The Political Economy of State Government Subsidy Adoption: The Case of Ethanol

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Abstract

In this paper we examine the factors that determine the adoption of state economic development incentives in the ethanol industry. We compile data on the implementation dates for subsidies/tax credits for all states for years 1984-2007, a period that covers the complete emergence of the biofuel industry in the United States and that was characterized by the passage of a numerous of state-level subsidies and tax breaks aimed at increasing ethanol production. Using Cox proportional hazard regression analysis, we find that states are more likely to adopt ethanol subsidies when corn production is high, when corn prices are low and gasoline prices are high, when a state is affiliated with the National Corn Growers Association, when a check-off is present, and when state government is under the control of Democrats.

Keywords: ethanol, subsidies, political economy, rent seeking, proportional hazard estimation.

JEL Codes: D72, H25, H71, Q4.

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I. Introduction

Beginning in the 1980s, state and local governments increasingly began to rely on subsidies and tax breaks to stimulate growth in employment and business activity. Between 1984 and 1993, the number of states offering various incentives increases from 27 to 44 (Chi, 1994). A significant motivation for these state incentive packages was to stimulate broad economic activity in economically distressed rural areas (Greenberg and Reeder, 1998). Coinciding with the increase in the use of broad subsidies were more targeted subsidies. The focus of this paper is on factors that influence the adoption of such targeted subsidies and tax credits, focusing on incentives to ethanol producers.[1] The United States experienced the complete emergence of the ethanol industry over a relatively short period, beginning in the early 1980s. As highlighted by Gardner (2007), federal policies have been an important driving force in fostering ethanol production, and state subsidies have also been influential (Cotti and Skidmore, 2010). Nearly all the current research on subsidies and tax credits has focused on evaluating the impacts of economic development incentives, whereas little research has focused on the factors the lead to subsidy adoption.

The present study makes several contributions to the work on public sector policy innovation. First, while there are now several studies that examine the adoption of new sources of state revenue such as lotteries or tax amnesties (Berry and Berry, 1990; Dubin, Graetz, and Wilde, 1992; Alm, McKee, and Skidmore, 1993), and while there is also work on changes to state political institutions such as the introduction of tax and expenditure limitations or balanced

[1] For the remainder of the paper, we use the term "subsidies" to refer to explicit subsidies, including tax credits offered to businesses.

budget requirements (Poterba, 1994, 1995; Rueben, 1996; Alm and Skidmore, 1999), researchers have not explicitly examined factors that determine the adoption of subsidies. Given the plethora of new subsidies and tax credits introduced across the states over the past 30 years, this gap is of note. In addition, while the work of Cotti and Skidmore (2010) evaluates the economic *effects* of the state level subsidies in the emerging biofuel industry, little is known about the underlying *factors* that have driven this important policy intervention. Finally, this research contributes to the literature on the policy innovation process (Poterba, 1994; Besley and Case, 2000), and it also offers insights into the political economy of the emerging ethanol industry.

Using hazard analysis methods, we find that state governments are more likely to adopt ethanol subsidies when corn production is high, when corn prices are low and gasoline prices are high, when a state is affiliated with the National Corn Growers Association (NCCA), when a check-off is present, and when state government is under the control of Democrats. We also uncover a complicated relationship between corn prices and affiliation with the NCCA. Specifically, when corn prices fall, states are more likely to become affiliated with the NCCA. While both of these factors are correlated with subsidy adoption, our analysis suggests that corn price is the strong force and leads both to NCCA membership and to subsidy adoption.

In the next section, we provide a brief review of the most relevant research on the policy innovation process in general as well as the relevant research on the emerging biofuel industry. In section 3, we present our theoretical framework, and section 4 presents the data and empirical analysis. Section 5 concludes.

II. Literature Review

In this section, we present a brief review of the ethanol industry, related research on policy innovation, and recent research on some effects from the emerging biofuel industry.

A Brief Overview of the Emerging Ethanol Industry

Ethanol or ethyl alcohol, typically produced from corn, is a primary biofuel additive for gasoline. While fuel ethanol has been around for over 100 years, until the early 1980s commercial production was trivial. However, spurred by a tremendous increase in state and federal subsidies throughout the 1980s, 1990s, and 2000s, ethanol production had expanded to over 10 billion gallons in the United States by the end of 2010. As of January 2010, the Renewable Fuels Association reports that there are currently 189 ethanol distilleries in operation and another 16 under construction. When current construction is complete, total U.S. production capacity will reach 14.46 billion gallons. The location of these plants is focused in the Midwest and Great Plains States, or in states nearest to corn growers, although ethanol producers can also be found throughout the country. Overall, there has been exponential growth in ethanol production and capacity in the United States over the last 30 years. While there are a number of studies that have examined the growth of the industry, to our knowledge researchers have not examined the underlying forces that led to subsidy adoption, which has been critical to the emergence of the industry. As discussed below, a number of studies have examined policy adoption in other areas. We draw on this literature to provide a framework for understanding the forces that have led to state government ethanol subsidy adoption in a numerous states over the last 30 years.

