be using the Tiebout framework to analyze the effects of the State of Oregon's Seismic Rehabilitation Grant Project (SRGP).

My primary research goal when assessing the SRGP is to answer if capital investments affect the neighborhoods of schools that receive upgrades. This question is meant to consider investments that are not obviously attractive to prospective households when choosing homes and schools, such as upgraded sporting facilities and expanded academic programs. To measure impacts of capital investments in schools, I use a difference-in-difference approach to compare the average home values of areas that contain schools which have received the SRGP to the average home value of areas that have not received the grant. Through this analysis, I find an increase in average home values of 3.7% of those areas that received the SRGP. Additionally, a secondary question regarding the distribution of the grant can be answered from the data. This secondary question will assess which variables are predictive to the receipt of the SRGP.

First, I will demonstrate the political and social history surrounding the formulation of the SRGP. I will then address the major theoretical consideration, economic effects known as Tiebout Effects. Once the theoretical implications have been assessed, I will describe the literature that informs other types of capital investments and the literature that justifies the model specification used in my empirical analysis. From the results of the empirical analysis, I will formulate three policy implications, each for a different level of government.

HISTORY AND POLITICS

The response of the Oregon State Legislative Assembly to seismic activity has historically been mixed. To understand this problem, I must consider the history of seismicity in the Pacific Northwest, and the evolving scientific predictions that culminated into the current predictions of the Cascadia Subduction Event, predictions of an earthquake that has been estimated will hit 8.5

on the Richter scale just off the coast of Oregon and Washington. Additionally, public opinion of Oregon earthquake risk will be considered as a mechanism that feeds into the political process.

Oregon has recently been tasked with the project of retrofitting many of its existing structures for seismic activity. Further, since the inception of the SRGP, the program aimed at completing this task, Oregon's earthquake risk has been upgraded. This comes in the wake of geological studies from not only DOGAMI, but also from geologists at OSU, and the FEMA. The historical support for preparing Oregon structures for earthquake readiness has increased incrementally following these studies. This trend can be reflected through The Oregon Legislative Assembly, and the increasing considerations of earthquake risk codified in public policy. The increases in political action regarding earthquake risk mirrors public opinion of earthquake risk in Oregon, signaling widespread acceptance of the literature regarding Oregon seismic risk. As the literature will illuminate, the move from the "slight" earthquake risk as understood throughout most of the 20th century has been supplanted with the risk presented by the Cascadia Event.

GROWING SCIENTIFIC CONSENSUS

1991, the US Geological Service (USGS) conducted a study of the Puget Sound-Portland area to assess seismic readiness (May). The scientific consensus at the time warned of earthquakes such as the 1949 Olympia quake, a magnitude 6.7 quake, and the 1965 Seattle-Tacoma quake, which also recorded at 6.7 on the Richter scale. Considering these "slight" risks of earthquake, the political landscape seemed hesitant to invest funds into retrofitting efforts. Some counties were labeled "leaders" in earthquake preparedness, many others lagged significantly behind. Notably, the larger counties, King, Multnomah, and Washington were identified as the "leaders," many of the rural counties considered earthquake risk to be low and economically unfeasible (May, 1991).

Research regarding the most recent Cascadia Event, which last occurred in 1700, can be illustrated by tsunami effects of the quake in Japan (Atwater, et al., 2005). In 2005, the USGS released a report linking the 1700 orphan tsunami in Japan to the large, recurring Pacific Northwest quakes. The tsunami flooded eastern coastal villages in Japan on January 27th, 1700. This tsunami was known as the “orphan” due to a lack of seismicity in the region prior to the tsunami. This tsunami determined to have a “parent” in the Cascadia Event in 1700. The importance of this study is its evidence of the 1700 quake, furthering the evidence in support of a major quake in the Pacific Northwest. From this study, FEMA began assessing region-wide seismic risk, the outcome of which can be seen in figure 1.

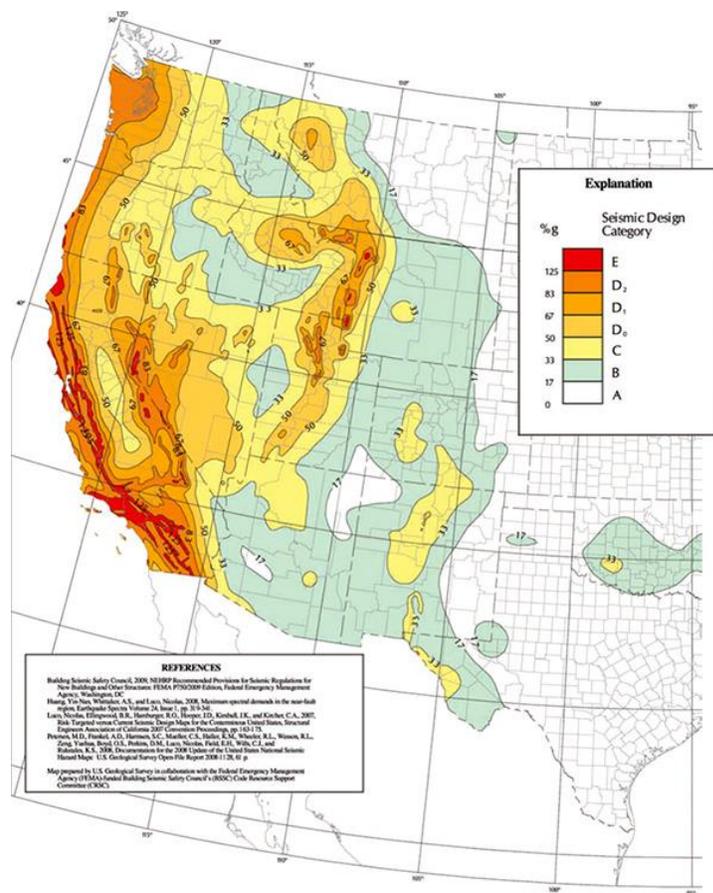


Figure 1

In 2012, Goldfinger et al. pointed to the turbidities, a geological deposit of a turbidity current, as a better indicator of when the Cascadia Event will occur. Goldfinger et al. created a timetable, which indicated these turbidities will reach a critical point in 2060. This acceleration in the timetable in which the large earthquake is likely to occur has been responded to by the Oregon State Legislature, which increased the funding of the SRGP from \$50 million per biennium, to \$150 million in the upcoming 2017-2019 fiscal biennium.

PUBLIC PERCEPTION

Seismic safety advocates have traditionally had difficulty mobilizing due to the low probability/high consequence view of many politicians and the public. “Daily concerns are simply more compelling for both community residents and political leaders” (Tierney, 2015). Earthquakes present a clear problem of risk uncertainty, as timelines for disaster give hundreds to thousands of years for a critical window. Another uncertainty arises in the costs of retrofitting, evident in LA’s hesitation to implement seismic code Division 88, which focused on the retrofitting of unreinforced masonry buildings (Tierney, 2015).

University of Auckland engineers (Paxton et al., 2015) conducted an analysis of the United States West Coast earthquake preparedness efforts in order to find useful methods employed in the US. Paxton et al. (2015) praised the State of California for statewide risk mitigation, particularly for unreinforced masonry buildings (URMs). The New Zealand study did note the limited efforts of the city of Portland, which had instituted requirements addressing URMs. In conclusion, Paxton et. al. noted a low rate of retrofitting in Portland due to a lack of URM risk

mitigation programs, and pointed to demolitions and occupancy renovations accounting for a large portion of the changes in Portland URMs.

In the early 1990's, the Oregon Public had been made aware of an increased risk of earthquake risk through some minor earthquakes in the Klamath area, and the Kobe earthquake in Japan. In 1993, the state implemented a new Structural Specialty Code, officially increasing Oregon's seismic zone rating from 2b to 3, an increase in risk that builders must consider. Reflective of this policy change, change in public opinion can be seen in a 1999 survey (Flynn, Slovic, Bertz, & Carlisle, 1999), which was conducted on a random sample of Portlanders finding not only were over 60% of those surveyed believed themselves to be well-informed about Portland earthquake risk, but also that about 80% of those surveyed believed that a major earthquake would occur within their lifetime.

POLITICAL RESPONSES

In response to the increased public awareness regarding Oregon's seismic risk, Oregon Senate President Peter Courtney introduced Senate Bill 2 2005 (SB2). SB2 called on the state agency DOGAMI to assess the seismic needs of emergency and public school buildings throughout the state. SB2 passed through both chambers of the Oregon Legislature, and was signed into law following adjournment of the legislative session.

