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Evaluating Voluntary Measures with Spillovers: The Case of Coal Combustion Products Partnership*

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Traditionally, voluntary measures have been evaluated using the same framework regardless of their structure. The framework assumes that the measure provides partners with a treatment (information, research support, etc) that will not be transferred to non-partners. In this framework, a voluntary measure is said to be worthwhile if there are significant differences between the behavior of partners and non-partners, correcting for the potential endogeneity of becoming a partner. However, voluntary measures take many different forms; some which are expected to have information transfers (spillovers) to non-partners. The Coal Combustion Products Partnership (C2P2) is a voluntary program to increase the re-use of coal combustion products (CCP) using a structure that is likely to provide spillovers to non-partners. This paper evaluates C2P2 and tests whether program spillovers are affecting non-partners' behavior. Results suggest that the traditional interpretation would find this program unsuccessful, however when spillovers are considered, evidence points to a successful program.

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Voluntary measures are now a large part of the environmental policy portfolio in most of the world. There are many reasons that a regulator may initiate a voluntary program, from facilitating information exchange to lack of political will to initiate mandatory regulation. Much of the economics literature on voluntary measures has found that they have little effect on environmental outcomes, controlling for the behavior of those who are not affiliated with the measure (non-partners) or trends leading up to the measures initiation (Morgenstern and Pizer, 2007). Traditionally, a voluntary measure would be labeled a success if the measure's partners statistically improved their environmental outcome compared to non-partners once the measure was initiated.

However, the evaluation method generally used assumes that voluntary measures provide the treatment exclusively to partners. For numerous reasons, the treatment provided to partners may also spillover to affect the behavior of non-partners. It is argued that an alternative interpretation of a successful measure is needed specifically for those that involve spillovers. Conditions under which a voluntary measure with spillovers would be considered successful are discussed and then tested using The Coal Combustion Products Partnership (C2P2). The goal of C2P2 is to increase the re-use, as opposed to disposal, of coal combustion products (CCP). Generally, coal-fired power plants supply CCP while firms producing cement, aggregate, gypsum or other materials demand them. This paper evaluates C2P2 using data from coal-fired power plants based on the potential for spillovers in the program. A difference-in-difference estimator is used to determine whether C2P2 partners improved their reuse of CCP at a statistically significant rate. Results generally find that C2P2 partners are no different than non-partners in their reuse rates, though the total re-use of coal combustion products has statistically increased.

Further, non-partners located in states with more C2P2 partners increase their re-use rate more than those in states with few partners. The evidence points to a program that is effective in reducing the disposal of CCP for partners and non-partners.

Background

The use of voluntary measures to improve environmental outcomes is common throughout the world, whether they be a voluntary program within one country or a voluntary agreement between countries. There are many reasons suggested in the literature why firms (countries) may join a voluntary program (agreement). Firms/countries may join to improve their reputation with consumers/voters (Khanna et al 1998; Arora & Cason, 1996) or to generate goodwill with the regulator/other countries (Dawson & Segerson, 2008; Barrett 1994)

The U.S. has initiated a number of voluntary programs, beginning with the 33/50 program in 1991.[1] The 33/50 program asked partners in the chemical industry to reduce emissions of 17 pollutants by 33% in 1993 and 50% by 1995 from a 1988 baseline. It is the most evaluated voluntary program in the economics literature, generally due to the data availability via the Toxic Release Inventory (TRI) and the fact that it is the oldest voluntary program. Khanna and Damon (1998), Sam and Innes (2006), and Gamper-

[1] A good background on voluntary programs in the U.S. can be found in Brouhle et al (2005).

Rabindran (2006) find mixed evidence that 33/50 led to improved environmental outcomes.

There is mixed evidence of effectiveness of voluntary programs and agreements in the economics literature, although more often the evidence points to a lack of effectiveness. Brouhle et al (2008) looks at a U.S. sector specific voluntary program (Metal Finisher's Strategic Goals Program) and find that its partners were not statistically different than non-partners in their emissions behavior until the threat of mandatory regulation became more likely. Finus and Tjotta (2003) simulate the net benefits to signatories of the Oslo Protocol to reduce sulfur emissions. They find that the abatement targets were very mild and much lower than the socially optimal targets. Arimura et al (2007) evaluates whether Japanese firms that adopted ISO 14001 reduced their natural resource use, solid waste generation, and wastewater production relative to those that have not adopted. They find strong evidence that ISO 14001 firms have outperformed non-ISO 14001 firms. Bratberg et al (2005) evaluates whether the Sofia Protocol reduced nitrogen oxide emissions among signatories more than non-signatories and find an annual effect of 2% reduction attributable to the protocol. Hamilton (1995) uses an event study to evaluate how the stock market value of companies whose emissions information were released with the first TRI report were effected. They find that firms' market values fell when TRI information was first released, with larger drops for companies that had not revealed environmental information previously. Evaluations of numerous voluntary programs throughout the world can be found in Morgenstern and Pizer (2007), with most finding only a small effect on environmental outcomes.

