ORIGINAL ARTICLE

ENVIRONMENTAL JUSTICE IN THE OIL REFINERY INDUSTRY: A PANEL ANALYSIS ACROSS UNITED STATES COUNTIES

Angela Carpenter (Corresponding Author)
University of Leeds
Sustainability Research Institute
School of Earth and Environment
Leeds, LS2 9JT
E-mail: A.Carpenter@leeds.ac.uk

Marcus Wagner
University of Augsburg
Faculty of Business Administration and Economics
Universitaetsstr. 16
86159 Augsburg
E-mail: Marcus.Wagner@wiwi.uni-augsburg.de

Abstract Environmental injustice due to economic inequality and its correlates and consequences has been a focus for researchers and policy makers alike over many years, with much of that research focusing on race as the major determinant of inequality. In this paper we extend this literature by focussing on emissions from the oil refinery industry at the community level. In particular, based on the use of panel data, we analyse econometrically how the environmental performance of individual petroleum refineries (emissions of benzene and toluene to the atmosphere) associates with determinants of economic inequality at the micro-level in terms of average per capita income at the level of United States counties as well as average county-level unemployment rates. The paper finds evidence of environmental injustice as a result of unemployment levels in areas around refineries and, to a slightly lesser extent, as a result of income inequality. It discusses these results in a wider context, referring amongst other things to the role of county-level community characteristics and the potential for private firms to substitute for the intervention of public institutions, if these are lacking.

Keywords economic inequality; environmental justice; United States; petroleum refining; oil refinery industry

1. Introduction

Worldwide economic inequality and its correlates and consequences have been a focus for researchers and policy makers alike over many years. Piketty (2014 [1]), for example, identifies the historical magnitude and variability of wealth inequality in a number of countries since the Industrial Revolution of the mid-1700s, and suggested a secular trend (i.e. long term and neither seasonal or cyclical) of its increase in many economies which creates ethical issues. The related need to orient research to firms, to clarify potentially major social and environmental consequences related to injustice that emerges from them, and to clarify their role in this has already been highlighted in the literature, specifically as concerns the ethicality of the instrumental approach to corporate social responsibility (CSR) (Garcia-Castro et al., 2009 [2]).

The discussion about inequality and firms is related to the environmental justice (EJ) debate. The latter is fundamentally linked to social justice issues and, on this basis, broadly deals with the domains of distributive as well as procedural justice. It also deals with justice in terms of recognition as experienced (or not) by groups or individuals identified by certain characteristics, such as race, education level, income, or social status, for example (Becker, 2004 [3]; Schlosberg, 2007 [4]; U.S. Environmental Protection Agency, 2017 [5]). As part of this, but more narrowly, EJ also posits that individuals or groups with lower incomes - as a special aspect of distributive justice - are more exposed to environmental pollution (Cory and Rahman, 2009 [6]), and it is in this area that the following analysis focusses. Our starting point here is that mainstream economics has often argued that non-use values typically do not exist for the poor; that they consider this as a lesser disadvantage. This would imply that low-income groups do not perceive higher exposure to environmental pollution as an injustice. However, more heterodox views have proposed a differentiated notion of environmentalism among individuals and groups with low incomes, suggesting that such inequality is indeed perceived strongly as injustice (Martinez-Alier, 1995 [7], Anguelovski and Martinez-Alier, 2014 [8]).

