12-2014

Essays in Public and Corporate Finance

Joseph Newhard
Clemson University, jmnewhard@gmail.com

ESSAYS IN PUBLIC AND CORPORATE FINANCE

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Economics

by
Joseph Michael Newhard
December 2014

Accepted by:
Dr. William R. Dougan, Committee Co-Chair
Dr. Robert D. Tollison, Committee Co-Chair
Dr. Robert K. Fleck
Dr. Sergey Mityakov

ABSTRACT

Each of the three chapters of this dissertation makes a unique contribution to the fields of public finance or corporate finance. In chapter one I show that tax-price is increasing in workplace risk due to a positive wage-risk response that is observed in the labor supply price for hazardous industries. This result implies that, holding human capital constant, workers in more dangerous industries will demand a relatively smaller public sector. I test this with county-level data on fatality rates and support for the two major party candidates in the 2004 US Presidential election. Taking Republicans to represent the party of limited government I find that industry fatality rates remain positive and significant drivers of support for smaller government through various regression specifications. These results are robust to cross-sectional data on individual contributions reported to the Federal Elections Commission for the 2004, 2008, and 2012 US Presidential elections and to panel data for individual contributions across the US Presidential elections in 2004, 2008, and 2012.

Chapter two uses the above panel data to test whether political support is influenced by location. For the subsample of individuals who move across states between elections, and taking the first difference in percent of votes for the Republican between the new state in time *t* and the old state in time *t-1* as the independent variable of interest, I find that donors who previously supported the Democrat are more likely to switch to the Republican when moving to a state where support for the Republican is greater than before, and vice versa.

In chapter three, I present an event study of the Castle Bravo nuclear test, recreating a paper by Armen Alchian that was conducted, confiscated, and destroyed at RAND Corp. in 1954. Even though its use was secret at time and the effects were only theoretical, Castle Bravo innovated the use of lithium deuteride fusion fuel, and the market price of Lithium Corp, the main producer of lithium at the time, saw a return of 28.2% in the month following the test and a return of 461% for the year, providing evidence that even military secrets may be reflected in the prices of publicly-traded companies.

DEDICATION

In celebration of the centenary of the birth of Armen A. Alchian, April 12, 1914 – February 19, 2013.

ACKNOWLEDGMENTS

My dissertation committee assumed great costs to help me improve my level of competence in economics despite receiving no material compensation for their effort. Thanks to William Dougan, without whose input this dissertation could not exist in its present, refined form. His guidance proved essential, especially due to his familiarity with the literature on taxation, risk, and equalizing differences. It was apparent that he was putting much thought into helping me improve my research even when I was away. He is uncommon in his candor, and his counsel and assistance exhibited an extraordinary dedication to education and to advancing the body of knowledge in economic science. Thanks to Robert Tollison whose door was always open to me. I took full advantage with frequent visits to his office, bringing plenty of questions and he had a profound ability to set me off in the right direction in pursuit of my ideas. Thanks to Robert Fleck whose interests were parallel to my own, who could always be counted on for insightful and useful comments on my papers, and who radiated an enthusiasm and a passion for economics which enhanced all of my workshops. Thanks to Sergey Mityakov for many invaluable comments on my papers which ultimately enhanced their quality.

Thanks to the members of the public economics workshop at Clemson University and the attendees of the University of Georgia Finance Department seminar. Kevin Tsui and Curtis Simon deserve special mention for helpful comments on chapter one. Thanks to Mike Maloney and Harold Mulherin for their help with chapter three, enabling it to be published in *Journal of Corporate Finance*. Thanks to Mark Mitchell and the guys at CNH

Partners for everything. Thanks to the benefactors of the Robert E. McCormick Fellowship, 2011 – 2014 and the Charles G. Koch 2010 summer fellowship. Thanks to Peter Vanderhart for his help getting me here.

Thanks to Trevon D. Logan, without whom I would not have attended graduate school, and who early on provided a model of a successful economist for me to emulate in my own graduate career.

Thanks to my parents, Michael and Patty.

TABLE OF CONTENTS

Table of Contents (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER ONE

The Effect of Equalizing Differences on Tax-Price: Explaining Patterns of Political Support across Industries

1.1 Introduction

A portion of the compensation that workers receive for their labor is nonpecuniary. In addition to wages including bonuses and pensions they enjoy such benefits as tenure, health insurance, workplace safety, job security, and local amenities. Firms must offer wage premiums to compensate workers for adverse occupational characteristics in order to attract laborers who would otherwise seek employment under more favorable conditions, while workers purchase favorable workplace characteristics at a positive price that is subtracted from the wage; the resulting equalizing differences across firms and occupations facilitate the long-run labor market equilibrium. Previous research establishes the relationship between nonpecuniary occupational characteristics and compensating differentials. However, these equalizing differences entail political implications not acknowledged in the literature. This paper establishes both a theoretical and an empirical link between compensating differentials and political behavior, showing that workers who face relatively greater workplace disamenities are more likely to demand a relatively small public sector. Since they earn wage premiums sufficient to make the marginal worker indifferent between the high disamenity and low disamenity industries, they also face a higher tax-price than the low disamenity industry workers who enjoy nontaxable nonpecuniary compensation. The cross-occupation differences in tax-price manifest themselves as systematic differences in the size of government that workers tend to support across occupations, explaining why professors, artists, teachers, actors, and other professions tend to support a large public sector relative to farmers, miners, factory workers, construction workers, truck drivers, and members of the armed forces who face significant disamenities in the workplace.

I test this theory using county level data on workplace fatality and injury rates and county votes for each major candidate in the 2004 US Presidential election. Fatal injuries are only one nonmonetary aspect of work, but a significant one and one for which data are readily available – and one which does not vary in degree or level of severity as injuries do, though both are included. Percent of votes for the GOP vs. Democrats are regressed on county weighted average fatality and injury rates based on industrial makeup of the county available from the Census Bureau, along with a range of personal characteristics also from the Census Bureau including race and ethnicity, age, educational attainment, and gender, as well as a dummy for county adjacency to the Great Lakes or oceans (except Alaska). These last two dummies are included to capture a major aspect of the nonpecuniary benefits workers enjoy due to differences in local or regional attributes. These may be captured either in (lower) wages or (higher) land prices, as people are generally willing to pay a positive price for them.

I find that fatality rates are positive and significant in their effect on GOP support. I then run a robustness check using the same data on industry injuries and fatalities from the Bureau of Labor Statistics and data on individual political contributions above $200 which are required by law to be reported to the Federal Elections Commission. Contributions to the two major party candidates for the US Presidential election in 2004, 2008, and 2012 are used. In the first set of logistic regressions, the dependent variable is dichotomous monetary support for the Republican or the Democrat candidate. Independent variables include industry mean wage, injury, and fatality rates, a gender dummy, and election year dummies. I find large and significant coefficients on fatality rates through all regression specifications, indicating that they explain some support for Republicans. Lastly, I match individual donor names across the 2004, 2008, and 2012 data sets to test if changes in the fatality rates donors face across elections affects their political support, finding that an increase in the fatality rate they face is a positive and significant driver of switching support from the Democrat to the Republican, and vice versa. All three regressions establish a consistent empirical link between workplace risk and Republican support.

1.2 Workers and Voters

As has been well-known since Adam Smith's Wealth of Nations, wages must compensate labor supply for differences in the nonpecuniary aspects of the workplace across occupations; such equalizing differences in wages allow the labor market to clear by equalizing monetary and nonmonetary advantages across all occupations to marginal workers, and represent the fundamental long-run equilibrium mechanism in labor economics (Rosen, 1994, p. 272). The wage premium for relatively negative workplace characteristics is known empirically to be positive in risk of injury and death, volatility in unemployment, and negative interregional aspects related to crime, crowding, and climate (e.g. See Viscusi, 1990). Empirical studies indicate that the size of the premium for risk can be significant (Moore & Viscusi 1990, Thaler & Rosen 1976, Viscusi 1992). Thaler and Rosen (1976) were the first to derive estimates of the demand price for safety in the workplace, finding the wage-risk function to be positive as employees were compensated $3.52 per week ($24.85 in 2014 dollars) per .001 increase in risk of death in an analysis of unusually risky jobs. Moore and Viscusi find that the process of workers learning about occupational risks leads to positive compensating differentials and greater employment turnover and self-sorting across occupations according to individual risk preferences and personal ability to cope with risk (Moore & Viscusi, 1990). Studies consistently reveal a wage gradient that is increasing in job risk, even if premiums may fall short of fully compensating workers for risk (see Fishback, 1998) or if they are too high (Moore & Viscusi, 1990, pg. 61). Below I derive some political implications of these equalizing differences.

Following Rosen (1994), suppose there are two industries, one dangerous (D=1) and one safe (D=0). In long run equilibrium, δ adjusts such that the labor market clears and the marginal workers of each industry are indifferent between each industry. Under perfect insurance, with perfect information, actuarially fair premiums, and no moral hazard, all workers have same relative marginal acceptance wage regardless of their individual extent of risk aversion (Thaler & Rosen, 270-273). This also assumes no differences in ability to deal with workplace risk, no fringe benefits, and no pain and suffering – compensation is for lost wages only. In reality, income replacement formulas, subject to ceilings, floors, and limits, "generally" provide two-thirds income replacement, with an income gap that is not eliminated despite tax exemption of workers' compensation benefits (Viscusi, 1992, 75). Additionally, nonpecuniary losses may be considerable (Viscusi, 1992, 85; Moore & Viscusi, 1987) and workers may reject actuarially fair insurance for the types of losses due to pain and suffering (Viscusi, 1992, 75-76). The assumption of perfect insurance is relaxed here – heterogeneous worker preferences results in the compensating differential varying positively with the level of employment, since those most willing and able to assume workplace risk are the first to enter dangerous employment. Workers in fact do demonstrate considerable heterogeneity in their willingness to accept risk with those less concerned with risk exhibiting lower implied valuations of life (see Viscusi, 1990, 14; Viscusi, 1992, 42 – 47). Assume that workers are only homogeneous in their reservation wage for employment in the baseline (safe) industry but differ in their willingness to assume workplace risk, resulting in heterogeneity in the premiums they demand for risk levels. This results in a perfectly elastic supply curve in the safe industry and a rising supply curve in the dangerous industry.

Assign $\delta > 0$ as the premium above the mean wage $\overline{w}$ that employers must pay to induce worker *i* to accept jobs *j* that are above-average in their onerous aspects. Alternatively, a $\delta < 0$ is the price subtracted from $\overline{w}$ that worker *i* forfeits for employment in occupations with desirable nonpecuniary characteristics, ceteris paribus:

$$\delta_{i,j} \epsilon (-\overline{w}, \delta)$$

The lower bound of $-\overline{w}$ demarcates the line between occupation and hobby. The wage premium, or compensating wage differential δ is a function of unobservable individual worker characteristics *I* and observable job characteristics *J*, such as fatality rates:

$$\delta_{i,j} = h\left(\underline{I}, \underline{J}\right)$$

Define tax price ϕ_i as the taxpayer i's share of each dollar of government spending. Across N individuals earning $Y_i = \overline{Y}$ each individual's tax-price is: $\phi_i = \frac{1}{N}$. Under a proportional tax, and even more so under a progressive tax, individuals earning more than $\overline{w}$ holding the number of hours worked constant will face a higher-than-average tax-price since tax-price is positive in income. Worker i pays income tax T_i depending on his compensating premium-adjusted wage and hours worked:

$$T_{i,j} = t_i y_i = t_i\left(\overline{w} + \delta_{i,j}(t_i)\right) L_{ij}\left(\delta_{i,j}\right)$$

Both $\delta_{i,j} = f(t_i)$ and $L_{i,j} = f(t_i)$. This is true since $\frac{\partial X_j}{\partial L_{i,j}} - T_i = \overline{w} + \delta_{i,j}$, where X_j is output in industry j. As the tax rises, both the marginal product of labor rises and $\delta_{i,j}$ falls through a decrease in $L_{i,j}$ until the equality is once again satisfied. The tax T_i paid by i is $\phi_i G$, his tax price multiplied by government expenditures G:

$$\phi_i G = t_i\left(\overline{w} + \delta_{i,j}(t_i)\right) L_{i,j}\left(\delta_{i,j}\right)$$

In the long-run equilibrium, if $\delta_{i1} > \delta_{i0}$, then normalizing $\delta_{i,0} = 0$:

$$\frac{t_i\left[\overline{w} + \delta_{k,1}(t_i)\right] L_{k,1}\left(\delta_{k,1}\right)}{G} \geq \frac{t_i \overline{w} L_{i,0}(\overline{w})}{G}$$

$$\phi_{i1} \geq \phi_{i0}$$

Tax price is increasing in δ, and thus in risk. This holds under a flat tax or a progressive tax. Tax-price is increasing in $\delta_{i,1}$ and in the tax rate i faces holding t_{-i} constant. Now consider the effect of a change in G on tax-price. In democracies, a change in G is decided by voters so assume that for the set of voters V and the set of workers W, W = V. If workers vote to increase G there must then be a corresponding change in t_i to balance the budget. Tax rates and tax-prices cannot be set simultaneously since $Y_i t_i = \phi_i G$. For a given G, if t_i is fixed and workers can choose Y_i (tax base) then ϕ_i is unknown ex ante. If ϕ_i is set and workers can choose Y_i, then t_i is unknown ex ante. If the tax rate is residually determined by the vote for G, then t_i will likely be set based on the current tax base. Then individuals can reduce their own tax-price by reducing their income (Buchanan, 1967, 34). This strategic behavior comes into play below.

As shown above, workers in the dangerous industry face a higher tax-price than ones in the safe industry simply because they receive a compensating premium for risk, holding all else constant. On this basis alone workers in the dangerous industry prefer a relatively lower quantity of government. However the welfare effects of subsequent changes in G will also differ between industries. Continue to assume imperfect insurance and heterogeneous worker preferences with respect to workplace risk. In the dangerous industry (D=1), workers earn $\overline{w} + \delta_1^*$, where δ_1^* is the premium demanded by the marginal worker in that industry; N inframarginal workers collectively earn rent of $\sum_{i=1}^{N}(\delta_1^* - \delta_{i,1}) > 0$ with $\delta_i \epsilon (\delta_{min,1}, \delta_1^*)$. In the safe industry, every worker receives $\overline{w} + \delta_0$ earning rents of $\sum_{j=1}^{M}(\delta_{j,0} - \delta_{j,0}) = 0$ across M workers. Assume $\overline{w}$ is exogenous so that $\frac{\partial \overline{w}}{\partial t} = 0$. Given some increase in G, $\frac{\partial t}{\partial G} > 0$. Specifically, since $G = t_i \sum_{i=1}^{M+N} Y_i$, $\frac{\partial t_i}{\partial G} = \frac{1}{\sum_{i=1}^{M+N} Y_i}$ per unit of G. This change in t_i in response to change in G affects rents earned by some workers. For the purpose of exposition, we begin with no income tax. By the above assumption under which workers equally value the baseline (safe) industry but differ in their willingness to assume workplace risk, the following general labor supply functions are posited. Safe Industry (j=0) Labor Demand:

$$L_D^0 = f(MPL_0)$$

Dangerous Industry (j=1) Labor Demand:

$$L_D^1 = f(MPL_1)$$

Assume $L_D^0 = L_D^1$. Normalize $\delta_0 = 0$. In original equilibrium:

$$L_D^0(\overline{w}) = L_S^0(\overline{w})$$

$$L_D^1(\overline{w} + \delta^*) = L_S^1(\overline{w} + \delta^*)$$

Where $\delta*$ is the premium commanded by the marginal worker. After the tax T is imposed, who pays it and what is the effect on labor supply rents across industries? The post-tax wage response is defined as:

$$\frac{\frac{dw}{dT}}{w} = \frac{\eta_D^j}{\eta_S^j - \eta_D^j}$$

Since $L_D^0 = L_D^1$, elasticity of demand for labor $\eta_D^0 = \eta_D^1$. Assume these equal -1. The safe industry elasticity of supply is:

$$\eta = \infty$$

The dangerous industry elasticity of supply is:

$$\eta = \alpha \frac{\overline{w} + \delta^*}{L_S^1}$$

Thus the net wage response to the tax in the safe industry is:

$$\left(\frac{dw}{dT}\right)_0 = \frac{-1}{\infty + 1} = 0$$

And in the dangerous industry:

$$\left(\frac{dw}{dT}\right)_1 = \frac{-1}{\alpha \frac{\overline{w} + \delta^*}{L_S^1} + 1}$$

Since $\alpha > 0$ and $\eta_S^1 > 0$,

$$\left(\frac{dw}{dT}\right)_1 < 0$$

In the dangerous industry, the market wage rises but employment and rents fall. We can compare change in lost rents R after the tax is imposed. In the Safe Industry:

$$dR_0 = \frac{1}{2}\left(L_{D,0}^0 - L_{D,1}^0\right)(\overline{w} - \overline{w}) + L_{D,1}^0(\overline{w} - \overline{w}) = 0$$

In the Dangerous Industry:

$$dR_1 = \frac{1}{2}\left(L_{D,0}^1 - L_{D,1}^1\right)(\overline{w} + \delta^* - \overline{w} - \delta^{**}) + L_{D,1}^1(\overline{w} + \delta^* - \overline{w} - \delta^{**}) > 0$$

Since δ^{**} is the premium commanded by the new marginal worker and $\delta^{**} < \delta^*$. Change in rents is thus zero in the safe industry and negative in the dangerous industry, specifically

$$-\sum_{i-1}^{M}(\delta^* - \delta_i) + N(\delta^* - \delta^{**})$$

(Where $\delta^* > \delta_i > \delta^{**}$) For M workers driven into unemployment and N workers who remain after the tax is imposed. Although some workers in both industries are driven into unemployment following the tax increase, those who remain in the safe industry earn the same rents as before since labor supply there is perfectly elastic. Workers who remain in the dangerous industry suffer a decrease in rents since the premium commanded by the new marginal worker, δ_1^{**}, is now less than before the imposition of the tax for the set of inframarginal workers who survive the layoffs:

$$\sum_{i=1}^{N} L_N\left(\delta_1^{*} - \delta_{i,1}\right) > \sum_{i=1}^{N} L_N\left(\delta_1^{**} - \delta_{i,1}\right)$$

Workers judge the relative pecuniary attractiveness of occupations in their returns after taxes. Imposing or increasing the income tax can distort this relative attractiveness since the tax base does not account for nonpecuniary factors (see Friedman, 1976, 246). This is true regardless of whether the tax is proportional or progressive, making working in occupations with large nonpecuniary advantages an effective strategy for reducing payments of the income tax (Friedman, 1976, 247). As the tax rate increases, necessitated by an increase in *G*, workers in the dangerous industry realize a decrease in their rents while those in the safe industry do not. Under both homogeneous and heterogeneous labor supply functions, workers close to the margin are left seeking new jobs. Given that taxes affect not only the labor-leisure decision but the wage-fringe benefit decision as well, Powell and Shan (2010) find evidence that workers seek jobs with lower wages and more amenities when taxes rise, estimating a .03 compensated elasticity. Like all productive activity, searching for job information is costly (e.g. see Stigler 1962, Alchian 1969) and involves delayed wages. This is particularly true when workers are driven out of their native industry; though individuals are well-informed about risks faced in one's own industry or general environment, where information is less costly to obtain and more relevant, they are less knowledgeable about aggregate workplace risk (see Benjamin and Dougan, 1997; Benjamin, Dougan and Buschena, 2001). A worker willingly assumes the costs involved in a job search until the expected wage gain of continuing the search equals the cost of searching for one more job, and at that point accepts the job offer that maximizes his net advantage. The longer the information search, or the more intensely it is conducted, the costlier it becomes. The greater the search costs, the greater the number of workers who choose unemployment following the tax increase. Thus delayed wages, transaction costs, and being bumped from one's previous optimal choice make the income tax costly. The more that disamenities are defining features of a particular industry, the worse off workers in that industry are since they cannot easily substitute nonpecuniary compensation for cash payments. For instance, Powell (2010) asserts that taxes disproportionately harm low amenity, high-compensating wage differential industries and finds that the wages of more dangerous occupations are more responsive to increases in the income tax than wages of safe occupations, compensating workers in high disamenity occupations for wage differentials that were taxed away in the same year.

Just as an increase in *G* decreases the rents of workers in the dangerous industry while holding fixed the rents of safe industry workers, a decrease in *G* increases their rents without improving rents in the safe industry, even while reducing the level of *G* those workers enjoy. Some professions are better able to substitute nonpecuniary compensation for income, and consequently vote for larger government than they otherwise would have (see Buchanan, 1967, 36-37). Those who think the ability of others to lower their own tax-price is constrained, but who themselves are more flexible, vote for large government and then reduce their own tax-price, simultaneously driving it up for others (see Buchanan, 1967, 37). Workers who are able to reduce their taxable income by substituting nontaxable income (including leisure by reducing $L_{i,j}$) "without great losses in utility" get discount pricing for public goods, and "we should expect individuals and groups with these characteristics to be relatively favorable toward extension in public spending programs" (Buchanan 1967, p. 36). These workers then demand a relatively large public sector. As far as voting strategically, even workers in the dangerous industry who are close to margin may vote for larger government, then switch to the safe industry when the tax rate increases, earn $\overline{w}$ and enjoy the benefits of larger G while lowering their tax-price. (As time goes on, as more newly marginal workers in the dangerous industry adopt this strategy, fewer people are left working there. As a result, the amount needed to tax workers receiving $\overline{w}$ in the safe industry increases.) Below I explain how the effect of equalizing differences on an individual's tax-price can explain patterns of political support across industries.

1.3 A Theory of Political Behavior

It's a common observation in American politics that many professionals who tend to be relatively well-educated and well-paid tend to vote Democrat and that the working class leans more Republican. More generally, the states with the highest incomes per capita reliably favor Democrats in national elections whereas the poorest are solidly Republican. This result is counterintuitive given that relative to Republicans, the Democrats generally advocate "big government" and income redistribution from higher to lower income earners. Gelman (2009) finds that the richer voters do tend to vote Republican, but that this correlation is stronger in poorer states than richer ones. He measures votes for Republicans relative to the national average across several occupation categories. He finds that between 1960 and 2004, voting for Republicans has trended strongly upward for skilled workers, unskilled workers, and business owners & proprietors; it trends slightly upward for managers and administrators; it trends slightly downward for routine white collar and non-fulltime employment, and strongly downward for professionals. “Professionals (doctors, lawyers, and so forth) and routine white collar workers (clerks, etc) used to support the Republicans more than the national average, but over the past half century they have gradually passed through the center and now strongly support the Democrats. Business owners have moved in the opposite direction, from being close to the national average to being staunch Republicans, and skilled and unskilled workers have moved from strong Democratic support to near the middle.” (Gelman, 2009 pg. 29) According to Gelman, “These shifts are consistent with oft-noted cultural differences between red and blue America. Doctors, nurses, lawyers, teachers, and office workers seem today like prototypical liberal Democrats, while businessmen and hardhats seem like good representatives of the Republican Party. The diving points were different fifty years ago.”

