Environmental Justice/Injustice and SCAQMD's Dry-Cleaners Initiative[1]

Paul Ong
UCLA School of Public Affairs
October 29, 2010

Abstract

This paper presents an analysis of an Environment Justice (EJ) program adopted by the South Coast Air Quality Management District (AQMD) as a part of its regulation to phase out a toxic chemical used by dry cleaners. AQMD has provided financial incentives to switch early, and establishments in EJ neighborhoods are given priority. Despite this pro-EJ policy, an analysis of available data shows that dry cleaners in low-income, predominantly minority and EJ designated areas are less likely to be an early adopter of green technologies, and this finding holds even after accounting for firm and market characteristics.

Introduction

Environment Justice (EJ) has become a major concern within the environment arena. At its core, EJ is concerned with the unequal burden on socially and economically disadvantaged communities and the government's role in producing the inequality. Since the seminal and influential publications by the United Church of Christ's Commission for Racial Justice (1987) and Robert Bullard (1990), there has been a growing body of increasingly sophisticated research documenting the pervasive socioeconomic inequality in the distribution of environmental hazards from stationary and mobile sources (Anderton, et al., 1994; Bowen, 2000; Oakes, et al. 1994; Bullard et al., 2007; Houston, et al. 2004; Morello-Frosch and Lopez 2006; Pastor et al. 2006; Rinquist 2005). The EJ movement has focused on "environmental racism" and has been

[1] The author wants to acknowledge the invaluable support provided by Dr. Ward Thomas, who generously allowed me to use his data on dry cleaners, SCAQMD for providing additional information, and UCLA's Luskin Center for

pursued as an extension of the Civil Rights Movement (Colopy, 1994; McGurty, 1997; Bullard and Johnson, 2000; Yang, 2002; Camacho, 1998; Schweitzer and Valenzuela, 2004; Pellow and Brulle, 2005). Given the intersection of racial and economic inequalities, the EJ movement has also been concerned with low-income communities.

A particular EJ concern is centered on the state's role as an active contributor to or passive participant in the creation of environmental inequalities. The former refers to *de jure* discriminatory actions by the state against minority and poor communities, and the latter refers to the failure of the state to prevent discriminatory societal and market actions, thus leading to *de facto* inequality. EJ activists have focused on fighting unfair siting of hazardous facilities, but inequality can also be generated when marginalized communities receive a disproportionately smaller share of the benefits from policies aimed at reducing pollution. To counter negative state actions, advocates have pressured public agencies to adopt principles prohibiting discriminatory practices and to open up the decision making process to those historically excluded. These objectives are means to the fundamental goals of redressing and hopefully eliminating the underlying inequality. At the federal level, President Clinton's 1994 Executive Order 12898 directs federal agencies to incorporate EJ in their programmatic activities, and there has been a proliferation of EJ related policies and programs at the state, regional and local levels, with California and its regional air districts being among the most active (Bonorris, 2010).

Merely adopting policies and programs, however, does not guarantee positive results because outcomes are critically dependent on successful implementation (Pressman and Wildavsky, 1973; Scheberle, 2004). Success requires several factors: careful and purposeful attention, procedures and processes to overcome internal and external barriers, explicit and

---

funds to help prepare the paper. I am also grateful to Silvia Jimenez and Erica Halchak for their assistance. I alone am responsible for the content.

quantifiable objectives to monitor progress, on-going assessments to identify implementation problems, and a willingness to revise and refine efforts when required. Quite often, this is not the case. For example, the implementation of E.O. 12898 has been at times haphazard and perfunctory, often undermined by changing political and competing organizational priorities (U.S. EPA, 2003; U.S. GAO, 2005). Moreover, effective implementation is hampered by a lack of research. Only a handful of studies have evaluated the effectiveness of governmental action in 'closing the environmental gap', defined as the systematic socioeconomic difference in cumulative exposure risks and health outcomes. Macro-level analyses using aggregated data over multiple time periods indicate a reduction in inequality following the adoption of broad governmental EJ policies, but the results are not consistent and depend on how the environmental gap is calculated. (Kahn, 2001; Sigman, 2001; Pastor, 2008) Program and policy level studies tend to highlight community capacity building, influencing decision making, and general measures of community benefits. (See for example, Baron, et al., 2009; Birnbaum, et al., 2009)

This paper partially fills the lacuna in the literature by evaluating an Environment Justice program adopted by the South Coast Air Quality Management District (AQMD) as a part of its regulation of the dry cleaning industry. This paper is organized into four parts. Part 1 summarizes the literature on the environmental risks generated by dry cleaners and the relevant environmental regulations. In response to the health hazards, the District has mandated a phase out of perchloroethylene (PERC), and has provided financial incentives to switch early, giving priority to establishments in EJ designated neighborhoods. Part 2 presents the results from a set of bivariate analyses to determine if establishments in low-income, predominantly minority and EJ designated areas are more or less likely to adopt non-PERC technology at two points in time, 2006 and 2010, and the relative likelihood of these EJ establishments receiving a grant from AQMD. The findings consistently show that disadvantaged communities benefit less. Part 3 uses multivariate models to control for firm and local market conditions to evaluate 2006 outcomes. The results also show that firms in predominantly minority, low-income and EJ designated areas are less likely to use non-PERC technology. Part 4 concludes with a discussion about future research needs.