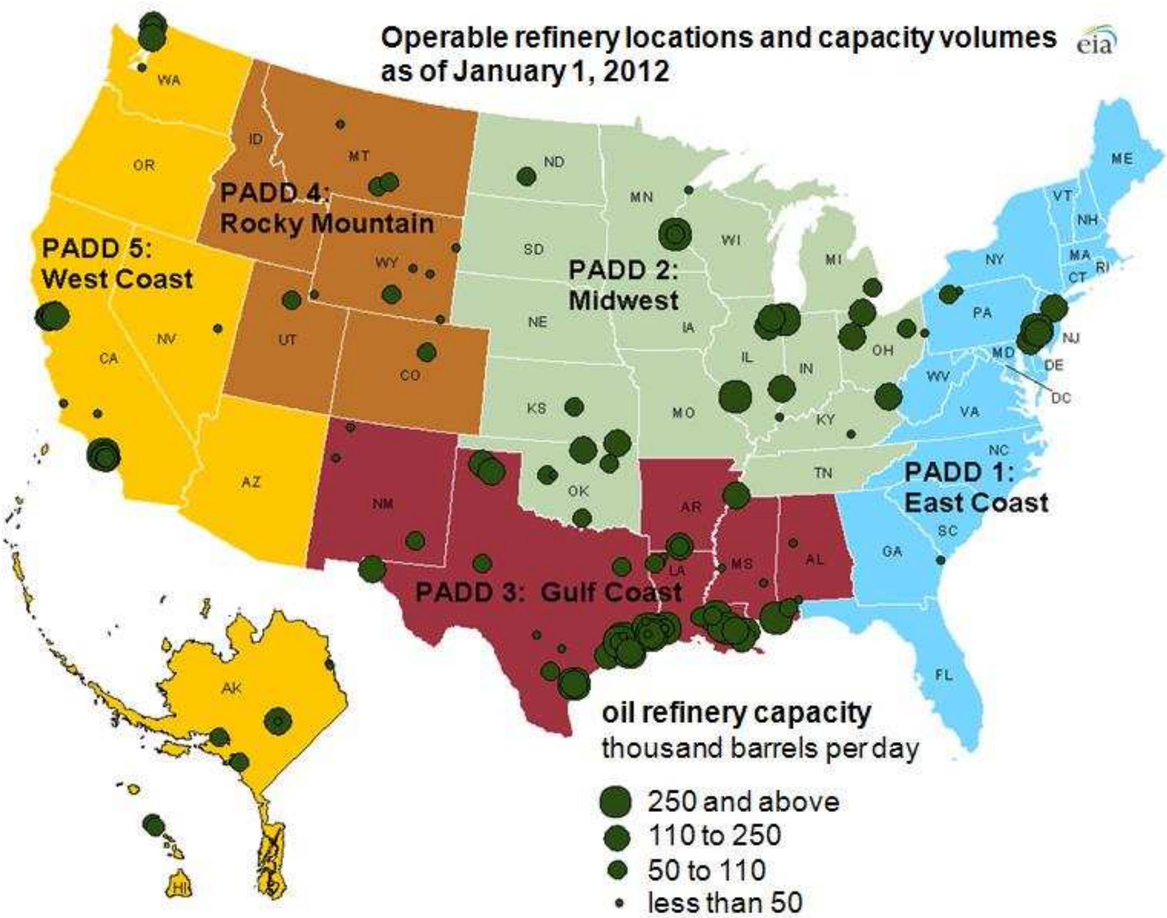
In this paper, we extend this literature by focussing on the oil refinery industry, a classic heavy industry with significant environmental risks and impacts that have been regulated in most industrialised countries for many years (Gouldson et al., 2014, 2015 [9, 10]). In particular, we analyse how environmental performance of individual refining plants can be associated with determinants of economic inequality at the micro-level. The determinants used are average per capita income at the county level, as well as average county-level unemployment rates for the sites chosen in the United States (U.S.). In doing so, we also raise the issue of whether information-based instruments (such as pollution and emissions registers/inventories and freedom-of-information regulations) can contribute to reducing inequality (Kalnins and Dowell, 2017 [11]).

The oil refinery industry is a very suitable focus for such an analysis, since it is associated with severe environmental and societal impacts (Wheeler et al., 2002 [12]). Furthermore, it is an industry that is still at the core of global economic activity, with oil price fluctuations contributing to serious economic impacts (Hamilton, 1983 [13]), to stock market volatility (Arouri et al., 2012 [14]), or responding to significant world events such as the Arab oil embargo of the early 1970s, and more recently to the global financial collapse of 2008 (U.S.