No explanation rooted in microeconomic theory exists to explain why educated upper middle class workers, such as professors and lawyers, consistently support “big government” whereas many working class and working poor voters do not, since one might expect those with higher incomes to want less redistribution. Often, the pattern is explained in terms of intelligence or education, taking for granted that smarter people will favor the left (e.g. Kanazawa, 2010). I advance the following explanation: among workers receiving the same level of total compensation, those with a higher non-pecuniary component will tend to want more public goods than those with a smaller nonpecuniary component ceteris paribus, and will endorse a larger public sector by supporting Democrats. Between two jobs that yield equal compensation to a worker in a pre-income tax environment, but which differ in the levels of pecuniary and nonpecuniary compensation offered, the one offering a greater degree of pecuniary compensation will become relatively less appealing after an income tax is instituted. This may explain in part why so many productive, well-educated, high income earners are Democrats. This increasingly Democratic bloc may be a result of its relatively lower tax price compared to those receiving wage premiums for stressful or dangerous work, with the result of many artists, actors, academics, teachers, and other professionals who enjoy relatively high levels of nonpecuniary amenities generally demanding a large public sector.

Like Joulfaian and Marlow (1991), I view political contributions as a form of "voting." Both activities require time and information costs, allow the individual to express support for one political option over another, and increase the probability by a small amount that one's preferred candidate wins the election. Individuals are taken to be supporting larger or smaller government independent of the composition of public goods. Political participation reveals that the individual is not indifferent – that he is made better off by the success of one party over the other. The issue of workers supporting one party or another out of interest for their industry cannot be ignored. The marginal government spending on each industry per dollar of revenue is not equal across industries. It is assumed that workers are content to have more government if it is directly benefitting them, and the marginal tax price compared to the marginal benefit of government spending is higher for workers in subsidized industries like education and technology and low for other industries such as mining. Workers in science and technology may support the party of larger government in order to increase their subsidies or at least to avoid research cuts while workers in industries like mining and manufacturing may also be supporting the party they view as less aggressive on environmental protections. Since inter-industry analysis cannot be performed due to the impossibility of assigning occupational codes beyond the two-digit level, this will remain an open question.

1.4 Data

To conduct cross-sectional analysis measuring the effects of occupational compensation on voting behavior, I draw from multiple data sets. The United States Census Bureau provides number of workers per NAICS industry sector by US county in 2004, as well as independent variables for county makeup by age group, educational attainment, gender, race and ethnicity, and percent of county employees working for the federal, state, or local government.[1] The Bureau of Labor Statistics provides data on fatality and injury rates by NAICS industry which, combined with the industry makeup by county, is used to generate weighted average fatality and injury rates by county. Risk rates are averages for the years 2003 – 2005 to reduce measurement error due to volatility from year to year. Risk of injury and death are used because they are not only readily available but are perhaps the most significant occupational disamenities that drive compensating wage differentials, with American workers experiencing 3.5 fatalities per 100,000 fulltime-equivalent workers

[1] http://www.census.gov/statab/ccdb/ccdbstcounty.html

in 2011.[2] The Bureau of Labor Statistics offers data on workplace injuries by industry, including the "Census of Fatal Occupational Injuries (2003 forward)" and "Nonfatal cases involving days away from work: selected characteristics (2003 forward)." Occupational injury rates are per 100 fulltime worker hours per year and include skin diseases or disorders, respiratory conditions, poisonings, hearing loss, and other. Since these data sets group the data by industry they will only broadly control for worker ability or occupational risk levels relative to more specific occupational data. Fatality Rate (by industry) is number of fatal occupational injuries per 100,000 fulltime-equivalent workers. Fatality rates include deaths caused by violence and other injuries by persons or animals, transportation incidences, fires and explosions, falls, slips, and trips, exposure to harmful substances or environments and contact with objects and equipment.

Similarly the "Employment, Hours, and Earnings – National" data is in terms of broad industrial categories. I link this data to the number of workers per NAICS industry per county in late 2004 to created weighted averages of compensation and injury rates of each county's work force.[3] Lastly, CNN Presidential election results by county are used to generate the dependent variable of the study, the percent of total votes for Republican George W. Bush (vs. Democrat John Kerry) within each county, ignoring third party votes. A few states also have independent cities, with the largest ones included in both the election

[2] There were 4609 workplace fatalities in the US in 2011 and 4690 in 2010. "Census of Fatal Occupational Injuries Summary, 2011." http://www.bls.gov/news.release/cfoi.nr0.htm

[3] According to Johnson, while nominal wages differ between the Southern US and the North, the consensus is that real wages do not; however, he finds much cross variation in real wages across large metropolitan areas, such as between Boston and Detroit where the real wage is 23% less in the former. Johnson, "Intermetropolitan Wage Differentials in the United States," p. 309.

and occupational make-up data sets. Alaska is not separated out into counties for the election. Age, race, and gender data is from 2005, and educational attainment is from 2000, all provided by County and City Data Book 2007 – State and County Data Tables, B-3 and B-4.

Table 1.1: Industry Injury and Fatality Rates, 2003-2005 Average

NAICS	NAICS Industry	Fatalities	Injuries
11	Farming	31.4	28.6
21	Mining	26.9	21.9
22	Utilities	4.5	4.2
23	Construction	11.6	10.7
31-33	Manufacturing	2.6	2.5
42	Wholesale Trade	4.4	4.6
44-45	Retail Trade	2.3	2.2
48-49	Transport & Warehouse	17.8	16.0
51	Information	1.8	1.7
52	Finance & Insurance	0.7	0.6
53	Real Estate	2.4	2.7
54	Professional	1.8	1.3
55	Management	3.2	2.6
56	Administrative	5.0	5.6
61	Educational	1.3	1.1
62	Health Care	0.7	0.8
71	Arts & Entertainment	3.8	3.9
72	Food & Hotels	1.7	1.9
81	Other	2.9	2.8
99	Public Administration	2.5	

Table 1.2 (at end of paper) shows correlations between all independent variables except ocean and Great Lakes-adjacent county dummies. County level fatality rates and injury rates have a correlation coefficient of .539. Both rates also correlate highly and positively with county rates for households with married couples, percent of those with less

than high school equivalency by county, and the age group 65 – 74, and negatively with the percent of adults 25 and over with a bachelor's degree or more by county, as expected.

1.5 Empirical Results

See full results in Table 1.3 at the end of the paper. The main coefficient of interest, on county fatality rate, regressed on votes in equation 1 is positive and significant, predicting an increase of 1% vote outcome in favor of the Republican for every 1 in 100,000 increase in the county fatality rate. Likewise, injury rates by themselves in Equation 2 is positive and significant, predicting an increase of 0.87% in vote outcome for the Republican for every 1 in 100 increase in the rate of workplace injuries by county. Coefficients remain positive and significant in Equation 3 where both fatality and injury rates are included as independent variables. The addition of more independent variables drives the coefficient on fatalities down slightly, and drives the coefficient on injuries negative. In Equation 9, all independent variables except the dummies for the oceans and Great Lakes are included, resulting in a decrease in the fatality coefficient from .010 to .007, and a decrease in the injury coefficient from .087 to -.034. Including the above-mentioned dummies in Equation 11 drives the fatality coefficient to .006 and the injury coefficient to -.035, both still positive and significant. In equation 12 the full specification minus fatality rates is run resulting in the adjusted R^2 falling from .510 to .491.

It is not surprising that the injury rate coefficient is negative when including all independent variables of interest since they suffer from a larger degree of measurement error than fatality rates (unlike fatalities, many go unreported) and also vary greatly in severity, from minor cuts and scrapes to burns and loss of limbs. The coefficients on fatality rates support the theory of voting behavior advanced above, but these too suffer from measurement error since like injury rates they are at the industry level and are then averaged according to the industrial makeup of each county. Because of this, more evidence is needed.

1.6 Robustness Check

To conduct a robustness check for the results for the county level study, I perform a cross-sectional analysis measuring the effects of workplace amenities on political behavior at the individual level. Again, I seek a dependent variable that captures the ratio of support for larger vs. smaller government across occupations and an independent variable that captures major workplace characteristics that drive compensating wage premiums. For the dependent variable, I again treat Republicans as the party of smaller government; for the independent variable, I again consider workplace hazard rates to be the most powerful factors in driving the wage premiums. To test the effect of tax-price across industries on political support, individual contributions to the two major party candidates for the US Presidential elections of 2004, 2008, and 2012 are gathered from the Federal Election Commission (FEC) website. The FEC provides data on all individual contributions over $200 made to federal election candidates. This includes name and address of the individual, occupation and employer, the recipient of the contribution, and the contribution amount. Committees can then be linked to candidates seeking election to the Presidency, the Senate, or the House of Representatives. Only contributions directed to the two major party nominees of each election year are used. Self-reporting of occupation allows individuals to be categorized by industry according to the same two-digit North

American Industry Classification System (NAICS) used in the county-level analysis, provided by the United States Census Bureau. NAICS categorizes all jobs within 20 broad industry categories identified by 2-digit NAICS codes. These are broken down further into 3 to 6-digit occupational codes, but assigning individual donors specific occupations based on their self-reported occupations was unworkable. Regressing political support on fatality rates within industries by linking self-reported occupations to 5 or 6 digit NAICS codes is not workable. Self-reported occupations are often unspecific and only suitable for assigning industries. For example, workers who just write “minor” or “mining” or “construction” links to industries just fine, but not specific occupations. This is an issue across all industries, with vague terms like “manager,” “scientist,” and “engineer” used often. In fact there is little overlap between self-reported occupations and the specific terms defining occupations in NAICS, although the self-reported terms are easy to classify according to industry. Even assigning donors to 3-digit industry codes would result in a loss of a majority of observations.

Using these industry classifications, individual donors are then linked to fatality rates by industry using fatality rates for NAICS two-digit industry sectors for the relevant years are provided by the Bureau of Labor Statistics (BLS). Fatality rates are per 100,000 fulltime-equivalent workers. To reduce measurement error, industry fatality rates are averages of the annual rates from 2002 - 2012. I also create an industry code for the military; fatality rates facing members of the US armed forces for this period are drawn from Defense Manpower Data Center (DMDC) but only goes through 2010. Lastly, individuals are assigned a dummy for gender (male = 1) assigned by the 600 most popular boys names for babies born in 1960, provided by the Social Security Administration. 1960 is arbitrarily chosen given that the ages of donors are unknown.

Observations are removed from the FEC data if the individual self-identifies as retired, unemployed, homemaker, mom, or similar occupational titles, or if the occupation cannot otherwise be linked to an industry code. Individuals who give to both candidates are deleted, and all but one observation are removed for individuals who make multiple contributions to the same candidate. There is a question as to whether the FEC sample is biased by eliminating all individual contributions below $200. I don't have political survey data of workers that could compare to my measure of political support. This threshold self-selects workers within industries who have higher incomes and who are particularly passionate about politics and it is not clear whether these factors might systematically bias the ratio of support for Republicans versus Democrats. Would results vary change if contributions under $200 were included? Perhaps one way to assess this is by comparing results across industries for different levels of contributions. I calculate percent of support for Obama within each industry taking all contributions; only $200-$299.99 contributions; only $300-$599.99 contributions; only $600-$999.99 contributions; and only contributions of $1000 and up. The correlations are below. The support for Obama within each industry counting only $200 - $299.99 contributions has a correlation of .94 with Obama support by industry counting only contributions of $1000 or more. This suggests that political support for each party by those who give relatively little in their industry and support by those who give a lot are very similar.

Table 1.4: Contribution Amount Correlations

	All	200 – 299.99	300 – 599.99	600 – 999.99	≥ 1000.00
All	1				
200 – 299.99	.9933	1			
300 – 599.99	.9896	.9872	1		
600 – 999.99	.9111	.9129	.8823	1	
≥ 1000.00	.9842	.9652	.9722	.8907	1

Table 1.5: Industry Injury and Fatality Rates, 2003 – 2012 Average

NAICS	NAICS Industry	Fatalities	Injuries
11	Farming	27.7	5.3
21	Mining	21.0	2.8
22	Utilities	4.0	3.5
23	Construction	10.6	5.0
31-33	Manufacturing	2.5	4.8
42	Wholesale Trade	4.6	3.8
44-45	Retail Trade	2.2	4.5
48-49	Transport & Warehouse	15.3	5.9
51	Information	1.7	1.8
52	Finance & Insurance	0.6	0.8
53	Real Estate	2.6	3.2
54	Professional	1.1	1.1
55	Management	2.4	1.8
56	Administrative	5.9	3.1
61	Educational	1.1	2.2
62	Health Care	0.8	5.2
71	Arts & Entertainment	3.8	5.0
72	Food & Hotels	1.9	4.1
81	Other	2.8	2.9
90	Military	101.1	
99	Public Administration	2.3	6.4

For the independent variable, I argue that fatality rates are more powerful than injury rates as drivers of compensating differentials. Not only are fatality rates orders of magnitude more serious for all involved, but injury rates can be misleading as they entail a greater degree of measurement error since they vary greatly in their seriousness and may or may not result in lost work days. Number of work days lost would be a suitable measurement of injury severity but this is not broken down for each industry by BLS. Injury rates are included in regressions below only out of curiosity. Graphs that aggregate support for Republicans by industry fatality rate by election year are found in Appendix II.

Table 1.6: Contributions by Industry in Decreasing Order of GOP Support

Industry	NAICS	N	Mean Contribution	St Dev	Min	Max	GOP Pct	Fatalities	GOP Pct
Mining	21	1558	2003.14	5460.05	200	50000	90.4%	21.0	90.4%
Agriculture	11	5437	942.47	2717.50	200	75000	81.1%	27.7	81.1%
Construction	23	7934	943.85	2773.49	200	75800	69.0%	10.6	69.0%
Wholesale	42	2058	982.86	3250.45	200	70000	62.9%	4.6	62.9%
Management	55	90552	2155.69	6145.37	199	150000	60.3%	2.4	60.3%
Manufacturing	31	1644	1069.38	3498.79	200	75800	59.0%	2.5	59.0%
Utilities	22	1693	1880.78	5615.08	200	100000	58.5%	4.0	58.5%
Real Estate	53	21842	1417.59	4373.94	199	100000	56.0%	2.6	56.0%
Transportation	48	2954	582.23	2312.64	200	75000	53.5%	15.3	53.5%
Military	90	2345	457.88	1624.25	199	75800	52.1%	101.1	52.1%
Finance	52	61366	1827.79	5563.91	200	150000	52.0%	0.6	52.0%
Retail	44	3109	983.98	3201.79	200	75000	46.1%	2.2	46.1%
Other	81	7554	853.99	2810.50	200	75000	42.4%	2.8	42.4%
Food & Hotel	72	1927	1055.21	3036.28	200	50000	40.6%	1.9	40.6%
Health	62	92939	755.97	2230.37	199	75800	36.3%	0.8	36.3%
Administrative	56	15556	1014.78	3178.62	200	86200	32.7%	5.9	32.7%
Public	99	60499	796.20	2772.56	199	110000	31.7%	2.3	31.7%
Information	51	13519	790.27	2244.96	200	50000	30.7%	1.7	30.7%
Professional	54	212732	885.87	2410.39	199	124000	26.3%	1.1	26.3%
Educational	61	96276	813.46	2741.49	199	75800	22.2%	1.1	22.2%
Arts	71	43337	1067.70	3769.00	199	250000	19.9%	3.8	19.9%

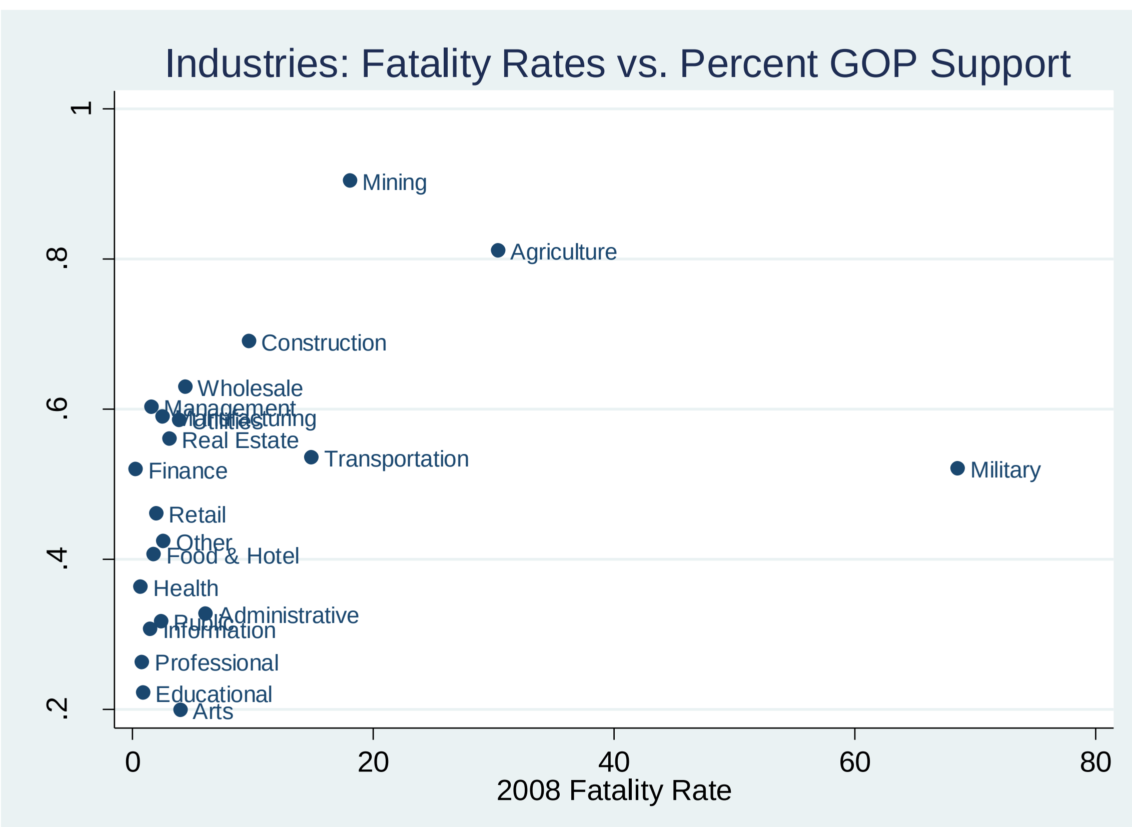
Table 1.5 shows the fatality rates (fatalities per 100,000 fulltime-equivalent workers) by industry averaged from 2003-2012, and injury rates per 100 workers for the same period. The average is taken due to fluctuations across time, most notably in the two

most dangerous industries; mining sees a decline of 12.7 fatalities per 100,000 workers between the Bush vs. Kerry and Obama vs. Romney elections, and farming sees a decline of 9.3 in this time. The next two most dangerous industries of construction and transportation & warehousing also see declines. Only three industries see increases in fatality rates from 2004 to 2012: administrative, wholesale trade, and food & hotels, evidence of increasing compensation for most American workers in the past decade. Table 1.6 lists summary statistics of contributions by industry, ranked in order of ratio of Republican support. Histograms of contributions by industry are provided in Graph 1.1.

Figure 1.1: Histograms of Contribution Amounts by Industry

Large contributions are driving up the averages by industry as evidenced by the large standard deviations. In fact, a great number of contributions are toward the low end of the spectrum, as the below histogram reveals. Each bin represents a range of contribution amounts, from $200 to $299.99 in bin 1, increasing by $100 in each bin through $1000. Bin 9 includes all contributions over $1000. Note that, for instance, over 60% of military and transportation contributions are $200 - $300, and over 50% are in this range from educators. A plurality of contributions from most industries are in the $200-$300 range, including agriculture, construction, and manufacturing, yet a plurality of mining and utilities contributions are over $1000. Graph 1.2 plots industry fatality rates against support

Figure 1.2: GOP Support and Fatality Rates by Industry



for the GOP. The military is an outlier; the most dangerous private sector industries of mining, construction, transportation, and construction clearly prefer the Republican relative to the average worker.

This data is used to test the hypothesis that workers facing higher rates of workplace injuries and fatalities and who are thus compensated with wage premiums will demand relatively less government than their peers due to facing a higher tax-price. It must also be noted that a competing hypothesis for the observing political behavior is that workers who have a lower risk aversion in general are more likely to support Republicans, perhaps due to a lower desire for a social safety net, and these workers are the ones who more dangerous occupations will attract. They still demand a risk premium, but a lower one relative to more risk averse workers. Then results estimate the combination of these two effects, the effect of higher wage premium plus the effect of whatever mechanism that drives the risk averse workers to systematically support Republicans, and these two possible effects cannot be separated out. However, in equilibrium the wage differential must compensate workers for their expected loss. Young workers may have a higher reservation wage due to risking the loss of greater length of life than older workers (Thaler & Rosen, 1976, 285). However, they also usually have a greater physical ability to cope with risk (Thaler & Rosen, 1967, 295). Viscusi (1980) finds that females have much higher quit rates than males within the first year of employment, which may indicate lower tolerance for risk. No ages or birthdates are provided in the data, but a dummy variable is generated matching names of donors with popular boy names in the United States.

I propose the following logit model. The probability *Pr* that voter *V* supports the Republican *R* is a function of tax price *P* (relative to the median $\overline{P}$) and their preferred government spending *q*:

$$Pr(V = R) = [\phi(P_i - \bar{P}); q]$$

Since *q* is not captured in the data, my model is:

$$Pr(V = R) = \phi(P_i - \bar{P})$$

For the left hand side variable, each donor supports either a Republican candidate or a Democrat candidate in that year's election. The right hand side variable is captured through fatality rates or injury rates since tax price has been shown to be increasing in compensating differentials. Since the dependent variable is dichotomous (Republican = 1) OLS cannot be used due to heteroskedasticity, non-normally distributed error terms, and possible predicted probabilities outside the range of 0 – 1. Instead, this binary logistic regression is used to estimate the odds of support for the Republican depending on the workplace fatality rate an individual donor faces. Although this study of the effect of compensating differentials on political behavior is unique, the use of logit regressions is consistent with the literature on worker quit rates (e.g. Viscusi, 1980) or political contributions (Joulfaian and Marlow, 1991). My first model specification is:

$$ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + X_{ijt}\beta_1 + Z_{ijt}\beta_2 + Y_{2004}\beta_3 + Y_{2008}\beta_4 + W_{ijt}\beta_5 + M_i\beta_6$$

Where p_i is the probability that donor *i* will support the Republican, X_{ij} is the fatality rate donor *i* faces in industry *j* during year *t*, Z_{ij} is the injury rate, *Y* are year dummies, *W* is wage, and *M* is the dummy for males. Results of the robustness check are found in Table

1.7. As in the county level analysis, the coefficient on fatalities is positive and significant and the coefficient on injuries is negative. The coefficient on fatalities increases from .026 in equation 1 to .113 in equation 7 with the inclusion of independent variables for injuries, males, year, and wage. A coefficient of .113 indicates that for every increase of 1 in 100,000 in the fatality rate, the probability of support for the Republican increases by about 2%, twice as large as in the county level analysis. Despite this difference in magnitude, the results show that individual level data follows the same pattern as the aggregated data at the county level, where those who assume more workplace risk reveal a preference for Republicans.