Part 1: Environmental Policies Regulating Dry Cleaners

Since the 1950s most dry cleaners in the United States have used perchloroethylene (PERC), a synthetically produced organic compound whose vapors are emitted into the ambient air during the dry cleaning process (Martin and Fulton, 1958; Campbell and Low, 2002; U.S. EPA, 2009). In recent years, a number of governmental agencies have classified perchloroethylene as a "possible" or "probable" human carcinogen.[2] Inhaling the chemical for short periods of time irritates the eyes, nose and throat, and adversely affects the nervous system, causing dizziness, fatigue, headaches, sweating, poor coordination, and unconsciousness (U.S. EPA, 1994). Longer-term exposure can increase cancer risks of the esophagus, kidney, bladder, lung, pancreas, and cervix (Brown and Kaplan, 1987; Solet, et al., 1990). Exposures are highly localized, so owners and employees in close contact are most at risk, but the danger also extends to those living and working nearby (California Environmental Protection Agency, 2002; Schreiber et. al., 2002; Altmann, et al., 1995; Smith, 2002). Moreover, the externalities are not

[2] This includes the Environmental Protection Agency (EPA), the Office of Environmental Health Hazard Assessment (OEHHA), the International Agency for Research on Cancer (IARC), and the Scientific Review Panel. It should be noted that a study conducted by the American Council on Science and Health (ACSH), funded by the dry cleaning industry, concluded that perchloroethylene is not hazardous to humans at typical levels of use (Ghasemi and Perryman, 2002).

just limited to these groups because most dry cleaners are located in or close to shopping centers, child daycare facilities, schools, and restaurants (Campbell and Low, 2002).

In response to the documented detrimental health effects, environmental agencies have adopted policies to regulate and ultimately eliminate the toxic chemical. In 1993 through the National Emission Standards for Hazardous Air Pollutants (NESHAP), the U.S. Environmental Protection Agency (EPA) required new and existing large dry cleaning facilities (those potentially emitting greater than ten tons of PERC annually) to control emissions to level achievable by available control technologies and management practices (U.S. EPA, 2006). A 2006 amendment included a phase-out of PERC at dry cleaners located within a residential building by the year 2020. States and regional agencies have been given responsibility for enforcing these regulations with discretion to adopt stricter regulations.

The State of California went beyond the NESHAP by enacting the 1994 Air Toxic Control Measure (ATCM), which requires dry cleaners to add primary control systems on older machines, and integrated primary and secondary control systems on newer machines (California Air Resources Board, 2010). PERC is also to be phased out in dry cleaner machines in residential buildings by 2010 and out of all machines and related equipment by 2023. To help with the phase out, California enacted Assembly Bill 998 in 2004, which provides $10,000 assistance grants to dry cleaning operators purchasing machinery utilizing qualifying non-PERC alternative technologies (California Air Resources Board, 2006). Regional air districts have been given responsibility for enforcing ATCM as well as NESHAP.

Within Southern California, the South Coast Air Quality Management District (AQMD) is responsible for regulating the dry cleaning industry. AQMD has jurisdiction over all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties, covering

10,743 square miles that are home to about 17 million people. The air basin is one of the most polluted in the country, and in many years the most polluted in the nation in the state (SCAQMD, 2009). In 2000, District researchers identified perchloroethylene as one of six major toxic air contaminants in the Basin. An estimated that 850 tons were emitted annually, with dry cleaners releasing about two-thirds. Residents living within 25 meters of a dry cleaner faced a cancer risk of 120 to 140 cases per 1 million people, 8 times higher than the acceptable level established by regulatory authorities (Ghasemi and Perryman, 2002; Polakovic, 2002).

In 2002, AQMD's Governing Board approved Rule 1421, a regulation designed to phase out perchloroethylene-based machines with approved alternatives such as wet cleaning, hydrocarbon, Green Earth, and CO2. Starting January 1, 2003, the rule has required new facility or a facility adding additional machines to purchase an alternative technology. Existing PERC machines are required to be replaced by non-PERC ones by no later than 2020. AQMD allowed for a long phase-in period because of the cost of adapting new technology. While new equipment can costs less than perchloroethylene equipment and is potentially more energy efficient (Ghasemi and Perryman, 2002; Dabirian, 2002; Krause, 2002), switching over nonetheless requires investing in new capital, whose estimated fixed cost ranges from about $40,000 to $150,000 depending on technology and size (Sinsheimer et al., 2007; CARB, 2008; Morris and Wolf, 2005; Green Earth Cleaning, 2010). The required investment is sizeable given that most dry cleaners are small, marginally profitable operations (Thomas, 2007). The typical dry cleaning firm is a family venture, a husband and wife team employing one or two employees and, in some cases, the owner's children. Four in five have fewer than 5 employees, and approximately two-thirds of the industry has annual sales of less than $100,000. Profits are low because the industry is highly competitive due to low barriers to entry. Access to capital from financial institutions is limited, and many rely on personal savings and family loans. Given the financial barriers, firms are not likely to switch technologies until their machines have reached the end of the equipment's economically useful life span, or when there is a market advantage to "going green", or when they reach the 2020 deadline, whichever comes first.

To help with cost, AQMD offers financial incentives to qualified operations to aid in transitioning to an approved alternative system, with grants ranging from $5,000 to $20,000, depending on the technology and machinery needed. The District initially allocated two million dollars to this program in 2002, and added more funds in subsequent years. By early 2010, the District gave out 599 awards, for a total amount of approximately $3.6 million. AQMD gives priority to establishments in Environmental Justice designated areas in applying for a grant (SCAQMD, n.d.). EJ locations are zip code areas that meet two criteria.

The first criterion is that at least 10% of the population have incomes below the federal poverty line (FPL). The poverty rate is calculated using tract-level data from the 2000 Census, which reports annual income for the prior year. The FPL is based on the minimum income needed to meet a family's most basic needs, which was originally defined as three times the cost of the Department of Agriculture's low-cost food plan. The FPL is adjusted for inflation and family composition, but is not adjusted not for any geographic differences in the cost of living. For a family of four with two children, the 1999 FPL was $16,895.

The second criterion for EJ designation is based on environmental impacts, which has two components. The first is the cumulative cancer risk from exposure to air toxics. (SCAQMD, 2008). The rates are estimated for two kilometer cells using data from stationary monitoring stations, an emissions inventory of toxic air contaminants, and parameters linking exposure to cancer risk from the scientific and health literature. The second environmental component is the level of exposure of ultra-fine particulate matter (PM2.5), which is estimated using information from the District's air monitoring system. If a zip-code area is among the most impacted by either of the two environmental hazards and has at least a 10% poverty rate, then it is designated as an EJ area.