Energy Information Administration (EIA), 2016 [15]). Oil price fluctuation can also have a more local effect, as identified by Michieka and Gearhart (2015 [16]) who consider the link between high oil price and higher employment levels in Kern County, California, for example.

In the case of the US, only 10 new refineries have been built since the 1970s[1] while the number of operational refineries has declined by almost half in recent years (Analysis Group Inc. 2004 [17]). In the 10 years to 2004, operating capacity of U.S. refineries remained fairly stable, with increased capacity in many refineries, and refineries operating at nearly 95% capacity to meet demand for petroleum products (Analysis Group Inc 2004 [17]. This makes it a very suitable industry for analysis, with the data collected covering virtually the whole industry across the U.S., and across a wide range of geographies (coastal refineries, urban refineries, rural refineries). Figure 1 illustrates the distribution of petroleum refineries across the entire U.S., including the States of Alaska and Hawaii.

Figure 1: Location and capacities of U.S. Petroleum Refineries in 2012



Source: U.S. EIA (2012). Available online at http://www.eia.gov/todayinenergy/detail.cfm?id=7170 and https://commons.wikimedia.org/w/index.php?curid=41852702

[1] Based on U.S. EIA data. For further information on build dates, location and refining capacities see: https://www.eia.gov/tools/faqs/faq.php?id=29&t=6

Research has suggested that oil firms engage in stakeholder management and environmental and social reporting (Guenther et al., 2007 [18]; Godfrey, 2007 [19]). This begs the question of whether such activities also lead to tangible performance effects and public good contributions, for example, in terms of avoiding injustice resulting from exploiting inequality. This could, for example, impact on the economic or political means and power of a group or community to defend against siting attempts or emission exposure (Bullard and Johnson, 1998 [20]). This paper addresses this issue by initially reviewing, in section 2, the literature at the intersection of EJ and inequality, as well as the linkages between these areas. It then develops specific hypotheses on the link between environmental performance and inequality in section 3. Section 4 introduces the data and method, while section 5 reports on the results of the hypothesis testing. Finally, section 6 concludes and discusses the findings in a wider context.

2. Literature Review

Schlosberg (2007 [4]), in his discourse on defining EJ, notes that there has generally been a focus on discussions of maldistribution of environmental goods and environmental protection, with poorer or indigenous communities, and communities of colour, receiving far fewer benefits and far more disbenefits. This focus on goods is, to some degree, in contrast to the broader definition of EJ put forward by the U.S. Environmental Protection Agency (EPA) in 1997. That definition identified EJ as being *"the fair treatment and meaningful involvement of* all people regardless of race, color, national origin, or income with respect to the development, implementation, a*nd enforcement of environmental laws, regulations, and policies"*, where fair treatment means that *"no group of people should bear a disproportionate share of the negative* environmental consequences resulting from industrial, governmental and commercial ope*rations or policies"* (see U.S. EPA: 2017 [5] for further details).

Schlosberg (2007 [4]) further notes that, since as early as 1990 through the work of Young (1990 [21]), for example, distributive justice discourse can provide models and procedures through which distribution might be improved. Such models and procedures consider the underlying social, cultural or institutional conditions that lead to inequity between groups, including maldistribution of goods Taylor (2000 [22]). This line of study even goes beyond the core distributive justice discourse to highlight that social location (the position held by a person or group in society, based on factors including gender, race and class) can also influence how a group or community is treated, the resources made available to them, the collective actions they can take, and the levels of access they may have to lawmakers and political bodies. Walker (2009 [23]) also identifies that EJ goes beyond local distribution, specifically the distribution of pollution and risk, and is not just an issue of race inequality. Instead it needs to consider diverse socio-environmental concerns, and go beyond local proximity to wider spatial scales.