DOGAMI quickly completed a study in 2006 to comply with the demand of the legislature (Wang & Goettel, 2007). To complete the assessment, the Rapid Visual Screening (RVS) method of analysis developed by FEMA (Federal Emergency Management Agency, 2015) was employed to assess the vulnerability of a structure. These assessments took place as "sidewalk surveys," with an emphasis on rapidity. RVS scores range from 0 to 7, with higher scores indicating greater

likelihood of a structure surviving an earthquake. This range has been violated in the assessment of Oregon school buildings, 273 of which received negative scores, creating a risk rate higher than the three levels indicated by FEMA. Due to the higher risk in Oregon, refinements to the RVS techniques were implemented. These refinements culminated in the Enhanced Rapid Visual Screening (E-RVS) method that considered additional soil types, expected ground shaking levels, and site-specific hazard data. Following the study, DOGAMI found of the 2,185 Oregon school buildings assessed, 273 were labeled “very high risk of collapse,” 745 were labeled “high risk of collapse,” 501 labeled “moderate risk of collapse, and 666 labeled “low risk of collapse” (Wang & Goettel, 2007).

Following the DOGAMI study, Senator Courtney sponsored Senate Bill 1 2007 (SB1) to appropriate money from the general fund to the seismic rehabilitation grant committee. The committee then settled on a method of distribution through competitive grants. These grants would ultimately culminate into the SRGP, and used the competitive nature of the grants to create an incremental approach to dispersing funds.

The incremental method used to distribute grant funds was modeled after FEMA recommendations (Kringold, Hattis, & Green, 2002) to “ultimately achieve the full damage reduction benefits of a more costly and disruptive single-stage rehabilitation” (p. A-6). This incremental approach, is thus, contrasted with a single-stage, high-cost approach that would have the added effect of shutting down schools in entire regions during construction. Finally, incremental rehabilitation was exalted as a “cost-effective means to protect the buildings and, most importantly, the safety of students, teachers, and staff, because it is a technically and financially

manageable strategy that minimizes disruption of school activities” (Kringgold, Hattis, & Green, 2002).

Since its inception, SRGP has ran as a competitive grant initiative in which public schools sought state dollars to retrofit existing structures as a means of preparation for the Cascadia Event. As noted, the competitive nature of the grant has been justified as a means to prevent distributional problems that may be associated with a pure allocation of resources to each affected school. The annual funding amount has varied, with an average number of four schools receiving the retrofitting benefits per year, working as an incremental method of distributing funds to affected schools.

Local Political Responses

The receipt of the SRGP funds has a stipulation that schools and communities fit the grant funds into a community-wide plan at earthquake readiness. These plans at community resilience building have required the renewal or implement new bond measures as a means of providing a portion of the funding for earthquake readiness. Some communities have failed to pass these bond measures. To examine this response, I will briefly describe the Jefferson School District’s attempts to receive bond funding that would allow the receipt of the SRGP funds.

Jefferson School District straddles both Linn and Marion counties in a small area along I-5 between Albany and Salem. Jefferson was able to pass Bond Measure 24-421 in the May 2017 special election, but the passage was by a very thin margin. 24-421 passed with a vote count of 893 to 883. This bond measure was the fourth attempt Jefferson School District had made in an attempt to upgrade school facilities and receive the SRGP, the first of which began in 2011 near the beginning of the SRGP distribution.

This look into the history of the SRGP provides the historical context necessary for moving forward in our analysis. In the following section, an attempt to understand how the investments made in school buildings as a result of the SRGP will be likely to affect neighborhoods. Further, I will demonstrate the space this study fits into with other bodies of work, and justify the controls I place on the empirical model used to perform my analysis.

LITERATURE REVIEW

The literature describing links between infrastructure and increases in home prices can largely be viewed as empirical tests of the Tiebout model. In this regard, we can look to literature assessing the impacts on home values from transit capital investments. For example, much of the literature regarding public investments into transportation show some mixed results regarding the association between property values and the proximity to public transportation stations. In summary, the owned housing market seems to show negative gains with the presence of public transportation stations (Armstrong & Rodriguez, 2006) (Bowes, 2001) (Chatman, Tulach, & Kyeongsu, 2012), while rental markets put a slight premium on proximity to such stations (Cervero, *Commuting in Transit Versus Automobile Neighborhoods*, 1995) (Cervero & Duncan, *Land Value Impacts of Rail Transit Services in Los Angeles County*, 2002). This trend is modified by stations that include parking lots (Pollack, Bluestone, & Billingham, 2010), which are associated with higher property values in the immediate area. This trend seems to be slightly different in Portland, Oregon though, as higher property values after the announcement and construction of public transport stations has occurred (Knapp, Ding, & Hopkins, 2001). This body

of literature provides a basis for investigating Tiebout effects brought on by public capital investments.

Further, to develop an understanding of theoretical mechanisms that may influence my analysis of the SRGP, special attention must be paid to the sociological theories showing empirical differences in schools, household selection of schools and homes, and differences in racialized institutions. Further consideration will be spent on the existence of private schools in areas, and the effects associated with private schools.

PRIMARY THEORETICAL CONSIDERATIONS

An Overview of Tiebout Effects

Charles Tiebout's **A PURE THEORY OF LOCAL EXPENDITURES** (Tiebout, 1956) puts together what is now known as the Tiebout Model in economics. In its most basic form the Tiebout Model argues that, given certain economic assumptions, people will live in the areas that provide the level of public goods or services they most prefer. People will "vote with their feet" and choose to live in the areas that provide the public services they most prefer, which is not limited to schools but also services such as firefighters, police, hospitals, and courts. This theory emphasizes the role of local governance, highlighting the role of city managers over the role of a central government. Within the Tiebout Model seven major assumptions are developed;

- 1. Consumer-voters are fully mobile and will move to that community where their preference patterns, which are set, are best satisfied.*
- 2. Consumer-voters are assumed to have full knowledge of differences among revenue and expenditure patterns and to react to these differences.*
- 3. There are a large number of communities in which the consumer-voters may choose to live.*
- 4. Restrictions due to employment opportunities are not considered [...]*
- 5. The public services supplied exhibit no external economies or*

diseconomies between communities... 6. For every pattern of community services set by, say, a city manager who follows the preferences of the older residents of the community, there is an optimal community size [...] 7. The last assumption is that communities below the optimum size seek to attract new residents to lower average costs. Those above optimum size do just the opposite. Those at an optimum try to keep their populations constant (Tiebout, 1956).

These assumptions describe consumer-voters and the communities in which they inhabit. These parameters are derivative of Rational Action Theory (RAT), and can be largely summed to describe the perfect scenario for consumers; total freedom in “voting with [their] feet” and perfect competition between municipalities attempting to woo or dissuade migration. From Tiebout, an understanding of why public school investments is likely to lead to an increase in the desirability of the immediate neighborhood is developed. That is, I would expect an increase in the prices of homes in the neighborhoods that school investments occur in through Tiebout effects. This theoretical mechanism provides the justification for a one-tailed test in the empirical analysis, the assumption that investments will be associated with increases in home prices of neighborhoods that receive the grant. With this basic understanding of the major theoretical mechanism at play, I can begin to consider the literature regarding the effects of capital investments on housing prices.

EFFECTS OF CAPITAL INVESTMENTS IN TRANSIT

Bowes and Ihlanfeldt (2001) show that the access to transit stations outweighs the negative effects of crime or the positive effects of retail within a quarter-mile radius. Homes within these close neighborhoods sold for about 19% less than those outside of the quarter-mile radius, while the existence of parking lots at stations would be associated with a 4.7% increase in sale price. Chatman et al. (Chatman, Tulach, & Kyeongsu, 2012) reaffirm these findings, though to a lesser

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degree in a study which found the net impact to be neutral to slightly negative in Southern New Jersey. Armstrong and Rodriguez (Armstrong & Rodriguez, 2006) show an increase between 9.6 and 10.1% in property values, with a penalty of about 1.6% for each minute of drive time required to reach a transit station.

Apartments and other rental units, on the other hand, have been shown to increase in value with proximity to public transportation. Cervero (1995) shows a 10-15% increase in rents in the San Francisco Bay area for units within a quarter-mile of the BART stations, and Cervero and Duncan (2002) show similar results in Santa Clara County.

This phenomenon may be a possible artifact of US culture. Gibbons and Machin (2005) show a 9.3% higher market price for South London homes near a rail station. Further, Ahlfeldt (2013) found an increase in monthly income of £383 with a doubling of transportation methods to employment in the Greater London area.

As an outlier in the US context, Chen et al. (1998) found a 10.5% increase in property value near stations in Portland, Oregon, and noted the value of accessibility overpowered the nuisance of the railway. Further, Knapp et al. (2001) found 31% higher prices for homes near railways in Portland two years after the announcement of railways.

INFRASTRUCTURE IN SCHOOLS

The literature assessing the effects of capital investments into schools can be split into three distinct themes: impacts on home values, impacts on student test-scores, and impacts from test-scores onto home values. As will be demonstrated in this section, the effects of test-scores on home values has little supporting evidence, strengthening our focus on the input (Capital Investment) and output (home value) variables considered in our empirical model.