It should be noted that AQMD's definition is not consistent with prevailing notions of disadvantaged communities. The most glaring difference is the absence of race in the formula, despite the fact that environmental racism is central to EJ concerns. A possible explanation for this is that California's Proposition 209 prohibits the state and local jurisdictions from granting "preferential treatment to any individual or group on the basis of race." Whether this prohibition applies to neighborhoods is debatable, but other air districts in the state do use racial composition as a factor in identifying EJ areas. The second problem is the definition for low-income neighborhoods. The overall poverty rate for the Southern California Consolidated Metropolitan Statistical Area, which contains the South Coast Air Basin, was 15.6% according to the 2000 Census, which is considerably higher than AQMD's threshold of 10%. Moreover, most academic researchers and policy analysts define a "poverty area" as one where at least 20% of the residents live below the FPL and an "extreme poverty area" as one where at least 40% of the residents fall below the FPL. (U.S. Department of Commerce, 1995) AQMD's low poverty threshold produces apparent anomalies, such as the inclusion of two Beverly Hills zip codes.

Part 2: Basic Assessment and Bivariate Results

Undeniably, AQMD's Rule 1421 will eventually produce benefits for both advantaged and disadvantaged communities when PERC is completely eliminated from the dry cleaner industry, but the rule does not address the question of whether there are systematic differences in the distribution of benefits during the phase-in period of alternative technologies. A neighborhood benefits if its dry cleaner is an early adopter of alternative technology because the residents, workers and others in the area experience fewer years of exposure to the toxic chemical. The critical question, then, is how early switchers to non-PERC technologies are distributed across neighborhoods as defined by income, racial composition and EJ designation. A related question is how AQMD grants are spatially distributed because assessing such pattern tests whether the incentives are structured in a way to offset market conditions that disadvantage EJ communities. Empirically, an evaluation entails examining variations in the proportion of establishments adopting new technologies or receiving a grant based on their location in categories of neighborhoods defined by socio-economic status (SES). This analytical approach has limitations because it does not take into consideration cumulative exposure nor does it relate the distribution to downstream health impacts. Nonetheless, analyzing changes in the sources of the toxic chemical is an important step in evaluating AQMD's EJ policy and program.

Five sources are used to construct the database for the distributional analysis: (1) AQMD inventories of dry cleaning machines by chemical type for 2006 and 2010; (2) a specialize list of cleaners using green technologies not on the AQMD lists; (3) aggregated 2000 Decennial Census data at the zip-code level; (4) a list of zip codes designated by AQMD as EJ eligible areas; and (5) a list of firms that received an AQMD grant to subsidize the purchase of qualified non-PERC equipment covering all awards up to the early part of 2010. The first four data sets are merged by zip code, and identifiable duplicates are deleted.

The dependent or outcome variable for the initial set of analyses is dichotomous indicating whether a machine uses a non-PERC technology. Over a quarter (28%) the 2006 machines used for the analysis (n=2,202) falls into this category, and over a half (57%) of the

2010 machines (n=1,943) do. Census data are used to classify zip codes by socioeconomic status (SES), one classification is based median household income and the other is based on the percentage of the population comprised of African Americans and Latinos, the two most disadvantaged minority groups in the region. These two SES characteristics are at the heart of the EJ problem, environmental racism and classism. For each time period, machines are assigned to ranked quartiles based on the income (lowest to highest) or racial composition of neighborhoods. Machines are also classified by whether they are in an AQMD designated EJ zip code or not. The EJ designated categorical variable is correlated with the two SES categorical variables, but the resulting overlap is not exact because of differences to the criteria used by AQMD discussed earlier. Contingency tables are used to examine the variations in the adoption rate of non-PERC by neighborhood types, and the chi-square test is used to determine if differences are statistically significant.

A second set of analyses focuses on the distribution of the AQMD incentive awards across neighborhoods by the SES categories described above. Each grant is equivalent to a single machine, and the list includes all awards since the inception of the incentive program to early 2010. Unfortunately, there is no comprehensive list of machines that have not received an award, so the 2010 machine count is used as the base, which means that approximately 31% of all machines or 54% of all non-PERC machines are covered by a grant. For each neighborhood category, the number of machines without a grant is estimated by subtracting the number of grants from the total number of machines in 2010. Contingency tables and chi-squares are used to test the distribution of the grants.

Table 1 contains the bivariate results. The top panel reports the result for the 2006 inventory, which shows a distinct and statistically significant variation in non-PERC usage. The proportion or probability is lower in the poorest neighborhoods and in areas with the highest percentage of African Americans and Latinos. (The p-value for the distribution by race is just slightly higher than 0.01.) The spread between the top and bottom quartiles is sizeable, with the differences equal to about a third of the overall non-PERC usage rate (28%). There is a similar gap between the dry cleaning machines in AQMD's EJ designated areas and non-EJ areas, with the latter having a higher proportion of non-PERC machines. Four years later, the percentage-point gap by income, race and EJ designated areas increased, that is the environmental inequality became more severe. (See Figure 1 for summary comparison of the environmental gap.).

The results for the distribution of subsidies provide insights into whether AQMD has played more than just a passive role in generating the environmental gap. It is possible, for example, that AQMD disproportionately awarded more grants to establishments in disadvantaged areas, but that was not sufficient to overcome the inequality produced by market-based decisions. Unfortunately, the data show the opposite, that is, the most disadvantaged neighborhoods received relatively fewer grants than the most advantaged neighborhood. There are two caveats in interpreting the results. One, the variations in the distribution of grants across SES categories are not strictly monotonic. The proportions receiving an award are similar for the three lowest income classes and for the three racial groupings with the fewest African Americans and Latinos. Two, the distribution by racial composition is not statistically significant, so this specific finding is inconclusive. At the same time, the third test shows a distribution favoring non-EJ designated neighborhoods, and the difference is highly statistically significant. Taken as a whole, the analysis of grants indicates that AQMD played a more than a passive role in generating environmental inequality.