The traditional economic evaluation method for voluntary programs/agreements (see Khanna and Damon (1999) and Bratberg et al (2005) for example) has labeled a program successful if those who are partners (or predicted to be partners) have statistically better environmental outcomes than those who are not. Lyon and Maxwell (2007) lay out a theory arguing that a different way to evaluate voluntary programs may be necessary for programs whose purpose is likely to cause information transfers (spillovers). It is argued that spillovers may occur for many reasons. First, it is in the regulator's interest to have information that will improve environmental performance disseminated as widely as possible, to partners and non-partners. Second, information provided by a voluntary program may easily diffuse in the industry, making it difficult to statistically find a differential impact of the program on partners. The rate of diffusion will be higher when the information available through a voluntary program does not alter the competitive position of firms.

This is consistent when it is expected that the program (treatment) is only affecting partners and will not affect the behavior of non-partners. This interpretation would also be acceptable for a voluntary program that claims to have spillovers, though it implies the spillovers are less successful. However, it is not the only interpretation that implies a successful program. An alternative interpretation for a successful voluntary program with spillovers would be if two conditions are satisfied:

Condition 1: There is an improvement in the environmental outcome (controlling for other factors) for both partners and non-partners.

Condition 2: Evidence exists that the spillovers are affecting non-partners' behavior (again controlling for other factors) in a manner that improves their environmental outcome.

The first condition ensures that the voluntary program is affecting behavior in a manner consistent with the goals of the program. The second condition ensures that the improved environmental outcome observed by non-partners does not imply that the outcome would have occurred in absence of the program. In essence, this means that it was the voluntary program that affected the environmental outcome of non-partners and not other, non-program factors.

The issue of whether a voluntary program induces spillovers to non-partners is important for policy as well as academic purposes. Most voluntary programs, in practice, contend that their program effects spillover to non-partners. The alternative interpretation provides a structure for these claims to be tested. Voluntary programs are increasingly coming under scrutiny to show that they are the cause of improved environmental outcomes. The US Office of Management and Budget has and uses its authority over most voluntary programs (as well mandatory regulations) to ensure that public funds are being allocated correctly. The US EPA Office of Inspector General has undertaken a number of analyses of voluntary programs in an attempt to encourage improvements in their operation.[2] If voluntary program spillovers are being ignored, oversight offices will find programs that are in fact successful, unsuccessful and potentially close them or curtail their funds and activities.

[2] For example, see http://www.epa.gov/oig/reports/xmedia.htm. Four of the last six reports concern specific voluntary programs or voluntary programs in general.

The above conditions are used to guide an evaluation of C2P2. C2P2 is a voluntary program housed in the Environmental Protection Agency's (EPA) Office of Solid Waste. It began in 2001 as an initiative and became a full program in 2003. C2P2 is part of the EPA's Resource Conservation Challenge, an attempt to encourage all members of an industry to have environmental outcomes similar to those of its cleanest member. C2P2 also has the support of Power Partners, an electric utility partnership with the Department of Energy (DOE). The program accepts entities interested in CCP re-use, be they on the supply or demand side of a CCP re-use transaction. There are currently over 150 partners in C2P2, including a number of trade associations, universities, federal agencies and private companies. The process of becoming a partner involves submitting a postcard with contact information to the EPA. The main benefit of joining C2P2, besides the potential for increased CCP sales, is that partners can submit C2P2 award applications and use the C2P2 logo.