By examining bond measures in California, a willingness to pay \$1.50 in home price for each dollar of school facility investments has been demonstrated, with home value increases of 5.8% after three years tied to the passage of bond measures increasing school capital investment (Cellini, Ferreira, & Rothstein, 2010). Further, an average effect of school capital investments on homes of 1.38% increase has been found in Connecticut following capital investments in schools (Nielson & Zimmerman, 2011). This piece contributes to this literature, providing another empirical study of the link between school capital investments and changes in nearby home values.

EDUCATION PRODUCTION FUNCTION

Education Production Function theory is an economic model identifying the inputs that are related to education outputs, and determining and measuring those outputs. These outputs have historically been identified as educational attainment, defined as highest grade completed, though debate has sprung up regarding including economic indicators of professional success (Psacharopoulos & Patrinos, 2004). The method of identifying inputs has included internal factors, those distinct to individual households and peer environments, and external factors that can be modified through policy changes.

Factors internal to households include parental education, family size, and income level. These inputs are identical to the minimum inputs for social class that will be explored later. Factors internal to peer groups look at trends of the schools, classrooms, or geographical regions which students attend. The culmination of those factors internal to households and those factors internal to peer groups largely make up the internal factors half of inputs.

Conversely, the external inputs include characteristics of teachers, structural organization, and community or district level factors. Teachers are examined largely through social class-related

variables, training variables, and physical characteristics. The structural organization of schools include variables such as class sizes, amenities, and expenditures. Community and/or district level factors often include total expenditure levels (Hanushek, 2007).

These external and internal inputs then undergo an empirical test culminating in the desired output variable, assigning strengths to each input factor. Though analyses such as this, policy makers are given access to the possible levers that may modify educational outputs, regardless of whether they are attainment or professionally derived.

School quality has also been shown to capitalize into the average values of homes. An increase of \$1,200 in average home values has been shown to occur with a \$100 increase in per pupil expenditure (Oates, 1969), while a one point increase in average test scores has been shown to have a positive effect of 0.2% average home values (Harris, 2001). This gives me the expectation for unobserved factors, as the data sets collected do not include a vector regarding school quality.

While this piece does not measure educational outputs, keeping these in mind when performing this analysis is important due to the possible unobserved effects educational achievement may have on the home value output variable that is important for this analysis. Further, this piece has the potential to inform Education Production Function theory through highlighting an interaction of policy changes regarding capital investments and the Education Production Function internal inputs.

LITERATURE INFORMING THE EMPIRICAL MODEL

The analysis has already considered the Tiebout model as the major theoretical mechanism that will be used to analyze the SRGP. Further theoretical mechanisms must be considered to account for mitigating factors. To this end a look at the interplay of school choice, the differences

in schools, and Rational Actors Theory (RAT) will be identified. This section will consider the mechanisms available to households in choosing schools. Finally, I will consider what effect private schools may have on neighborhoods, and the interplay between public school funding and private schools allowing op-out. These areas will each be aimed at informing the empirical model used to understand the impacts of the SRGP on neighborhood households.

EDUCATION AND RESIDENTIAL CONVERGENCE

Residential Choice and School Choice

Approximately 73% of students attend the public schools of the districts their homes are in (US. Department of Education, 2009). Because such a high proportion of students attend the schools they are assigned to, residential choice and school choice will be used interchangeably for the purposes of this piece. Further, even if the selection of a neighborhood or home is not based on the specific educational options afforded to that area, an educational decision is being made simply by selecting a home. When selecting homes, households limit educational options. Based on the assumptions of the Tiebout model I can further expect localities to compete with one another through the provisions of services, in this case school services. Further, two broad inputs which inform parents' decisions to choose a home have been identified as economic capital and social capital (Lareau, 2014). These factors have important differences across social classes as will be demonstrated.

Differences in Racialized Institutions

In the early 2000's, through a series of analyses of metropolitan schools, Jonathan Kozol found a significant difference in the amount of per pupil spending between schools with high concentrations of Black and Hispanic students than those schools with a large proportion of white

and other race students (Kozol, 2005). Through an incorporation of Human Capital Theory (Becker, 1975), the empirical results are not surprising; students attending schools with large concentrations of minority students have severely diminished outcomes when compared to their peers who attend schools with a greater proportion of white students. The lack of resources afforded to schools with high minority populations shows that an expectation for differences exists. This difference alone provides justification for controlling for racial concentration in the empirical model.

Class-Based Differences in Residential/Education Choices

When selecting educational institutions, households are not as mobile as the Tiebout Model treats them. This is not to say there is no rationality within these decisions, but there are some bounds on rationality. RAT can be seen in three clear examples of middle-class households. Clearly, the use of private schools to maintain social advantages is calculated through a cost-benefit analysis, which manifests in the “belie(f) that paying for a private education would provide them with an edge over other young people in the competitive world of academic success and high-status careers” (Roker, 1993). Second, in the selection of secondary schools, middle-class households, “skilled choosers” engage in “strategic decisions involved in the careful construction of their child's school career” (Gewirtz, Ball, & Bowe, 1995). Finally, those members of middle-class households who are enrolled in schools characterize their choices as either natural (high achieving) or “a rational choice in a competitive market” (Biggart & Furlong, 1996). These choices represent clear calculations that occur within these middle-class households in regards to the selection education institutions.

Often the desires of the parents of the working-class children mimic the middle-class “skilled choosers,” but lack the information of their counterparts, or are disconnected from educational opportunities (Gewirtz, Ball, & Bowe, 1995). “Here we have examples of young people and their parents from the same class locations with very different educational orientations. These intra-class differences cannot be accounted for by RAT, since the cost-benefit-probability calculation should be the same for all of them” (Hatcher, 1998). Even in the presence of housing vouchers, low-income households relocate to other low-income areas (Rhoades & De Luca, 2014). Further, low income households often lack the cultural capital that provides them with information about a wide range of education options (Neild, 2005), and have preferences based on various family and transportation options (Rhoades & De Luca, 2014).

Many low-income households engage in the selection of educational institutions have been to continue to select low-income neighborhoods presence of housing vouchers (Rhoades & De Luca, 2014). Often those households in low-income areas consider a smaller pool of potential neighborhoods to move into than those in higher income-brackets (Lareau, 2014).

Measuring Class and Limitations of the data

Producing a measure of social class is not immediately available through the data set given. As such, the indicator that has been made available is the number of students receiving free and reduced lunch. This variable ultimately culminates into a measure of poverty, which is one in a set of indicators that would provide a robust understanding of social class. A minimum set of variables would include parental education, family size, and income level. Further, finding an established set of variables that would “truly” determine social class is contested (Bulmer, Gibbs, & Hyman,

2016). While the desired measure would be one that produces a distinct, identifiable measure of social class, I am ultimately limited to an indicator in my empirical analysis.

Availability of Private Schools

The areas in which schools exist prior to the receipt of the grant funds is an important factor to consider when performing an empirical analysis. For example, Barse et. al. (2001) find significant negative impacts that private schools have on the amount of expenditures a municipality is willing to provide to public schools. These effects are especially pronounced in areas with centralized funding mechanisms, such as Oregon. This occurs through the option to disengage from the public system, leaving those who pay into a private schooling system unwilling to pay more into a public system that they do not utilize. This effect of private schools justifies applying a private school control on the empirical model.

METHODS AND DATA

DATA SOURCES

Data has been compiled from three primary sources. First, the OBDD has provided data regarding the parameters and allocation of the SRGP. Zillow Group, a private relator, holds data regarding the historical pricing of homes throughout the US. Finally, the National Center for Education Statistics (NCES) collects data regarding characteristics of schools. All these data sources have made the data available to the public, and it can be found through either online databases, as in the case with both Zillow and the NCES, or through publicly available online documents.

Data from OBDD includes which schools were granted funds, what year the decision was made, and the amount granted to each school. Additionally, OBDD provided details on requirements schools and municipalities must meet to receive grant funds. These requirements

include that each school must undergo an ASCE 41-13 seismic retrofit assessment, a cost estimate, a benefit-cost analysis, have pictures taken of the buildings to be retrofitted, and a RVS report from DOGAMI. Additionally, the applications are assessed based on six criteria: 1) project readiness; 2) a detailing of the scope of work; 3) financial feasibility; 4) community-wide efforts at earthquake preparedness; and 5) an evaluation of the importance of the building to the community it serves are other factors considered. These applications are looked over by a committee within the OBDD Infrastructure Finance Authority.