1.7 Panel Study

After matching names across elections, I perform one last test using the data of the robustness check to create a panel. I test to see if change in risk levels that individuals face from one election to the next explains variation in individual donor support between the Republican candidate and the Democrat candidate in each year. The panel links names between the 2004 and 2008 elections, and the 2008 and 2012 elections. My model specification is:

$$f(S,i) = \beta_{0,S} + F_{1,i}\beta_{1,S} + T_i\beta_{2,S} + N_i\beta_{3,S}$$

Here *S* represents donor *i* switching parties as a function of change in fatality rates between elections. *F* is the difference of fatality rates F_t - F_{t-1} between two consecutive elections. *T* is a dummy for switching states and *N* is a dummy for switching industries. Donors may switch from Republican to Democrat or vice versa or may support the same party across consecutive elections:

- *Unit of Observation*: Individual donor who gave to a Presidential candidate in two consecutive elections.
- *Independent Variable*: Fatality Rate t_{+1} – Fatality Rate t for donor i
- *Dependent Variable*: Political Dummy for donor i :

$$\text{POLITICS} = \begin{cases} -1\ if\ Support\ Republican\ in\ 2008, Democrat\ in\ 2012 \\ 0\ if Support\ same\ party\ in\ 2008\ and\ 2012 \\ 1\ if\ Support\ Democrat\ in\ 2008, Republican\ in\ 2012 \end{cases}$$

If the fatality rate a donor faces is larger in the second election than in the first, the probability of such donors supporting the Republican in the second election is expected to increase even if they supported the Democrat previously, and the coefficient will be positive. Results are provided in Table 1.8. As expected, a decline in the fatality rate faced between two elections is a significant determinant of switching from the Republican to the Democrat, and an increase is a significant determinant of switching from the Democrat to the Republican, even when accounting for switching industries or states. Where switched state and industry dummies are included, in equation 3, the coefficient on switching to the Republican is .005, indicating that for every 1 in 100,000 increase in the fatality rate faced by a donor between elections, the probability of switching from the Democrat to the Republican increases by about .0044%. This small amount is not surprising given the high correlation in party support across elections, but it does support the theory advanced above. For both kinds of political switching, the coefficients on switching industries and switching states are positive and significant. Equations 3 and 4 reveal the interesting result that the act of switching states itself plays a very large role in motivating people to switch parties of support. This is investigated further in Chapter 2.

1.8 Conclusion

Workers receive both monetary and nonmonetary compensation for labor. Only monetary compensation can be captured by the income tax. This means that workers who receive compensating differentials face a higher tax-price than their peers. They are therefore more likely to support a smaller public sector. I test this theory using county level data on fatality rates and votes for each major candidate in the 2004 US Presidential election to test whether workers with greater levels of compensating wage differentials, as indicated by higher workplace risk rates, are more likely to vote for Republicans, the party seen as favoring smaller government. I find that fatality rates are positive and significant in their effect on county level GOP support. These results are robust to individual level data on political donations for the US Presidential elections from 2004 – 2012. Lastly, I match individual donor names across the 2004, 2008, and 2012 data sets to test if changes in the fatality rates donors face across elections affects their political support, finding that an increase in the fatality rate they face is a positive and significant driver of switching support from the Democrat to the Republican, and vice versa. All three sets of regressions reveal the same pattern, that the effect of workplace fatalities on support for Republicans is significant and positive. There are no similar studies for which to compare the reasonableness of my findings. My next step will be to incorporate Political Action Committee donation data from the FEC, and General Social Survey data to further strengthen my results.

REFERENCES

Alchian, Armen A. 1969. "Information Costs, Pricing, and Resource Unemployment." *The Collected Works of Armen A. Alchian, Vol. 1: Choice and Cost under Uncertainty.* Liberty Fund: Indianapolis, pp. 53 – 77.

Aldy, Joseph E. and W. Kip Viscusi. 2003. "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World." *Journal of Risk and Uncertainty*, Vol. 27, No. 1 (August), pp. 5 – 76

Aldy, Joseph E and W. Kip Viscusi. 2008. "Adjusting the Value of a Statistical Life for Age and Cohort Effects." *The Review of Economics and Statistics*, Vol. 90, No. 3 (August), pp. 573 - 581

Benjamin, Daniel K. and William R. Dougan. 1997. "Individuals' Estimates of the Risks of Death: Part I – A Reassessment of the Previous Evidence." *Journal of Risk and Uncertainty*, Vol.. 15 No. 2, Special Issue on the Value of Life – Part II (November), pp. 115 – 133

Benjamin, Daniel K, William R. Dougan and David Buchena. 2001. "Individuals' Estimates of the Risks of Death: Part II – New Evidence." Journal of Risk and Uncertainty, Vol. 22, No. 1 (January), pp. 35 – 57.

Buchanan, James. 1967. *Public Finance in the Democratic Process.* Liberty Fund, Indianapolis.

Feldstein, Martin. 2008. "Did Wages Reflect Growth in Productivity?" NBER Working Paper

Fishback, Price V. 1998. Operations of "Unfettered" Labor Markets: Exit and Voice in American Labor Markets at the Turn of the Century." *Journal of Economic Literature*, Vol. 36, No. 2 (June), pp. 722 – 765.

Frank, Thomas. 2004. *What's the Matter with Kansas? How Conservatives Won the Heart of America.* Henry Holt, New York.

Friedman, Milton. 1976. *Price Theory.* Aldine Publishing Company, New York

Gelman, Andrew. 2009. *Red State, Blue State, Rich State, Poor State.* Princeton University Press, Princeton.

Joulfaian, David and Michael L. Marlow. 1991. "Incentives and Political Contributions." Public Choice, Vol. 69, No. 3, pp. 351 – 356.

Kanazawa, Satoshi. 2010. "Why Liberals are More Intelligent than Conservatives." *Psychology Today*. Accessed: June 13, 2014. http://www.psychologytoday.com/blog/the-scientific-fundamentalist/201003/why-liberals-are-more-intelligent-conservatives

Moore, Michael J and W. Kip Viscusi. 1990. *Compensation Mechanisms for Job Risks.* Princeton University Press, Princeton.

Powell, David. 2012. "Compensating Differentials and Income Taxes." The Journal of Human Resources, Vol. 47 No. 4, pp. 1024 – 1054.

Powell, David and Hui Shan. 2010. "Income Taxes, Compensating Differentials, and Occupational Choice: How Taxes Distort the Wage-Amenity Decision." RAND Working Paper

Rosen, Sherwin. 1994. "Safety and the Saving of Life: The Theory of Equalizing Differences." *Cost-Benefit Analysis, 2nd ed*. University Press, Cambridge.

Rosen, Sherwin and Richard Thaler. 1976. "The Value of Saving a Life: Evidence from the Labor Market." *Household Production and Consumption*, pp. 265 – 302.

Stigler, George J. 1962. "Information in the Labor Market." *Journal of Political Economy*, Vol. 70 No. 5 Part II: Investment in Human Begins (October), pp. 94 – 105.

Thaler, Richard H. 1989. "Anomalies: Industry Wage Differentials." *Journal of Economic Perspectives*, Vol. 3, No. 2 (Spring), pp. 181 – 193.

Viscusi, W. Kip. 1980. "Sex Differences in Worker Quitting." *The Review of Economics and Statistics*, Vol. 62, No. 3 (August), pp. 388 – 398.

Viscusi, W. Kip. 1992. *Fatal Tradeoffs: Public and Private Responsibilities for Risk.* Oxford University Press, New York

Table 1.2 – Regression 1 Independent Variable Correlations

	Fatal	Injury	Male	Mar	BA+	< HS	< 5	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	W	B	A	I	H	G
Fatal	1																				
Injury	.539	1																			
Male	.156	.091	1																		
Married	.263	.222	.111	1																	
B.A.+	-.403	-.618	-.060	-.183	1																
< H.S.	.286	.352	-.036	-.128	-.651	1															
< 5	-.122	-.114	-.081	-.108	.024	.219	1														
5 – 14	-.002	.028	-.107	.178	-.108	.150	.781	1													
15 – 24	-.060	-.125	.130	-.212	.286	-.139	.171	.014	1												
25 – 34	-.400	-.224	.306	-.168	.160	.086	.407	.188	.203	1											
35 – 44	-.266	-.173	.385	.092	.167	-.111	.119	.208	-.288	.489	1										
45 – 54	.092	.004	.071	.126	.117	-.399	-.445	-.221	-.392	-.449	.229	1									
55 – 64	.195	.161	-.104	.132	-.150	-.060	-.611	-.436	-.511	-.547	-.124	.607	1								
65 – 74	.337	.274	-.138	.142	.358	.122	-.541	-.462	-.411	-.574	-.443	.168	.708	1							
75 +	.296	.208	-.178	.037	-.214	-.093	-.520	-.466	-.300	-.657	-.487	.207	.476	.780	1						
White	.115	.083	.064	.606	.002	-.330	-.372	-.229	-.110	-.195	-.054	.229	.285	.279	.330	1					
Black	-.109	-.035	-.075	-.563	-.072	.368	.294	.177	.069	.240	.085	-.203	-.203	-.172	-.238	-.860	1				
Asian	-.234	-.346	.073	-.180	.436	-.198	.136	.040	.095	.203	.256	-.018	-.195	-.304	-.206	-.223	.010	1			
Indian	.095	.039	.091	-.127	-.032	.005	.221	.212	.110	-.104	-.073	.003	-.075	-.097	-.126	-.335	-.106	.010	1		
Hispanic	.162	-.053	.125	.033	.026	.272	.396	.357	.129	.048	-.053	-.266	-.250	-.148	-.160	.070	-.100	.139	-.002	1	
Govt %	.160	.011	.319	-.208	-.052	.102	.132	.038	.393	.083	-.113	-.224	-.207	-.116	-.145	-.291	.179	-.023	.322	.105	1

Table 1.3: County- Level Cross-Sectional Analysis Results

Dependent Variable "Politics"

	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5	Eq 6	Eq 7	Eq 8	Eq 9	Eq 10	Eq 11	Eq 12
Fatality	.010 (.001)	.009 (.001)	.009 (.001)	.006 (.001)	.007 (.001)	.009 (.001)	.009 (.001)	.010 (.001)	.007 (.001)	.008 (.001)	.006 (.001)	
Injury		.019 (.007)	-.010 (.008) **	-.003 (.006) **	.006 (.007) **	-.006 (.007) **	.020 (.007)	.013 (.0073) **	-.034 (.007)	.009 (.007) **	-.035 (.007)	-.008 (.007) **
< High School			-.459 (.031)						-.079 (.039) *		-.099 (.039) *	-.010 (.039) **
B.A. +			-.504 (.041)						-.024 (.043) **		-.032 (.043) **	.011 (.043) **
Married				1.179 (.023)					.858 (.048)		.842 (.047)	.938 (.047)
Under Age 5					-.199 (2.373) **				3.250 (1.891) **		2.951 (1.875) **	3.706 (1.909) **
Age 5 to 14					3.688 (2.364) **				1.619 (1.890) **		1.508 (1.874) **	2.274 (1.908) **
Age 15 to 24					1.753 (2.355) **				1.184 (1.876) **		1.004 (1.859) **	1.779 (1.893) **
Age 25 to 34					2.137 (2.365) **				1.018 (1.884) **		.799 (1.868) **	1.329 (1.902) **
Age 35 to 44					1.248 (2.355) **				-.153 (1.875) **		-.216 (1.858) **	.326 (1.893) **
Age 45 to 54					2.819 (2.372) **				1.063 (1.893) **		.876 (1.876) **	1.976 (1.909) **
Age 55 to 64					-.126 (2.364) **				-.092 (1.887) **		-.257 (1.870) **	.297 (1.905) **
Age 65 to 74					4.716 (2.367) *				3.589 (1.889) **		3.473 (1.867) **	4.340 (1.906) **
Age 75 +					.949 (2.361) **				.018 (1.884) **		-.120 (1.867) **	.753 (1.901) **
White						-.576 (.181)			-.128 (.157) **		-.172 (.156) **	-.153 (.158) **
Black						-.851 (.180)			-.262 (.157) **		-.299 (.156) **	-.271 (.158) **
Asian						- 1.832 (.270)			-.831 (.242)		-.827 (.240)	-.755 (.244)
Indian						-.951 (.194)			-.503 (.168)		-.544 (.166)	-.505 (.169)
Hispanic						-.055 (.016)			-.198 (.019)		-.187 (.019)	-.168 (.019)
Male							.102 (.023)		.195 (.195)		.198 (.027)	.246 (.027)
Pct Govt Workers								-.306 (.0304)	-.072 (.032) *		-.066 (.031) *	-.018 (.031) **

Great Lake Dummy										-.075 (.103)	-.064 (.010)	-.076 (.010)
Ocean Dummy										-.073 (.008)	-.025 (.007)	-.029 (.007)
Intercept	.528 (.004)	.446 (.032)	.768 (.043)	.085 (.023)	-1.46 (2.356) **	1.185 (.184)	.340 (.041)	.515 (.034)	-.857 (1.88) **	.504 (.033)	-.633 (1.867) **	-1.619 (1.900) **
Adj R^2	.130	.132	.193	.428	.184	.267	.136	.159	.501	.160	.510	.491
N	3083	3083	.3082	3082	3083	2820	3083	3083	2819	.3083	2819	2819

Data from County & City Data Book 2007 (closest year to the election). Educational attainment restricted to those age 25 and over. "High school" includes those with some college, or an associate degree. Graduate degrees are combined with bachelor degrees. Fatalities are per 100,000 fulltime equivalent workers. All coefficients significant at the .99 level unless otherwise stated:

** Significant at the .95 level.*

*** Not significant at the .95 level.*

Table 1.7: Binomial Logistic Regression Results

2004 – 2012 Elections Individual Donors – Dependent Variable is Dummy: (Republican=1)

	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5	Eq. 6	Eq. 7
Fatality	.026 (.001)	.099 (.001)	.026 (.001)	.122 (.001)	.026 (.001)	.120 (.001)	.113 (.001)
Injury#		-.048 (.001)				.043 (.002)	-.0003* (.002)
Male			1.739 (.011)		1.798 (.011)	1.746 (.011)	1.787 (.011)
Wage#				.039 (.000)		.048 (.001)	.026 (.001)
2004					-.683 (.008)		-.558 (.009)
2008					-.819 (.005)		-.763 (.006)
Intercept	-.631 (.003)	-.641 (.004)	-.744 (.003)	-1.865 (.012)	-.302 (.004)	-2.312 (.018)	-1.204 (.021)
P Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R^2	.004	.012	.035	.020	.060	.051	.071
N	746,831	744,486	746,831	744,486	746,831	744,486	744,486

*#Except military. Fatality rates are per 100,000 fulltime-equivalent workers. Injury rates are per 100 workers. All coefficients significant at the .99 level except where specified. * Not significant at the .95 level.*

Table 1.8: Multinomial Logistic Regression Results

Panel Data - Dependent variable “Politics” described below

Political Contributions – Significant at .99 in Bold – Politics is Dependent Variable

Politics	Indep. Var	’04 – ‘08	’04 – ‘08	’04 – ‘08	’04 – ‘08	’08 – ‘12	’08 – ‘12	’08 – ‘12	’08 – ‘12
-1	**Fatality**	-.019	-.013	-.011	-.013	-.018	-.011	-.009	-.011
	Switch Ind		1.409	.622			2.223	.977	
	Switch St			2.383	2.626			2.83	3.338
	Intercept	-2.913	-3.907	-5.145	-4.880	-3.447	-4.856	-6.029	-5.742
0		*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
1	**Fatality**	-.007**	-.003**	-.003**	-.004**	.021	.014	.013	.014
	Switch Ind		1.074	.444*			2.193	.942	
	Switch St			1.682	1.859			2.853	3.345
	Intercept	-4.950	-5.672	-6.408	-6.229	-1.929	-3.317	-4.508	-4.234
N		27882	27882	27882	27882	99508	99508	95508	95508
P > Chi2		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Panel Data - Dependent Variable “Politics” All Years

Politics	Indep. Var	Eq 1	Eq 2	Eq 3	Eq 4
-1	**Fatality**	-.016	-.010	-.009	-.011
	Switch Ind		2.007	.870	
	Switch St			2.716	3.147
	Intercept	-3.289	-4.596	-5.779	-5.501
0		*base*	*base*	*base*	*base*
1	**Fatality**	.011	.007	.005	.006
	Switch Ind		2.017	.877	
	Switch St			2.734	3.169
	Intercept	-2.196	-3.511	-4.710	-4.430
N		123,390	123,390	123,390	123,390
P > Chi2		0.000	0.000	0.000	0.000

*All coefficients significant at the .99 level unless specified. * Significant at the .95 level. ** Not significant at the .95 level.*

Politics: *-1 = Switch from Democrat in $_{t-1}$ to Republican in $_t$*
0 = Contribute to same party in $_{t-1}$ and $_t$
1 = Switch from Republican in $_{t-1}$ to Democrat in $_t$

Fatality: *$(Fatality_t) – (Fatality_{t-1})$*

Switch Ind: *Donor switches industries between elections = 1*

Switch St: *Donor switches states between elections = 1*

CHAPTER TWO

Donor Location and Donor Choice: Evidence from Individual Political Contributions

2.1 Introduction

There has been much discussing in recent decades on the factors that affect political behavior of voters. Some research has studied the effect that environment and information have on the decision *whether* to vote, as opposed to how one votes. As a complement to the voting literature, this paper studies how one chooses to contribute in an election. I attempt to shed light on the role that location plays in the individual's decision to contribute to a particular political candidate. I ask the question: does moving from a red state to a blue state systematically cause donors to switch their political contributions from Republicans to Democrats, or vice versa? If location plays a role in influencing political behavior then donors who move from one state to another are expected to converge with local political behavior and, on the margin, switch their party of support to the dominant one in their new state. As with other recent papers, the analysis is conducted at the individual level rather than on an aggregate statistic. Data on individual political contributions comes from the Federal Elections Commission for the three US Presidential elections from 2004 – 2012, using contributions to the two major party candidates in each election. The sample is made up of individual donors who contribute in consecutive elections and who switch states between elections. Running a multinomial logistic regression, I find that for every 0.10

increase in percent of support for Republicans in their new state of residence, the probability that a donor switches from the Democrat to the Republican increases by about 4.5%. Conversely the probability of switching support from the Republican to the Democrat increases by about 0.5% for every decrease of 0.10 in local Republican support.

2.2 Literature Review

Most of the literature on political choice is on voting rather than contributions. Voting behavior is generally viewed as being either investment motivated or consumption motivated (Tollison et al, 1975). Under instrumental (investment) voting, individuals vote for the candidate they think will leave them materially better off. Under expressive (consumption) voting, voters recognize that since the probability of their vote affecting the outcome is negligible, they express support for a candidate as an end in itself, much like cheering or booing a sports team. Downs (1957) was the first to describe voting as rational behavior carried out by individuals who vote for their own self-interest according to the costs and benefits involved, and is taken to be the standard account of instrumental voting. Yet if voting is rational, the expressive view has great appeal since the probability of being the pivotal voter is often low, especially in national elections. The present analysis is agnostic with regard to whether donors view their contributions as investment or consumption, though one might expect the former explanation to dominate here due to the increased cost over voting for most individuals. In addition to giving up a non-trivial amount of resources, costs of contributing include effort and information costs, and contributions increase the probability by a small amount that one's preferred candidate wins the election. Contributions above a certain threshold and that therefore must by law be reported to the government have the added dimension of being public information whereas voting in the United States is private. In that sense, contributions may be superior to voting as a means of self-expression.

Much of the literature analyzes the effect of information on voter turnout rather than on how an individual votes. Information can cut both ways on voting turnout. Better-educated individuals may be more likely to participate in the political process since the cost of information about candidates is lower, but they may also be more informed about the futility of making a difference in the outcome of a large election. Tollison and Willett (1973) argue that there is no theoretical basis for the assertion that information will systematically affect the decision to participate. Thus Tollison et al (1975) approach the problem empirically, studying media information which broadcasts a biased message that attempts to persuade voters to support particular policies or candidates. Using newspaper circulation as a fraction of the voting age population, paid political broadcasting (expenditures), and free broadcasting time (in minutes), they find paid political time and newspaper circulations to be positive and significant drivers of voter turnout. In addition to mass media, social networks – especially within the household – also play a role in influencing voters. Spouses' political beliefs are known to be highly correlated (Niemi et al, 1977) but there is also evidence that political attitudes can be predicted by the background characteristics of family members living in the same household, such as in Bean and Hayes (1992) where spousal characteristics increase the explained variance in political and economic attitudes of individuals. Nickerson (2008) finds evidence that the act of voting is contagious within two-voter households. Kenny (1994) finds that interaction not only with spouses but with close friends and acquaintances influences political attitudes, and such influence may cascade across friends of friends (McClurg, 2004). Such effects from social interactions are referred to as contagion or peer effects. "Contagion" may be informational or behavioral (McClurg, 2004). Informational contagion spreads through conversation and behavioral contagion operates through changes in social norms, signaling "appropriate political behavior" and encouraging peers to behave like each other. However, this assumes that voters are amenable to information that contradicts previously-held beliefs. Cowen (2005) argues that "self-deception" in politics is rampant. He observes that many voters engage in confirmation bias and tend to discard free information that contradicts their priors. If true, such ideological close-mindedness could impede the realization of a location effect.

This paper tests the hypothesis that individuals who live in the same state are susceptible to convergence in their political behavior, specifically in their political contributions. Such convergence may be driven by a number of factors, including exposure to similar information – through common media and social networks – regarding political issues on which they form beliefs and opinions. Members of the same household or social circle, and to some extent the local community, all share information with each other; this is probably the defining feature of a social circle. Even those who do not interact directly will be exposed to the same local news sources, including radio, television, and print, which exhibit bias in their news reporting (Gentzkow & Shapiro, 2010; Groseclose & Milyo, 2005; Lott & Hassett, 2004). These common exposures to political information may result in convergence of behavior. Alternatively, perhaps any observed effect of location on political choice is driven by a general preference for supporting whichever local party seems more competent. This could explain why a donor supports Democrats in Democrat strongholds and then Republicans when moving to conservative states. Perhaps whether one resides in a swing state plays a role in shaping political choice, or perhaps it matters whether one is participating in a primary or a general election. Whatever may be driving the effect, all that can be observed is the behavior: all other things equal, if there is a location effect influencing political behavior then moving from California to Texas should increase the likelihood that a former Democrat contributor switches to supporting Republicans. In the next section I model change in individual political contributions as a function of local political behavior to test for a location effect.