CCP are residuals from the coal combustion process such as fly ash, bottom ash and flue gas desfulurization wastes. C2P2 encourages re-use of CCP through educational workshops, case studies, facilitating research, and providing information on their uses and past regulatory decisions. (Re-)Uses for CCP include concrete/cement, drywall, pavement production, snow/ice control, and fill. The goal of C2P2 is to increase the re-use ratio (re-use divided by total generation) of all CCP to 50% by 2011. The American Coal Ash Association (ACAA) whose mission is to encourage proper management and use of CCP, surveys power plants to collect data on production and use of CCP. The

C2P2 program uses these data to track progress towards the goal of 50% re-use.[3] According to the ACAA and the DOE (2006), around 120 million tons of CCP are generated a year, making it one of the largest non-hazardous, non-municipal waste flows. Fly ash accounts for a little over half (55%) of the total CCP generated with bottom ash accounting for 15%, and flue gas desulfurization material around 29%. CCP were initially exempted from the Resource Conservation and Recovery Act (RCRA) while the EPA studied whether they should be classified as hazardous. In 1993, the EPA determined that coal combustion products do not need to be regulated under RCRA. The existence of other federal and state programs (dealing with solid wastes) was listed as one of the reasons.

The direct goal of C2P2 is to increase the amount of CCP re-used, however some re-uses have additional environmental benefits. The largest category of reuse is fly ash as an input to concrete/cement products. An additional environmental benefit is that adding fly ash to concrete/cement production reduces the energy intensity (and greenhouse gas emissions) of the production process. The re-use of flue gas desulfurization waste reduces the energy intensity of the production of wallboard.

The C2P2 program fits the style of programs Lyon and Maxwell (2007) argue are likely to have program spillovers. First, a large amount of information is available to partners and non-partners on the C2P2 webpage concerning re-use of CCP, such as past regulatory decisions and case studies. Second, information disseminated by C2P2 is unlikely to affect the competitive position of power plants due to CCP disposal being a small fraction

[3] However this data is not publicly-available at the plant level thus it is not used in this analysis. The data used in this analysis have similar numbers for CCP, as is discussed below.

of power plants' costs and the fact that most power plants or utilities don't really compete with each other in the usual way, being regulated and/or geographically distinct. Third, C2P2 encompasses both suppliers and demanders of CCP in the program. A scenario can be imagined where a potential demander of CCP learns more about them through C2P2 and contacts a local power plant who is not a member of C2P2 to discuss purchasing CCP. The resulting increased reuse of CCP would be attributed to a non-partner power plant in this analysis, though the impetus for the reuse came from C2P2 information. It is this third method of spillovers that this analysis will exploit for evidence that C2P2 spillovers are improving non-partners' re-use of CCP.

Data

Data for this analysis comes from the Energy Information Administration (EIA) and the United States Geological Survey (USGS). Voluntary programs are generally difficult to evaluate due to the lack of data available before the program started and for non-partners once the program is in effect. This is not the case here as the EIA has been collecting information on CCP for many years as part of its Form 767: Annual Steam-Electric Plant Operation and Design Data. Observations used here are from the years 1996-2005. In 2001, the EIA began collecting information from smaller boilers (<25 MW) in Form 767. These smaller boilers are removed from the sample due to their lack of information before the C2P2 program started.

This analysis will utilize the ratio of fly ash re-used as the dependent variable.[4] As discussed above, this is the largest CCP category and accounts for ~55% of all CCP. The EIA asks plants to report total by-products generated, the amount landfilled on-site (both wet and dry), the amount landfilled offsite, the amount used or stored on-site and the amount sold. The fly ash re-use ratio is calculated as the amount of fly ash sold divided by the total by-products fly ash generated.

The C2P2 webpage lists its partners, though it does not list the date at which the firm became a partner. However, the Utilities Solid Waste Activities Group (a trade association) lists the firms that initially committed to C2P2 on their webpage.[5] A list of these firms is given in Table 1. For this analysis, the firms listed in Table 1 are considered partners. The firms listed on the C2P2 webpage, but not in Table 1 are called late partners and are excluded from the econometric analysis due to the missing information on their year of entrance to C2P2. The balance of firms is considered non-partners. It is assumed that if a utility is a partner (non-partner), then all the plants it owns are partners (non-partners).