Data provided by Zillow includes information on home values. Zillow produces these averages based on a median valuation of homes in a specified geographic area. This produces, what Zillow refers to as the Zillow Home Value Index (ZHVI). The ZHVI provides data specification levels as granular as month for time-based variables, and neighborhood level from spatial-based variable. The decision to use ZIP code-level data was made due to many of Oregon areas being too large for neighborhood-level data to be appropriate. The breadth of the time variable at the month level of specification dates to 1995 in some cases. This piece uses the ZHVI as a proxy for average home values throughout the empirical analysis.

Data on school characteristics were retrieved from the National Center on Education Statistics (NCES). NCES is a federal agency that collects a large amount of data on public schools, and a smaller set of data on private schools throughout the US. As an agency that is subject to the Freedom of Information Act (FOIA), NCES allows the public access to databases regarding a large vector of school characteristics, which date back to the 1986-1987 school year. The NCES database provides users with data on demographic makeup, teacher-student ratios, and district-level funding expenditures to name a small sample of variables available. While this data begins to give us some

of the variables that are internal to the households that sent their children to these schools, it is incomplete in this regard. This data was collected from the year of 2009, the first year in which the SRGP was granted, to the 2016-2017 school year.

EMPIRICAL RESEARCH DESIGN

Following the literature, an empirical model aimed at understanding the impacts of the SRGP on neighborhood households through house prices must incorporate the following; racial differences between institutions, poverty characteristics, and the availability of private schools. Due to the nature of this data, a difference-in-difference regression has been developed to understanding any effects the SRGP may have on housing prices within school attendance zones. This would produce a predictive model for an individual area in a given month (t) that would be formulated as:

$$lAvHV_{it} = \beta_0 + \beta_1 SRGP_{it} + \beta_2 race_{it} + \beta_3 poverty_{it} + \beta_4 pschool_{it} + \beta_5 locality + \varepsilon$$

On the left-hand side of this model, I have $lAvHv_{it}$ as the outcome variable. This outcome indicates the natural log of the average home value in a particular area in a given month, meaning the changes in housing price will be interpreted as a percentage change. The $SRGP_{it}$ variable is a dummy variable indicating the receipt of grant funds by an individual school i in month t . The β_1 indicates the effect of receiving a grant through the SGRP has on the average housing price, indicating a percentage change. A one unit change in the SRGP coefficient would indicate a 100% change in home value. More realistically, a positive coefficient of 0.05 would indicate a 5% increase in home values. The $race_{it}$ variable indicates the concentration of racial minorities of students of an individual school in each month. Following the literature (Kozol, 2005), race is controlled for through the concentration of Black and Hispanic students. This is achieved by

finding the percentage of the entire student body that is Black and Hispanic of an individual school at time t .

The $poverty_{it}$ variable is calculated through the use of a percentage of students receiving free and reduced lunch. The β_3 indicates the effect class difference may have in an individual school in a given month. While this indicator of class is imperfect, a more robust *class* variable would require at least information on parental education achievement as well as household size inputs. As stated earlier, the nature of the collected data excludes these inputs that would be required to create a *class* vector of variables. This is to say, an ideal formulation of the *class* variable would be a vector of at least poverty, parental education level, and household size. Due to this limitation, I would suggest follow-up research to include mechanisms to capture the multidimensional aspects of *class*. In this regard, this piece works as preliminary research in this regard. As with the *Race* variable, the values associated with *poverty* are a concentration indicating the percentage of students who receive free or reduced lunch.

The $pschool_{it}$ variable was calculated from the NCES data through the addition of private schools in each ZIP code. The β_4 indicates the effect of private schools will have on the individual schools, which may be as diverse as district expenditure totals or even differences in average home values. Finally, time invariant factors, such as rurality, can be omitted due to the nature of a fixed-effects model.

Alternatively, a random-effects regression and an Ordinary Least Squares (OLS) regression will be performed that will include the vector of locality size variables, which was provided from the NCES data and moves from the value of 11, the value schools in a large city would receive, to 43, the value rural remote schools would receive. These scores are ordinal two digit codes, with the first

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digit indicating size category, and the second indicating ranking within a category. In this structure, the first digit can range from 1 to 4, 1 indicating City, 2 indicating Suburb, 3 indicating Town, and 4 indicating rural. Within each of these categories, three ranks have been established, 1 indicating large, 2 indicating midsize, and 3 indicating small¹. The NCES has identified twelve possible classifications. For example, a school that has a *locality* score of 31 would be identified as a school within a large town. From these scores, a set of dummy variables can be developed to categorize the areas in which these schools reside. This vector of four dummy variables can be reformulated in the random-effects regression as *City*, *Suburb*, *Town*, and *Rural*.

The *rvs* variable that will be utilized in the secondary questions section indicates the likelihood of collapse for a building. The lower the score, the more likely the building will collapse. These scores typically range from 0-7, but as noted earlier Oregon's seismicity risk has pushed the bounds of what these scores can achieve, giving some areas negative values. These scores can be divided into a vector of dummy variables that indicate risk levels. The risk levels associated would indicate four categories of risk: scores smaller than 0, Very High; scores greater than 0 but less than 1, High Risk; scores greater than 1 but less than 2, Moderate Risk, and; scores greater than 2, Low Risk.

SUMMARY STATISTICS

Variable	Mean (Standard Deviation)
AvHv	237,188 (106,387.4)
SRGP	0.046

¹ In the case of the rural and town categories, these definitions are slightly modified, but translate to have the same ranking function within the categories.

Variable	Mean (Standard Deviation)
	(0.21)
grant_tot	83,397 (304,228)
grant/stu	274.08 (1197.51)
rvs	1.31 (0.198)
vh_risk	0.08 (0.27)
h_risk	0.20 (0.40)
m_risk	0.16 (0.37)
l_risk	0.12 (0.33)
race	0.0415 (0.0977)
poverty	0.51 (0.22)
dist_tot	2,627,884 (5,428,446)
pschool	0.179 (0.397)
town	0.29 (0.45)
rural	0.26 (0.45)
urban	0.25 (0.43)
suburb	0.19 (0.39)

Table 1, Summary Statistics

A look at the summary statistics presented on table 1 can give us some insight into the makeup of Oregon schools and the SRGP. About 4.6% of schools received the SRGP funds with an average grant amount of \$83,397. Per pupil on average, the SRGP dispersed about \$274 demonstrated by *grant/stu*. This per pupil value is highly skewed toward the lower end as most schools have not received a grant. Schools received an average RVS score of 1.31, indicating the average school had a

moderate risk of collapse in the event of a large earthquake. Schools have an average student body of 3.7% racial minorities demonstrated by *Race*, and about 50.9% of students receive free or reduced lunch demonstrated by *Class*. Districts have an average expenditure total of \$2,627,884. I also see private schools are rather uncommon in Oregon, as the average number of private schools in a ZIP code area is about 0.179. Finally, our vector of locality size variables, *town*, *rural*, *urban*, and *suburb* can be summed to exactly 1, indicating each school area is exclusive to one of these categories. Further, I show that more school areas are classified as either rural or town than urban or suburban. While in the empirical model I use the log of average home values (LAvHV), for the purposes of summary statistics those values would not be illustrative. Instead, the average price of homes in the same ZIP code as a particular school is provided. Looking at average home value (AvHV), I see the average home value throughout the state is \$237,187.50.