In the extant literature relating to EJ issues and the oil industry, this sector has been analysed in a number of contexts. These include oil transport (e.g. Casey et al., 2008 [24]), water quality (e.g. Cory and Rahman, 2009 [6]), waste facilities (e.g. Farber, 1998 [25]) and fracking (e.g. Fry et al., 2015 [26]). Toxic Release Inventory (TRI) data has, for example, been used to show a negative relationship between county per-capita income and pollutants (Helland and Whitford, 2003 [27]) when looking at emissions of a broad sample of firms from manufacturing and other U.S. establishments. However, to our knowledge, research focussing in more depth and detail on the oil refinery industry is still comparatively rare in this context, and in our case has been done over a different and more recent time period compared to other research. Thus our analysis, based on extensive original data, contributes new insights that provide a more differentiated and disaggregated picture on specific aspects of environmental inequality that emerge in the context of oil refineries.

Empirical research into environmentally harmful activities has in the past been undertaken at a more aggregate level. For example, Kellogg and Mathur (2003 [28]) highlighted the issue of America's ageing cities, where industrial heritage and current industrial activities operate in older neighbourhoods mainly occupied by low income families that are unable to afford housing away from areas contaminated by such activities. In respect of siting of waste disposal and other polluting facilities, Bowen and Wells (2002 [29]) as well as others, identified over 40 studies relating to siting of such facilities in high ethnic minority or poorer neighbourhoods that had been conducted during the 1980s up until 1998. However, in a more recent study probing into the association of ethnicity, income and water contamination with arsenic, Cory and Rahman (2009 [6]) find no evidence of minority or low-income groups being disadvantaged disproportionally.

More specifically, concerning the effect of low incomes, Arora and Cason (1999 [30]) identify, out of a large set of socio-demographic variables in the US, that unemployment, home ownership and income are the best predictors of environmental performance. In line with this, others (Gray and Deily [31], 1996; Becker, 2004 [3]) show that sites in economically disadvantaged areas experience less enforcement and inspection activities, and that income levels and home ownership rates affect the level of environmental protection at the site level, and is also related to inefficient implementation of regulation (Murphy-Greene and Leip, 2002 [32]). The study by Casey et al. (2008 [24]), using a conjoint experiment, finds that environmental injustice likely disadvantages poor individuals more profoundly than is typically argued by mainstream economics. They provide evidence of substantial non-use values of the environment among the poor in an analysis of oil transport choices along the Amazon River. Finally, Konisky (2009 [33]) also identifies that state regulatory enforcement behaviour is strongly related to economic class at the county level, with no similar relationship between enforcement and minority groups.

Concerning discrimination of ethnic minorities, Boer et al. (1997 [34]) provide evidence that areas with larger shares of minorities in the U.S. face a significantly higher likelihood of experiencing hazardous waste facility siting. However, Lynch et al. (2004 [35]), in examining petroleum refineries penalised for environmental violations, reported that their findings were inconclusive, suggesting that ethnic minorities do not experience strong environmental injustice. Similarly, Cory and Rahman (2009 [6]), when analysing effects of the Safe Drinking Water Act in Arizona, find that mainly latitude and longitude, acting as a proxy for transport of arsenic contamination between locations, determines arsenic exposure, and they relate this to the partly natural occurrence of arsenic hazards. Cole et al. (2013 [36]) show that ethnic fractionalisation and polarisation correlates negatively with environmental performance in the U.S. at the 5-digit postal code level.