Policy Innovation/Adoption

A standard approach in the economic analysis of policy is to find some source of policy variation and to use this source to identify the independent impact of policy variation on

behavior. For example, the wide variation in policies across state governments – in taxes, regulations, minimum wages, balanced budget requirements, investment incentives, and the like – provide a natural laboratory in which the effects of these policies can be investigated. However, when the policies themselves are subject to adoption as part of the formation of endogenous policy formation, then it clearly cannot be assumed that these policies are in fact exogenous variables. Put differently, time- and state-varying policies can be studied as either right-hand side variables (e.g., as exogenous variables) or as left-hand side variables (e.g., as endogenous variables) in any empirical formulation (Besley and Case, 2000). In the latter case, the choice of these policies can be usefully examined as the outcome of the political process in the state. This is the underlying premise of our approach here. Indeed, there are large theoretical and empirical literatures on the endogenous determination of tax, expenditure, trade, agricultural, and other policies.[2] These literatures form the basis for our theoretical approach, as discussed later.

Research on the Effects of the Ethanol Industry

Much of the research on policies related to the ethanol industry has focused on the economic impacts of policy, especially on the allocative effects of ethanol subsidies. These subsidies have a strong appeal for certain farm interests (i.e., corn producers), but the net societal gains of such policies are questionable. For example, Gardner (2007) employs a cost-benefit analysis to determine the net societal benefits of relying more heavily on ethanol as a renewable fuel source. Gardener's work indicates that the $0.51 per gallon federal ethanol subsidy results in a significant deadweight loss. He concludes that "ethanol subsidies and mandates are unlikely to generate social gains." Similarly, Hahn and Cecot (2007) employ a cost-benefit method to

[2] For example, see Persson and Tabellini (2002) and Mueller (2003) for comprehensive discussions of much of this work.

evaluate current federal biofuel policies, concluding that under current policies the costs of increased production are likely to exceed the benefits. Hahn and Cecot (2007) identify federal as well as state and local government subsidies and regulations as the driving force of the ethanol industry. "Corn states" use a variety of incentives.[3] For example, Illinois grants up to $5.5 million for the production of new plants; Indiana gives a $0.125 per gallon production tax credit; Iowa extends 0 percent interest loans up to half the cost of production project; and Missouri gives producers tax incentives of $0.20 per gallon of ethanol produced. Even many states that are not typically thought of as "corn states" have adopted similar subsidies in an attempt to attract the industry. Hawaii has a tax credit equal to 30 percent of nameplate capacity; Maine also has a tax credit of $0.05 per gallon; and Vermont gives loans to assist research and planning for the production of biofuels.

Most recently, Cotti and Skidmore (2010) examine the impact of state government subsidies on ethanol production. They conclude that state subsidies have played an important role in ethanol plant location decisions.

To our knowledge, no studies have evaluated the underlying forces that determine why states adopt subsidies in general, or subsidies targeted at the ethanol industry in particular. Despite the plethora of new state subsidies and tax credits that have been introduced over the past 30 years, no research has examined the political economy of state government subsidy adoption. Given the implications of subsidies and tax credit adoption for economic activity as well as for state tax bases, we believe that this analysis is necessary and useful. The next section presents our theoretical framework for this analysis.

III. Theoretical Framework

[3] A "corn" state is defined by Hahn and Cecot (2007) as a state that grows greater than 1 million bushels of corn per year.

Government revenue and expenditure decisions are made in political markets, and the role of political forces in the design of government revenue structure and expenditure allocation has received increasing attention. The starting point for much of this analysis is the standard median voter model. As first argued by Bowen (1943) and Black (1958), the median voter model indicates that a community's choice of public services under majority rule is the median of the individual demands; that is, under certain restrictive conditions, a political equilibrium under majority rule reflects the preferences of the median voter. Borcherding and Deacon (1972) and Bergstrom and Goodman (1973) use this framework to demonstrate that a jurisdiction's demand for public services depends upon the income of the median voter, the median (tax) price of the public good, and the tastes of the median voter, or variables that capture the demand side of the political process. This approach has been usefully applied to a wide range of theoretical and empirical issues in public choice, with generally favorable but sometimes mixed results.[4]