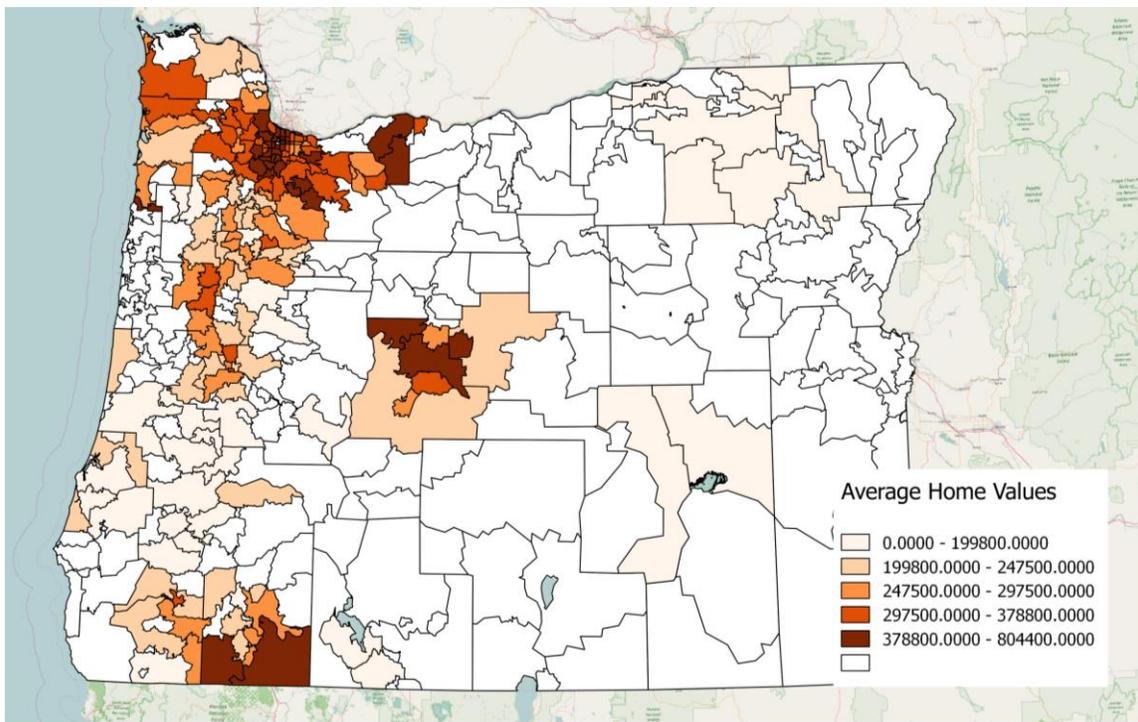


Figure 2 Average Home Value by Zipcode

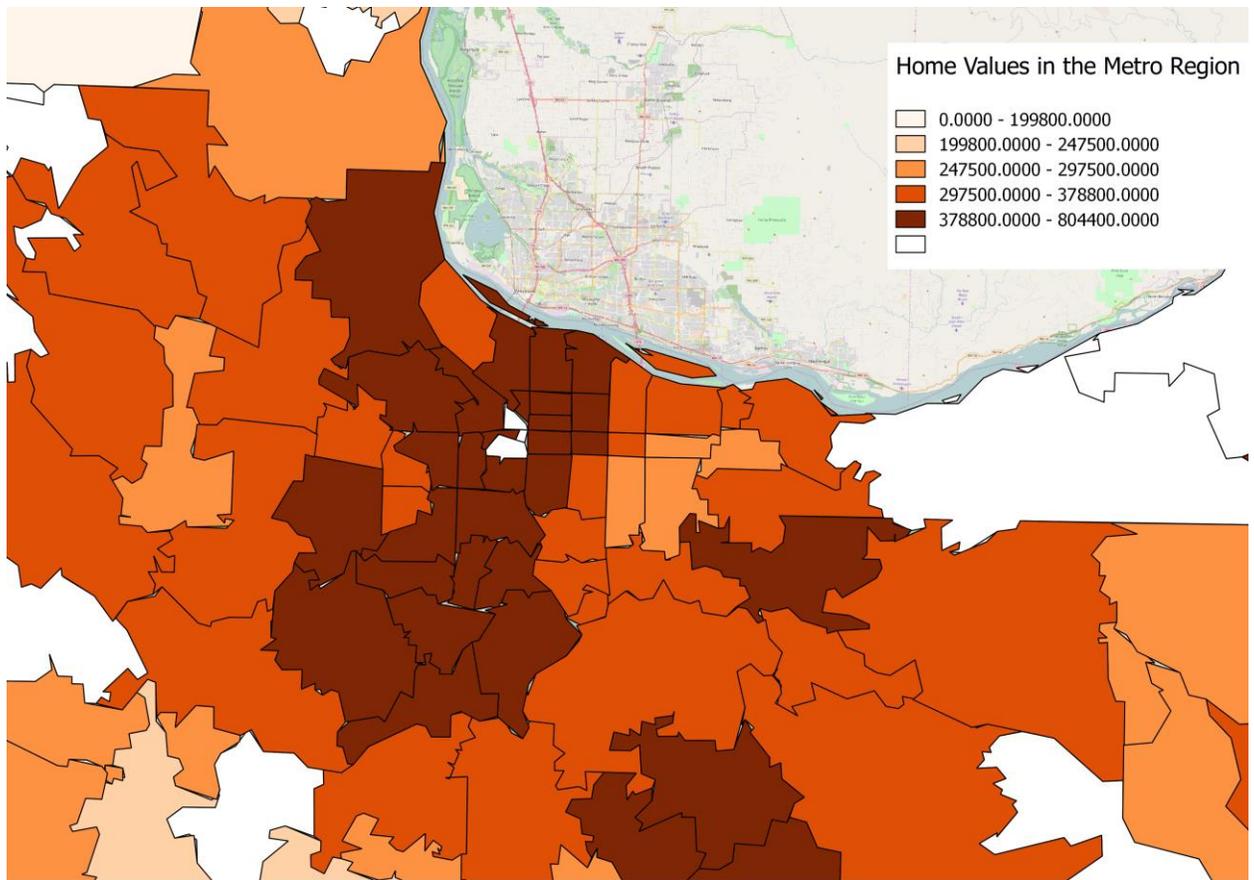


Figure 3 Average Home Values by Zipcode detail Portland Metro Area

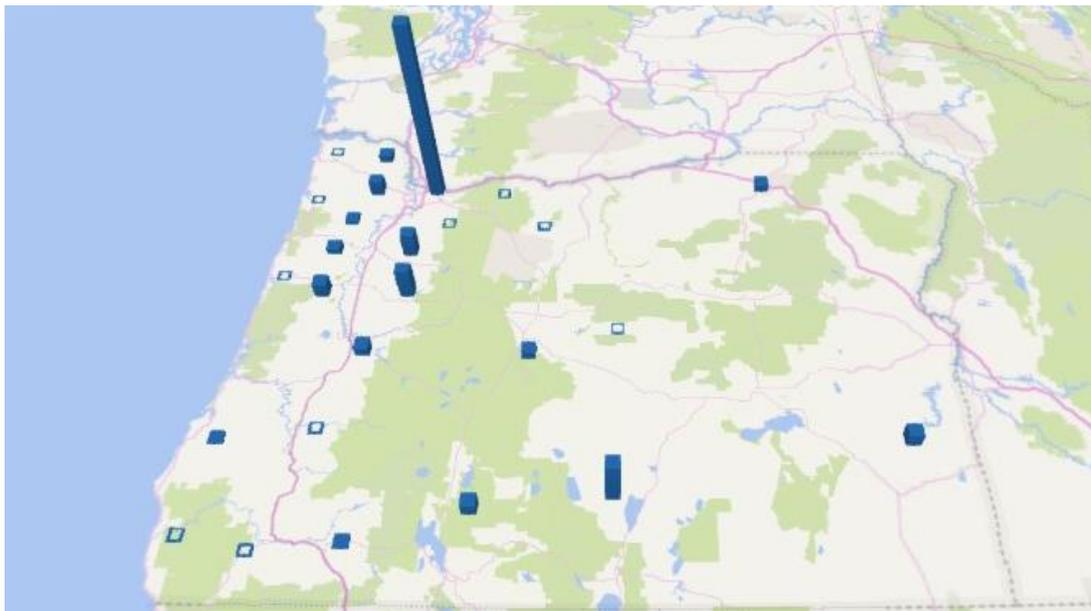


Figure 4 rvs scores indicating Very High Risk by county

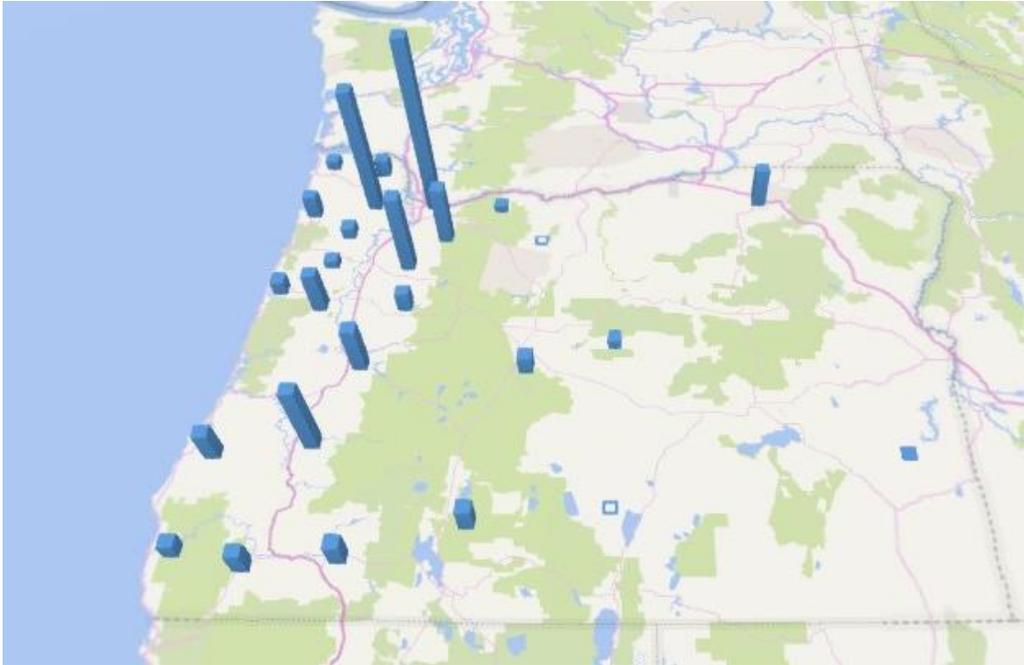


Figure 5 rvs scores indicating High Risk by county

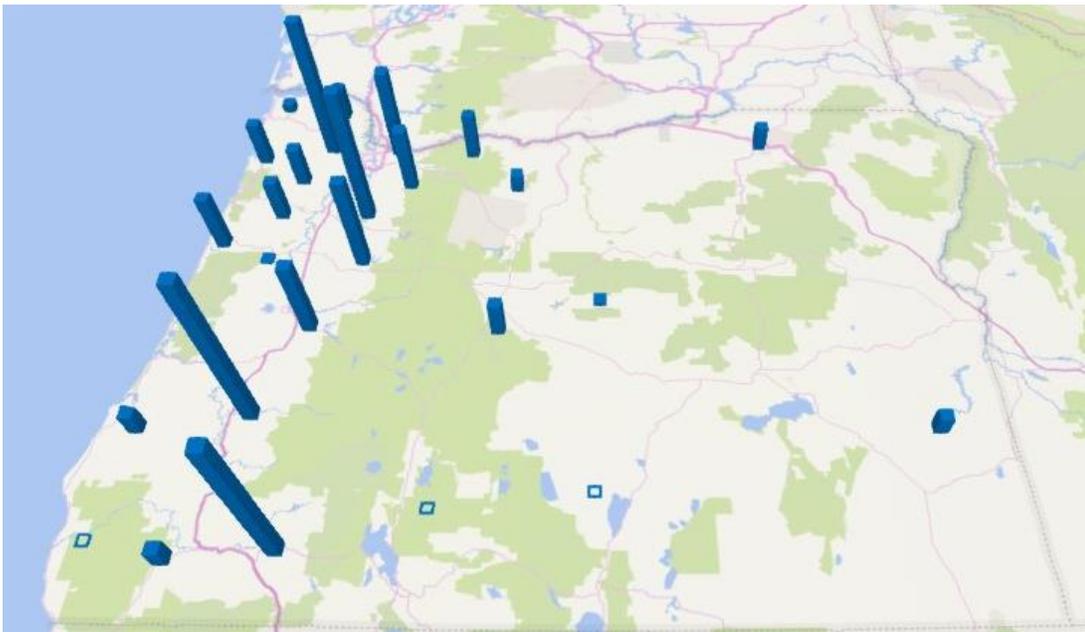


Figure 6 rvs scores indicating Moderate Risk by county



Figure 7 rvs scores indicating Low Risk by county

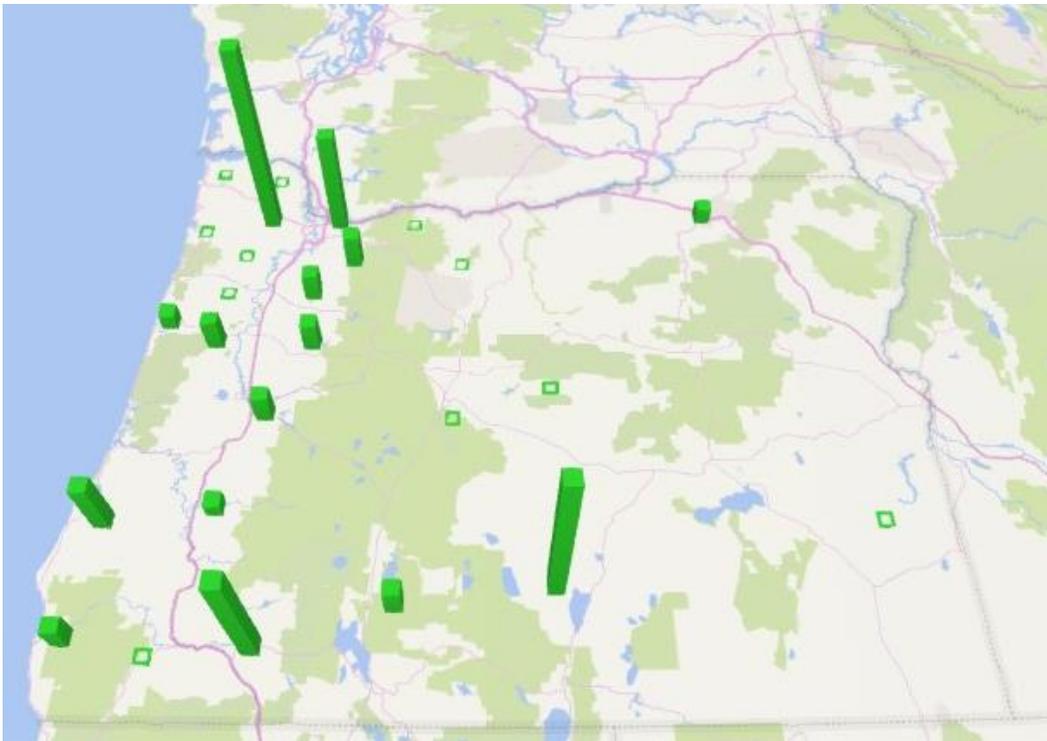


Figure 8 dispersal of the SRGP by county

Figure 2 displays the distribution of property values as of November 2016 throughout the state of Oregon, while Figure 3 demonstrates the differences throughout the Portland Metro

region. These figures demonstrate the concentration of home values throughout the state, with local particularities. Specifically, the concentration of home value in the Portland Metro region is clearly centered around the Portland Pearl District. Figures 4 through 7 demonstrate the geographical distribution of RVS scores by risk rating, and Figure 5 demonstrates the geographical distribution of the SRGP.

What is largely demonstrated in the above figures is the region distribution of Oregon's population, with the majority of Oregonians residing near Interstate 5 (I-5). A concentration of high-risk schools can also be seen within Multnomah County, the most populous county in Oregon. Further, the risk of the schools in each county is also largely concentrated in the population corridor that surrounds I-5.

This model reflects the theoretical limitations placed upon the model through economic and sociological understandings of RAT, the role of education, and how opting-out of public education affects local expenditures. A further control is also placed on metropolitan areas, accounting for differences in housing markets these areas face when compared to other areas in Oregon.

SECONDARY QUESTIONS

The secondary question that can be answered by this data set was also examined: Is the allocation of the SRGP funds largely following the recommendations of the DOGAMI risk assessments? While some political factors are present, such as community's willingness to participate, I would largely expect the RVS score that DOGAMI assigned to each school building following the passage of SB1 to be a key predictor in the receipt of the SRGP. To this end, our secondary question can be answered with the following model:

$$SRGP_{it} = \beta_0 + \beta_1 RVS_i + \delta X_{it} + \varepsilon_{it}$$