2.3 Empirical Strategy

To test the above hypothesis, it is necessary to obtain a dependent variable that captures individual support for Republicans or Democrats across elections when changing locations and an independent variable that captures change in local political attitudes that individuals face when moving between two elections to represent exposure to the informational environment in the new location. For the dependent variable, I use political contributions to the Republican and Democrat nominee for the US Presidential elections of 2004, 2008, and 2012, available from the Federal Election Commission "Contributions by Individuals" data sets. By law, contributions of $200 or more must be reported to the FEC. Donors self-report industry, occupation, home address, and other data. This data allows donors to be matched by name across consecutive elections in order to observe change in political support at the individual level, and the sample includes only those who switch states of residence between elections. From this, the dummy dependent variable POLITICS is created, and coded as follows for consecutive elections:

$$POLITICS_i = \begin{cases} 1 \; if \; switch \; from \; Democrat \; to \; Republican \\ 0 \; if \; support \; same \; party \; in \; both \; elections \\ -1 \; if \; switch \; from \; Republican \; to \; Democrat \end{cases}$$

This time frame will allow observation of behavior in the short run which is appropriate for this test. In the long run it is more likely that there may be pork barrel effects, such as farmers supporting Roosevelt in the 1930s, and long periods of time may see the evolution of the political parties. Testing for a location effect assumes both unchanging political parties and constant composition of government.

To create the main independent variable of interest, I begin with state of residence of individual donors at the time of each contribution, drawn from the FEC data sets. Each donor resides in one state in the first election and a different state in the subsequent election. Election results by state and year are then drawn from Federal Elections: Election Results for the U.S. President, the U.S. Senate, and the U.S. House of Representatives, summary tables from the FEC website for the 2004, 2008, and 2012 national elections. Total votes for each candidate by state are reported, and the number of votes for the Republican Presidential nominee over the sum of the number of votes for the Republican and Democrat Presidential nominees is calculated, the variable P. Third part votes are ignored. The first difference of these values across elections yields the independent variable VOTES, as a measurement of change in local political behavior that donors face:

$$VOTES \; = P_{t+1} - P_t$$

I theorize that change in the political party that one contributes to is a function of the political leanings of their location – defined here as their state of residence – and that if donors change states, a change in their odds of supporting each party should be observed. Change in other individual-level characteristics must also be taken into account as explanations for change in political behavior. The data does not include income, political affiliation, religion, church attendance, union status, age, or other personal characteristics. However occupations are self-reported. Since self-reported occupations are provided in the data, donors are also linked to 2-digit NAICS industry codes available from the US Census Bureau. Using these codes, donors are then linked to industry fatality rates available from the Bureau of Labor Statistics, using the average of the industry fatality rates for the year preceding, during, and following the current election. Then the variable FATALITY is generated as the first difference in the industry fatality rate across elections, $\textit{Fatality Rate}_{t+1} - \textit{Fatality Rate}_{t}$. This paper is thus able to identify change in donor industries, and so change in the industry fatality rates they face, following Chapter 1 where I explain cross-industry patterns in political support as driven in part by compensating differentials. Risk of workplace death is used because it is readily available and is perhaps the most significant occupational disamenities that drive compensating wage differentials. As the workplace fatality rates that donors face increase, so do their compensating wage differentials and thus their tax-prices. This is expected to result in a decreased quantity demanded for government, manifesting itself as increased support for the Republican. (This process is discussed in further detail in Chapter 1). Since switching industries is a primary driver of migration between states, and results in other changes such as the above-mentioned exposure to workplace risk, it is important to control for this aspect of location in influencing political choice. A SWITCHIND dummy is generated, coded as 1 if a donor switches industries across elections. This is then separated out into SWITCHSAFER, coded as 1 when individuals switch to a safer industry, and SWITCHDANGER, coded as 1 when they switch to a more dangerous industry. This will allow measurement of the different effect that each has on switching political support. Lastly, since donors contributing in both 2004 and 2008 or 2008 and 2012 are combined into one data set, a dummy variable 0408DUMMY is created, coded as 1 for the subset of the sample who contribute in both 2004 and 2008 and 0 for those who contribute in both 2008 and 2012. Of those switching to a safer industry, 85.5% of them do so between 2004 and 2008, yet only 36.4% of switching to a more dangerous industry occurs between 2008 and 2012. This is as expected since most workers will seek safer and higher wage occupations over time. Regressions will also be run separating our 2004 – 2008 and 2008 – 2012 data, described further in the results section.

Table 2.1: Independent Variable Correlations

	Politics	**Fatality**	**Switch Safer**	**Switch Danger**	**Votes**
Politics	1				
Fatality	.004	1			
Switch Safer	.030	-.273	1		
Switch Danger	.014	.260	-.594	1	
Votes	.190	-.007	.027	-.027	1

There are 54,210 observations of individuals who have been linked up between consecutive election cycles, with 13,994 contributing in both 2004 and 2008 and 40,216 contributing in both 2008 and 2012. 42,307 individuals switch industries between elections and all within the sample switch states. For those contributing in 2004 and 2008, the correlation in their NAICS industry code is .0416, and .0471 for those contributing in both 2008 and 2012. Clearly change in career is a primary driver in prompting people to assume the costs of moving to a new state. Of the 54,210 in the sample, 39,305 support the same party between elections, 3,746 switch their support from the Republican to the Democrat and 11,159 switch from the Democrat to the Republican. Of these, 65% of those switching from the Republican to the Democrat do so between 2008 and 2012, as do 98.6% of those switching to the Republican. Three times as many Democrats are switching to Republican than vice versa.

Table 2.2: Observation Count by Industry by Election

INDUSTRY	NAICS	2004	2008	2012
Agriculture	11	28	155	207
Mining	21	1	50	71
Utilities	22	7	79	79
Construction	23	120	430	442
Manufacturing	31	15	146	80
Wholesale	42	17	149	136
Retail	44	49	212	137
Transportation	48	54	224	219
Information	51	208	1,043	822
Finance	52	840	4,080	3,188
Real Estate	53	234	1,254	978
Professional	54	5,729	17,627	11,891
Management	55	1,149	5,680	4,676
Administrative	56	264	927	719
Medicine	61	1,993	7,126	5,367
Education	62	1,267	6,052	4,438
Entertainment	71	734	3,503	2,187
Food & Hotel	72	40	116	109
Other	81	53	468	364
Military	90	38	285	170
Public	99	1,154	4,604	3,936
TOTAL		13,994	54,210	40,216

Table 2.3: Republican Support by State within the Sample

Percent Republican Support by State & D.C.								
STATE	2004	2008	2012		STATE	2004	2008	2012
AL	62.9%	60.9%	61.2%		MT	60.5%	51.2%	57.0%
AK	63.2%	61.1%	57.3%		NE	66.8%	57.6%	61.1%
AZ	55.3%	54.3%	54.6%		NV	51.3%	43.6%	46.6%
AR	54.9%	60.2%	62.2%		NH	49.3%	45.1%	47.2%
CA	45.0%	37.7%	38.1%		NJ	46.6%	42.1%	41.0%
CO	52.4%	45.4%	47.3%		NM	50.4%	42.3%	44.7%
CT	44.7%	38.7%	41.2%		NY	40.7%	36.4%	35.7%
DE	46.2%	37.4%	40.6%		NC	56.2%	49.8%	51.0%
DC	9.5%	6.6%	7.4%		ND	63.9%	54.4%	60.1%
FL	52.5%	48.6%	49.6%		OH	51.1%	47.7%	48.5%
GA	58.4%	52.6%	54.0%		OK	65.6%	65.6%	66.8%
HI	45.6%	27.0%	28.3%		OR	47.9%	41.6%	43.7%
ID	69.3%	63.0%	66.4%		PA	48.7%	44.8%	47.3%
IL	44.8%	37.3%	41.4%		RI	39.4%	35.8%	36.0%
IN	60.4%	49.5%	55.2%		SC	58.6%	54.5%	55.3%
IA	50.3%	45.2%	47.0%		SD	60.9%	54.3%	59.2%
KS	62.9%	57.6%	61.1%		TN	57.2%	57.6%	60.4%
KY	60.0%	58.2%	61.5%		TX	61.5%	55.9%	58.0%
LA	57.3%	59.5%	58.7%		UT	73.3%	64.5%	74.6%
ME	45.4%	41.2%	42.1%		VT	39.7%	31.1%	31.8%
MD	43.4%	37.1%	36.7%		VA	54.1%	46.8%	48.0%
MA	37.3%	36.8%	38.2%		WA	46.4%	41.2%	42.4%
MI	48.3%	41.6%	45.2%		WV	56.5%	56.7%	63.7%
MN	48.2%	44.8%	46.1%		WI	49.8%	42.9%	46.5%
MS	59.9%	56.6%	55.8%		WY	70.3%	66.6%	71.2%
MO	53.6%	50.1%	54.8%					

Testing the effect of exposure to the local political behavior is difficult since shared behavior of those living near each other may also be driven by other factors such as self-selection or shared material interests (Nickerson, 2008), potentially introducing the problems of endogeneity and omitted variable bias. Surely some degree of geographic self-sorting with respect to political ideology is expected (Tiebout, 1956), but with respect to national election outcomes movement between states will be mitigated since the subsequent public policies cannot be evaded by switching states. These alternative explanations expose the complexity of measuring any location effect. Even though it cannot be ruled out that the change in preference for a political party preceded the move, it seems unlikely that individuals switch parties and then decide they must switch states so they can contribute to their newly preferred national party.

For individuals who contribute across multiple elections, and who change states between them, I analyze the effect that a change in state of residence has on the decision to contribute to a Republican or a Democrat candidate. The decision of who to support after moving, POLITICS, is modeled as follows:

POLITICS = f(VOTES, FATALITY, SWITCHSAFER, SWITCHDANGER, 0408DUMMY)

For an individual who moves from a red to a blue state VOTES is negative, and positive for those who move from a blue state to a red state. Moving from one state to another that support the same party may result in either a positive or negative value of VOTES depending on the relative intensity of statewide support. Then VOTES represents the greater degree of intensity in the political leanings of the new state faced by the individual. This is the independent variable of prime interest. The coefficient on VOTES is the peer effect. My model specification is:

$$ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + VOTES\beta_1 + FATALITY\beta_2 + SWITCHSAFER\beta_3 + SWITCHDANGER\beta_4 + 0408DUMMY\beta_5$$

Where p_i is the probability that donor *i* will support the Republican. The use of logistic regressions is consistent with the literature and follows, for example, the Laband et. al. (2009) study of expressiveness and voting in Auburn, AL, and the Joulfaian and Marlow (1991) study of political contributions as driven by age and income. Results are discussed in the next section.

2.4 Results

Full regression results are provided in Table 2.4. All coefficients are significant at the .99 level. Equations 1 through 5 reveal that a decline in support for the GOP from one's old state to his new state results in an increased likelihood that he will switch from contributing to the Republican to the Democrat. Likewise a relative increase in support for the GOP in the new state greatly increases the likelihood of switching monetary support from the Democrat to the Republican. These results hold even with the addition of the other independent variables. For both groups, those who initially support Republicans and those who initially support Democrats, switching industries increase the likelihood of switching their political support regardless of if the switch is to a safer or a more dangerous industry. Change in fatality rates affect switching one's party of support in the expected fashion as outlined in Chapter 1 with the exception of those who switch from the Democrat to the Republican in equation 6. In equations 6 and 7 I am running the full specification for 2004 to 2008 only and 2008 to 2012 only, respectively. This is done in case moving in 2008 – 2012 is endogenous to the Great Recession, which could play a large role in influencing moving across states. It is here in equation 6, for 2004 – 2008 only, that we see the coefficients on VOTE suddenly flip for both groups of voters. Apparently some interesting difference between the 2008 and 2012 elections requires identification. The observed effects seen in equations 1 through 5 are driven by the 2008 – 2012 data, and the expected signs on the coefficients on VOTE and FATALITY return in equation 7. However, very few individuals switch to the Republican from 2004 – 2008, just over 100. The estimate may be unreliable with such a small sample. From equation 5, in terms of probabilities, for every increase of 0.10 in VOTES, the probability that a donor switches from the Democrat to the Republican increases by about 4.5%. For every fall of 0.10 in VOTES the probability that he switches from the Republican to the Democrat increases by about 0.5%. In the next section I conclude with a brief discussion of the paper.

2.5 Discussion

In addition to personal characteristics, one of the determinants that influences political behavior may be location, by any number of processes. Relatively little attention has been focused on the role that location plays in influencing political choice, in part because of the difficulties that impede such statistical analysis. This unique study identifies individual donors across time and between states and allows this paper to make a unique contribution to the literature on the influences of political behavior. I test for evidence of a location effect using individual level data on political contributions reported to the FEC for the US Presidential elections of 2004, 2008, and 2012. There is no need to rehash the full study here, but most importantly I find that when one faces an increase (decrease) in support for Republicans when moving to a new state between elections, the increased likelihood that one will switch their support from the Democrat (Republican) to the Republican (Democrat) is statistically significant. To the extent this study reveals a location effect in individuals political party support, this result indicates that it can take effect swiftly since members of the sample had been living in the new state for only 0 – 4 years. The results are consistent with the expected findings if a location effect plays a role in shaping political behavior.

REFERENCES

Ashworth, John, Benny Geys, and Bruno Heyndels. 2006. Everyone Likes a Winner: An Empirical Test of the Effect of Electoral Closeness on Turnout in a Context of Expressive Voting

Bean, Clive S. and Bernadette C. Hayes. 1992. "The Impact of Spousal Characteristics on Political Attitudes in Australia." *The Public Opinion Quarterly*, Vol. 56, No. 4 (Winter), pp. 524-529

Cowen, Tyler. 2005. "Self-Deception as the Root of Political Failure." *Public Choice*, Vol. 124, No ¾ (September), pp. 437 – 451.

Downs, Anthony. 1957. *An Economic Theory of Democracy*. Harper & Row, New York.

Gentzkow, Matthew and Jesse M. Shapiro. 2010. "What Drives Media Slant? Evidence from U.S. Daily Newspapers." *Econometrica*, Vol. 78, No. 1 (January), pp. 35 – 71.

Groseclose, Tim and Jeffrey Milyo, 2005. "A Measure of Media Bias." *The Quarterly Journal of Economics*, Vol. CXX, Issue 4 (November), pp. 1191 – 1237.

Joulfaian, David and Michael L. Marlow. 1991. "Incentives and Political Contributions." *Public Choice*, Vol. 69, No. 3, pp. 351 – 356.

Kenny, Christopher B. 1994. "The Microenvironment of Attitude Change." *The Journal of Politics*, Vol. 56, No. 3 (August), pp. 715 – 728.

Laband, David N, Anne M. Laband, Ram Pandit, and John P. Sophocleus. 2009. "Patriotism, Pigskins, and Politics: An Empirical Examination of Expressive Behavior and Voting." Public Choice, Vol. 138, No. ½ (January), pp. 97 – 108.

Lott, John R., Jr. and Kevin A. Hassett. "Is Newspaper Coverage of Economic Events Politically Biased?" Manuscript, American Enterprise Institute, 2004.

McClurg, Scott D. 2004. "Indirect Mobilization: The Social Consequences of Party Contacts in an Election Campaign." *American Politics Research*, Vol. 43 No. 2, pp. 406 – 443

Nickerson, David W. 2008. “Is Voting Contagious? Evidence from Two Field Experiments.” *The American Political Science Review*, Vol. 102, No. 1 (February), pp. 49 – 57.

Niemi, Richard G, Roman Hedges, and M. Kent Jennings. 1977. “The Similarity of Husbands’ and Wives Political Views.” *American Politics Quarterly*, Vol. 5, No. 2, pp. 133 – 148.

Tiebout, Charles M. 1956. “A Pure Theory of Local Expenditures.” *The Journal of Political Economy*, Vol. 64, No. 5 (October), pp. 416 – 424.

Tollison, Robert D, Mark Crain, and Paul Paulter. 1975. “Information and Voting: An Empirical Note.” *Public Choice*, Vol. 24 (Winter), pp. 43 – 49.

Tollison, Robert D. and T. D. Willett. 1973. “Some Simple Economics of Voting and Not Voting.” *Public Choice*, Vol. 16 (Fall), pp. 59 – 71.

Table 2.4: Multinomial Logit Regression Results

Dependent Variable = Politics dummy

Politics	Ind. Var	1	2	3	4	5	6*	7**
	Vote	-.985 (.115)	-.993 (.116)	-.999 (.117)	-.990 (.117)	-.930 (.117)	2.581 (.195)	-2.654 (.139)
-1	**Fatality**		-.011 (.002)	-.010 (.002)	-.010 (.002)	-.010 (.002)	-.008 (.004)	-.009 (.002)
	Switch Ind			.585 (.047)				
	Switch Safer				.573 (.049)	.584 (.049)	.636 (.093)	.632 (.059)
	Switch Danger				.565 (.048)	.544 (.048)	.472 (.078)	.636 (.062)
	’04-’08 Dummy					.109 (.038)		
	Intercept	-2.340 (.017)	-2.344 (.017)	-2.815 (.043)	-2.781 (.040)	-2.812 (.041)	-2.603	-2.906 (.050)
0		*Base*	*Base*	*Base*	*Base*	*Base*	*Base*	*Base*
	Vote	3.285 (.076)	3.288 (.076)	3.348 (.077)	3.346 (.077)	2.780 (.081)	-2.853 (.559)	2.779 (.083)
1	**Fatality**		.008 (.001)	.008 (.001)	.009 (.001)	.009 (.002)	-.010 (.011)	.009 (.002)
	Switch Ind			.676 (.030)				
	Switch Safer				.691 (.031)	.529 (.031)	.264 (.266)	.532 (.032)
	Switch Danger				.591 (.031)	.791 (.032)	.409 (.212)	.802 (.033)
	’04-’08 Dummy					-3.469 (.083)		
	Intercept	-1.358 (.012)	-1.360 (.012)	-1.911 (.028)	-1.857 (.026)	-1.495 (.026)	-4.853 (.193)	-1.506 (.026)
N		52,918	52,918	52,918	52,918	52,918	13,559	39,359
P > Chi2		.000	.000	.000	.000	.000	.000	.000

*All coefficients significant at .99 level. * 2004 – 2008 only. ** 2008 – 2012 only.*

$$POLITICS_i = \begin{cases} 1 \; if \; switch \; from \; Democrat \; to \; Republican \\ 0 \; if \; support \; same \; party \; in \; both \; elections \\ -1 \; if \; switch \; from \; Republican \; to \; Democrat \end{cases}$$

CHAPTER THREE

The Stock Market Speaks: How Dr. Alchian Learned to Build the Bomb

3.1 Introduction

Fifteen years before Fama conducted "the original event study" in 1969 (Fama, 1991 pg. 1599), Armen A. Alchian was pioneering financial event studies in his spare time. In this paper I reconstruct a confiscated and destroyed event study of the Castle Bravo nuclear test conducted by Alchian at RAND in 1954. This event is chosen because of the historical importance it holds as one of the world's earliest event studies, and due to the subsequent declassification of top secret information surrounding the test it also provides an excellent case study of market efficiency. Realizing that positive developments in the testing and mass production of the two-stage thermonuclear (hydrogen) bomb would boost future cash flows and thus market capitalizations of the relevant companies, Alchian used stock prices of publicly traded industrial corporations to infer the secret fissile fuel component in the device in a paper titled "The Stock Market Speaks." Alchian (2000) relates the story in an interview:

> We knew they were developing this H-bomb, but we wanted to know, what's in it? What's the fissile material? Well there's thorium, thallium, beryllium, and something else, and we asked Herman Kahn and he said, 'Can't tell you'… I said, 'I'll find out', so I went down to the RAND library and had them get for me the US Government's Dept. of Commerce Yearbook which has items on every industry by product, so I went through and looked up thorium, who makes it, looked up beryllium, who makes it, looked them all up, took me about 10 minutes to do it, and got them. There were about five companies, five of these things, and then I called Dean Witter… they had the names of the companies also making these things, 'Look up for me the price of these companies… and here were these four or

> five stocks going like this, and then about, I think it was September, this was now around October, one of them started to go like that, from $2 to around $10, the rest were going like this, so I thought 'Well, that's interesting'… I wrote it up and distributed it around the social science group the next day. I got a phone call from the head of RAND calling me in, nice guy, knew him well, he said 'Armen, we've got to suppress this'… I said 'Yes, sir', and I took it and put it away, and that was the first event study. Anyway, it made my reputation among a lot of the engineers at RAND.

Alchian's study using only public information to successfully identify the fissile material of a secret US nuclear bomb test provides powerful evidence in favor of market efficiency; it was public information that the US was conducting atomic bomb tests, but it was not publicly known at the time how the bombs were constructed and even for top scientists working on the bomb, it was purely speculative what the best fissile fuel for hydrogen bombs would turn out to be. A timeline of notable dates in the secret development of lithium fissile fuel as well as public information on lithium appearing in the media is found in Table 3.1. This original event study is a testament to Alchian's great contributions to economic thought; unfortunately, his work was so insightful that the paper was suppressed and is now lost and largely forgotten. Alchian (2006 pg. xxv – xxvi) provides some additional information on the relevant test:

> The year before the H-bomb was successfully created, we in the economics division at RAND were curious as to what the essential metal was—lithium, beryllium, thorium, or some other… For the last six months of the year prior to the successful test of the bomb, I traced the stock prices of those firms. I used no inside information. Lo and behold! *One* firm's stock price rose, as best I can recall, from about $2 or $3 per share in August to about $13 per share in December. It was the Lithium Corp of America. In January I wrote and circulated [the memorandum]. Two days later I was told to withdraw it. The bomb was tested successfully in February, and thereafter the stock price stabilized.

The first hydrogen bomb test, Mike shot of Operation Ivy on November 1, 1952, used liquid deuterium as its fuel. The purpose of Operation Ivy was to upgrade the US nuclear arsenal from atomic bombs to much more powerful hydrogen bombs. After Operation Ivy which involved a total of two tests, both in November 1952, Operation Upshot-Knothole followed with eleven detonations in Nevada between March and June 1953. The purpose of these tests was hydrogen bomb component development, measuring the effects of fallout and radiation, and the testing of the effects of nuclear artillery. Shot Ruth, the third of eleven tests in Upshot-Knothole, was detonated on March 31 and tested a bomb made with uranium hydride – it fizzled. The fifth test, Shot Ray, tested a device made of uranium deuteride on April 11 and also fizzled. The failures of both Ruth and Ray demonstrate the difficulties engineers faced in the development and testing of nuclear weaponry, especially in the early days with the uncertainty regarding the effectiveness of various radioactive materials available. The last, Shot Climax, was detonated on June 4, 1953 and tested the MK 7 primary detonator to be used in the two-stage weapons of Operation Castle. Climax was followed by Operation Castle - the first series of hydrogen bomb tests to make use of lithium fuel - with seven detonations from March 1 (February 28, local time) to April 22, 1954 in the Marshall Islands. At the time, scientists had only publicly speculated on the usefulness of lithium in the development of the hydrogen bomb; the Castle tests were the first to experiment with what were only theoretical uses of lithium fuel, though the public was not aware of this experimentation due to the secrecy surrounding nuclear development. The first of these tests, Castle Bravo, was the first American test of a dry fuel thermonuclear bomb, using lithium deuteride instead of the cryogenic liquid fuel of previous tests. It was a great success and remains the largest detonation in US history, yielding 15 megatons, about 1000x the power of Little Boy or Fat Man. The lithium deuteride fuel generated an unexpected boost to the yield and Castle Bravo exceeded the predicted energy output by 150%, paving the way for powerful yet practical aircraft-deliverable weapons. It was so unexpectedly powerful that U.S. servicemen and Japanese fishermen who were thought to be at a safe distance from the test were dusted with fallout. The press reported on the destructive power of the bomb after a lag of several days, but mistakenly reported that it was an atomic rather than hydrogen bomb, illustrating the secrecy and lack of public information that surrounded the tests. The Castle test was followed by Romeo on March 26 with fissile fuel composed of 7.5% lithium. It exceeded its expected energy by a factor of 3, yielding 11 megatons. Shot Echo, which had been scheduled for March 29, was canceled after the success of Bravo rendered cryogenic fuel bombs obsolete. The next shot, codenamed Koon, was run on April 6 but fizzled due to a design defect, and was followed by Union on April 25. Union used highly enriched lithium fuel and was a success, yielding 6.9 megatons. This was followed by Yankee II on May 5 with 40% partially enriched lithium fuel, doubling expected yield with 13.5 megatons, the second most powerful test in US history. Operation Castle concluded with Nectar on May 3 consisting of uranium and plutonium with a lithium booster. Given its importance, its timing, and its fuel source, Castle Bravo is the most likely subject of Alchian's suppressed paper. The following batch of tests called Operation Teapot were run from Feb 18 to May 15, 1955 and included 14 small 1 to 30 kiloton tests, but their purpose was to improve nuclear battlefield tactics, not bomb manufacturing.