Table 1: Percent Using Non-PERC Or Receiving AQMD Grant			
	Stratified by Median HH Income	Stratified by Percent Black+Latino	Stratified by EJ Area
2006 Machines (28%)			
Quartile by Neighborhood			
Most Disadvantaged	24%	23%	NA
Disadvantaged	25%	26%	NA
Not Disadvantaged	27%	30%	NA
Most Advantaged	34%	31%	NA
EJ Neighborhood			
Designated as EJ	NA	NA	23%
Not Designated	NA	NA	31%
Chi-square Probability	<.001	<.05	<.001
2010 Machines (57%)			
Quartile by Neighborhood			
Most Disadvantaged	51%	49%	NA
Disadvantaged	56%	56%	NA
Not Disadvantaged	56%	61%	NA
Most Advantaged	65%	62%	NA
EJ Neighborhood			
Designated as EJ	NA	NA	52%
Not Designated	NA	NA	61%
Chi-square Probability	<.001	<.001	<.001
Grants (31%)			
Quartile by Neighborhood			
Most Disadvantaged	28%	26%	NA
Disadvantaged	29%	32%	NA
Not Disadvantaged	29%	33%	NA
Most Advantaged	37%	31%	NA
EJ Neighborhood			
Designated as EJ	NA	NA	27%
Not Designated	NA	NA	34%
Chi-square Probability	<.05	0.116	<.001

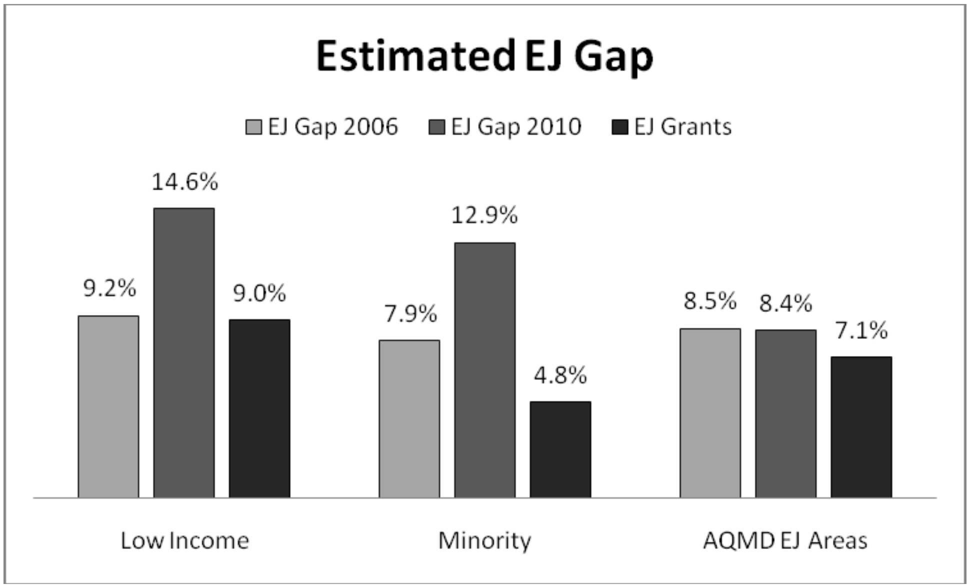

Figure 1

Part 3: Firm Decision and Multivariate Results

Some of the gap observed in the previous section may be due to unaccounted causal factors. In other words, establishments in more advantaged areas may be more inclined to switch technology for reasons other than the SES of their location. This section examines this proposition by empirically testing models that control for firm and other neighborhood characteristics. Firm behavior related to replacing capital (equipment) is based on an economic decision, which is not unique to the timing of adopting non-PERC technology but is nevertheless very applicable. Before the end of the 18-year phasein period of alternatives, purchasing a new machine is based on profit maximizing, which is equivalent to minimizing cost (in present value) under most circumstances. The costs of an existing PERC machines include the cost of ownership (payments and opportunity cost of the sale of the machine or business), operating costs (inputs, energy, etc.), and maintenance. As a machine ages, it becomes less efficient, and maintenance cost increases. The economic aging of capital is not necessarily chronological, but is dependent on factors such as how intensely the machine is used, and the availability and price of parts and repair services. The alternative is replacing the aging machine with a new one, which has a different set of associated ownership, operating and maintenance costs. Capital cost is influenced by a firm's ability to secure financing, particularly the interest rate of loans. Governmental incentives and requirements can also influence the bottom line. At some time point, the cost of keeping the older machine surpasses that of purchasing a new one, leading the firm to switch.

The second set of factors influencing firm behavior is comprised of localized market conditions, which affect demand for services produced by alternative technology. The dry cleaning industry is a spatially competitive market with relatively free entry and geographically fragmented territories with individual firms operating under competitive monopolistic or oligopolistic conditions.[3] Markets are localized to lower travel-related transaction costs for consumers, who are most likely to do their dry cleaning near their place of employment or residence. The importance of proximity can be seen in the fact that a large majority of customers live or work within 1-2 miles of their dry cleaner (U.S. Environmental Protection Agency, 1995). Highly differentiated urban space produces variations in the willingness of consumers to pay for greener products. The composition of consumers varies from one neighborhood to another, and the differences matter. Non-resident clients are less concerned about exposure to hazardous chemicals because they have very short exposures, but the opposite holds for residents. Highly commercialized areas create positive externalities for dry cleaners by increasing foot traffic and lower transaction cost by enabling consumers to consolidate shopping trips. At the same time, dry cleaners face pressure from other retailers to go green in order to make the business district

[3] For discussions on this type of market structure, see Hotelling, 1929; Chamberlain, 1938; Smithies, 1941; Lösch, 1954; Mills and Lav, 1964; Capozza and Van Order, 1978.

more attractive, and the lower transaction cost makes it easier to pass along higher prices. In submarkets that support two or more dry cleaners, competition could accelerate early adoption if product differentiation is a viable marketing strategy or delay adoption because of price competition.

One of the challenges to implementing an empirical model based on the above description of firm behavior is the lack of data directly tied to the conceptual factors. For example, it is extremely difficult and prohibitively expensive to collect data on the economic age of capital, underlying costs, and access to financial resources. It is also challenging to observe the demand for green products. What is possible is to create proxies that are reasonably correlated with the factors affecting economic decisions. For example, it is reasonable to assume that a measure of firm size is related to the cost of financing new equipment, that is, small "mom and pop" operations pay higher interest for loans than bigger operations.