If the SRGP is allocated largely based on risk, I would expect our vector of variables, X_{it} , would not have predictive power while the RVS variable would. Because RVS is a time-invariant variable, a cross-section regression will be performed on the most recent date in which substantial data exists.

The vector of variables represented in X_{it} of our secondary model will include those variables included in the primary model and the total district expenditure ($dist_tot$). District expenditure may have some relationship with the receipt of the grant funds, as those schools that receive those funds may either be likely to engage in more capital investments or abate capital investments.

Because of this, the $dist_tot$ variable has been analyzed as a two-tailed variable.

I would expect all variables to be uncorrelated with the outcome variable, SRGP, except RVS as the RVS value indicates the likelihood of building collapse. RVS is calculated in an ordinal fashion, with the smaller the number indicating the greater likelihood of collapse. Because of the nature in which schools must compete for the grants, it is possible that no association between the RVS variable and the SRGP variable could occur due to reasons beyond the scope of this study.

FINDINGS

PRIMARY QUESTION

Ordinary Least Squares Regression

When performing an Ordinary Least Squares (OLS) regression, Model 1 of Table 2, many of the theoretical assumptions seem to fail. For example, we see the receipt of the SRGP associated with a 7.7% decrease in average housing value. However, Model 1 is likely flawed simply due to the fact that OLS does not correct for unobserved features about these schools in a panel

data setting. Further, the Education Production Function literature indicates some capitalization of student performance into home values does occur.

Fixed-Effects Regression

To correct for the issue of failing to account for unobserved factors, I estimate a fixed-effects regression, the outcome of which, can be seen in Model 2 of Table 2. Using a fixed-effects model that incorporates a time dimension, the SRGP is associated with about a 4.2% increase in home values following the capital investments. Following theoretical expectations, I can also see both high minority concentrations and high concentrations of students receiving free and reduced lunch (poverty proxy) having negative associations with home values. Further, I see that the number of private schools in the area do to not have a significant effect. This model can be compared to the random-effects model that uses individual controls for time-invariant measures. Model 2 omits the place size variables due to the Fixed-Effects assumption that individual specific effects are correlated with the independent variables.