The efficient market hypothesis holds that prices are "accurate," that they reflect all available information (Fama, 1969). As a test of market efficiency, several questions must be addressed surrounding Castle Bravo. First, to what extent was the Operation Castle test series kept secret before and after the tests, and how quickly and in what manner was the information surrounding tests disseminated to the public? French and Roll (1986) observe that most information falls in a continuum between public and private, and Maloney and Mulherin (2003) and Maloney and Mitchell (1989) provide evidence that the stock market reflects secret or unknown information in the price discovery process. Operation Castle clearly entailed both public and private information components. Second, to what extent did the public understand the importance of lithium fuel in advancing the development of small high-yield thermonuclear weapons? Were there any unexpected positive developments regarding the use of lithium for commercial purposes that could have driven Lithium Corp's price upward in the time immediately preceding and subsequent to the successful Castle tests? As I demonstrate below, while stories mentioning lithium appearing in the New York Times or Wall Street Journal throughout 1953 – 1954 were consistent with a positive outlook for the lithium market, there were no sudden positive changes that alone would seem to explain very large increases in the valuation of Lithium Corp in the months surrounding Operation Castle.

Table 3.1: Timeline of Major Events

DATE	PRIVATE INFORMATION	PUBLIC INFORMATION
June 17, 1951	AEC agrees to begin producing lithium for possible use in the hydrogen bomb	
August 1952		*Popular Science* speculates that lithium may be used in the hydrogen bomb due to its use in producing tritium
March 18, 1953		"Much about the new development is secret. But what is known is this: the new device uses only three-quarters as much fissionable material as the bombs that destroyed the Japanese cities"
March 1, 1954	Castle Bravo, the first US test of a lithium fuel hydrogen bomb exceeds expected yield. Navy and Japanese fishing ships are dusted with radioactive fallout.	
March 2, 1954		"'Joint Task Force Seven has detonated an atomic device at the A.E.C.'s Pacific proving ground in the Marshall Islands. This detonation was the first in a series of tests.' The statement did not make clear whether the 'atomic device' was of the fission or thermonuclear (hydrogen) type." - NYT
March 14, 1954		"A high government official indicated today that the United States has set off the most powerful hydrogen blast yet achieved… a few days ago." - NYT
March 26, 1954	MK-21 bomb based on Castle Bravo test begins production	

This table shows major public and private events reported in the New York Times and the Wall Street Journal regarding the Castle Bravo test. This is an abridged version of the full table in Appendix C.

Using daily closing bids of major publicly traded manufacturers of fissile fuel producers I find significant upward movement in the price of Lithium Corp. stock relative to other metal-producing corporations and to the Dow Jones Industrial Average (DJIA) in March 1954; within three weeks of Castle Bravo the stock was up 48% before settling down to a monthly return of 28% despite secrecy and public confusion surrounding the test. This greatly outperformed the other stock returns for the same month and the DJIA which saw an increase of 2.3% for the month. The price of Lithium Corp continued to rise for the remainder of 1954 and saw a return of 461% for the year, some of which was gained in the two months leading up to the test despite little price movement in the twelve months prior. Lithium Corp. was seemingly singled out not only in the lead-up to the test, suggesting insider information, but after the successful test as well, suggesting successful dissemination of information relevant to the value of Lithium Corp. in the weeks and months following Operation Castle's success.

The paper proceeds as follows. I briefly describe the development of lithium fissile fuel in hydrogen bomb production as well as the market for radioactive metals generally in the early 1950s in section II; I observe price reactions of these manufacturers leading up to and after Castle Bravo in section III, and make some generalizations about the results in section IV, with concluding comments in section V.

3.2 The Market for Lithium

In late 1948, Soviet scientists proposed using lithium deuteride instead of deuterium and tritium in nuclear bombs. By early 1949, they were told to develop a bomb using lithium. But "at the time, this was just another theory … and would not be revisited for five years" (DeGroot, 2005 pg. 168). Working in parallel in the United States, Edward Teller proposed exploring the use of lithium deuteride in bombs as an alternative fuel to liquid deuterium; being a solid at room temperature, it would not require being kept several hundred degrees below zero inside the bomb, although its high rate of radiation, nine times that of hydrogen isotopes, appeared much more difficult to ignite. "Assuming the ignition problem could be overcome, Teller thought that hundreds of kilograms of Li^6D might need to be produced" (Rhodes, 1996 pg. 306). In June 1951 Edward Teller wrote a memo noting the advantages of using lithium deuteride and "the AEC agreed to begin producing lithium deuteride as a possible fuel for both the equilibrium thermonuclear and a radiation-imploded Alarm clock" device (Rhodes, 1996 pg. 476). However, the usefulness of lithium fuel was still highly speculative, and in the lead-up to the first hydrogen bomb test as Ivy Mike, lithium fuel was regarded as too complicated and was put on the back-burner (Rhodes, 1996 pg. 483-484):

> One early and important decision concerned which thermonuclear fuel to use. Lithium deuteride was one choice. Deuterated ammonia was another. Liquid deuterium was a third. Each had its advantages and disadvantages. Lithium deuteride—LiD—would be the simplest material to engineer because it was a solid at room temperature, but breeding tritium within a bomb from lithium required a complex chain of thermonuclear reactions that involved only one of lithium's several isotopes, Li^6. "We were very much aware of lithium deuteride," Hans Bethe comments. "We were not totally sure how well it would work."… [They] soon settled on liquid deuterium despite its engineering challenges… primarily because it would give the cleanest physics… The description of the [thermonuclear] burning process of pure deuterium is much simpler than the description of the burning process with either Li^6 or normal lithium deuteride… To avoid discussing the lithium seemed like a virtue. Every departure from the simplest picture seemed like something to avoid.

Despite the secrecy surrounding nuclear development, the September 1952 issue of *Popular Science* suggested that lithium may come to be used in hydrogen bombs due to its use in producing tritium, leading to an increase in demand for lithium in coming years: "For lithium, there seems good reason to believe, may be called 'the H Bomb metal.' It is expected to play a key part in making the hydrogen bomb, the most awesome military weapon ever projected… In addition, although this is pure speculation, lithium itself might actually be put into H-Bombs." In addition to being a source for tritium, the article noted that "Fusion-type atomic reactions between hydrogen and lithium are among those that could yield enormous energy [and] the purely mechanical problem of squeezing as much hydrogen as possible into a bomb might favor using lithium hydride—a solid lithium-hydrogen compound" (Armagnac, 1952 pg. 111-112). But the author makes it clear this is all pure speculation. However, the scientists did come around to the use of lithium fuel despite earlier objections, and "by August 1953, Los Alamos was actively preparing to test (in 1954) a lighter, lithium-deuteride-fueled successor to Mike that could be weaponized quickly for delivery by air" (Rhodes, 1996 pg. 525).

Even though lithium was viewed as a possible component for hydrogen bombs leading up to the Castle Bravo test, it is clear that the theoretical possibility still required successful design of a bomb that wouldn't fizzle. The Soviets had a parallel research plan that also was considering Lithium Deuteride and in August 1953, the Soviets successfully tested a bomb using lithium deuteride and uranium, their first hydrogen bomb" (Miller, 1986). Although lithium deuteride was known secretly by American scientists to be a possible contributor to a workable H bomb, it was not until the successful March 1954

Castle Bravo test which used lithium deuteride instead of deuterium that its usefulness was substantiated; "This explosion was twice as large as expected and 40 times more powerful than [the soviet bomb]" (DeGroot, 2005 pg. 192-193).

Table 3.2: Major Producers of Radioactive Metals

Element	Major Producers
Uranium	- Anaconda Copper Mining Co - Homestake Mining Co - Kerr-McGee Oil Industries, Inc - United States Vanadium Co - Canadian Radium & Uranium Corp
Radium	- Canadian Radium & Uranium Corp
Thorium	- Lindsay Chemical Co - Maywood Chemical Works - Rare Earths, Inc - Westinghouse - Metal Hydrides, Inc
Polonium	- Monsanto Chemical Co - Mound Laboratories
Plutonium	- DuPont Company
Beryllium	- Beryllium Corp - Beryl Ores Co. - Brush Beryllium Co
Bismuth	- American Smelting & Refining Co - Anaconda Copper Mining Co - US Smelting Lead Refining Inc
Thallium	- American Smelting & Refining Co
Lithium	- Lithium Corp. of America - Foote Mineral Co - American Potash & Chemical

This table shows major producers of radioactive metals in 1954. Source: Bureau of Mines, Minerals yearbook metals and minerals (except fuels) 1954, Year 1954, Volume I United States Government Printing Office, 1958

According to Alchian's interview, the fissile materials that he suspected of being used in the hydrogen bomb at the time of Operation Castle included beryllium, thallium, thorium, and lithium. To recreate the event study, I record stock prices of publicly traded manufacturers of the possible fissile components of early two-stage thermonuclear weapons from 1953 to 1954. Using the "Minerals Yearbook Metals and Minerals (Except Fuels) 1954" from the now-defunct US Bureau of Mines, I obtain information on radioactive materials including which firms produced them. (In Tables 3.2 and 3.3 I also include producers of radioactive material other than the four Alchian specifies.) I then determined which of these were publicly traded. Of these, I tracked down their daily closing bid prices for 1953 – 1954 in the Wall Street Journal archives on ProQuest. Table 3.2 lists radioactive material producers, and Table 3.3 identifies publicly traded ones.

Table 3.3: Publicly Traded Manufacturers

Metal	Company	Exchange	Pricing Source
Beryllium	**Beryllium Corp**	OTC	WSJ OTC Industrials
Beryllium	Brush Beryllium	NYSE*	WSJ New York Stock Exchange Transactions
Thallium	**American Smelting & Refining Co.**	NYSE**	WSJ New York Stock Exchange Transactions
Thorium	Westinghouse Electric Co.	NYSE	WSJ New York Stock Exchange Transactions
Thorium	**Metal Hydrides Inc.**	OTC	WSJ OTC Weekly List
Polonium	Monsanto Chemical Corp.	London	WSJ London Stock Averages
Plutonium	DuPont	NYSE	WSJ New York Stock Exchange Transactions
Lithium	**Lithium Corp. of America**	OTC	WSJ OTC Industrials
Lithium	Foote Mineral Co.	OTC	WSJ OTC Industrials
Lithium	American Potash & Chemical Co.	NYSE	WSJ New York Stock Exchange Transactions

This table shows all publicly-traded producers of metals from Table 3.2. The ones in bold are the focus of this paper.
** After 1956 ** In DJIA 1901 – 1958*

Of the lithium producers, Foote Mineral Co. produced only lithium carbonate up to this time (used for glasses, adhesives, and batteries) and spent 1953-1954 expanding its lithium production capacity. American Potash & Chemical was also expanding into lithium at this time, and produced such a diverse range of chemicals that the stock price response to developments in the lithium market would be diluted. As such I use Lithium Corp to represent lithium production, as Alchian did. The New York Stock Exchange-traded companies Westinghouse, Monsanto, and DuPont are all too large and diversified to expect any significant price response based solely on their radioactive metal interests. American Smelting (ASARCO) is also a large producer but is included as the sole publicly traded producer of thallium. All companies included in the event study are listed in bold in Table 3.3. (Lithium Corp. went on to merge with Gulf Resources in 1967).

3.3 Market Reaction to the Castle Bravo Detonation

3.3 i: The Operation Castle Tests

Operation Castle was part of the effort to develop powerful weapons that were small enough to be delivered by aircraft, a drive requiring innovative bomb designs. The relatively weak bomb at Nagasaki was only 17% efficient as measured by percent of material fissioned, while the Hiroshima bomb was only 1.4% efficient, yielding about 20 and 15 kilotons each, respectively (see Nuclear Weapon Archive). Such pure fission atomic weapons used uranium or plutonium fuel. These were followed by the development of boosted fission atomic weapons which more than doubled the energy output of pure fission weapons. These in turn were replaced by a third design, the Teller-Ulam configuration, a radical innovation that greatly increased the efficiency of nuclear weapons utilizing a two-stage design with a primary fission trigger that compressed a fusion fuel capsule.

Commonly called a hydrogen bomb, it was first tested at Ivy Mike in November 1952, resulting in a yield of 12,000 MT and was an important step in developing small, extremely powerful nuclear weapons.

In addition to the new design, other approaches for boosting the energy output of nuclear weapons were tested. “One of the new approaches – the use of non-cryogenic “dry” (lithium deuteride) fuel – was a spectacular (and disastrous) success with a yield far exceeding expectations” (Nuclear Weapon Archive). Castle Bravo was the first “dry” (solid fuel) H-bomb the US detonated, using lithium deuteride in a natural uranium tamper. It was the basis for the MK-21 bomb which went into further development beginning on March 26; by December 1955, mass production began and 275 units were built through July 1956. In late 1957 it was upgraded to the MK-36 design (Nuclear Weapon Archive). Yet just a few years earlier, the development of the hydrogen bomb had stalled prior to the 1951 development of the Teller-Ulam design and no plans were made to produce lithium enriched in Li^6. As such, “it became a race to get a large lithium enrichment plant into production” once the working hydrogen bomb design was developed (Nuclear Weapon Archive). Due to the lack of lithium-6, some of the Operation Castle tests used partially enriched or unenriched lithium instead. The second test, Castle Romeo used lithium deuteride fusion fuel consisting of cheap and abundant unenriched lithium. It was unknown ex ante whether unenriched natural lithium would be effective fuel; “In fact as late as October 1953, Los Alamos was considering not even testing this device. The decision to include it was thought to be a crap-shoot to see if this cheap fusion fuel would be useful” (Nuclear Weapon Archive). Despite this concern, it produced the 4th largest nuclear detonation in US history. Romeo was a test of the MK-17 bomb which was deployed months later after the test was successful. Once the effectiveness of lithium dry fuel was demonstrated in the first of the Castle tests, the Castle Jughead test of cryogenic (liquid deuterium) fuel was seen as obsolete and was canceled. Four more Castle tests followed, concluding with Castle Nectar on May 14, 1954.

3.3 ii: Lead-up to the Tests

Nuclear testing was shrouded in secrecy. Bomb design and even test schedule and location were classified. The article "Wide Open Secrecy" appearing in the Wall Street Journal on June 20, 1958 discusses how some information surrounding the tests was disseminated beyond the military:

> While the Atomic Energy Commission keeps secret the timing of its series of atomic blasts now going on in the Pacific, another government agency is busy broadcasting warnings to planes telling pilots to keep out of the area. The Civil Aeronautics Administration has been sending unclassified, uncoded messages to everybody who wants to listen telling pilots of specific periods of time when the test areas will be hazardous to airplanes. A spokesman for the A.E.C. condones the C.A.A. on the ground that "telling people they ought to stay out of an area is not the same as saying a test has occurred."

The article also notes that despite the secrecy surrounding tests, the Tokyo Meteorological Board detects the shock waves that nuclear tests generate at Bikini Atoll, 2424 miles away. The article "Ally for Peace" of March 18, 1953 discusses some unknowns regarding the new hydrogen bomb first tested 4 months earlier as Ivy Mike:

> Much about the new development is secret. But what is known is this: the new device uses only three-quarters as much fissionable material as the bombs that destroyed the Japanese cities; when finally it is perfected it will be small enough to be carried to its target by a jet plane, yet it is the equivalent of 15,000 tons of TNT.

Operation Castle itself was mysterious and its timing and the nature of the tests were not clear to the public. The public was only informed about upcoming tests with a cryptic and brief statement from the military ("Atom Blast Opens Test in Pacific; No Hint of Hydrogen Plans Given," New York Times, March 2, 1954):

> The only prior announcement was made Jan. 8. When the Atomic Energy Commission said that "men and materials" were being transported to the proving ground "to carry out a further phase of a continuing series of weapons tests of all categories."

This seems to have been the extent to which the public was informed of any specific upcoming nuclear testing by the US prior to Castle Bravo.

3.3 iii: Dissemination of Information Following the Detonation

The Castle Bravo test was detonated on Monday, March 1, 1954 at 06:45 EST (February 28, 18:45 GMT) at Bikini Atoll. It was a surface burst producing a yield of 15 MT, 150% more powerful that the 6 MT that was expected and producing a crater 2 miles wide. On March 1, 1954, the US detonated its first lithium-deuteride-fueled thermonuclear weapon called Shrimp, code-named Castle Bravo (Rhodes 1996, pg. 542). "The room-temperature Shrimp device used lithium enriched to 40 percent lithium6; it weighed a relatively portable 23,500 pounds and had been designed to fit the bomb bay of a B-47 when it was weaponized. It was expected to yield about five megatons, but the group at Los Alamos that had measured lithium fusion cross sections had used a technique that missed an important fusion reaction in lithium7, the other 60 percent of the Shrimp lithium fuel component. "They really didn't know," Harold Agnew explains, "that with lithium7 there was an n, 2n reaction [i.e., one neutron entering a lithium nucleus knocked two neutrons out]. They missed it entirely. That's why Shrimp went like gangbusters." Bravo exploded with a yield of fifteen megatons, the largest-yield thermonuclear device the US ever tested. "When the two neutrons come out," says Agnew, "then you have lithium6 and it went like regular lithium6. Shrimp was so much bigger than it was supposed to be because we were wrong about the cross section" (Rhodes 1996, pg. 542).

The test is also one of the worst radiological disasters in U.S. history. The unexpectedly large yield combined with unfavorable weather patterns resulted in contamination of several inhabited islands including one where U.S. servicemen were stationed; evacuations were conducted only after victims received significant exposure to radiation. U.S. Navy ships and at least one Japanese fishing vessel were also dusted with fallout. "The US offered radiation specialists to treat the fishermen but refused to reveal fallout content for fear the Soviets would learn that the Shrimp had been fueled with lithium deuteride" (Rhodes 1996, pg. 542). The next day, the New York Times reported on a statement from the Atomic Energy Commission which the paper noted was not clear on whether an atomic or hydrogen weapon had been tested:

> "Joint Task Force Seven has detonated an atomic device at the A.E.C.'s Pacific proving ground in the Marshall Islands. This detonation was the first in a series of tests." The language of Admiral Strauss' statement did not make clear whether the "atomic device" was of the fission or thermonuclear (hydrogen) type. There have been unofficial indications, however, that a variety of hydrogen weapons or devices will be tested during the next several weeks. The most powerful of these is expected to be an actual hydrogen bomb with perhaps twice the explosive power of the experimental device that disintegrated an island of Eniwetok Atoll on Nov. 1, 1952.

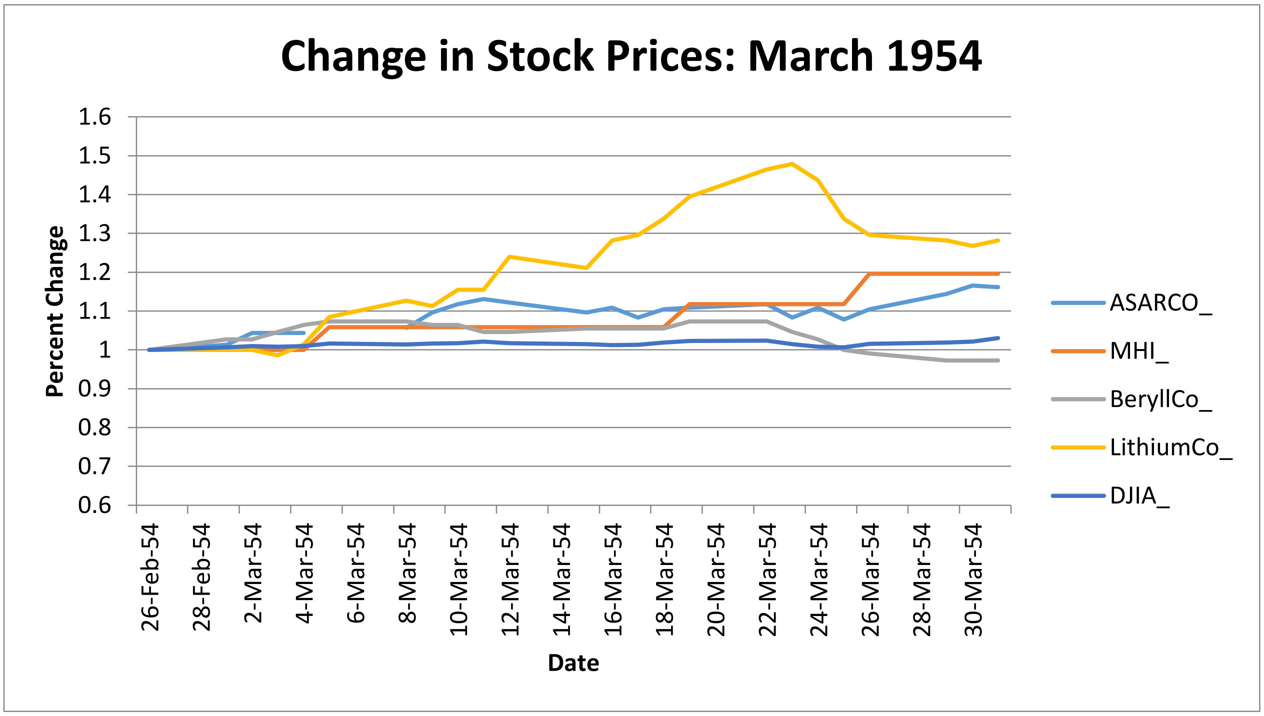
On March 7 and again on March 11 it was reported that a hydrogen bomb test was imminent. On March 12 it was announced that recent testing had resulted in radiation exposure to US servicemen and island natives. Not until March 14 was it reported that the test conducted in early March was a hydrogen bomb. Following the great success of the lithium fissile fuel in Bravo, "the Castle tests continued with tests of an unenriched lithium-deuteride device… 'The results of Operation Castle,' Raemer Schreiber writes, 'left me with the unpleasant job of negotiating the closeout of a sizeable cryogenic hardware contract.' Future US thermonuclear weapons would be fueled with lithium deuteride" (Rhodes 1996, pg. 542-543).