Studies utilising data from the U.S. EPA's TRI[2] Program further confirm that race may not be the most significant factor. Bowen et al. (1995 [37]), in a study using TRI data on chemical releases to air, water and land, together with data from the 1990 U.S. Census on Population and Housing[3], concluded that, at least to some extent, while older toxic waste sites are located in inner-city areas in Ohio and Cleveland, with high incidences of minorities and poor housing, newer waste sites are being situated in higher income, majority white population suburbs on the urban fringes. This is, they suggest, a result of lower land costs in those fringe areas. They highlight, therefore, the need for environmental discrimination and injustice to be examined empirically, systematically and based on objective and reliable data. It should be noted that the TRI is not perfect in this respect; its minimum reporting requirements means that smaller industrial facilities are not required to report releases. Further, the TRI database does not consider the environmental fate and transport of industry emissions, and emissions are reported at county level and therefore do not capture highly localised impacts (Dolinoy and Miranda, 2004 [38]). At the same time, TRI covers the most significant impacts, is federally audited and comprehensive without any other source being better able to predict emission transport and fate in the U.S.

In an earlier survey, Farber (1998 [25]) analyses the effect of undesirable land uses on property values and finds that some types of land use reduced values specifically in their vicinity. In this study, hazardous waste facilities were found to have stronger effects than municipal landfills or refineries. Correspondingly, at the macro-economic level, Borghesi (2000 [39]) points out that inequality affects time preferences and cost-benefit assessments with regard to polluting actions, such that, in more unequal societies, environmental pollution is more widespread. He further points to a correlation of power and income, suggesting that those with higher income have more influence on politicians and other decision makers that affect, for example, siting decisions or (expected) emission exposure. Summing up more recent studies, Ringquist (2005 [40]) undertook a meta-analysis of 49 such studies in order to assess evidence of the inequitable distribution of sources of potential environmental risk that considered race and class as measures of inequity. Other variables considered in that meta-analysis include measures for population density, unemployment, and per-capita income at different geographic scales as potential indicators of environmental pollution, rather than race or class. While that study concludes that environmental inequities exist and are ubiquitous, it also indicates that the average magnitude of these inequities is small.

Specific to our context, whilst Ness and Mirza (1991 [41]) show that oil firms have above-average levels of environmental reporting due to the strong environmental opposition they are experiencing, Sharma (2001 [42]) indicates that different regulatory regimes do not much affect

---

[2] For further information on the UP Environmental Protection Agency's TRI Program see: https://www.epa.gov/toxics-release-inventory-tri-program

[3] For data from the 1990 U.S. Census on Population and Housing see: https://www.archives.gov/research/census/1990-statistics.html

the environmental strategies of oil and gas firms in Canada and the U.S., suggesting that other factors drive these more. Escobar and Vredenburg (2011 [43]) find heterogeneity in oil firms' response to institutional pressures, which suggests the possibility of these creating, whether purposely or unintentionally, environmental inequality. Whilst the latter issue (namely, environmental inequality) has been the topic of work on other industries, such as waste disposal or fracking (Farber, 1998 [25]; Fry et al., 2015 [26]) it has not been addressed much in the context of the oil refinery industry which thus remains as a gap in the literature.

Beyond this, Berman and Bui (2001 [44]) compare firms in the U.S. oil refinery industry for the period 1987 to 1995 in terms of total factor productivity. Making use of a natural experiment with California having tighter air pollution emission thresholds than other U.S. States, they find that tighter regulations correspond to higher productivity despite the potentially higher pollution abatement costs. Whilst this last insight is at least partly supporting the induced-innovation hypothesis at the state level (Porter and van der Linde, 1995 [45]), comparatively less is known about more micro-effects at the county level. At this latter level, the siting of individual refineries takes place, and our analysis thus contributes insights on a so far less-researched issue and its implications based on TRI data. By focussing on actual environmental performance, we also can provide for stronger tests of inequality effects by analysing emission exposure (Wolverton, 2009 [46]; Cole et al., 2013 [36]). This is further enabled by our focus on one specific industry, which allows us to control for effects of the business environment in ways superior to multi-industry studies, which for example only include a smaller number of firms in any individual industry. We should note here that the average age of refineries examined in this study is 56 years (Table 1) and that only 10 new refineries have been built in the U.S. since the 1970s. No refinery built after 1990 was included in the study (see Section 4 for further details). The results of this study therefore relate to emissions from refineries, and not to siting decisions for refinery locations, even though these are somewhat related.