Figure 1 gives the reuse ratio for fly ash, by C2P2 partner designation, over the sample years. ACAA information on re-use shows that the average reuse ratio for all plants is ~45% in the early 2000s. The average reuse ratios found with the sample used here from the EIA-767 data is higher (~47%). The figure reveals that initial partners were generally re-using less of the fly ash than the other two and late partners have the highest re-use ratio. This pattern suggests that the initial partners initiated C2P2 due to their difficulty

[4] Information on other CCP are not consistent enough in the data for an analysis to be undertaken.
[5] http://www.uswag.org/c2p2.htm, last accessed 3/10/08

in re-using CCP while the late partners, who joined after the program was started, were the industry leaders in re-using CCP. The pattern of partner timing choice with C2P2 has been observed in other programs (Delmas and Montes, 2007).

The explanatory variables in this analysis come from the EIA-767 and the USGS. Explanatory variables from the EIA-767 data are the annual coal consumption (in 100,000 tons), the ash content of the coal burned and the presence of a selective catalytic reduction (SCR) technology at the plant. The ash content is the average ash content, in percent by weight, of the coal burned in the year. An SCR is a nitrogen oxide (NOx) pollution control device which, when used when combusting coal, can affect the lower the quality of the resulting fly ash.[6]

Information was also gathered from the USGS Mineral Yearbook. Fly ash can be a substitute for cement (though the resulting concrete has different characteristics than if fly ash is not used) and crushed stones/aggregates. The average value of cement per state in dollars per metric tons is taken from Table 11 of the USGS Cement Minerals Yearbook for the years 1996-2005. Some states prices are not listed thus the closest neighboring states value is used (For example, Delaware is not listed thus Maryland's price is used for Delaware). The average value of crushed stone in dollars per metric tons per state is taken from Table 4 of the USGS Crushed Stone Minerals Yearbook for the years 1996-2005. During the sample time period, the cement industry was operating close to capacity. Fly ash re-use and cement imports, two close substitutes for domestic cement, rose to meet the excess demand. Thus the level of cement imports for each year

[6] Mercury control through activated carbon injection can also affect the quality of the resulting fly ash. However, none of the plants during our sample years used activated carbon injection.

is taken from the USGS Cement Mineral Yearbook to control for the effect of excess demand on the re-use of fly ash. Finally, nine regional dummy variables based on Census Division regions and ten annual dummy variables are constructed with the region/year in question taking the value of one and the others zero.

Variables specifically relating to the evaluation of the C2P2 program are based around the partner designation described above and suggestions given by Lyon and Maxwell (2007). The sample time period is split into three variables: pre-C2P2, early-C2P2, and late-C2P2. Each variable is equal to one during the corresponding years and is zero otherwise. The pre-C2P2 time period is equal to one in the years 1996-2000, before C2P2 was formed. The early-C2P2 period is equal to one in the years 2001-2002 and the late-C2P2 period is equal to one in the years 2003-2005. The early-C2P2 and late-C2P2 variables are then interacted with the partner variable to determine whether partners' behavior is significantly different from non-partners' behavior.

Analysis

Summary statistics for the variables used in this analysis can be found in Table 2 for all groups and by partner designation. The information presented in Figure 1 provides evidence of a pattern in the choice of partner designation. Table 2 reveals other patterns, such as non-partners on average burning lower ash coal and facing a lower price for aggregates. The price of cement and coal burned per plant generally does not differ by partner designation. Given the pattern of the dependent and independent variables and the potential for selection bias in becoming a partner, this analysis will first generate a prediction as to whether a plant will participate in C2P2.[7]

The dependent variable in the participation analysis will be the initial partner variable. The explanatory variables for the participation analysis include three variables that are also in the reuse analysis (though not in the same form): the average fly ash re-use ratio, the average price of cement, and the average price of aggregates for the years 1996-2000. Each is the averages of the variables across the years 1996-2000. It is expected that a higher fly ash re-use ratio for the years 1996-2000 would make it less likely a plant joins the program in light of the information in Figure 1. Higher cement and aggregate prices would seem to have an ambiguous effect on the likelihood of a plant joining since the higher price would encourage CCP demanders to seek out the power plant while also bringing in more revenue to the plant if more CCP are re-used.