Random-Effects Regression

Comparing Model 2 to the random-effects model, Model 3, I see similar coefficients on each of the variables. As demonstrated in table 2, the coefficients associating the SRGP with positive changes in home values remains very close to 4.1%, at about 3.7%. Further, Race and Class coefficients stay largely similar. Peculiarities arise when looking at the Pschools variable, which becomes significant and associated with a 3% increase in home values. Rurality gives an expected negative association, as rural homes would be predicted to be, on average, less valuable than more urban homes.

What is illustrated by the differences between these two models is the significance of three of our variables: SRGP, Race, and Class. Our predicted Pschool variable is seems to be less relevant, but the inclusion of the variable allows greater capture of the relationships which can be demonstrated in the increased adjusted r-squared value.

Variable	Model 1 (OLS)	Model 2 (Fixed Effects)	Model 3 (Random Effects)
SRGP	-0.08* (0.01)	0.042* (0.006)	0.0377* (0.006)
race	0.20* (0.03)	-0.38* (0.04)	-0.291* (0.03)
poverty	-0.88* (-0.01)	-0.412* (0.009)	-0.43* (0.01)
pschool	0.165* (0.006)	0.014 (0.009)	0.034* (0.001)
urban	0.04* (0.006)	(omitted)	0.23* (0.02)
suburb	(omitted)	(omitted)	0.22* (0.02)
town	-0.264* (0.006)	(omitted)	-.011* (0.02)
rural	-0.170* (0.006)	(omitted)	(omitted)
_cons	12.803* (0.006)	12.502* (0.005)	12.39* (0.02)

* indicates values is significant at the 1% level
 ** indicates value is significant at the 5% level
 *** indicates value is significant at the 10% level

Table 2 Comparison of the models

Similarly, when considering the fixed effects regression, Model 2, the assumption that correlation between inputs and outputs does not hold. While the coefficients on Model 2 are quite like those on Model 3, indicating similar results, some of the assumptions of a Fixed-Effects model are less accurate than those of a Random-Effects model. Because more accurate methods are available, Model 2 will not be utilized for the final interpretation. Finally, the random-effects

regression, Model 3, affirms the structure of the data, accounts for unobserved factors, and makes the appropriate assumptions about the relationships between the input variables and the output variable. These features cement Model 3 as the most accurate analysis of the effects of the SRGP on average home values.

DIFFERENCE-IN-DIFFERENCE

Variable	Three years prior (2006) Coefficient (Standard Error)	Two years prior (2007) Coefficient (Standard Error)	One year prior Coefficient (2008) (Standard Error)
year variable	0.117* (0.003)	0.094* (0.003)	0.03* (0.03)
race	-0.24* (0.03)	-0.23* (0.03)	-0.23* (0.03)
poverty	-0.33* (0.008)	-0.343* (0.009)	-0.409* (0.0099)
pschool	0.032* (0.008)	0.033* (0.008)	0.034* (0.009)
urban	0.22* (0.02)	0.22* (0.02)	0.22* (0.02)
suburban	0.25* (0.02)	0.24* (0.02)	0.25* (0.02)
town	-0.12* (0.02)	-0.12* (0.022)	-0.11* (0.02)
constant	12.34* (0.02)	12.34* (0.02)	12.38* (0.02)

* indicates values is significant at the 1% level
 ** indicates value is significant at the 5% level
 *** indicates value is significant at the 10% level

Table 3, Trends Three Years Prior to the Disbursal of the SRGP

Table 3 demonstrates trends in the average home value of Oregon as a state through 2006 to 2008, the three years prior to the distribution of the SRGP. What is displayed follows intuition in regards to the 2008 national housing market failure, in which the average values of homes plummeted. What is displayed is the boom year of 2006, which showed an average increase in

average home values of a little over 11%, followed by a slight stall in 2007 when homes only gained about 9%. In 2008, the average growth dropped to 2% showing significant shifts in the market caused, likely linked to the national financial crisis.

When comparing these areas to areas that received the SRGP, we would expect the treatment areas to have the changes to their home values mitigated by the SRGP. That is to say, if a 3% increase is felt throughout the state, areas affected by the SRGP would be expected to have an additional 3.7% increase in the average values of their homes.

SECONDARY QUESTION, MODEL 1

Variable	Coefficient (Standard Error)
rvs	0.0049 (0.0063)
dist_tot	1.75E-10 (1.54E-09)
AvHV	-1.42E-07 (1.22E-07)
Race	1.67* (0.12)
poverty	-0.083 (0.050)
Pschool	-0.02 (0.03)
_cons	0.08 (0.05)

*indicates values is significant at the 1% level
 **indicates value is significant at the 5% level
 ***indicates value is significant at the 10% level

Table 2, Secondary Question Model 1

When looking for the factors that are predictive regarding the receipt of the SRGP grant, each of the variables *RVS*, *dist_tot*, *AvHV*, *Class*, and *pschool* are not significantly associated with the receipt of the grant. This is concerning due to the *RVS* variable indicating the risk of a structure

collapse. However, the *Race* variable is associated with a 1.6% increase in the likelihood of receiving the grant. Further, there is a possibility that those schools within the highest risk areas are more diverse than other schools in Oregon for unexplored reasons.

The lack of predictive power on the *rus* variable could be due to the structure of the application process to receive the grant funds. The process itself may have a low degree of visibility, or may not be a concern for all schools, regardless of their probability of collapse in the event of a catastrophic earthquake. Further, it may be that the *rus* variable needs to be considered as a categorical variable indicating four distinct levels of risk. Because of this, another model will be constructed that considers *rus* scores as distinct categories.

The predictive power of the *Race* variable on the receipt of the grant could be due to multiple factors outside of the scope of this initial analysis. I do not immediately believe this predictive association on *Race* is truly due to biases for the following reasons. First, if *Race* were to be a consciously decided upon criteria for the receipt of the grant I would expect to see some of the variables associated with high racial concentration, such as *AvHV* and *poverty*, to have levels of significance. What the predictive power on the *Race* variable signals is that further specification of a model looking specifically into the distribution of the grant is necessary.

SECONDARY QUESTION, MODEL 2

Variable	Coefficient (Standard Error)
vh_risk	0.074* (0.028)
h_risk*	0.028*** (0.015)
m_risk*	0.027*** (0.016)
dist_tot*	-2.52 ^{-8*}

Variable	Coefficient (Standard Error)
AvHv*	(1.17 ⁹) -1.68 ⁸
poverty*	(9.05 ⁸) -0.03
race	(0.03) 1.39*
pschool*	(0.10) -0.0047 (0.021)
*indicates a variable is statistically insignificant	

**indicates values is significant at the 1% level*
***indicates value is significant at the 5% level*
****indicates value is significant at the 10% level*

Table 2, Model 2 Secondary Question

When considering the *rvs* variable as a categorical variable, the category Very High Risk becomes predictive of receipt of the SRGP, increasing the likelihood that a school receives the grant by about 7-percentage points. The *race* variable is still a significant variable in the prediction of the receipt of the grant. This may be due to the distribution of schools with high concentrations of racial minorities, which largely reside in the Portland/Multnomah County area. As I discovered when assessing the distribution of school risk, the county that has the highest number of schools that are ranked Very High Risk are within Multnomah County. Further, the finding of the category Very High Risk as a predictive variable of the receipt of the SRGP is intuitive, and supports the position that OBDD is distributing the SRGP funds in a way that is largely determined by the risk of collapse a school has. Because I ultimately find that the most predictive factor for the receipt of the SRGP is rooted in the meaning of the RVS score, it becomes clear that OBDD is largely using risk as a means of assessing applicability of the SRGP.

LIMITATIONS

Major limitations of this study come in the form of the level of analysis in which the study was performed. Because the unit of measure was ZIP code for area, I expected much of the effects of the *SRGP* on *AvHV* to be washed-out over these larger geographical areas. In an ideal study, neighborhoods in which the schools reside would be the ideal unit of analysis. Due to the nature of using available data, neighborhood-level data was only available for a small number of the areas included. To improve upon this study, I would suggest developing a method to reliably marry school attendance zone data with the *ZHVI* average home value data I used in this study.

Again, I must return to the poverty measure that only worked as an indicator of a class variable that I had aimed at when constructing this study. While poverty is surely an important measure of internal properties of households, I believe it is a very small piece of internal characteristics that are important in households. For these reasons, this study was limited in its ability to produce a more accurate measure internal to households.

Further limitations come in the form in relying on private data sources. In this study, a dependency was put on data provided by Zillow. While I have no reason to immediately distrust or complain against Zillow, relying on private data to make decisions for public policy has a host of problems that could arise. The alternative source of home value data would be the various county commissioners throughout the state. Considering Oregon's history around property tax increase limits, primarily Measure 5 and Measure 50, the mechanisms of school funding in the state have been centralized largely to the state, while local funding has dwindled. Given that Zillow data is largely tied to the market and is collected in a single database, it is likely the best source of home value data for this project.