3.3 iv: Price Reaction

The pre-event period saw a run-up on the price of Lithium Corp that was not seen by the other stocks. The January preceding Castle Bravo, the price of Lithium Corp. began rising following a year where the stock didn't see much change in price. On January 2, 1953 it was priced at \$5.25 and ended the year at \$5.125 on December 31, 1953, having hit a low of \$3.50 in mid-September. Yet in the 2 months leading up to Castle Bravo, Lithium Corp. of America rose from \$5.125 on December 31, 1953 to \$8.875 on February 26, 1954, the last trading day before the detonation. Figures 3.1 and 3.2 begin on this date and show the changes in stock prices for March for each day relative to February 28th. While there was no immediate price reaction to the successful test in any of the stocks, by March 5th all had gone up slightly but Lithium Corp. had overtaken the rest in return, a position it never relinquished. On March 8th, Lithium Corp. was up 12.7% to \$10.00. It hit \$11.00 on March 12th, jumped from 11 7/8 to 12 3/8 on March 19th, and was up over 48% to \$13 1/8 on March 23, just over three weeks after the detonation, before settling down to \$11.375 on March 31 for a monthly return of 28%. By comparison the Dow Jones Industrial

Average (DJIA) had only risen 2.3% in March from 294.54 to 303.51. ASARCO and Metal Hydrides (MHI) saw very high growth relative to both the Dow and to their own prior 3 month averages, but rose much less than Lithium Corp, rising 16% and 19.6%, respectively. This would have presented strong circumstantial evidence to Alchian that lithium was the fuel used in Castle Bravo. Additionally, only in the case of Lithium Corp. did the price rise seen in March represent the continuation of high returns in previous months, a lead-up that Alchian referenced in his memories of the study.

Figure 3.1: Stock Prices, March 1954



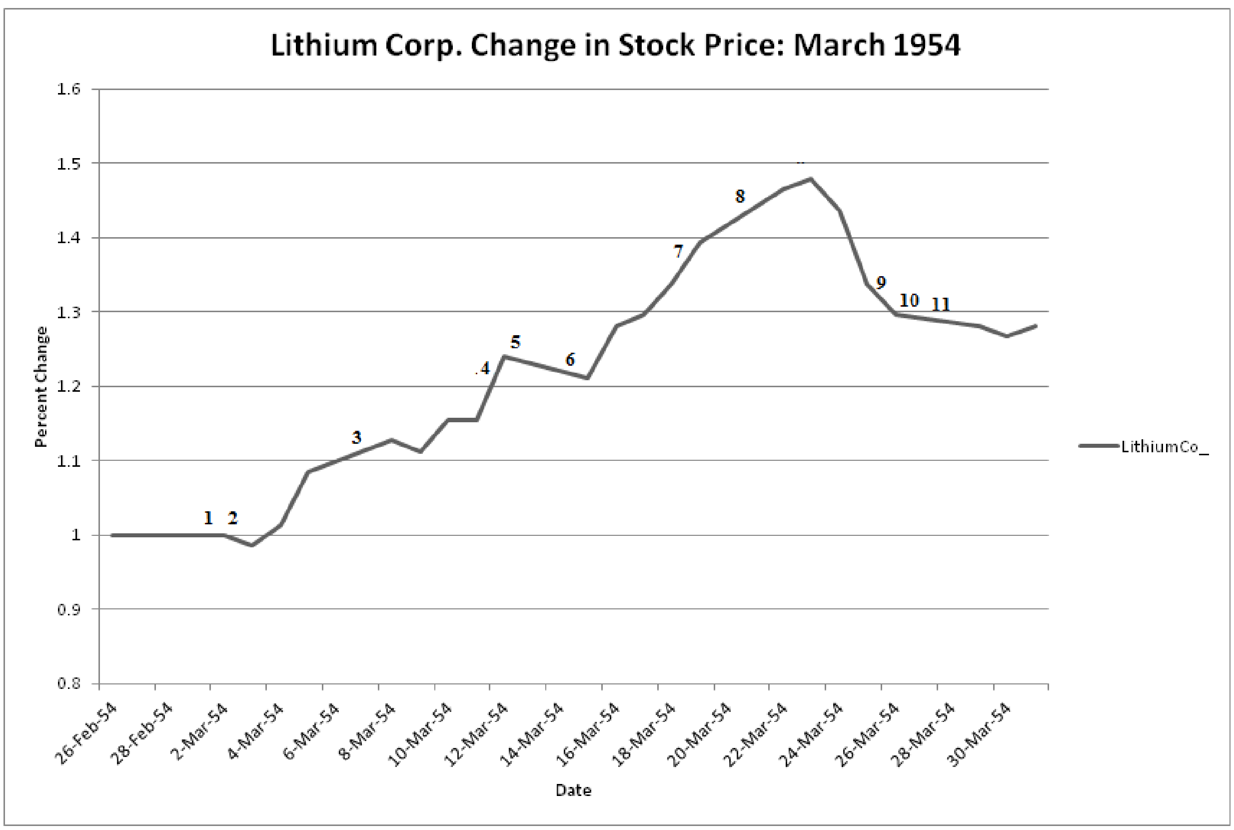
Castle Bravo detonated on March 1. February 26 is last trading day prior.

Figure 3.2 graphs only Lithium Corp. stock for March, with key dates. At (1), Castle Bravo is successfully tested. The test remains secret, and the stock price is unaffected. At (2), the New York Times reports that Joint Task Force Seven announces the detonation of an "atomic device" in the Pacific. At this point, as far as the public knows only an atom bomb has been tested, and nothing extraordinary is reported. On March 3, the stock price dips to $8 ¾ before rebounding and steadily climbing to $10 on March 8, the day after the New York Times reports that "The United States detonated last week its forty-sixth nuclear device and prepared to test in the next couple of weeks its first operating model of a hydrogen bomb," appearing on Figure 3.2 as (3). At this point the press still believes that the March 1 device was atomic, but the stock price continues to climb. On March 11 - (4) on Figure 3.2 - the New York Times repeats the same error: "A hydrogen bomb designed for combat may produce history's greatest man-made blast in the Marshall Islands between March 16 and 28… The first blast in the current series of tests was March 1. The commission announced that an atomic device had been detonated, indicating that the hydrogen bomb was yet to come since hydrogen bombs are usually referred to as thermonuclear."

At (5) on Figure 3.2, March 12, 11 days after the test, the Wall Street Journal reports that "Twenty-eight Americans and 236 natives were "unexpectedly exposed to some radiation" during recent atomic tests in the Marshall Islands." This is followed by a decline of 25 cents in the stock price. Over the weekend on March 14, (6) on Figure 3.2, the New York Times reports, "A high government official indicated today that the United States has set off the most powerful hydrogen blast yet achieved… a few days ago." Then the stock price really begins to take off. On March 15 the stock price is at $10 ¾ but climbs up to $11 7/8 on March 18, the day when the New York Times reports, "Shattering power hundreds of times greater than any previous man-made explosion was unleashed when the US set off its hydrogen explosion No. 2," seen at (7) on Figure

3.2. The stock price continues up through a March 22 Wall Street Journal article reporting, “Commentators and some congressmen are busily telling us that the horrors implied by the latest explosion are beyond belief,” marked at (8) on Figure 3.2. The price hits a new high of $13 1/8 on March 23. At this point the stock begins to come back down. On March 25, (9) on Figure 3.2, the Wall Street Journal reports, “All fish brought into Japanese and West Coast ports are being checked for radioactivity.” On this date the stock price hits $11 7/8. The next day, at (10), the stock price drops to $11 1/2 as the Wall Street Journal reports, “Atomic Energy Commission reported plans to step up US production of hydrogen and other atomic weapons.” On Saturday, March 27, (11) on Figure 3.2, Castle Romeo is successfully tested and the stock price drops to $11 3/8, closing at this

Figure 3.2: Stock Prices, March 1954, Lithium Corp. Only with Key Dates



price on March 31 two days later. Despite volatility in the stock price, it rose steadily throughout the month and would have indicated to Alchian that lithium was the likely fuel used in the Operation Castle devices.

Table 3.4: Stock Returns Surrounding March 1 Castle Bravo Test

March 1954	Lithium Co	Beryllium Co	ASARCO	MHI	DJIA
March 1954 Return	.282	-.054	.147	.196	.023
Prior 3 Month Average Return	.170	.023	.007	-.048	.016
March 1954 St. Dev	1.37	.93	1.24	.83	1.98
Prior 3 Month's Average St. Dev	.54	.57	.75	.42	2.42
Post-Test 1954 Returns	**Lithium Co**	**Beryllium Co**	**ASARCO**	**MHI**	**DJIA**
Feb 26 Price	8.875	27.25	28.625	12.75	294.54
Dec 30 Price	28.75	40.5	45	23.5	401.97
Return	224%	49%	57%	84%	36%
1954 Returns	**Lithium Co**	**Beryllium Co**	**ASARCO**	**MHI**	**DJIA**
Dec 31 53 Price	5.125	24.75	28	14.5	280.90
Dec 30 54 Price	28.75	40.5	45	23.5	401.97
Return	461%	64%	61%	62%	43%

Figures 3.3 and 3.4 plot monthly returns for the stocks and the Dow for the one-year period centered around the Castle series of tests. It shows that Lithium Corp. saw relatively high returns of 34.3% in November 1953, 48.8% in January 1954, 16.4% in February, 28.2% in March when the tests began, and then saw returns of 23.1%, 14.3%, and 46.9% in the following three months. From November 1953 through June 1954,

Figure 3.3: Monthly Stock Returns, Year Around Castle Bravo

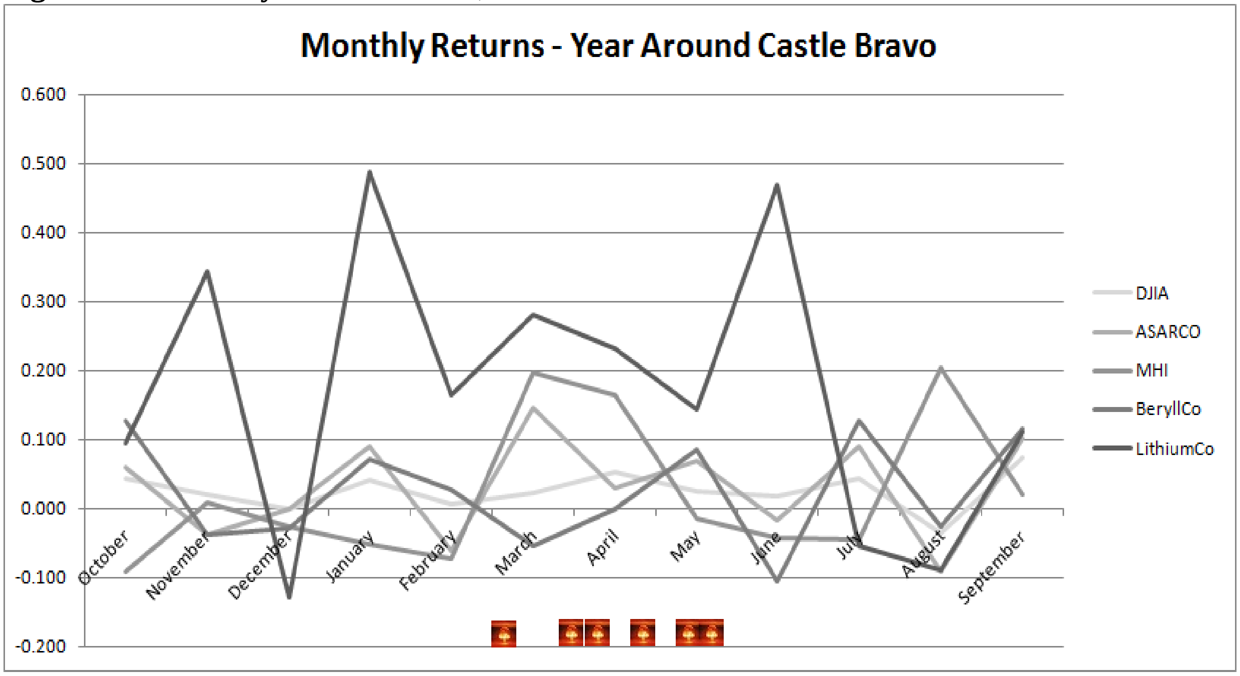
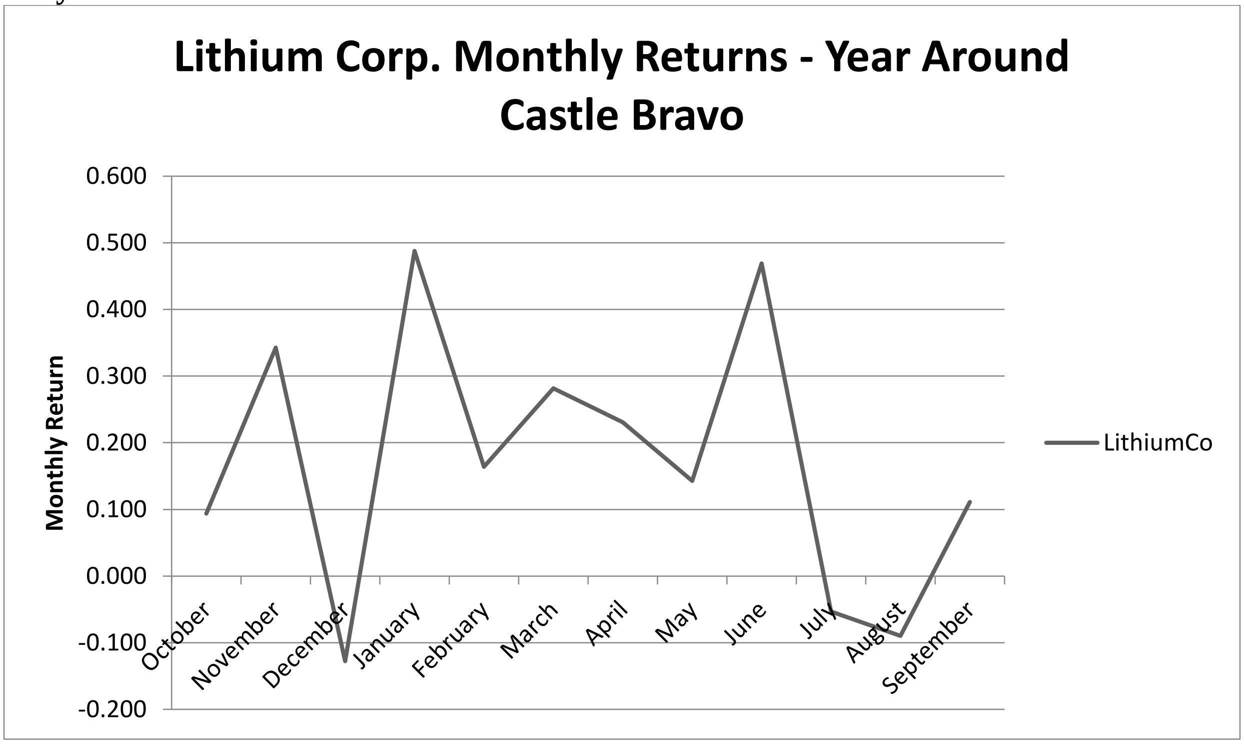
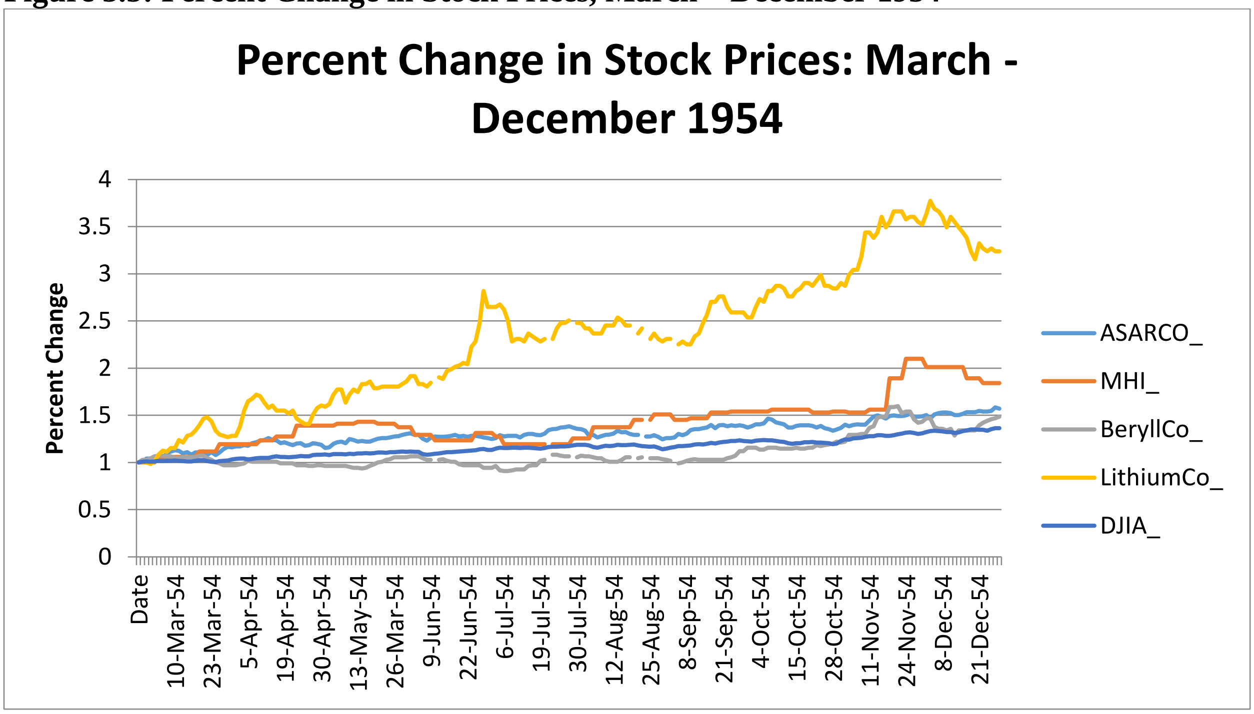


Figure 3.4: Monthly Stock Returns, Year Around Castle Bravo , Lithium Corp. Only



Lithium Corp. beat the other stocks and the Dow in every month except December 1953 where it saw a negative return of -12.8%, two months prior to Castle Bravo. Comparing Lithium Corp, Beryllium Co, MHI, and ASARCO in the lead-up to and during the Castle tests, it is obvious which one would have stood out to Dr. Alchian or anyone else who knew to look to the stock market for information on the secret components of the hydrogen bomb.

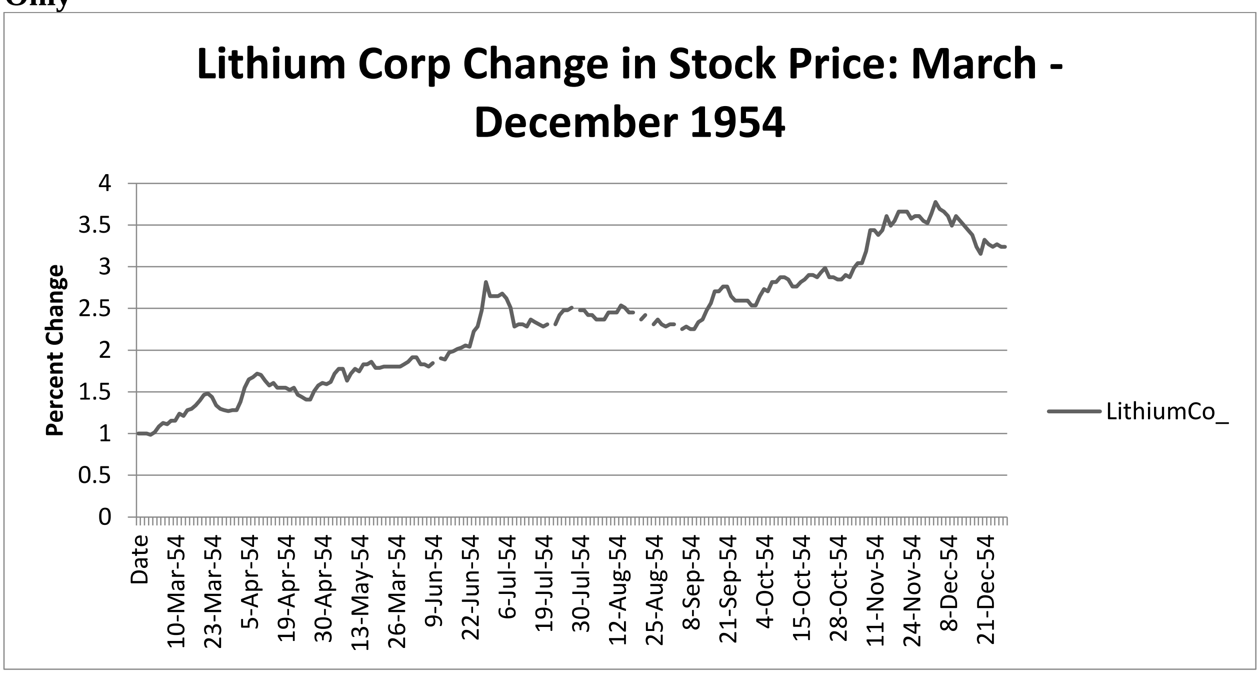
Figure 3.5: Percent Change in Stock Prices, March – December 1954



Figures 3.5 and 3.6 graph the cumulative changes in stock prices and the value of the Dow from February 28, 1954 through December 30. The relatively growth and volatility exhibited by Lithium Corp. following Castle Bravo is clear; after steadily climbing over 46% in 21 days, it dipped to a cumulative return of only 26.7% by March 30 before rebounding to a cumulative return of 71.8% on April 8th. By April 8th, ASARCO was up 21% and MHI was up 19.6%, both impressive in their own right. On this date the Dow was

up 4.5% and Beryllium Co. was up less than 1%. By the end of the year, December 30, 1954, Lithium Corp was at $28.75, a 224% return over the February 26 price, greatly exceeding the returns of the other companies as well as of the Dow, yet they all saw tremendous 10-month returns. Between the four companies, Beryllium Co. did the worst with only a 49% return by the end of 1954. Although at first the unusual price movements of Lithium Corp. in early 1954 may have been considered by a cautious skeptic to be a mere coincidence, if Alchian continued following the stocks through the end of the year his confidence in his findings undoubtedly grew.