However, the relevance of the median voter model to the issue of ethanol subsidy adoption is not especially obvious. Special targeted tax incentives benefit a small group of individuals (e.g., the recipients of the incentives) at the expense of those individuals who must pay for the incentives (e.g., the median voter); that is, these incentives generate "rents" (or above-normal returns), and individuals are willing to invest considerable resources in "rent seeking" activities to obtain these rents from government. It seems unlikely that the median voter would favor such programs. Put differently, an ethanol subsidy may well be proposed, but the median voter should not vote for the subsidy because the subsidy generates rents that accrue to others and the subsidy also generates inefficiencies that reduce welfare. What can explain the political success of special targeted tax incentives in this setting?

[4] See Persson and Tabellini (2002) and Mueller (2003) for comprehensive surveys of the public choice literature.

Other public choice approaches have been proposed that seem more relevant to the adoption of special provisions like ethanol subsidies. These approaches often pursue different modeling strategies, but even so all incorporate four common features: individual voter preferences, the preferences of elected politicians, political institutions, and collective action by lobby groups. It is especially the last feature that seems most relevant to the adoption of subsidies.

For example, Peltzman (1976) considered the incentives facing an elected politician to introduce regulations like price supports that generated both rents and excess burdens. He concluded that a vote-maximizing politician would support regulations that balanced the marginal gain in voting support from producers from an increase in their rents with the marginal voting loss from consumers due to the combined increase in rents and excess burdens. Using a different approach (e.g., probabilistic voting), Hettich and Winer (1988) argued that tax structure is the result of a process of balancing the political costs of generating revenues (e.g., expected votes lost) against the political gains from making increased expenditures (e.g., expected votes gained), where individual voters are assumed to value expenditures and oppose taxation. The politically optimal tax structure is one that equalizes across all taxpayers the marginal political cost per dollar of added revenues, where the marginal cost is measured in terms of the loss of expected votes. Grossman and Helpman (1994) similarly assumed that government chooses protective trade policies in an attempt to maximize a weighted sum of the utilities of all citizens plus the political contributions of lobbyists seeking protection. The politically optimal tariff is one in which the marginal reduction in social welfare from the tariff equals the marginal increase in political contributions from the tariff. Other approaches generally give similar results, and conclude that the political costs and benefits of specific government policies are balanced on the margin.

This work suggests that subsidies/tax credits will be introduced when the votes lost are more than matched by the votes and/or the political contributions gained. The factors contributing to the two sides of this equation are examined here. The focus is on decisions by state government policy makers to adopt new subsidies and/or tax credits targeted at ethanol production. These factors relate mainly to the likelihood that additional subsidies will generate additional political contributions from the ethanol industry (e.g., a benefit to politicians), that they may generate additional economic activity in the affected region (e.g., a benefit to voters and so to politicians), and that they may cost votes via the inefficiencies that they generate and the revenues that must be generated to finance them (e.g., a cost to voters and so to politicians).

On the *political benefits* side of the scales, political gains of subsidy/tax credit adoption could be generated from political contributions from the ethanol industry. Of particular relevance here is the corn lobby; corn producers have much to gain from the increased demand for corn resulting from such subsidies.

Other political benefits could stem from the additional economic activity in the targeted industry and regions. In a broader context, subsidies may also generate perceived environmental benefits from reduced reliance on fuels that are thought to generate green-house gases, and they may reduce the risks associated with a heavy reliance on imported petroleum. Of course, special interests highlight these potential benefits as they lobby for subsidies.

The *political costs* to subsidy/tax credit adoption arise from several sources. Public opposition to ethanol subsidies may come from those who recognize that tax credits can narrow the tax base. Similarly, some recognize the opportunity costs associated with the introduction of subsidies. More broadly the world food price spike that occurred in 2007-2008 renewed concerns

about potential food/fuel trade-offs that may exist.[5] If it is widely perceived that the expansion of ethanol production contributed to the food price spike, then many voters may argue that we should rethink state and federal policies designed to encourage biofuel production. In addition, under current technologies corn-based ethanol is considerably more expensive to produce than relying on existing petroleum reserves.