Seven variables are used to instrument for participation (they are only used in the participation analysis). First is the utility size, measured by the number of boilers a utility owns, as given in the EIA-767 data. Most of the literature on voluntary programs finds that larger firms are more likely to join. Second is the average bottom ash reuse ratio for the years 1996-2000, given in the EIA-767 data. Similar to the expected effect of fly ash re-use rates over this time period, it is expected that plants with less bottom ash re-use ratios are more likely to join C2P2. Third is the total amount invested in solid waste disposal at the plant for the years 1996-2000, as given in the EIA-767 data. It is presumed that plants with less invested in solid waste disposal would be more interested in re-using their CCP and thus more likely to join C2P2. Fourth is whether the state the

[7] The evaluation will also be run with the actual partner data so that the two can be compared.

plant is located in has authorized CCP re-use in some form as given by the DOE National Energy Technology Lab. Fifth is whether the state the plant is located in exempts CCP from solid waste permitting requirements (DOE, 2006, Table 20). The authorization of CCP re-use and exemption from solid waste permitting are steps states take in order to encourage re-use, thus these two variables are expected to increase the likelihood of joining C2P2. This may seem counter for the exemption from solid waste permitting, but if there is not an exemption the regulations surrounding the re-use are more complicated.[8]

Sixth is whether the state a plant is located in was part of the NOx SIP Call, a tradable permit program for NOx control that began in May 1999. Plants in NOx SIP Call states are more likely to install SCR in the future, perhaps making it less likely that they join C2P2 given the SCR will lower the quality of their fly ash. Seventh and final is whether the state a plant is located in has restructured its electricity market, according to the EIA (2003). There is no expectation as to how the restructuring of electricity markets would affect the likelihood of joining C2P2. All of these dummy variables take the value of one to indicate plants located in states that meet the criteria listed above and is zero otherwise.

A probit model is used to predict partner designation, which takes the following form:

$$P_i = \beta_0 + \beta_1 R_i + \beta_2 S_j + \beta_3 I_i + \mu_i \quad [1]$$

[8] This information comes from personal conversations with Jon Sager, the lead for the C2P2 program.

Where Pi is a binomial variable equal to one if the plant was an initial partner and zero if it is not a partner (late partners are excluded from this analysis), Ri is the average reuse ratio for fly and bottom ash for the years 1996-2000, Sj is a vector of the average price of cement and aggregates for the years 1996-2000, Ii is the vector of instruments described above, and μi is an error term.

The results from Model 1 are then used as part of the analysis of the voluntary program. In this analysis, we hypothesize that the level of fly ash re-use by plants is a function of: the total coal burnt, the ash content of the coal, the price of cement and aggregates in the state, the level of cement imports, the presence of an SCR at the plant, plant specific effects (management, etc) and the information disseminated by C2P2. Information dissemination by C2P2, such as educating state and local agencies, conducting research on re-use applications, and discussing the benefits of CCP re-use to potential demanders, is likely to impact the re-use decisions of partners and non-partners. In order to determine whether the C2P2 program has led to increased reuse of coal combustion products a random effects model is estimated. The evaluation model is given in Equation 2:

$$R_{it} = \beta_4 X_{it} + \beta_5 S_{jt} + \beta_6 N_{it} + \beta_7 \hat{P}_{it} + \beta_8 T_{it} + \beta_9 T \hat{P}_{it} + v_i + \varepsilon_{it} \quad [2]$$

Where Rit is the reuse ratio for fly ash for plant i at time t, Xit is a vector of coal consumption variables, Sjt is a vector of cement and aggregate variables by state, Nit is the SCR dummy, $\hat{P_i}$ is the predicted partner variable, Tit is a vector of C2P2 period dummies, $T\hat{P_i}$ is an interaction of C2P2 period and predicted partner variables (the difference-in-difference parameter), v_i is the random effects parameter, and eit is an error term.

Equation 2 is estimated using three specifications: a random-effects ordered probit model, a random effects model, and an ordered probit model (where the vi is absent from Equation 2).[9] For all models expect the random-effects ordered probit, the errors are clustered by plant to control for serial correlation. When the random effects ordered probit or the ordered probit specification is used, the fly ash reuse variable is rounded to the nearest five percent due the need for no more than 20 categories.

Results

The results of the estimation of model 1 are listed in Table 3. A number of the instruments are statistically significant. If the state has authorized re-use of CCP or an exemption for CCP from solid waste permitting requirements then the plant is more likely to join C2P2 as expected. However, the amount invested in solid waste disposal has no statistical impact on the decision to join the program, perhaps because it is a sunk cost. Larger utilities are more likely to join the program, a result that is common in the voluntary program literature. Past re-use rates do not have a statistically significant

[9] The random effects ordered probit estimation (reoprob) comes from code written for Stata by Guillaume R. Frechette at Ohio State University. The authors wish to thank Dr. Frechette for use of the code.

impact on the decision to join C2P2. A higher price for aggregates significantly increases the probability that the plant is a partner, but higher cement prices have the opposite effect.