Figure 3.6: Percent Change in Stock Prices, March – December 1954, Lithium Corp. Only



Similarly, Figure 3.7 graphs cumulative changes in stock prices and the value of the Dow for the entire year, from December 31, 1953 through December 30, 1954. From the beginning of January, Lithium Corp increased from $5.125 to $28.75, yielding a return of 461% for the year vs. 61% - 64% for the other 3 companies and 43% for the Dow. Lastly, Figures 3.8 and 3.9 graph monthly returns of all four stocks and the Dow from January, 1953 through December, 1954. Relative to the other companies, Lithium Corp. was not unusual in its volatility and price movements for most of 1953. It enters a period of unusual volatility and unusually high returns only in the months immediately preceding, during, and after the Castle tests. This alone could have suggested to Alchian that lithium was likely the fuel used in the Castle series of nuclear devices, the high returns and volatility indicative of the dispersion of secret and increasingly certain knowledge favorable to the usefulness of lithium in hydrogen bombs.

Figure 3.7: Percent Change in Stock Prices, January – December 1954

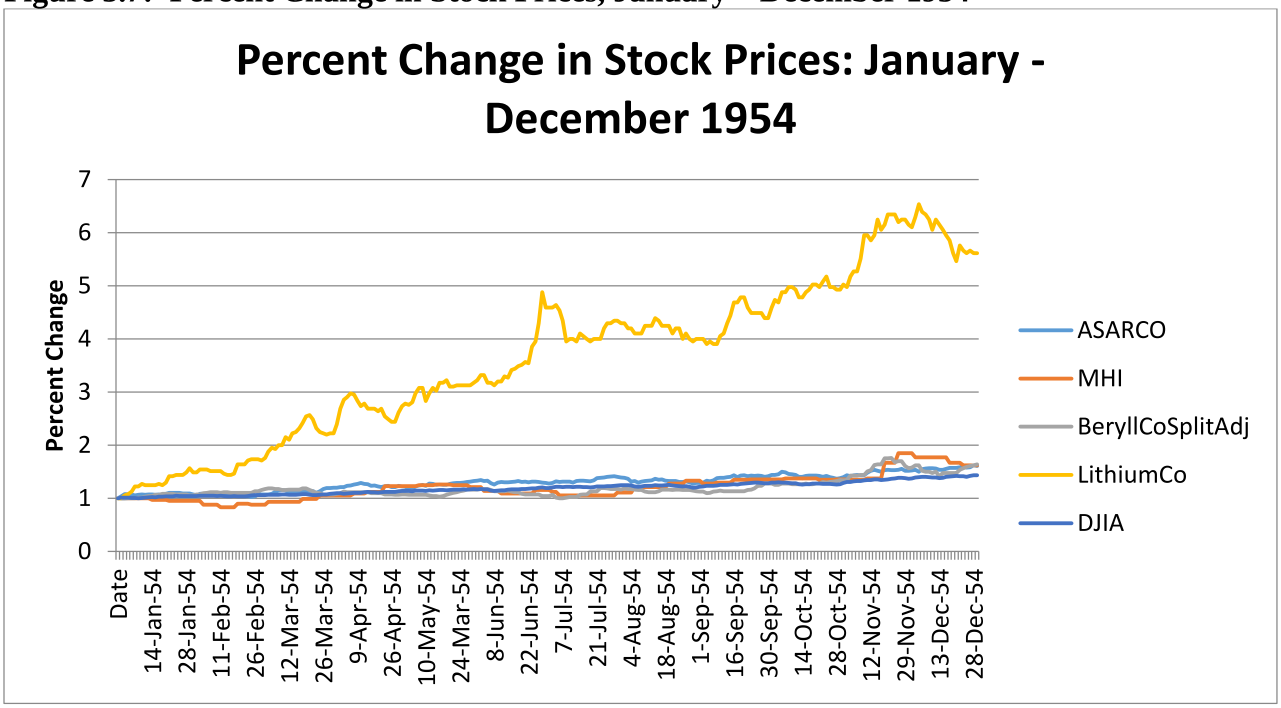


Figure 3.8: Monthly Stock Returns 1953 – 1954

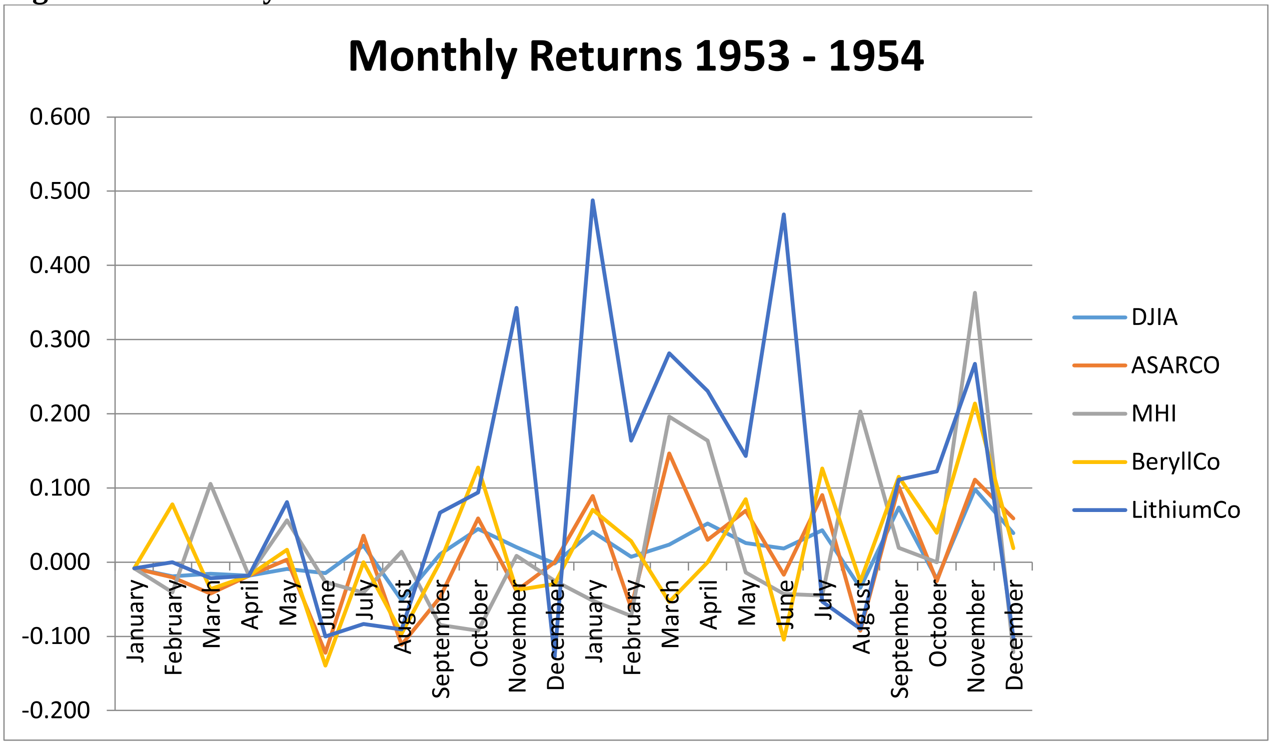
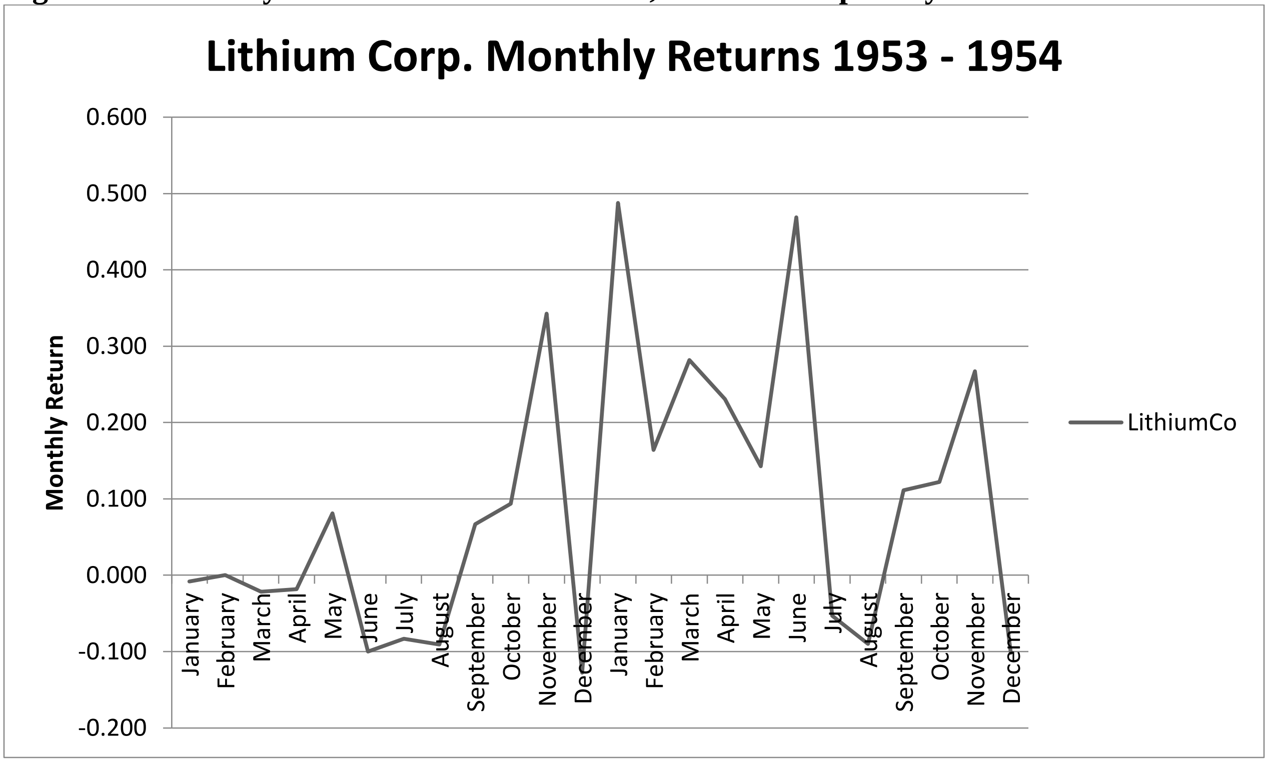


Figure 3.9: Monthly Stock Returns 1953 – 1954, Lithium Corp. Only



3.3 v: Spot Prices

The 1954 Minerals Yearbook on Lithium from the US Bureau of Mines specifically notes that lithium prices were not regularly quoted at the time. However, annual prices collected by the Geological Survey reveal that the price and production went up from 1953 to 1954, but that the 1954 price was below the 1952 real price. This suggests that the increased valuation of Lithium Corp was not driven solely by a sudden increased spot price in lithium. American imports are listed as primarily originating from Southern Rhodesia, South West Africa, and Mozambique (Arundale and Marks, 1958 pg. 731). After the US, the largest importers of lithium in 1953 were West Germany, United Kingdom, France, Netherlands and Australia (Arundale and Marks, 1958 pg. 735). While "no official consumption figures were available," the Minerals Yearbook for 1954 states that two thirds of lithium that year was used for greases and ceramics, with lesser amounts input into "air conditioning, refrigeration, aluminum brazing, metallurgy, organic synthesis, batteries, and other applications" (Arundale and Marks, 1958 pg. 730). However, according to Moody's Industrial Manual 1961, over 50% of lithium production was going to the Atomic Energy Commission only seven years later. Also in 1954, the Department of Defense requested a report "on the availability of lithium, past and present, with particular emphasis on the advantages that might come to the national defense" through use of lithium, a report that had not been completed by year's end (Arundale and Marks, 1958 pg. 731). As Table 3.6 reveals, Lithium Corp was a major player in the sudden rise in demand for lithium, doubling its net sales from 1954 to 1955, and then doubling again from 1955 to 1956.

Table 3.5: Spot Price of Lithium 1950 – 1955

Year	US Production	World Production	Value ($/t)
1950	347	18,000	NA
1951	444	25,200	NA
1952	505	25,500	2,380
1953	821	57,800	1,870
1954	1,140	93,200	2,200
1955	1,250	86,000	2,130

Source: Lithium Statistics, U.S. Geological Survey, http://minerals.usgs.gov/ds/2005/140/ds140-lithi.pdf. Production is in metric tons.

Table 3.6: Lithium Corp. Annual Accounting

YEAR	DIVIDEND	NET SALES	NET INCOME	NO. SALES
1953		$2,296,619	$197,807	547,750
1954		$3,178,287	$298,362	737,500
1955	.05	$6,381,876	$172,622	763,622
1956	.06	$12,151,856	$365,620	812,885
1957	.03	$12,209,874	$485,674	837,303
1958	.04	$11,186,616	$763,368	877,556
1959		$10,841,382	$593,357	930,698

Data on Lithium Corp revenue Moody's Industrial Manual 1961

3.4 Generalizations

Market efficiency "gauges the extent to which stock prices quickly and accurately respond to new information" (Maloney and Mulherin, 2003). How secret was Operation Castle in its timing and the nature of the tests, including its role in developing the MK21 and MK17 weapons, and how quickly and by what means was this private information disseminated to the public? The large, sudden increase in price and volatility seen in Lithium Corp stock beginning in January 1954 indicates new, positive information being absorbed into the price discovery process that singled out Lithium Corp. among metal producers as suddenly warranting a higher valuation. The continued rise in the price of

Lithium Corp. through 1954 demonstrates market efficiency given the ongoing uncertainty surrounding lithium fuel and the slow release of private information into the market.

The government statements concerning the tests that occurred as part of Operation Castle were vague, neither revealing the exact dates nor the nature of the tests. The first reports following the test stated that it was not clear whether the tests were atomic or hydrogen bombs. Even to those who understood the importance of lithium in new hydrogen bombs, the success of Castle Bravo could not be interpreted positively for the lithium market without first ascertaining if the test was of an atomic or hydrogen bomb. Indeed the price of Lithium Corp. remained flat for several days after the test. To the extent that subsequent price movements were in response to Castle Bravo, this slow reaction reveals a gradual spread of information regarding its implications for profitability of lithium producers. The lead-up to the test also shows significant gains in Lithium Corp, consistent with the possible dispersion of insider information. Since Castle Bravo also represented a test of what was to become the MK21 bomb which was built and deployed thereafter, this knowledge would have made investments in lithium producers seem highly lucrative following the successful test.

For the public, how well-understood was the importance of lithium in the development of hydrogen bombs? The bidding up of the price of Lithium Corp in response to the Castle Bravo test relies on bidders not only being aware that the test was of a hydrogen rather than an atomic bomb, but that lithium deuteride was being used in the hydrogen bombs to increase their destructive power. Three stories appearing in the Wall Street Journal in 1953 to 1954 mention lithium with regard to atomic weapons. On January

28, 1954, the story “Firms Flock to Adapt Bomb-Making Research to Scores of Civil Uses” noted that lithium is used in newly-developed hydrogen. The March 9, 1954 story “Abreast of the Market” notes that lithium is used in atomic weapons. The December 30, 1954 story “A Special Background Report on Trends in Industry and Finance” also notes that hydrogen bombs use lithium. However, the fissile fuel used in atomic weapons, including hydrogen bombs, differed from test to test. Even Alchian who worked at RAND didn’t know which fuel was used in Castle Bravo, and the engineers refused to tell him. This suggests that nobody outside of a small circle of scientists knew that Castle Bravo was the first test of a hydrogen bomb using dry fuel in the form of lithium deuteride, and in any case its effects were only speculative before the test. Up to that point, lithium had been used only as a booster in a couple tests following Ivy Mike. It was in these tests that the importance of lithium in the construction of hydrogen bombs was discovered as it increased the destructive power of the bombs. Yet as late as Castle Romeo, there were doubts as to how useful lithium would be in hydrogen bomb construction. Even if the information surrounding the tests was fully public, this uncertainty would have resulted in greater volatility and price discovery being drawn out over time.

The tests were announced by the military beforehand and reported on by major newspapers afterwards, but the exact dates were not known by the public ahead of time, nor did they know the internal bomb components, nor what was specifically being tested by the military, whether energy output, effects of radioactive fallout, or nuclear war-fighting strategy, or posturing to the Soviets, or some combination of intentions. Nor could they have known that Castle Bravo was in fact a test of the MK21 bomb prototype that was to be mass produced and deployed within the next 18 months as the US military's first deliverable hydrogen weapon pending the successful test. As news stories following the test reveal, information surrounding Castle Bravo was disseminated slowly, and some remained classified throughout the Cold War.

This seems to be a case where private information held by a few was slowly dispersed among market participants until this knowledge was reflected in stock prices allowing for the efficient allocation of lithium, consistent with Hayek's (1945) analysis of the price mechanism as a means of communicating information. While Romer (1993) notes that "outside observers very often cannot identify any news that could plausibly have been the source of observed changes in stock prices," this is expected in a market involving secret military weapons testing. Together, Romer and Hayek can explain the volatility seen in Lithium Corp. stock surrounding the Castle tests as new information was dispersed and market actors made judgments about the uncertain but promising future for lithium. Under secret information and uncertain benefits of lithium, a slower price reaction and greater volatility is perfectly consistent with well-functioning efficient markets. Dow and Gorton (1993) argue that price responses to information may not be quick, with a resulting pattern of price discovery that is not obviously related to any specific news. To the extent that the stock price of Lithium Corp was responding to Operation Castle, some of the price movement must have emanated from what was once private information including the use of lithium fuel, the yield boost it generated, and the consequent mass production and deployment of lithium fuel hydrogen bombs, but such price responses need not have occurred on any specific day since the dissemination of this private information is expected to be gradual given its classified nature. Castle Bravo occurred 12 years before the case SEC v. Texas Gulf Sulphur Co. (1966) where federal circuit court ruled that those who possess insider information cannot trade on it. Major legislation restricting insider trading did not come about until the 1980s.

In addition to hydrogen bomb manufacturing, lithium was used in a variety of products including ceramics, greases, glass, and batteries, and it is expected that the price of Lithium Corp. would respond to information regarding these products as well. Many of the news stories cover the expansion of lithium interests by major lithium producers. Of the 22 Wall Street Journal articles found that mention lithium between 1953 – 1954, 11 are primarily on the expansion of lithium mines, the upfront costs these investments entail and thus the declines in earnings, even though they are expected to increase future profits as demand for lithium continues to increase. On April 23, 1954, Foote Mineral Co. announces that a large portion of first quarter sales were of lithium and that the company is well-positioned to supply lithium to the US government if it demanded it. On June 10, 1954, it is reported that a Senate committee votes to increase the depletion rate of lithium mines for tax purposes. On August 31, 1954, the Wall Street Journal reported earnings for Lithium Corp. of America for the 6 month period ending June 30. A net income (after federal taxes) of $152,287 for 1954 was reported versus a 1953 net income of $77,980, an increase of 95%. It was clear in the press at the time that the market for lithium was doing well and that it was expected to continue growing due to both commercial and military uses of lithium.

Given the large returns seen by Lithium Corp in 1954, perhaps the market also foresaw the massive magnitude of the arms race that followed. If lithium was considered to be the likely source of the much greater destructiveness of new hydrogen bombs, and if this destructiveness suggested to investors that the arms race would only accelerate, then an expectation of massively increased demand for lithium by the government could justify the returns seen by Lithium Corp. This would suggest that the market predicted that increasingly powerful weapons would, perhaps counter-intuitively, result in the stockpiling of even more nuclear weapons than otherwise would have been built. Indeed, the US achieved its all-time high of 31,255 nuclear warheads in 1967, up from 1,436 in 1953, an increase of 2000% in 14 years. Ex post, the returns seen by Lithium Corp following Castle Bravo seem quite reasonable.

Even with insider trading still legal, the slow speed of adjustment in Lithium Corp. prices could be explained in part by the high cost of information over large distances in 1954 given that the proving grounds were thousands of miles away from the mainland US. With the cost of information higher over greater physical differences, such a rate of price adjustment is not unexpected. Indeed, Peterson and Rajan (2002) find that "advances in computing and communications have increased the availability and timeliness of hard information" since the 1970s, allowing for more distant and impersonalized bank lending, it is reasonable that investors of the past were biased toward investments that were close to home in the age preceding artificial satellites and subsequent advances in telecommunications, and that information from Castle Bravo and lithium production trickled in over the course of days or weeks.

3.5 Conclusion

This event study confirms Armen A. Alchian's report of the event study he conducted at RAND, revealing that he successfully determined the fissile fuel that started being used in hydrogen bombs at that time, contributing to his reputation among the scientists and engineers who developed them. He accomplished this 15 years before what Fama referred to as the original event study, conducted by Fama, Fisher, Jensen, and Roll in 1969 in a study that analyzed stock splits, a development that Fama himself attributed to mere "serendipity" as a means to justify continued monetary support for CRSP data (Fama, 1991 pg. 1599). The price responses of mineral producers seen before and after Operation Castle provide evidence in support of market efficiency through the dissemination of formerly private information into the public sphere. Whereas previous research by Maloney & Mitchell (1989) and Maloney & Mulherin (2003) demonstrates the ability of the stock market to place blame, Alchian's event study shows that it incorporates positive news just as well, including secret or unknown information. Following the Operation Castle series of nuclear tests, it would have been apparent to insiders that the use of lithium fissile fuel in hydrogen bombs was a tremendous innovation that boosted the energy output of smaller weapons, and that whoever manufactured the components of what was to become the MK21 bomb stood to profit from the test's success. There is some evidence that the Lithium Corp stock price reflected this positive implication for the lithium market due to the Castle Bravo test, information that was not immediately known to the public. Lithium Corp stock increased greatly in the two months preceding the test and then exploded for the remainder of 1954 with a return of 461% for the year.

Alchian's event study also implies that through capital markets, inferences can be made about military secrets in countries that outsource military technology research and development to the private sector, and outsiders may be able to make such inferences about US military technology as well. Much as prediction markets can help predict political events (Wolfers and Zitzewitz, 2004), careful analysis of foreign stock exchanges may reveal secret government activities that affects the profitability of publicly traded firms.

REFERENCES

Alchian, Armen A., 2000. The Intellectual Portrait Series: A Conversation with Armen A. Alchian. Liberty Fund, Indianapolis.

Alchian, Armen A., 2006. Principles of Professional Advancement. The Collected Works of Armen A. Alchian. Liberty Fund, Indianapolis

Alchian, Armen A., 2006. Uncertainty, Evolution, and Economic Theory. The Collected Works of Armen A. Alchian. Liberty Fund, Indianapolis

Armagnac, Alden P, 1952. Lithium: The H-Bomb Metal. Popular Science, September 1952

Arundale, Joseph C and Annie L. Marks, 1958. Lithium. Minerals Yearbook Metals and Minerals (Except Fuels) 1954. Bureau of Mines, 729 – 736

DeGroot, Gerard L, 2005. The Bomb: A Life. Harvard University Press, Cambridge

Dow, James and Gary Gorton, 1993. Trading, Communication, and the Response of Asset Prices to News. The Economic Journal, Vol. 103, No. 418 639-646

Fama, Eugene, 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. The Journal of Finance Vol. 25, No. 2, Papers and Proceedings of the Twenty-Eighth Annual Meeting of the American Finance Association New York, N.Y. December, 28-30, 1969, 383-417

Fama, Eugene, 1991. Efficient Capital Markets: II. The Journal of Finance, Vol. 46, No. 5 1575-1617

Fama, Eugene, Lawrence Fisher, Michael C. Jensen, and Richard Roll, 1969. The Adjustment of Stock Prices to New Information. International Economic Review 10, 1-21

French, Kenneth R. and Richard Roll, 1986. Stock Return Variances: The Arrival of Information and the Reaction of Traders. Journal of Financial Economics 17, 5-26

Hayek, F. A. 1945. The Use of Knowledge in Society. The American Economic Review Vol. 34, No. 4, 519 – 530.