How can these various factors be measured and included in an empirical framework? Our main interest is the role of political and lobbying factors. The political bases of the Republican and Democratic parties differ considerably. Thus, the likelihood of ethanol subsidy adoption may be influenced by party control. In addition, the passage of subsidy/tax credit legislation might be more likely to arise if the house, senate, and governorship represent the same political party. If the governorship, house, and senate of a state are controlled by a single party, it is more likely that a state will adopt a subsidy/tax credit because a unified government is more likely to pass a bill than a government with split control. Two dummy variables are used here, one for whether or not the government is controlled by the Democrats and another for whether or not the government is controlled by the Republicans.[6] This separation of Democrats and Republicans also provides information about which political party is more likely to support an ethanol subsidy/tax credit bill. Additional political variables include an election year dummy variable. Significant new legislation may be more likely to be introduced during election years. However, if ethanol subsidy/tax credit adoption represents a departure from the normal course of political business, and it is possible instead that a government will not wish to introduce one during an election year. The sign on the election year variable is therefore ambiguous. Political agents may receive pressure from

[5] According to the United States Agency for International Development, world food prices increased 43 percent between March 2007 and March 2008 (http://www.usaid.gov/our_work/humanitarian_assistance/foodcrisis/). Increased biofuel production was cited as one of several contributing factors to rising food prices.

[6] Note that some states have split control, so that democratic control and republican control do not sum to one.

constituents to adopt subsidies/tax credits if competitor states have such programs. Therefore, we test for neighboring states effects in our analysis as well.

As for lobbying activity, the National Corn Growers Association (NCGA) lobbies federal and state governments on behalf of corn growers. Corn growers strongly favor policies that increase the demand for corn, and ethanol subsidies clearly favor corn producers. We include a dummy variable equal to 1 if there is an NCGA affiliation in a given state and 0 otherwise. Similarly, we also include a variable that measures the number of years that a "check-off" has been in place in a state. The check-off is something like a tax on corn, but the revenues from the check-off are used to promote, market, and lobby on behalf of corn growers. The check-off is a measure of the resources available to the corn lobby. However, the check-off is not the sole source of funds for the NCGA. As highlighted on the NCGA website (http://ncga.com/out-and-about-industry), large agri-business organizations such as Archer Daniels Midland Company, Monsanto, and Syngenta are important partners with the NCGA, and these organizations also have an incentive to boost demand for agricultural products and thus the price of corn.

It is important to note that over the period of analysis a number of states became affiliated with the NCGA and subsequently adopted a check-off. Related to these factors is the pressure put on the lobby firms and on state government by farmers when corn prices fall. As a result, we anticipate that corn prices play an important role in motivating farmers and their agents to promote subsidies. We also note that there are complicated interrelationships between corn prices, NCGA membership, and the adoption of a check-off. Namely, we observe that the likelihood of NCGA membership is more likely during periods of low corn prices.[7] We explore these inter-relationships in our empirical analysis. Last, to measure the influence of the potential "corn constituency" in a state, we also include the annual production of corn in a state.

[7] This analysis is available from the authors upon request.

We also include economic and demographic factors that may play a role in ethanol subsidy adoption, factors that largely reflect voter preferences. During times of economic distress, political agents may be inclined to introduce subsidies/tax credits aimed at business activity. We therefore include per capita income and the retail price of gasoline in our analysis. We hypothesize that during state-years in which per capita income is lower, subsidy/tax credit adoption is more likely. Similarly, in periods of high gasoline prices subsidy/tax credit adoption is more likely because constituents may have a heightened interest in reducing reliance on petroleum imports. As an additional demographic control variable, we include population. We have no a priori expectations about the role that population may play in ethanol subsidy adoption.

Data are collected by state annually for the period 1984 through 2007. Table 1 presents summary statistics of the variables used in our analysis, and detailed variable definitions, and data sources are provided in the Appendix.

IV. Methods, Data, and Empirical Analysis

Methods and Data

Our dependent variable in this analysis is based on detailed information that we have collected on state-level ethanol subsidies and tax breaks, which were obtained from the U.S. Department of Energy.[8] Our research focuses on 1984 through 2007, a period that covers the complete emergence of the biofuel industry in the United States. Importantly, this time period was characterized by the passage of a number of state-level subsidies and tax breaks aimed at increasing ethanol production and capacity. We conducted a thorough search through state statutes in order to identify specific dates of implementation. Table 2 provides an overview for

[8] http://www.eere.energy.gov/afdc/progs/all_state_summary.php/afdc/0.

all states of key ethanol policies that were implemented during the time period that we study, as well as some details about those policies for each state.

We group subsidies into three general categories. Subsidies can be recurring or not, they can be based on plant size, or they can simply be a lump sum amount. The column listings in Table 2 reflect these categories. Column 1 of Table 2 includes all general subsidies that are not expressed on a per gallon basis. In column 2, we list subsidies that are grants or subsidized loans to assist with plant construction and the like. In column 3, we list subsides that recur annually and are expressed on a per gallon basis, which is the most common form of subsidy offered by the states. Note that in several states the subsidies are substantial, up to 20 to 40 cents per gallon of ethanol produced. Together with the 51 cent per gallon federal subsidy, the combined state-federal subsidies total 71 to 90 cents per gallon of ethanol produced.