The results of model 1 are then used to predict partner designation in the C2P2 program. This predicted partner designation variable is used to estimate model 2 using three specifications (a random effects ordered probit, a random effects, and an ordered probit).[10] Table 4 lists the results of the three specifications using the predicted partner designation and Table 5 lists the results of the three specifications using the actual partner designation.

All three specifications of model 2 reveal the same pattern, regardless of whether the predicted or actual partner designation is used. The rate of fly ash re-use has increased since C2P2 went into effect for both partners and non-partners. This increase occurs in both the early-C2P2 and the late-C2P2 variables, as they are positive and statistically significant. However, when these variables are interacted with the predicted initial partner or the actual initial partner variable, the coefficients are not statistically different from zero. This implies that plants that were initial partners or those with a higher predicted probability of being a partner do not increase their reuse rate relative to those that are not partners or those with a lower probability of being a partner. Under the traditional interpretation of a voluntary program evaluation, C2P2 would look like an

[10] We would like to remind the reader that the ordered probit coefficients do not have an economic interpretation outside of sign and statistical significance.

ineffective program. However, if evidence of program spillovers could be found the interpretation would be changed.

In order to test for evidence of program spillovers, information on the location of CCP demander (non-power plant) partners was gathered and paired with the location of non-partner power plants. The scenario discussed above, where a potential demander of CCP learns more about them through C2P2, contacts a local power plant who is not a member of C2P2 and begins purchasing their CCP is an example of program spillovers. If this scenario was occurring, it is expected that non-partner power plants in states with many CCP demander partners would increase their re-use rates compared to non-partner power plants in states that have few CCP demander partners.

This hypothesis is tested for states that have a large number of observations on non-partner power plants in our sample. These states are: Arizona, Indiana, Kansas, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, West Virginia, and Wisconsin. Of those states, Indiana, Kansas, Oklahoma, and West Virginia have one or less CCP demander partners. The remaining states have at least five CCP demander partners. A low-CCP demander partner dummy variable is set to one for the four states with one or less CCP demander partner, it is set to zero for the remaining six states. The above analysis is re-run for non-partners exclusively with the low-CCP demander partner dummy interacted with the C2P2 dummy. This interaction will reveal if non-partner power plants that are less likely to receive program information have different re-use rates once C2P2 was in effect from non-partner power plants that are more likely to receive program information.

The results of this test for program spillovers are given in Table 6. Consistent with Tables 4 & 5, non-partners increased their re-use rate after C2P2 went into effect, given by the positive and significant coefficient of the post-C2P2 dummy for all three specifications. However, plants in states with fewer C2P2 demand partners have a statistically significantly smaller increase in re-use rates for two of the three specifications.

The traditional condition to suggest C2P2 is successful would be whether partners (or those predicted likely to be partners) were reusing CCP at a higher rate than non-partners (or those predicted unlikely to be partners). Using this interpretation, the program is likely unsuccessful. However, C2P2 is unlikely to ever be found effective using this interpretation given the spillovers inherent in its design. The alternative set of conditions proposed here would be that both partners and non-partners improve their re-use of CCP and evidence that the spillovers are affecting non-partner behavior is found. This analysis finds that fly ash re-use has statistically significantly increased for partners and non-partners and, further, non-partners with many C2P2 demander partners located in the state increased their re-use rate at a statistically larger rate than those non-partners located in states with few C2P2 demander partners. This evidence suggests that C2P2 is a successful voluntary program.

Conclusion

Economic analyses of voluntary programs have found little evidence that they improve the environmental performance of firms in the program compared to those not in the program. Lyon and Maxwell (2007) argue this may be because the programs have spillover effects that will make it unlikely that partners and non-partners will act differently. The traditional interpretation of a voluntary program evaluation states that partners must have a better environmental outcome than non-partners for the program to be successful. If the program induces spillovers, then this traditional view is unlikely to be found (and indeed may lead to incorrect interpretations). In the case of spillovers, an evaluation should find that a) both partners and non-partners improve their environmental outcome and b) evidence that spillovers are affecting non-partners behavior.