DISCUSSION AND POLICY IMPLICATIONS

My findings show that areas in which a local school received the SRGP experiences a 3.7% increase in average home value. These findings highlight the unintended consequences, or tertiary effects of policy-making, which once uncovered, must be inserted into the decision-making process. The primary normative questions that arise from these findings concern the use of discovered unintended consequences in policy-making and distributive justice, informing policy recommendations for an increased awareness of tertiary effects of policy. Another theme that arises from this study is a question weighing the preparation for an uncertain event and the certain gains that are incurred by the public through policy, which will inform a recommendation to local governments to engage in capital investment strategies. A final general recommendation will be provided, which takes inspiration from the more general Tiebout Model.

TERTIARY EFFECTS OF POLICY AND IMPLICATIONS

Unintended consequences of policy have the potential to override the intended aims of policies. This often occurs when the unintended consequences promote a harm to society. For the purposes of this piece, I will not weigh in on legislative intent of policies, and simply refer to those effects not explicitly stated.

Tertiary effects of policy can be seen in criminal policies, which have shown racially disproportionate effects on different communities within the public (Davies, 2003). The parallel here is simply the focus on the tertiary effects, in this case disproportionate effects of criminal policies. Such differences have lead scholars to assess the efficacy of 'stop-and-frisk' policies (Goel, Perelman, Shroff, & Sklansky, 2017) and discretion allowed within use of force following particularly high-profile events (Legewie, 2016) to name a few. These studies highlight the tertiary

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effects of policy, and advocate for the consideration of these effects in policy-making, particularly highlighting a question of distributive justice. That is, highlighting these policies with tertiary effects that produce racially disproportionate effects on different communities, the question whether or not the state should consider the differences in how institutional justice is distributed amongst those communities arises. Similarly, the inclusion of the tertiary effects of capital investments bring with them a similar question of whether or not the state should consider these tertiary effects impact communities arises.

My first recommendation is to state-level governments that are currently engaged in hazard mitigation policies through capital investment. This recommendation would be that state-level governments strongly consider the tertiary effects of capital investments when engaging in hazard mitigation policy. As it stands, the tertiary benefits I highlight play no role in the assessment or dissemination of hazard mitigation through capital investments within the SRGP structure. This primary recommendation would imaginably lead state-level governments to increase the scope of capital investments programs. The Oregon Executive branch has already heeded this primary recommendation with an increase in the scope for capital investment measures. This is demonstrated by Oregon Governor Kate Brown in the Governor's Budget for the 2017-2019 biennium in which the SRGP has been allocated \$150 million, tripling the largest budget the SRGP had previously (Department of Administrative Services, 2016).

UNCERTAINTY IN INVESTMENT

Capital investments such as the SRGP are primarily aimed at the abatement of uncertain events. Despite the consensus regarding the likelihood of the Cascadia Event the SRGP is preparing for, there is no certainty regarding when the earthquake will occur. In fact, it is possible

that the geological event that the SRGP would prepare for may occur outside of the lifespan of the buildings that receive the abatement grant. Considering this uncertainty, does the inclusion of tertiary benefits to housing values justify the cost to the public?

When considering the question of uncertainty in regards to the SRGP, I would propose a thought experiment. Suppose the earthquake does not occur, and geologist discover their conclusions regarding the Cascadia Event were fundamentally flawed. From this point, I still ask residents of localities to fund retrofitting measures through local bond measures if those bonds cost the average homeowner to pay less than 3.7% of their home value toward the new measure. If I were to incorporate RAT and hold all other things equal, the average resident would be expected to prefer the retrofitting if bond measures are less than 3.7% the value of their homes. Further, if the bond measure reaches 3.7% of their housing value, residents would be expected to be completely indifferent to the passage of bond measures that would allow the receipt of the SRGP. While this reasoning may can be undermined due to the possibility of outliers adjusting the mean voter from the median voter, it provides a base to understand the distribution of benefits that the SRGP does incur.

From this thought experiment arises a likely preference to engage in those local efforts that would promote the receipt of the SRGP. From the outside of the thought experiment, we can consider other benefits that communities would likely incur from seismic retrofits of their school buildings. As highlighted earlier in the Jefferson School District zone, an analysis of the amount of taxes paid out to the new bond measure can be compared to the expected increase in home values. If RAT holds outside of the thought experiment, it could be that the benefits beyond the increase in home values would indicate preferences for survival of the children within the schools, which

would likely be greater than zero. Again, Jefferson residents would also be given access to an assessment of the added community value of upgraded school facilities.

From this line of reasoning, my secondary recommendation, to increase local support and participation in the SRGP program, is born out of certain municipality's refusal to engage with the SRGP. Because the SRGP requires those areas that receive the funds engage in some seismic stabilization measures throughout the community, some communities have pushed back refusing to renew or pass bond measures that would fund community efforts required by OBDD to receive the grant. For those localities, this study would serve as a support of the renewal and/or implementation of bond measures aimed at securing state and/or federal funding into local infrastructure.

BUILDING INFRASTRUCTURE FOR COMMUNITY RESILIENCE

The final recommendation comes in the form of a general recommendation for capital investments. Through the lens of the Tiebout model, we expect to see positive impacts on those areas that invest in infrastructure and services. This study confirms those expectations, providing a single point of reference for a complex justification of federal-level capital investment. This modest recommendation would call for federal-level government officials to consider investments into various forms of infrastructure as a means of "double-dipping" and receiving these tertiary benefits along with the intended effects.

FURTHER STUDY

This study supports bodies of work aimed at assessing the impacts of capital investments, especially those impacts that are not the primary aims of the investment. This study also demonstrates some shortcomings in available datasets. Further study would be required for a

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robust analysis of the dispersal of grant money, as this study is aimed primarily at the effects after the grant has been received. Additionally, a consideration of smaller levels within ZIP code areas may find greater granularity in the effects of capital investments, which could provide more specific recommendations.

LIMITATIONS OF THE EMPIRICAL MODEL

As noted in the Data and Methods section, the *poverty* variable is an imperfect indicator of class. This limitation stems from the lack of data on families within the data made available in schools. This empirical model used the proportion of students who receive free and reduced lunch, a measure of poverty, attempting to inform a *class* variable. To overcome this limitation, further study would be required that specifically collects data on the internal characteristics of households that send children to the studied schools. Preferably, the measures of social class would be embedded into the NCES databases.

DISTRIBUTION OF GRANT FUNDS

Further study of the SRGP could clearly include an empirical model more specified to test the distribution of the grant. When considering this question, I did find the variable *Race* to be associated with the receipt of the grant. A more robust analysis of the inputs communities must complete to receive the funds would be required. This could occur through an analysis of the application procedure and a consideration of more local factors that may be predictive of the receipt of the grant.

INCREASED GRANULARITY

My final recommendation for further study of the SRGP would be to further refine the boundaries around schools that are considered. For the purposes of this study, I was limited to ZIP

code-level analysis due to the shape of the data in most cases. Only about half of the home values could be dissected into regional boundaries smaller than ZIP code-level. This limitation is due to the method in which Zillow collects data, reporting on neighborhoods in the City and Suburb levels, and only ZIP code in smaller areas. As demonstrated in the data and methods subsection summary statistics, more schools are in these smaller areas defined as towns and rural in the state of Oregon.

To overcome this limitation a redefinition of boundaries in which home values are aggregated would be required. In an ideal setting, this would be set by school attendance boundaries. To achieve this, a collection of disaggregated home value data would be needed that GIS school attendance boundaries could be overlaid upon. This level of granularity is possible, but the collection of this data may be daunting.

CONCLUSION

This piece analyzes a statewide infrastructure grant aimed at hazard mitigation of earthquake risk in the state of Oregon. Using panel data on characteristics of schools throughout the state and the average home value of homes within the zipcode in which the SRGP capital investments have occurred, I have produced a difference-in-difference analysis of tertiary impacts of the capital investment grants on home values. Using this method, I have found 3.7% increase in the average value of homes in the areas within the same ZIP code area of the schools that received the capital investment grant.

After finding about a 3.7% increase in the average home values of areas in which schools that received the SRGP money reside, I have suggested three policy responses for three levels of governance. For states, I have suggested increasing the focus on tertiary effects of policy. For local

areas, I have suggested that they engage in state and/or federal programs that would provide funds for capital investments. For the federal government, I have suggested a general mode of considering capital investments as investments that enrich areas in ways beyond those metrics that may be immediately ascribed to a project. Through the understanding of the historical, social, and political climate surrounding the SRGP I have developed an understanding of the tertiary effects of capital investments into public infrastructure.

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