Maloney, Michael T. & Mark Mitchell. 1989. Crisis in the Cockpit? The Role of Market Forces in Promoting Air Travel Safety. Journal of Law and Economics Vol. 32, No. 2, 329 – 355

Maloney, Michael T. & J. Harold Mulherin, 2003. The Complexity of Price Discovery in an Efficient Market: The Stock market Reaction to the Challenger Crash. Journal of Corporate Finance 9, 453 – 479

Miller, Richard L., 1986. Under the Cloud: The Decades of Nuclear Testing. Two Sixty Press, The Woodlands, TX

Mitchell, Mark L. and Harold Mulherin, 1994. The Impact of Public Information on the Stock Market. The Journal of Finance Vol. 49, No. 3, Papers and Proceedings Fifty-Fourth Annual Meeting of the American Finance Association, Boston, Massachusetts, January 3-5, 1994, 923-950

The Nuclear Weapon Archive, 2007. NuclearWeaponarchive.org. (Accessed March, 2013)

Rhodes, Richard, 1996. Dark Sun: The Making of the Hydrogen Bomb. Simon & Schuster, New York

Peterson, Mitchell A. and Raghuram G. Rajan, 2002. Does Distance Still Matter? The Information Revolution in Small Business Lending. The Journal of Finance Vol. 57 No. 6, 2533 – 2570

Romer, David, 1993. Rational Asset-Price Movements without News. American Economic Review, Vol. 83, No. 5, 1112-1130

Wolfers, Justin and Eric Zitzwitz, 2004. Prediction Markets. Journal of Economic Perspectives, American Economic Association, vol. 18(2), 107-126.

APPENDICES

Appendix A: NAICS: North American Industry Classification System[4]

Sector 11--Agriculture, Forestry, Fishing and Hunting
The Agriculture, Forestry, Fishing and Hunting sector comprises establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.

Sector 21—Mining
The Mining sector comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas.

Sector 22—Utilities
The Utilities sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal.

Sector 23—Construction
The construction sector comprises establishments primarily engaged in the construction of buildings or engineering projects (e.g., highways and utility systems).

Sector 31-33—Manufacturing
The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.

Sector 42--Wholesale Trade
The Wholesale Trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing.

Sector 44-45--Retail Trade
The Retail Trade sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.

[4] http://www.census.gov/eos/www/naics/

Sector 48-49--Transportation and Warehousing
The Transportation and Warehousing sector includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. The modes of transportation are air, rail, water, road, and pipeline.

Sector 51—Information
The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.

Sector 52--Finance and Insurance
The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions.

Sector 53--Real Estate and Rental and Leasing
The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services.

Sector 54--Professional, Scientific, and Technical Services
The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

Sector 55--Management of Companies and Enterprises
The Management of Companies and Enterprises sector comprises (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company
or enterprise and that normally undertake the strategic or organizational planning and decision making role of the company or enterprise.

Sector 56--Administrative and Support and Waste Management and Remediation Services

The Administrative and Support and Waste Management and Remediation Services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.

Sector 61--Educational Services
The Educational Services sector comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated.

Sector 62--Health Care and Social Assistance
The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities.

Sector 71--Arts, Entertainment, and Recreation
The Arts, Entertainment, and Recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure-time interests.

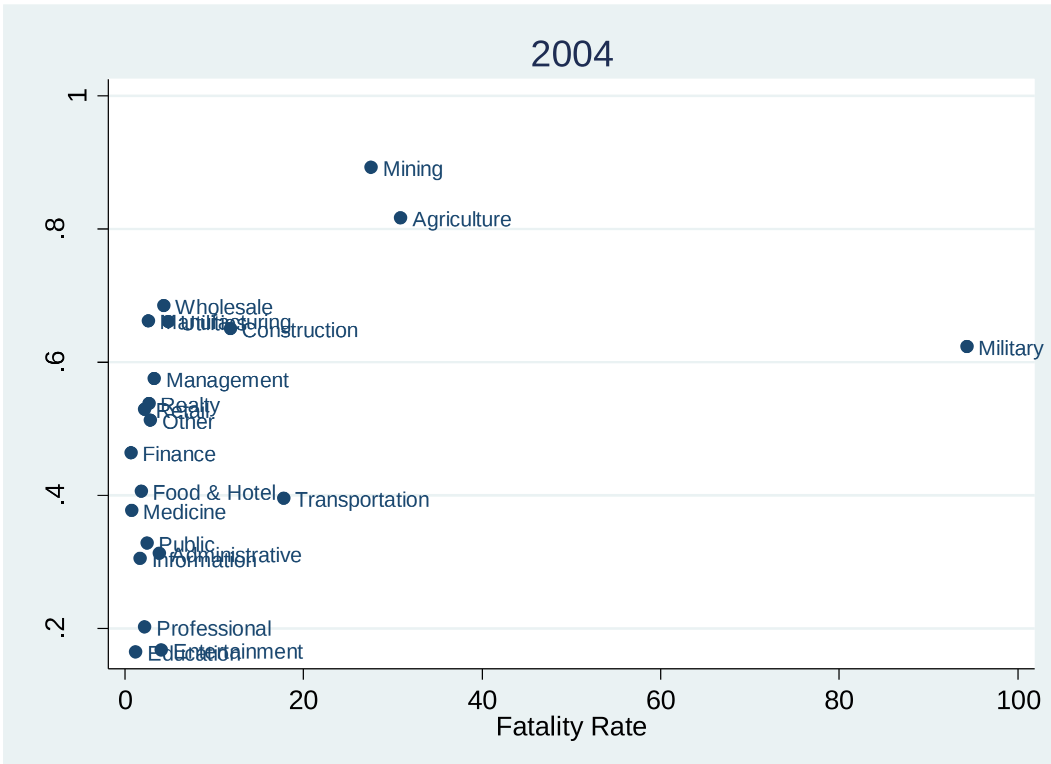
Sector 72--Accommodation and Food Services
The Accommodation and Food Services sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services establishments because the two activities are often combined at the same establishment.

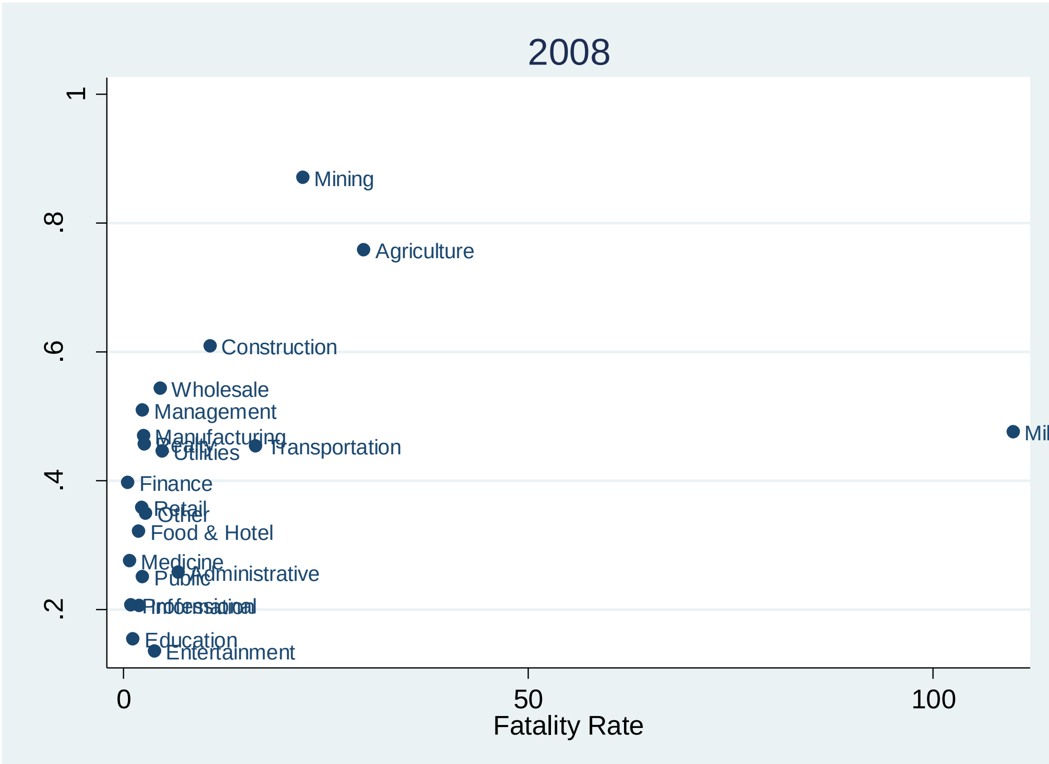
Sector 81--Other Services (except Public Administration)
The Other Services (except Public Administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care

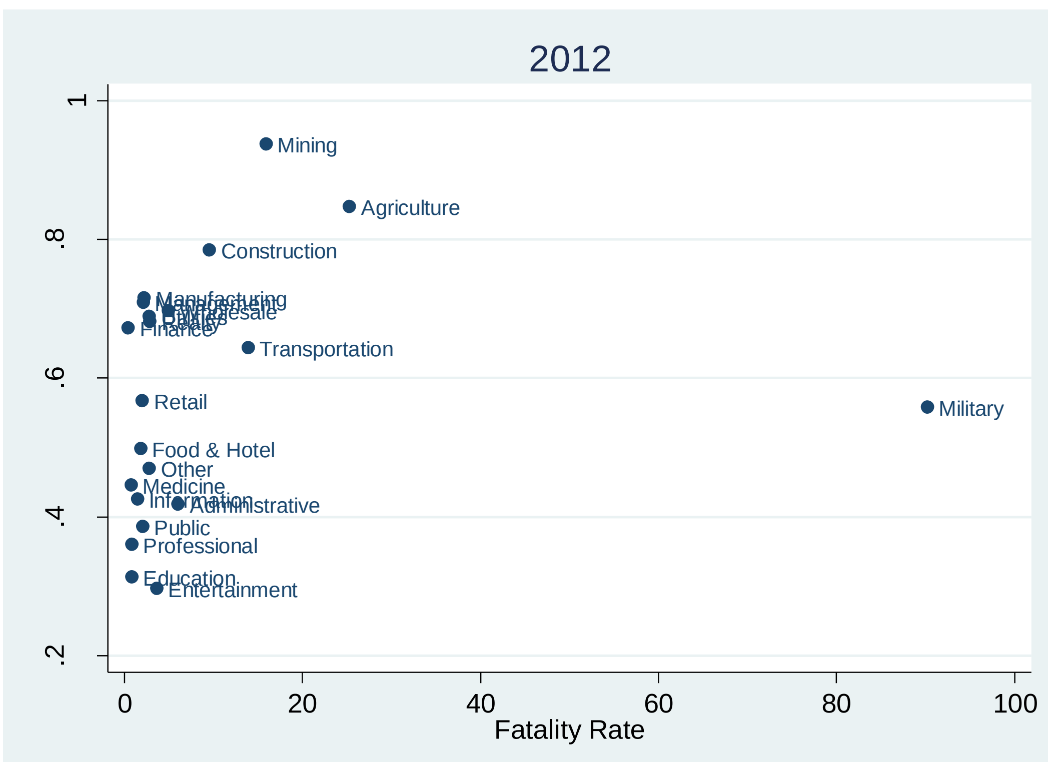
services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.

Sector 99-- Public Administration

Appendix B: Aggregated Industry Fatality Rates and GOP Support




2008
Mining
Agriculture
Construction
Wholesale
Management
Manufacturing
Utilities
Transportation
Military
Finance
Retail
Other
Food & Hotel
Medicine
Public
Administrative
Education
Entertainment
Fatality Rate
0
50
100
.2
.4
.6
.8
1


2012
Mining
Agriculture
Construction
Manufacturing
Finance
Transportation
Retail
Military
Food & Hotel
Other
Medicine
Administrative
Public
Professional
Education
Entertainment
Fatality Rate
0
20
40
60
80
100
.2
.4
.6
.8
1

Appendix C: Timeline of Public and Private Events Regarding Lithium

DATE	PRIVATE INFORMATION	PUBLIC INFORMATION
Late 1948	Soviets theorize that lithium deuteride fuel could replace deuterium and tritium in nuclear weapons	
June 1951	Edward Teller writes a memo on the possible advantages of lithium deuteride fuel	
June 17, 1951	AEC agrees to begin producing lithium for possible use in the hydrogen bomb	
August 1952		*Popular Science* speculates that lithium may be used in the hydrogen bomb due to its use in producing tritium
November 1, 1952	Ivy Mike, world's first hydrogen bomb, using liquid deuterium fuel is a success.	
March 9, 1953		Foote Mineral Co. earnings down for 1952 due to in part to heavy non- capital expenditures in its lithium expansion program. – WSJ
March 18, 1953		"Much about the new development is secret. But what is known is this: the new device uses only three-quarters as much fissionable material as the bombs that destroyed the Japanese cities"
July 13, 1953		Foote Mineral Co. is completing new plants in NC and VA to produce various ores and lithium chemicals, which are expected to increase assets, sales, and profits. – WSJ
August 1953	Los Alamos is preparing a lithium fuel	

	hydrogen bomb test for 1954	
August 1953	Soviets test their first lithium deuteride bomb	
August 7, 1953		Foote Mineral Co. sees a decline in earnings due in part to investments in new plants. A decline in sales was the result of its "temporary inability to fully supply the expanding market for lithium chemicals and ores," but is increasing production. "Current market estimates indicate continued high demand for lithium ores and chemicals and Foote is intensifying its search for lithium-bearing deposits and other chemicals." -WSJ
November 19, 1953		American Potash and Chemical Corp. is adding lithium ores from a new source in Africa. It will "handle lepidolite and petalite ore mined from a large deposit of high-grade lithium-bearing minerals near Fort Victoria, Southern Rhodesia." "Lepidolite and petalite are used primarily by manufacturers of specialty glass and ceramics. Demand for all lithium products has been steadily increasing, and they have long been in short supply." – WSJ
November 30, 1953		Lithium Corp. of America reports quarterly earnings ending Sep. 30 with a net income of $53,448 or 10 cents per share, no indication of net income for same quarter in previous year. Its 9 month earnings ending Sep. 30 are reported to be $113,071 for 1953 vs. $16,446, in 1952, an increase in earnings per share from 3 cents to 26 cents. -WSJ

January 15, 1954		Foote Mineral Co. reports a record month in earnings for December due to its new lithium-producing plants. "In addition to lithium, which is finding expanding uses in lubricants, industrial coatings and other chemical applications, Foote produces a variety of other rare metallic articles used in electronics and atomic power fields." – WSJ
January 28, 1954		"Lithium is one of several other scarce metals not previously refined I commercial quantities but now easier to extract as a result of research spurred by the A.E.C.'s need for this light metal. It is the key in making a new top-secret hydrogen bomb that's simpler, cheaper, and easier to transport than earlier models. The increased knowledge and availability of this metal has now led its producers – Foote mineral Co., American Potash & Chemical Corp., and Lithium Corp. of America – to embark on experiments aimed at developing commercial uses for it, too." – WSJ
March 1, 1954	Castle Bravo, the first US test of a lithium fuel hydrogen bomb exceeds expected yield. Navy and Japanese fishing ships are dusted with radioactive fallout.	
March 2, 1954		"'Joint Task Force Seven has detonated an atomic device at the A.E.C.'s Pacific proving ground in the Marshall Islands. This detonation was the first in a series of tests.' The statement did not make clear whether the 'atomic device' was of the

		fission or thermonuclear (hydrogen) type." - NYT
March 4, 1954		Foote Mineral Co. directors approve expansion of production facilities for lithium ores and chemicals. - WSJ
March 7, 1954		"The United States detonated last week its forty-sixth nuclear device and prepared to test in the next couple of weeks its first operating model of a hydrogen bomb." - NYT
March 9, 1954		"Markets for lithium products have developed even more rapidly than anticipated," with Foote Mineral Co. planning to increase output. "Lithium compounds are used in wide temperature range lubricating greases, ceramics, welding rod coatings, alkaline type electric storage batteries, air conditioning materials and atomic energy development." - WSJ
March 10, 1954		"An expansion since 1946 of approximately 1,000% in the consumption of lithium in the ceramic, grease, air conditioning, metallurgical and organic chemical fields, according to K. M. Leute, president of Lithium Corp. of America, Inc., is behind that firm's $7 million expansion program at Bessemer City, NC adjacent to deposits of lithium ore acquired by the company in the past 8 years and said to be the largest single reserve of lithium ore in the world." – WSJ
March 11, 1954		"A hydrogen bomb designed for combat may produce history's greatest man-made blast in the Marshall Islands between March 16 and 28… The first blast in the current series of tests was March 1. The commission announced that an atomic device had been detonated, indicating that

		the hydrogen bomb was yet to come since hydrogen bombs are usually referred to as thermonuclear." - NYT
March 12, 1954		"Twenty-eight Americans and 236 natives were "unexpectedly exposed to some radiation" during recent atomic tests in the Marshall Islands." - WSJ
March 12, 1954		"The United States is expected to set off the mightiest nuclear explosion in history sometime between March 15 and 28." - NYT
March 14, 1954		"A high government official indicated today that the United States has set off the most powerful hydrogen blast yet achieved… a few days ago." - NYT
March 18, 1954		"Shattering power hundreds of times greater than any previous man-made explosion was unleashed when the US set off its hydrogen explosion No. 2." - NYT
March 18, 1954		"That hydrogen blast two weeks ago jarred a Pacific isle 176 miles distant. It unleashed power hundreds of times greater than any previous weapon." - WSJ
March 19, 1954		"A Japanese fishing boat, 800 miles away from the test site when the US set off a hydrogen bomb March 1 at Bikini Atoll was found to be radioactive." - WSJ
March 19, 1954		"The March 1 explosion had left an area of total destruction about twelve miles in diameter." - NYT
March 20, 1954		"A Congressional investigation of the immense hydrogen explosion in the Pacific March 1 has been started to determine whether adequate security and safety precautions were taken in the area." - NYT
March 22, 1954		"Commentators and some congressmen are busily telling us that the horrors implied by the latest explosion are beyond belief." - WSJ
March 25 1954		"All fish brought into Japanese and West Coast ports are being checked for radioactivity." - WSJ

March 26, 1954		"Atomic Energy Commission reported plans to step up US production of hydrogen and other atomic weapons." - WSJ
March 26, 1954	MK-21 bomb based on Castle Bravo test begins production	
March 27, 1954	Castle Romeo test is successful	
March 28, 1954		"The biggest explosion in the current nuclear tests in the Pacific will be set off next month, probably about April 22." - NYT
March 29, 1954		"The hydrogen bomb test early this month is having some delayed but not necessarily surprising reactions… demanding an outright end to nuclear tests" - WSJ
March 31, 1954		"Churchill rejected Laborite demands to try to persuade the U.S. to halt H-bomb tests." - WSJ
April 1, 1954		American Potash & Chemical Corp's new high grade lithium beryllium interests in Southern Rhodesia "have resulted in a 'significant strengthening' of the company's position in [lithium]." – WSJ
April 5, 1954		Foote Mineral Co. "expects 1954 to be the best year in Foote's long history… 'the market is expected to absorb readily both the present and proposed capacity' for lithium and its compounds, which Foote produces and markets." - WSJ
April 7, 1954	Castle Koon test	
April 23, 1954		"A 'large portion' of the first quarter sales were in lithium, L. G. Bliss, sales vice president, stated. He remarked that queries were often made as to what effect developments in nuclear physics may have on Foote's prospects, and added 'If the US government desires lithium for any purpose we believe we

		are in the best position of any firm in the industry to serve that need. You can draw any conclusion you wish from that'." – WSJ
April 26, 1954	Castle Union test	
May 5, 1954	Castle Yankee test	
May 14, 1954	Castle Nectar test	
June 10, 1954		"The committee voted to give lead, zinc and lithium a 23% depletion rate on domestic mining operations. They now get 15% and would continue to get 15% on any overseas operation." – WSJ
June 16, 1954		"Cash is also being poured into preliminaries for a German leap into the atomic age. Although Allied regulations forbid West German atomic research or production, chemists here are making all the preparations for the day when these rules are scrapped. They already extract atomic energy materials, such as lithium from the giant cinder dumps of the industrial Ruhr. And researchers, financed by industry and the government, are doing extensive 'paper work' in the atomic field." – WSJ
July 30, 1954		"H. C. Meyer, chairman, said record sales and earnings figures could be attributed to increased production from new facilities added in 1953. He said the company's current enlargement of facilities for production of lithium ore concentrates will be substantially completed by the end of this year and further expansion of lithium chemical refining plants should be in operation early in 1955." – WSJ
August 31, 1954		For the 6 month period ending June 30, Lithium Corp. of America reports net

		income of $152,387 in 1954 vs. $77,980 for 1953 – WSJ
September 10, 1954		"Lithium Corp. of America thinks increased operating efficiency will put second half earnings 'substantially in excess' of the $152,387 posted for the first six months of this year, which was up from $77,980 in the 1953 first half, according to Herbert W. Rogers, president." – WSJ
October 20, 1954		American Potash & Chemical Corp. plans to construct a lithium chemical plant in San Antonio, to be owned by the newly-formed American Lithium chemicals, Inc. of which American Potash owns 50.1%. "Initially, lithium hydroxide will be produced there. Addition of the San Antonio plant is a major step in American Potash & Chemical Corp.'s program of expansion in the lithium chemicals field… 'There is a large unsatisfied demand for lithium products as a result of substantial growth in their use in enamels, ceramics, all-weather greases, air conditioning and other fields'."
October 29, 1954		"Foote Mineral's Quarter Indicated Sales Jumped 85% over a Year Earlier" – WSJ
November 1, 1954		To get both stability and water resistance, more and more grease makers are turning to thickeners which replace sodium or calcium with lithium or barium, both of which are soft white metals. The new Cities Service, Tide Water and Gulf greases all are lithium based. Lithium or barium increases the water resistance and raises the melting point of greases." – WSJ

December 12, 1954		"Development of the hydrogen bomb and intensive industrial promotion have raised the world's lightest metal, lithium, from obscurity to a stellar role in half a dozen civilian and defense industries in the last five years." – NYT
December 30, 1954		"Next mining boom may be in lithium, lightest of metals. It's greatly needed for the hydrogen bomb. But it also has growing and important uses, in the form of lithium compounds, in all-weather greases for autos, enamels, special kinds of glass, air conditioning and in low temperature batteries." – WSJ

Timeline of major events surrounding Operation Castle, from New York Times and Wall Street Journal articles.