The data for a multivariate analysis starts with the merged 2006 data set described earlier (machines by technology, neighborhood SES characteristics, and AQMD's EJ designation), which is aggregated by firm to produce a count of machines in each establishment. Two additional data sets are then attached: individual firm characteristics taken from a 2005 Dun&Bradstreet (D&B) file, and zip-code level business statistics from the 2004 County Business Pattern. There are 1,442 matched observations, which accounts for seven-eighth of the establishments in AQMD's inventory of machines. A part of the mismatch is due to the fact that not all dry-cleaning facilities are retailing operations. The number of machines is imputed from D&B revenue for about 5% of the observations using environmentally friendly equipment not in AQMD's database.

The available data are used to construct three sets of independent variables. The first set contains EJ related characteristics of the neighborhood: (1) the log of median income, (2) the percent of the population that is African American or Hispanic, and (3) AQMD's EJ designated areas. While these variables are included to estimate the environmental gap, they also capture local market conditions that can affect firm behavior. The most obvious example is that higher income may be related to a preference for greener products as well as a greater ability to pay higher prices (lower price elasticity).

The second set captures key firm characteristics. Firm size is measured by the number of dry-cleaning machines, and the hypothesized effect is that larger firms are more likely to adopt because they have better access to financial resources. The second variable is the number of employees per machine, rescaled by dividing by ten. This captures the intensity of machine usage, which is predicted to accelerate the aging of capital thus increase the likelihood of switching. The final variable identifies firms operating three or few years, many of which were established or changed hands after the passage of Rule 1421, and thus are more likely to have adopted the required technology.

The third and final set of independent variables is related to local market characteristics. Two variables captures the size of the market, one based on number of nearby residents per firm and the other based on the number of nearby workers per firm. As discussed earlier, the *a priori* assumption is that local residents have a stronger preference for greener products, but workers from the outside prefer price over their miniscule risk. A measure of commercialization is included because business oriented land-use patterns could encourage switching, as discussed earlier. Finally, the number of firms per zip code is included to capture the level of local competition. The net effect is dependent on the relative importance of two offsetting factors – gains from product differentiation from switching versus greater price competition.

Logistic regressions are used to estimate the independent effects of the variables. The logistic function is defined as:

$$\textit{Probability (Early adopter)} = e^{\beta X}/(1+e^{\beta X})$$

$$\textit{for Early adopter} \subset (1,0)$$

X is the vector of independent variable, and β is a vector of coefficients. Maximum likelihood is used to estimate the parameters.

Table 2: Multivariate Results, Using Non-PERC

	Model 1		Model 2		Model 3		Model 4	
Intersect	-6.16		-9.76	***	-2.78	***	-2.92	***
SES of Neighborhood								
Log of HH Income	0.29		0.61	***				
Percent Black+Latino	-0.03				-0.75	*		
Designated EJ Area	-0.34						-0.47	***
Firm Characteristics								
Total machines	1.05	***	1.04	***	1.04	***	1.06	***
Employees per Machine	0.29	*	0.35	***	0.35	***	0.35	***
Operating 0-3 years	0.30	*	0.30	*	0.30	*	0.31	*
Local Market Characteristics								
Residents per Firm	0.58	*	0.58	*	0.55	*	0.52	*
Workers per Firm	-1.46	*	-1.61	***	-1.53	*	-1.45	*
Commercial Index	1.93	***	2.09	***	1.90	***	1.92	***
Number of Firms	-0.02		-0.02		-0.02		-0.02	
Likelihood Ratio	96.96	***	92.87	***	89.374	***	95.55	***
Number of Observations	1,442		1,442		1,442		1,442	

* p<.05; ** p<.01; *** p<.001

Table 2 reports the results of the logistic regressions. Model 1 contains all independent variables, and Models 2-4 include one EJ-related variable at a time. The non-EJ control variables are not the main variables of interest, but it is worth noting that they largely perform well. The estimated coefficients for all firm characteristics and two local market conditions (size of residential and worker markets) have the *a priori* predicted effects, are statistically significant, and fairly robust across models. Gross land-use (commercialization index) also has a sizeable positive and highly statistically significant impact on switching. The coefficient for the proxy for localized competition (number of firms in a zip code) is not statistically significant, indicating that any potential gains from product differentiation are offset by price competition.

The estimated coefficients for three EJ-related variables in Model 1 suggest that firms are more likely to use non-PERC if they are in higher income neighborhoods with relative few minority residents and outside designated EJ areas. Individually, none of the coefficients is statistically significant, but a joint test shows that including them is statistically significant at the $p<.01$ level. This indicates that collinearity makes it difficult to isolate their independent effects. Models 2-4 test the EJ-related variables separately, and the estimated coefficients are sizeable and statistically significant. Interestingly, AQMD's EJ designation provides the most explanatory power. The size of the coefficient for race in Model 3 is substantially larger than in Model 1, suggesting that the racial composition is important but works through the other two factors.

The relative contribution of firm and market conditions to the overall environmental gap is estimated by comparing the unadjusted and adjusted probability in using non-PERC equipment. The unadjusted difference is the probability for firms in the most advantaged neighborhoods relative the most disadvantaged neighborhoods using the method described in the previous section on bivariate analyses. The adjusted difference in the probability of being an early adopter (ΔPr) is estimated using the following equation:

$$\Delta Pr=B(p(1-p))*\Delta x$$

B is the estimated coefficient for one of the EJ-related variables, p is the observed probability of being an early adopter for the total sample, and Δx is the difference in the means for the independent variable for the most advantaged category of neighborhoods and for most disadvantaged category of neighborhoods. The results are reported in Figure 2, and they indicate that firm and market characteristics have little or no effect on the environmental gap. The largest difference between unadjusted and adjusted is for race, and the result suggests that *ceteris-paribus* gap is noticeably larger than observed in the simple bivariate assessment.