We want to understand the factors that determine which states are most likely to pass ethanol subsidies. To address this issue, we specify a discrete time proportional hazard model linking adoption of an ethanol subsidy to a number of state-level characteristics that may play an important role in a state's choice to pass such incentives, as discussed earlier.[9] Our hazard model is defined as:

$$(1) \qquad H(t|X) = H_0(t) * \exp(\beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k)$$

where $H(t|X)$ is the hazard of ethanol policy adoption given at time t, X_1 ... X_k are predictor variables, and $H_0(t)$ is the baseline hazard at time t, which represents the hazard for a state with the value 0 for all the predictor variables. The baseline hazard, which is the hazard for the respective state when all independent variable values are equal to zero, provides significant

[9] Jones and Branton (2005) show that Cox duration models are generally preferable to logit or probit approaches, particularly when investigating state policy adoption. Specifically, they demonstrate that when using a logit or probit approach the baseline hazard rate is either assumed to be constant or strong assumptions need to be made about the specification. In the Cox model the baseline hazard rate is left unspecified, which allows it to take any form the data suggests.

strength to this empirical approach, as it corrects for baseline differences between states that might influence the likelihood of subsidy adoption over time.[10] Specifically, the Cox proportional hazard regression model produces an adjusted hazard ratio that takes into account any baseline differences between states that may have influenced the choice to adopt and are not captured in the predictor variables. With hazard analysis framework, the goal is to capture the factors that lead to change in policy. In this context, a state is included in the analysis up to the point that it adopts its first subsidy. Once the subsidy is adopted, from that point on that state is no longer included as part of the "at-risk" set. As shown in Table 2, some states introduced more than one subsidy, introduced them at different points in time, or modified existing subsidies in subsequent periods. In this hazard analysis, it is appropriate to focus on the first subsidy introduced in a particular state, and thus our dependent variable marks the introduction of the first subsidy for each state that adopts at least one subsidy during the period of analysis. We recognize that in many states other general subsidies are available to businesses in general, including ethanol plants. Our analysis focuses on the ethanol industry-specific subsidies, and thus does not consider these more general subsidies.

Our primary interest is the role of political and lobbying interests in subsidy adoptions, so we include several measures and indicators of state-level characteristics that may affect the strength of the pro-subsidy political environment in a particular state. As described in the previous section, we include two dummy variables indicating party control by Democrats or Republicans, a NCGA indicator variable, a check-off revenue time variable, and a state gubernatorial election year indicator variable. The Democratic rule variable is equal to 1 when the Governor is a Democrat and the Democratic Party has majority control in both the Senate and

[10] This issue is less of a concern if randomization has rendered both groups similar in terms of their baseline characteristics, but, obviously, this is not the case in studies of public policy adoption.

House, and 0 otherwise. Republican rule dummy is equal to 1 when the Governor is a Republican and the Republican Party has majority control in both the Senate and House, and 0 otherwise.[11] We hypothesize that political control by one party or another may influence the propensity to which a state imposes ethanol subsidy legislation. The NCGA variable indicates whether or not a state has an affiliation with the corn growers association, and may reflect the political "clout" or "sway" that corn farmers may hold in their state to influence the likelihood of the introduction of incentives. The check-off variable indicates the number of years that a check-off has been in place in a state, and we hypothesize that the longer the check-off has been in place, the greater the financial resources available to corn growers lobby on behalf of their interests in a given state. We note that over our sample period numerous states became affiliated with the NCGA and introduced check-offs.[12] We also include an indicator for whether or not the year is an election year in a given state; this variable indicates each year that a particular state held a gubernatorial election during the sample period. State elections may lead to an environment that is more conducive to new policy implementation. Moreover, we hypothesize that declines in corn prices will motivate farmers and their agents to more vigorously pursue subsidies, so state corn prices are included as well. Lastly, as a measure of "corn interest", we include state corn production as a variable; states with higher levels of corn production are more likely to adopt subsidies.[13]

[11] The omitted category is state-years in which neither the Democrats nor the Republicans have full control.