The C2P2 program is likely to have spillovers due to the fact that the program includes both suppliers and demanders of CCP. A scenario where a C2P2 demander partner that potentially could use CCP would learn of their benefits and transact with a non-C2P2 partner for supply of the CCP is quite possible. However, the increased reuse of CCP in this scenario is attributable to the C2P2 program even though it looks like a non-partner's re-use has increased. An evaluation of the C2P2 program is performed with a difference-in-difference estimator to determine whether C2P2 partners improved their reuse of CCP at a statistically significantly different rate. Results generally find that C2P2 partners are no different from non-partners in their reuse rates, though the total reuse of coal combustion products has statistically increased since the C2P2 program went into effect. Further, evidence points to a larger increase in re-use for non-partners near other partners relative to those that are not near other partners If this program were evaluated in the same manner as other voluntary programs (33/50 for example) it would be considered ineffective. However, the design of the program along with the empirical results described above provides evidence that this program is indeed effective.

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Table 1: Initial C2P2 Partners

Inital C2P2 Partners
Alliant Energy
Ameren Corporation
American Electric Power Company
Constellation Energy Group
Consumers Energy
Duke Energy
FirstEnergy
Indianapolis Power & Light Company
LG&E Energy Corporation
Mirant Corporation
Montana-Dakota Utilities Company
Progress Energy
Public Service Company of New Hampshire
Public Service Enterprise Group
Reliant Energy
Southern Company
Tennessee Valley Authority
Tri-State Generation & Transmission
Xcel Energy

Table 2: Summary Statistics

Variable	Estimation Sample		Initial Partners		Non Partners		Other Partners	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Fly Ash Reuse Ratio	0.31	0.35	0.26	0.33	0.36	0.37	0.40	0.35
Restructed Market	0.36	0.48	0.34	0.47	0.36	0.48	0.47	0.50
Utility Size (# of boilers)	8.80	12.00	12.80	15.40	6.03	7.59	7.50	7.63
NOx SIP Call State	0.53	0.22	0.07	0.25	0.04	0.20	0.10	0.30
Re-Use Authorized	0.86	0.34	0.92	0.27	0.79	0.40	0.86	0.34
No CCP Permit Required	0.28	0.45	0.34	0.47	0.23	0.42	0.29	0.45
Solid Waste Investment 96-00 (100,000 $)	10.60	32.50	13.50	40.22	8.85	25.50	12.60	29.20
Total Coal (100,000 tons)	11.20	9.90	11.10	10.10	11.60	10.08	9.80	9.01
Ash Content (% by weight)	8.03	3.70	8.38	3.21	7.78	4.01	7.84	4.31
USWAG Member	0.41	0.49						
Aggregate Price ($ per ton)	5.23	1.26	5.58	1.22	5.10	1.45	5.50	1.01
Cement Price ($ per ton)	75.30	5.03	74.30	4.40	76.01	5.32	74.30	6.45
Cement Imports (million tons/year)	23.70	5.24	23.68	5.24	23.78	5.18	23.95	5.12
SCR Installed	0.03	0.16	0.04	0.18	0.03	0.15	0.04	0.20

Table 3: Participation Regression Results

Dependent Variable:	Initial Partner Dummy	
Model:	Probit	
Explanatory Variable	Coefficient	Stnd. Error
Avg Fly Ash Reuse Ratio 1996-2000	-0.11	0.28
Avg Bottom Ash Reuse Ratio 1996-2000	0.2	0.24
Avg Aggregates Price 1996-2000	0.34***	0.08
Avg Cement Price 1996-2000	-0.01	0.01
Utility Size	0.04***	0.01
Restructed Market	-0.41*	0.22
NOx SIP Call State	0.15	0.5
Total Solid Waste Disposal Investment 1996-2000	0.03	0.02
No CCP Permit Required	0.45**	0.21
Re-use Guidelines Set	1.1***	0.3
N	305	
R2	0.18	