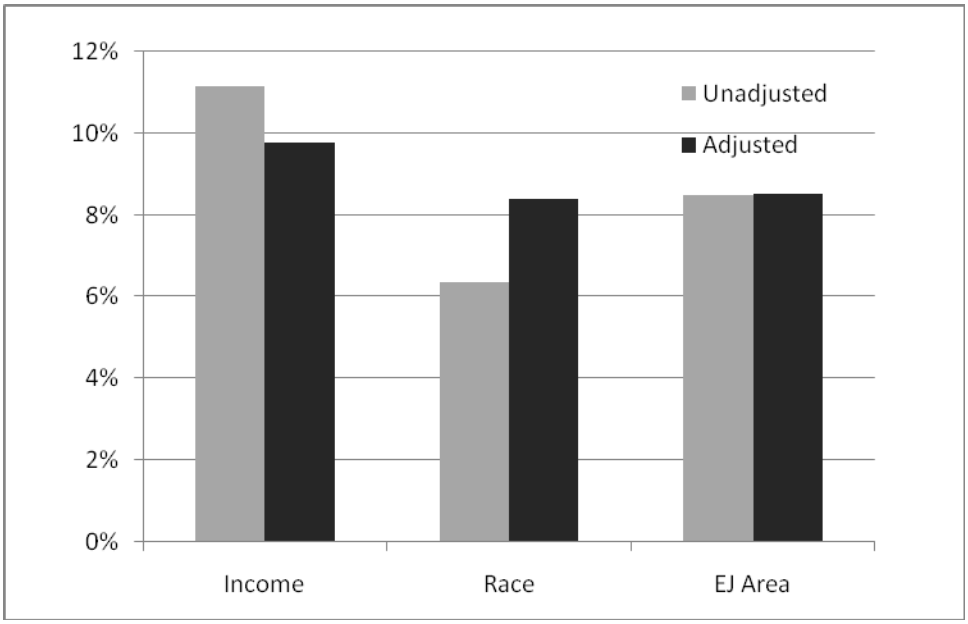

Figure 2. Unadjusted and Adjusted Environmental Gap

Additional specifications are estimated to test the robustness of the results for the main independent variables of interest.[4] This included using a different dependent variable. In the above models, an establishment using both PERC and non-PERC machines is classified as a switcher. The alternative specification is to define that establishment as a non-switcher. The new estimates for the EJ-related variables are very similar in size to those reported for the original models, although the statistical significances for the race variable drops to $p>.10$. A second set of models excludes the 5% observations with imputed on the number of machines, and the

[4] The results from these alternative specification show that the estimated parameters for firm and market variables are highly robust.

results for household income and EJ-designated areas are comparable to those based on the full sample. The re-estimated coefficient for the race variable is considerably larger (-1.01 v. -0.75) and statistically significant at the $p<0.01$ level. The wide range for the race coefficients across alternative models indicate that the estimates are sensitive to specification, but nonetheless the results consistently reveal that minority neighborhoods benefit less. Finally, the poverty rate is used instead of the log of household income, and the estimated coefficient for this variable is sizeable (-2.30) and significant ($p<.05$), although it does not have the explanatory power of household income. Overall, findings are highly consistent across alternative specifications and data sets, and the multivariate results mirror those from the bivariate assessment.

Part 4: Discussion and Conclusion

The analyses produce highly robust but undesirable results, that is, AQMD has failed to achieve environmental justice in its dry cleaners program. One could argue that without the EJ program, the outcomes could have been worse. For example, it may be possible that the firms receiving grants in advantaged neighborhoods would have been more likely switched without the financial incentives than their counterparts in disadvantaged neighborhoods. The hypothetical consequence of not having the incentive program and its EJ priority would have been a larger environmental gap. Unfortunately, the lack of credible counter-factual evidence makes testing such an assertion difficult. Even the multivariate analysis is insufficient because it relies on a natural experiment and uses proxies for some underlying economic behavior; therefore, the estimated adverse impacts on disadvantaged neighborhoods could be biased upward (or even downward). While one cannot absolutely dismiss this assertion, the indisputable bottom line is that white and affluent communities have benefited disproportionately more because dry cleaners in their neighborhood are more likely to be an early adopter of non-PERC technologies. This disparity is likely to continue throughout the protracted phase-in period.

What are plausible explanations for the inability to achieve environmental justice? It is difficult to interpret the results given that the analyses only test for the presence of *de facto* inequality. Available documents clearly show that the District's stated intention is to promote EJ. If taken at face value, this implies that implementation has been ineffective; organizational practices ignore or fail to carry out the adopted policy. Determining if this is a plausible requires a detailed process study of institutional procedures and actions.

This study has other limitations that should be addressed by future research. PERC usage is only a proxy for emissions, exposures and health risks. While these phenomena are highly correlated, the chain between originating sources to downstream outcomes is complicated and nonlinear. Further research is needed to understand the results at these different stages. The research reported here also does not examine how the negative results for one EJ program is related to inequality in cumulative impacts. Cumulative analysis refers to examining disparities from all pollutants rather than a single source at a time. EJ advocates have argued that this approach is needed to understand the problem in its totality to accurate assess the magnitude and nature of the environmental injustices (Corburn 2002). Further evaluations of the EJ dry-cleaner program should include an assessment of how it affects cumulative risks and health impacts.

The study is also limited because the findings are not generalizable to other EJ policies and programs. This is a case study of a single effort in a specific region covering a limited time span. While the results cannot be extrapolated, it demonstrates that the mere adoption of a policy or program is not sufficient to ensuring positive outcomes. This cautionary note needs to be taken seriously. It is critical that other EJ interventions be rigorously evaluated to determine if they are producing quantifiable results consistent with the intended goal. Such information would contribute to a much needed body of academic and applied knowledge. Unfortunately, public agencies seldom conduct such assessments. Even if they do, in-house evaluations may not be adequate. To ensure transparency and credibility, it is essential that outside independent researchers play a central role in conducting or reviewing the assessments.

References

Altmann L, Neuhann HF, Kramer U, Witten J, Jermann E. 1995. "Neurobehavioral and neurophysiological outcome of chronic low-level tetrachloroethene exposures measured in neighborhoods of dry cleaning shops". *Environ Res* 69: 83-89.

Anderton, D. L., Anderson, A. B., Oakes, J. M., and Fraser, M. 1994. "Environmental Equity: The Demographics of Dumping." *Demography* 31(2): 221-240.