[12] These states and the years that they joined the NCGA and introduced check-offs are, respectively: Arkansas--1997, 1998; Colorado—1979, 1987; Georgia—1984, 1996; Illinois—1971, 1982; Indiana—1971, 2007; Iowa—1967, 1977; Kansas—1975, 1977; Kentucky—1982, 1990; Louisiana—1985, 1985; Maryland—1977, 1991; Michigan—1973, 1993; Minnesota—1978, 1990; Mississippi—1993, 2006; Missouri—1978, 1984; Nebraska—1973, 1978; New York—1988, no check-off; North Carolina—1978, 1979; North Dakota—1987, 1991; Ohio—1977, 1989; Oklahoma—1996, no check-off; Pennsylvania—1973, no check-off; South Carolina—1991, no check-off; South Dakota—1986, 1988; Tennessee—1986, no check-off; Texas—1989, 1990; Virginia, 1979, 1980; Wisconsin—1975, 1982.

[13] We recognize that politicians are sometimes influenced by actions taken in neighboring jurisdictions. To test for this possibility, we also included several different measures of neighbor state influences, such as measures of the

We also include several economic and demographic variables that play a role in ethanol subsidy adoption, or gasoline prices, per capita income, and state population. As previously discussed, we hypothesize that higher gasoline prices increases the likelihood of subsidy adoption. State population and per capita income are incorporated into the analysis to capture any potential effects of state size or wealth on the likelihood of adoption. Specifically, more rural states or states with lower income individual may be more inclined to support agricultural subsidies.

Results

Hazard ratios for various specification of equation (1) are reported in Table 3. The stated statistical significance of the hazard ratios (and their underlying parameter estimates) are calculated from robust standard errors that have been clustered at the state-level to allow for non-independence of observations from the same state over time (Bertrand et al., 2004). To provide guidance on the interpretation of the results, note that a hazard ratio of greater than one indicates a greater likelihood of subsidy adoption as this variable increases, while a ratio below one indicates the opposite.

Column (1) in Table 3 presents results from a basic specification. These results show that most of the variables (with the exception of corn prices and state per capita income) have hazard ratios above one, which indicates a positive effect on subsidy adoption. However, only two variables seem to be meaningful with a high level of significance. First, the coefficient on corn production is both large in magnitude and statistically significant; the hazard ratio indicates that a state with 100,000 more bushels of corn production is 10 percent more likely to adopt an

number of contiguous states or proportion of contiguous states that have some sort of ethanol subsidy in place. Results were never significant and were left out for brevity, but these results are available upon request.

ethanol subsidy in a given year. Second, the coefficient on corn prices is also large and significant. The estimated hazard ratio on corn price suggests that as corn prices fall the likelihood that a state will adopt an ethanol subsidy in a given year increases dramatically. This is a striking estimate, and indicates how changes in prices in this market are likely to motivate lobbying efforts.

Although not always statistically significant, the other factors often have signs consistent with expectations, and a few are economically meaningful, though not measured precisely enough to be statistically significant. Specifically, gas prices estimates fall just short of significance in model 1 (p-value =0.136), and indicate that a state is 25 percent more likely to introduce subsidies for ethanol production during a period in which gasoline prices are 10 cents higher. Estimates of single political party control (whether Democrat or Republican) and the presence of and gubernatorial election year are suggestive of increasing the likelihood of subsidy adoption.[14] The estimates for the effects of average state per capita income suggest that states with wealthier residents (and so states that may be less agriculturally focused) are less likely to adopt subsidies as well.

We have also hypothesized that declines in corn prices increase the marginal value of ethanol subsidies, and thereby increase efforts to pass ethanol subsides. Such efforts should be most effective in states where farmers have NCGA affiliations. Recall from the earlier discussion the important linkages between corn prices and NCGA affiliation. Due to these linkages, in our initial exploration we exclude the corn variable in column (2) of Table (3) and replace it with the NCGA indicator variable. These results are consistent with expectations, as NCGA affiliation increases the likelihood that a state will adopt an ethanol subsidy in a given

[14] We undertook a specification where we replaced the Democrat and the Republican dummy variable with a dummy variable that was equal to one if either party was in control and zero otherwise. Our results were unaffected.

year by 257 percent. This result clearly indicates the importance of a strong political lobby in influencing the policy adoption process.

Similar to NCGA affiliation, we have mentioned how the presence of "check-off" revenues might be used to promote, market, and lobby on behalf of corn growers. In column (3) of Table 3 we replace the NCGA indicator variable with a measure of the "check-off", a variable that captures variation across states in resources available to the state corn lobby. These results demonstrate that the longer that a check-off has been in place the greater is the likelihood of ethanol subsidy adoption.