*, **, *** indicate 10%, 5% and 1% statistical significance

Table 4: Evaluation Regression Results w/ Partner Prediction

Time Period : 1996-2005						
Dependent Variable:	Fly Ash Reuse Ratio		Fly Ash Reuse Ratio		Fly Ash Reuse Ratio	
Model:	Random Effects Ordered Probit		Random Effects		Ordered Probit	
Explanatory Variable	Coefficient	Stnd. Error	Coefficient	Stnd. Error	Coefficient	Stnd. Error
Predicted Partner	-0.61**	0.22	-0.33***	0.07	-0.45	0.3
Early-C2P2 (2001-2002)	0.44**	0.15	0.06*	0.03	0.57***	0.11
Late-C2P2 (2003-2005)	0.53***	0.15	0.07**	0.03	0.58***	0.11
Early-C2P2* Predicted Partner	0.38	0.28	0.08	0.07	0.29	0.22
Late C2P2* Predicted Partner	0.1	0.25	0.05	0.06	0.07	0.21
Aggregates Price	0.10***	0.03	0.03**	0.01	0.10	0.06
Cement Price	-0.01	0.01	-0.01	0.01	0.01	0.01
Cement Imports	0.02**	0.01	0.01**	0	0.01***	0.01
SCR Installed	-0.01	0.13	-0.02	0.01	-0.06	0.21
Avearge Ash Content	-0.15***	0.01	-0.02***	0.01	-0.10***	0.01
Total Coal	0.01***	0.00	0.01***	0.00	0.01***	0
N	2263		2678		2263	
Plants	305		305		305	
R2			0.3		0.07	

Region & Year Dummies Not Shown for Brevity

*, **, *** indicate 10%, 5% and 1% statistical significance

Table 5: Evaluation Regression Results with Actual Partners

Time Period : 1996-2005

Dependent Variable:	Fly Ash Reuse Ratio		Fly Ash Reuse Ratio		Fly Ash Reuse Ratio	
Model:	Random Effect Ordered Probit		Random Effects Model		Ordered Probit	
Explanatory Variable	Coefficient	Stnd. Error	Coefficient	Stnd. Error	Coefficient	Stnd. Error
Actual Partner	0.11	0.1	-0.03	0.03	0.04	0.15
Early-C2P2 (2001-2002)	0.54***	0.12	0.06**	0.03	0.66***	0.09
Late-C2P2 (2003-2005)	0.63***	0.12	0.09**	0.04	0.67***	0.09
Early-C2P2* Actual Partner	0.1	0.14	0.05	0.06	0.08	0.12
Late C2P2* Actual Partner	-0.17	0.12	0.02	0.06	-0.13	0.12
Aggregates Price	0.10***	0.03	0.01	0.01	0.06	0.06
Cement Price	-0.01	0.01	-0.01	0.01	0.02	0.01
Cement Imports	0.02***	0	0.01**	0.01	0.01**	0
SCR Installed	0.01	0.15	0.02	0.01	-0.08	0.2
Avearge Ash Content	-0.17***	0.01	-0.02***	0.01	-0.10***	0.01
Total Coal	0.01***	0	0.01**	0.00	0.01***	0
N	2263		2678		2263	
Plants	305		305		305	
R2			0.27		0.07	

Region & Year Dummies Not Shown for Brevity

*, **, *** indicate 10%, 5% and 1% statistical significance

Table 6: Spillover Test Results

Time Period : 1996-2005						
Dependent Variable:	Fly Ash Reuse Ratio		Fly Ash Reuse Ratio		Fly Ash Reuse Ratio	
Model:	Random Effects Ordered Probit		Random Effects		Ordered Probit	
Explanatory Variable	Coefficient	Stnd. Error	Coefficient	Stnd. Error	Coefficient	Stnd. Error
Low C2P2 Partners Nearby	-0.57***	0.17	-0.06	0.07	-0.46*	0.25
Post-C2P2 (2001-2005)	0.93***	0.18	0.16***	0.05	0.86***	0.18
Post-C2P2* Low C2P2 Partner	-0.45**	0.21	-0.09	0.05	-0.42*	0.23
Aggregates Price	0.27***	0.08	-0.01	0.03	0.04	0.14
Cement Price	-0.05***	0.01	-0.01*	0.00	-0.05**	0.02
Cement Imports	0.05***	0.01	0.01***	0.00	0.03***	0.01
SCR Installed	-0.11	0.34	0.03	0.05	-0.71	0.44
Avearge Ash Content	-0.19***	0.01	-0.03***	0.01	-0.16***	0.03
Total Coal	0.01***	0.00	0.01***	0.00	0.01***	0.00
N	631		627		631	
Plants	81		81		81	
R2			0.38		0.11	

Year Dummies Not Shown for Brevity

*, **, *** indicate 10%, 5% and 1% statistical significance

Figure 1: Fly Ash Reuse Ratios over Time