Baron S., Sinclair R., Payne-Sturges D., Phelps J., Zenick H., Collman G.W., and L.R. O'Fallon. 2009. "Partnerships for Environmental and Occupational Justice: Contribution to Research, Capacity, and Public Health." *American Journal of Public Health*. 2009 Nov;99 Suppl 3:S517-25. Supplement 3. Vol 99(S3): p. S517-25.

Birnbaum, L. S., Zenick, H., and C.M. Branche. 2009. "Environmental Justice: A Continuing Commitment to an Evolving Concept. *American Journal of Public Health* 2009 Nov;99 Suppl 3:S487-9.

Bonorris, S., 2010. Editor, *Environmental Justice for All: A Fifty State Survey of Legislation, Policies and Cases* (fourth ed.). University of California Hastings School of Law. See http://www.uchastings.edu/centers/public-law/environmental-justice.html.

Bowen, W. M. 2000. *Environmental justice through research based decision-making*. Garland, New York.

Brown D.P. and S.D. Kaplan. 1987. "Retrospective cohort mortality study of dry-cleaner workers using perchloroethylene." *J Occup Med* 29:535-541.

Bullard, R.D. , *Dumping in Dixie: Race, Class, and Environmental Quality*, San Francisco, Westview Press, 1990.

Bullard, R. D.and G.S. Johnson. 2000. "Environmentalism and Public Policy: Environmental Justice: Grassroots Activism and Its Impact on Public Policy Decision Making," *Journal of Social Issues*. 56(3):555-578.

Bullard, R.D., Mohai, P., Saha, R., and B.Wright. 2007. *Toxic Wastes and Race at Twenty 1987-2007: Grassroots Struggles to Dismantle Environmental Racism in the United States*. Cleveland OH: United Church of Christ Justice and Witness Ministry.

California Air Resources Board. 2006. **"**Non-Toxic Dry Cleaning Incentive Program Grant Guidelines for the California Dry Cleaning Industry." Online at: http://www.arb.ca.gov/toxics/dryclean/grantcriteria.pdf. [Accessed 27 Jul 2010].

California Air Resources Board. 2008. “Dry Cleaning Alternative Solvents: Health and Environmental Impacts Fact Sheet.” Accessed from http://www.arb.ca.gov/toxics/dryclean/AlternativeSolvts_E.pdf on July 21, 2010

California Air Resources Board. 2010. “Dry Cleaning Program.” Accessed from http://www.arb.ca.gov/toxics/dryclean/dryclean.htm on July 28, 2010

California Environmental Protection Agency. 2002. “Chemicals Known to the State of California to Cause Cancer or Reproductive Toxicity.” Office of Environmental Health Hazard Assessment; June 28, p. 10

Camacho, David E. 1998. *Environmental Justice, Political Struggles: Race, Class, and the Environment*. Durham, NC: Duke University Press.

Campbell T and L Low. 2002. “Hung Out to Dry: How the Use of Perchloroethylene in Dry Cleaning Endangers You and Your Family’s Health. Coalition for Clean Air Report.” Accessed from: http://www.coalitionforcleanair.org/pdf/reports/cca-reports-hung-out-to-dry.pdf

Capozza, Dennis R., and Robert Van Order “A Generalized Model of Spatial Competition,” *American Economic Review*, Vol. 68, No. 5. (Dec., 1978), pp. 896-908.

Chamberlain, Edward H., *The Theory of Monopolistic Competition*, Cambridge, MA: Harvard University Press, 1938.

Colopy, James H., 1994. “The Road Less Traveled: Pursuing Environmental Justice Through Title Vi Of The Civil Rights Act Of 1964,” *Stanford Environmental Law Journal*, Volume 29, Number 4, 451-466,

Corburn, Jason, 2002. “Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community-Based Cumulative Exposure Assessment,” *Environmental Management* Volume 29, Number 4, 451-466.

Corburn Jason. 2009. *Toward the Healthy City: People, Place and the Politics of Urban Planning*. Cambridge, MA: The MIT Press, 2009

Dabirian, S. (2002, November). “Final socioeconomic assessment for proposed amendments to rule 1421: Control of perchloroethylene emissions from dry cleaning systems.” South Coast Air Quality Management District. Pomona, California.

Ghasemi, A. and P., 2002. “Final Staff Report, Proposed Amendment Rule 1421 – Control of Perchloroethylene Emissions from Dry Cleaning Systems,” South Coast Air Quality Management District. Pomona, California.

Green Earth Cleaning. 2010. “Alternative systems at-a-glance.” Accessed from http://www.greenearthcleaning.com/Resources/AFF_Lib/FactsResearch/AlternativeSystemsRev5.04.10lowres.pdf on July 28, 2010

Griliches, Zvi. “Hybrid Corn: An Exploration in the Economics of Technological Change,” Econometrica, Vol. 25, No. 4 (Oct., 1957), pp. 501-522

Hotelling, H., “Stability in Competition,” *Economic Journal*, 39(March 1929):41-57.

Houston, Douglas, Jun Wu, Paul Ong, and Arthur Winer. (2004). “Structural Disparities of Urban Traffic in Southern California: Implications for Vehicle-Related Air Pollution Exposure in Minority and High-Poverty Neighborhoods.” *Journal of Urban Affairs*, 25(5):565-92.

Kahn, Matthew E. 2001. “The Beneficiaries of Clean Air Act Regulation,” *Regulation Magazine*, Vol. 24, No. 1. 2001, pp. 34-38.

Krause, K. (2002, October). “Final environmental assessment: Proposed amended rule 1421 – control of perchloroethylene emissions from dry cleaning systems.” South Coast Air Quality Management District (No. 020813MK).

Lösch, August, *The Economics of Location*, New Haven, Conn.: Yale University Press, 1954.

Martin AR and GP Fulton. 1958. *Dry cleaning Technology and Theory*. New York: Textile Book Publishers, Inc.

Mills, Edwin S., and Michael R Lav, “A Model of Market Areas with Free Entry,” *The Journal of Political Economy*, Vol. 72, No. 3. (Jun., 1964), pp. 278-288.