Recognizing that corn prices, NCGA affiliation, and measures of the "check-off" may be correlated, in column (4) of Table 3 we include all three measures in order to determine which factor or factors plays the most important role in driving ethanol adoption. Results from this more comprehensive regression analysis indicate that, in addition to corn production and gas prices, changes in corn prices are a primary factor in ethanol subsidy adoption. This result suggests that falling corn prices motivates farmers to look for ways to boost corn demand, and farmers are likely to turn to the NCGA for this support. Similarly, falling corn prices provide an avenue through which the NCGA can offer services to farmers. Thus, corn prices appear to be the dominant factor driving farmers to the NCGA, which in turn leads to "check-off" support and ultimately to ethanol subsidies.

Last we note that across specifications in columns (1) to (4) that the coefficients on Democrat and Republican Party control are large in magnitude, but are too imprecisely measured to be statistically significant. This result suggests that there may be environments in which party control is important, but others in which it is not. Specifically, it may be the case that party

control plays an important role in ethanol subsidy policy when gasoline prices are high, when corn prices are low, or in states with high levels of corn production.

To investigate these interrelationships further, we interact the political party control dummy variables with these covariates in separate regressions. While the interactions between party controls and either gas prices or corn prices yield no significant coefficients (and are not reported in Table 3), the corn production-party control interaction reveals a statistically significant and meaningful relationship. As shown in column (5) of Table 3, the interaction between Democrat control and corn production suggests that subsidy adoption is more likely in states with Democratic control when levels of corn production are high.

V. Conclusions

We present evidence that state government subsidies/tax credits for ethanol are strongly influenced by several factors, especially political considerations. Specifically, we find that states are more likely to adopt ethanol subsidies when corn production is high, when gasoline prices are high, when corn prices are low, when a state is closely affiliated with the NCGA, when a check-off is present, and when state government is under the control of Democrats (but only in corn producing states). A particularly interesting feature of our work is that it tracks policy innovation in an industry from its inception. Over the 1984-2007 period, we observe the complete emergence of the ethanol industry, and our empirical work identifies the impact of numerous state-level policy changes aimed at a subsidizing the industry. More generally, our work contributes to the literature that has sought to evaluate the policy innovation in which policies are deliberately chosen to reflect the political calculus of the relevant actors. To our

knowledge this is the first study to explicitly study subsidy adoption in general and ethanol subsidies in particular.

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TABLE 1: SUMMARY STATISTICS, 1984 - 2007	
Variables	**Mean (Standard Deviation)**
Ethanol Subsidy Indicator	0.143 (0.350)
Bushels of Corn Produced (in 1,000s)	173.456 (363.227)
Corn Price (in 2007$)	1.565 (1.671)
Population (in 100,000s)	52.156 (56.947)
State Per Capita Income (in 1,000s)	28.869 (6.405)
Gasoline Prices (2007 $)	128.956 (40.011)
Democrat Control	0.257 (0.437)
Republican Control	0.168 (0.373)
NCGA Affiliation	0.466 (0.499)
Years of Check-off	3.762 (7.031)
Gubernatorial Election Year	0.261 (0.440)
Number of Border States	0.292 (0.455)
Observations:	1400

TABLE 2: STATE ETHANOL SUBSIDY POLICIES, 1984-2007			
State	**Tax Credit/ Subsidy**	**Grants/Loans**	**Per Gallon Tax Credit/Subsidy**
Alabama	---	---	---
Alaska	---	---	---
Arizona	---	---	---
Arkansas	---	---	2007
California	---	2006-2007	---
Colorado	---	---	---
Connecticut	---	---	---
Delaware	---	---	---
Florida	2006 – 2007	---	---
Georgia	---	---	---
Hawaii	2002 – 2007	---	---
Idaho	---	---	---
Illinois	---	2003-2007	---
Indiana	---	---	1982-1986, 2004 - 2007
Iowa	2001-2007	1994-2007, 1996-2007	---
Kansas	---	---	2001 - 2007
Kentucky	---	---	---
Louisiana	---	---	---
Maine	---	1999-2007	2004 - 2007
Maryland	---	---	2006 - 2007
Massachusetts	---	---	---
Michigan	2003 – 2007	---	---
Minnesota	---	---	1986 - 2007
Mississippi	---	---	2002 - 2007
Missouri	---	---	2002 - 2007
Montana	---	---	1983 - 2007
Nebraska	1990 – 1999	---	2000 - 2007
Nevada	---	---	---
New Hampshire	---	---	---
New Jersey	---	---	---
New Mexico	---	---	---
New York	---	---	---
North Carolina	2000 – 2007	---	---
North Dakota*	---	2007	2005 - 2007
Ohio	---	---	---
Oklahoma	---	---	2004 - 2007
Oregon	2006 – 2007	---	---
Pennsylvania	---	2006-2007	2005 - 2007
Rhode Island	---	---	---
South Carolina	---	---	2007
South Dakota	---	---	1996 - 2007
Tennessee	---	---	---
Texas	---	---	2004 -2007
Utah	---	---	---
Vermont	---	---	---
Virginia	---	---	2007
Washington	2003 – 2007	---	---
West Virginia	---	---	---
Wisconsin	---	---	2001 - 2006
Wyoming	---	---	1998 - 2007
*North Dakota also has a per plant credit.			