Morello-Frosch, Rachel and Russ Lopez. (2006). “The riskscape and the color line: Examining the role of segregation in environmental health disparities.” *Environmental Research* 102:181-196.

Morris M and K Wolf. 2005. “Hydrocarbon Technology Alternatives to Perchloroethylene for Dry Cleaning.” Prepared for Cal EPA, accessed from http://www.irta.us/Hydrocarbon%20Report.pdf on July 21, 2010.

McGurty, Eileen Maura, 1997. “From NIMBY to Civil Rights: The Origins of the Environmental Justice Movement,” *Environmental History*, Vol. 2, No. 3 (Jul., 1997), pp. 301-323 26

Oakes, John Michael, Douglas L. Anderton, and Andy B. Anderson. 1996. “A Longitudinal Analysis of Environmental Equity in Communities with Hazardous Waste Facilities.” *Social Science Research* 25:125-148.

Pellow, David N. and Robert J. Brulle, Eds. 2005. *Power, Justice, and the Environment: A Critical Appraisal of the Environmental Justice Movement*. Cambridge, MA: The MIT Press.

Pastor, Manuel. 2008. “Toxics Over Time: A Longitudinal Look At Environmental Disparities In California Using The U.S. EPA’s Toxic Release Inventory,” Memo, USC, 2008.
Pastor, Manuel, James Sadd and Rachel Morello-Frosch. 2006. “The Air is Always Cleaner on the Other Zide: Race, Space, and Air Toxics Exposures in California.” *Journal of Urban Affairs* 27(2): 127-148.

Polakovic, G. (2002, October 21). “How to get clothes clean? A plan to phase out use of a popular solvent has stirred protests from dry cleaners, mostly ‘mom and pop’ operations that depend on it.” *Los Angeles Times*, p. B1.

Pressman, Jeffrey L. and Aaron Wildavsky, *Implementation*, Berkeley and Los Angeles: UC Press, 1973, 1979 1984.

Ringquist, Evan J. 2005. “Assessing Evidence of Environmental Inequities: A Meta-Analysis.” *Journal of Policy Analysis and Management* 24:223-247.

SCAQMD. 2009. “About South Coast AQMD.” Accessed from http://www.aqmd.gov/aqmd/index.html on July 26, 2010.

SCAQMD, “MATES III, Final Report,” September 2008, http://www.aqmd.gov/prdas/matesIII/MATESIIIFinalReportSept2008.html, downloaded September 29, 2010.

SCAQMD, “Environmental Justice Area Analysis Geography,” n.d.

Scheberle, Denise, 2004. *Federalism and Environmental Policy: Trust and the Politics of Implementations*, Washington, D.C.: Georgetown University Press, 2004.

Schweitzer, Lisa and Abel Valenzuela, Jr. (2004) “Environmental Injustice and Transportation: The Claims and the Evidence,” *Journal of Planning Literature*, 18:383-398.

Schreiber JS, Hudnell HK, Geller AM, House DE, Aldous KM, Force MS, et al. 2002. “Apartment residents' and day care workers' exposures to tetrachloroethylene and deficits in visual contrast sensitivity.” *Environ Health Perspect* 110:655-664.

Sigman, Hilary. 2001. “The Pace Of Progress At Superfund Sites: Policy Goals And Interest Group Influence,” *Journal of Law and Economics*, vol. XLIV (April 2001), pp. 315-344.

Sinsheimer P, Grout C, Namkoong A, Gottlieb R, and A Latif. 2007. “The Viability of Professional Wet Cleaning as a Pollution Prevention Alternative to Perchloroethylene Dry Cleaning.” *J. Air & Waste Manage. Assoc.* 57:172–178.

Smith G. 2002, December 7. “Ban on dry cleaning chemical approved.” *The Daily Breeze* (Torrance Edition), p. A4.

Smithies, A. "Optimum Location in Spatial Competition," *Journal of Political Economy* 44(1941):423-39.

Solet D, Robin TG, and C Sampaio. 1990. "Perchloroethylene Exposure Assessment Among Dry Cleaning Workers." *AIHA*. 51(10): p. 566-574.

Thomas, Ward. (2007). "Environmental Regulations and the Diffusion of Clean Technologies in the Dry Cleaning Industry." *Interdisciplinary Environmental Review*, Vol. 10 (2), pp. 154 – 184.

United Church of Christ, Commission for Racial Justice. 1987. Toxic wastes and race in the United States. New York: United Church of Christ, Commission for Racial Justice.

U.S. Department of Commerce, Economics and Statistics Administration, "Statistical Brief, Poverty Areas," June 1995, http://www.census.gov/population/socdemo/statbriefs/povarea.html, downloaded September 29, 2010.

U.S. GAO. 2005. "Environmental Justice: EPA Should Devote More Attention to Environmental Justice When Developing Clean Air Rules," GAO-05-289, July 2005.

U.S. EPA Office of Pollution Prevention and Toxics. 1994. Chemicals in the Environment: Perchloroethylene. Accessed on July 20, 2010 from http://www.epa.gov/chemfact/f_PERChl.txt

U.S. Environmental Protection Agency. (1995, September). Profile of the dry cleaning industry. Washington, DC: U.S. Government Printing Office. (EPA/310-R-95-001).

U.S. Environmental Protection Agency. 2003. "Towards an Environmental Justice Collaborative Model An Evaluation of the Use of Partnerships to Address Environmental Justice Issues in Communities", EPA/100-R-03-001, January 2003.

U.S. Environmental Protection Agency. 2006. Final Amendments to Air Toxics Standards for Perchloroethylene Dry Cleaners Fact Sheet. Accessed on July 21, 2010 from http://www.epa.gov/ttn/atw/dryperc/percfs20060717.pdf.

U.S. Environmental Protection Agency. 2009. Basic Information about Perchloroethylene. Accessed from http://epa.gov/drycleaningrule/basic.html on July 21, 2010.

Yang, Tseming, 2002, "Melding Civil Rights and Environmentalism: Finding Environmental Justice's Place in Environmental Regulation" *Harvard Environmental Law Review* Volume 26, Number 1