Source: Compilations by authors.

TABLE 3: ETHANOL SUBSIDY ADOPTION: ESTIMATES FROM A PROPORTIONAL HAZARD MODEL					
	Model: Hazard Ratios for Ethanol Subsidy or Credit Adoption				
Variable	**1**	**2**	**3**	**4**	**5**
Bushels of Corn Production (in 1,000s)	**1.001**	**1.001**	**1.001**	**1.001**	**1.001**
	[0.006]	[0.002]	[0.019]	[0.059]	[0.019]
State Corn Price (in 2007$)	**0.085**	**---**	**---**	**0.131**	**0.138**
	[0.003]	---	---	[0.051]	[0.066]
Population (in 100,000s)	1.003	1.002	1.002	1.002	1.003
	[0.246]	[0.679]	[0.390]	[0.263]	[0.279]
State Per Capita Income (in 1,000s)	0.964	0.954	0.943	0.961	0.955
	[0.359]	[0.196]	[0.135]	[0.344]	[0.269]
Gasoline Price (2007 $)	1.025	**1.041**	1.024	**1.034**	**1.036**
	[0.136]	[0.016]	[0.159]	[0.035]	[0.045]
Democrat Control	1.659	1.745	1.674	1.669	0.975
	[0.345]	[0.293]	[0.346]	[0.351]	[0.968]
Republican Control	1.221	1.443	1.494	1.229	1.300
	[0.652]	[0.450]	[0.402]	[0.642]	[0.607]
Gubernatorial Election Year	1.073	1.146	1.140	1.126	1.027
	[0.868]	[0.765]	[0.753]	[0.770]	[0.952]
NCGA Affiliation		**3.569**	---	1.417	1.793
		[0.017]	---	[0.646]	[0.370]
Years of Check-off			**1.055**	1.018	0.755
			[0.063]	[0.638]	[0.585]
Corn Production (in 1,000s) X Democrat Control					**1.006**
					[0.000]
Corn Production (in 1,000s) X Republican Control					1.000
					[0.820]
Observations	1011				
p-values are reported in brackets. All robust standard errors (not shown) were clustered at the state-level.					
Estimates that are statistically significant at the 0.10 level or less are highlighted in bold.					

Appendix
Definitions and Sources of Variables

Variable	Definitions	Source
Population	Number of people residing in a state in a given year	Census
Gasoline Price	Price of natural gas sold to commercial consumers in each state-year in dollars per thousand cubic feet	DOE, EIA
Per Gallon Credit/Subsidy	Per gallon tax credit and/or direct subsidy in real 2007 dollars. A full listing of existing subsidies is available at http://www.afdc.energy.gov/afdc/incentives_laws.html.	DOE, SCA
Production Tax Credit/Subsidy	Indicator variable equal to one if the state has a production tax credit or subsidy, and zero otherwise. This variable includes an array of subsidies including: grants, loans, per plant subsidies, production tax credits, and infrastructure tax credits. A full listing of existing subsidies is available at http://www.afdc.energy.gov/afdc/incentives_laws.html.	DOE, SCA
State Corn Price	Average corn price per bushel in each state-year	USDA
State Per Capita Income	Average income per capita in a state	BEA
Bushels of Corn Production	State corn production in millions of bushels per year	USDA
Democrat (Republican) Control	Indicator variable equal to one if the Democrat (Republican) Party controls both the state legislature and governor's office in a given year, and zero otherwise.	SCA
NCGA Affiliation	Dummy variable that equals one if there is a National Corn Grows Association affiliation in a given state in a given year, and zero otherwise.	SCA
Check-off	Number of years a check-off has been in place in a state in each year.	SCA
Gubernatorial Election Year	Dummy variable that equals one if there is a gubernatorial election in a given state in a given year, and zero otherwise.	SCA

Sources:
BEA: United States Bureau of Economic Analysis
Census: United States Census Bureau
DOE: United States Department of Energy, available at http://www.doe.gov
EIA: Energy Information Administration (part of DOE), available at http://www.eia.doe.gov
SCA: Compiled by the authors
USDA: United States Department of Agriculture, available at www.usda.gov