3. Theory and Hypotheses

Stymne (2000 [47]) argues that income levels and their variation can affect environmental quality since there are links between income and power. In this sense, Stymne (2000 [47]) suggests one potential issue of environmental inequality; that environmental performance levels associate with socio-demographic characteristics in a way that could disadvantage certain groups of individuals. Political economic theory suggests that, in this situation, organisations such as firms could continue behaviour fostering environmental inequality, even though facing stakeholder demands, as well as regulatory or institutional pressures, (Arndt, 1983 [48]).

It has been argued that this specifically applies to legal systems based on common law, as here the courts tend to be slow (or at least slower than in legal systems based on codified law) to address social inequality (Dowling and Pfeffer, 1975 [49]). In the context of this paper, these issues are operationalised in terms of differences in socio-demographic characteristics across U.S. counties. The paper specifically focusses on absolute and relative per-capita income and unemployment levels, and their link to the environmental performance of oil refinery sites located in those counties.

Overall, depending on the absolute and relative average per-capita income and unemployment levels, counties may differ in their propensity to react more or less favourable to siting attempts or (expected) emission exposure. More specifically, the higher the per-capita income in a county, the more likely it is that residents of that country will take legal action, because they can afford more and better lawyers (Weersink and Raymond, 2007 [50]). This means that, as suggested by Stymne (2000 [47]), income enables power and, in turn, it would suggest that oil firms anticipate the threat of considerable obstacles which ultimately lets them shy away from even trying to site a refinery in such a county. On the other hand, in poor counties, where residents cannot afford to hire lawyers, this makes them more susceptible to siting or higher emissions from a site. Furthermore, all else being equal, higher county-level unemployment makes residents more inclined to accept risks because of the necessity of additional employment coming to the country. On siting issues, for new high polluting facilities, Earnhart (2004 [51]) notes that these are more likely to be sited in areas where expected community pressure is lower, while the resulting lower property values will drive away people on higher incomes, opening up housing to those on lower incomes.

Whilst unemployment is partly reflected in average county per-capita income, it needs to be pointed out that it has, independent of this, by itself a potentially positive effect on siting decisions and emission exposure, since residents want additional jobs to come into their county. Thus, an effect of unemployment levels independent of, and possibly even in the opposite direction to, income levels is possible. This effect should consequently be gauged in an integrated model beyond any effects of income. Furthermore, relative income and unemployment levels (as for example captured by county per-capita income as a percentage of state per-capita income or the difference between county and state unemployment rates) may matter, as they reflect more strongly distributional effects and differences among counties.

Since refineries are the major industrial sources of benzene and toluene emissions, among others, as a result of the refining of crude oil, absolute emissions of the two aforementioned pollutants are an appropriate measure for environmental performance which leads to the following hypotheses:

> H1: The absolute county per-capita income is negatively associated with emissions of benzene and toluene.
>
> H2: The county unemployment rate is positively associated with emissions of benzene and toluene.
>
> H3: The county per-capita income as a percentage of average state per-capita income is negatively associated with emissions of benzene and toluene.
>
> H4: The difference between the county unemployment rate and the state unemployment rate is negatively associated with emissions of benzene and toluene.

In all of these cases, the null hypothesis is that there is no relationship between income and emissions, or between unemployment and emissions. In the remainder of the paper, we test these four hypotheses. For this hypothesis testing, a single industry, single country study is highly desirable to achieve a largely constant institutional setting since the numerous relevant institutional factors are typically hard to observe, which could thus introduce omitted variable bias in an analysis across several countries or industries, if they are not observed. In focussing on U.S. oil refineries' location choices within the U.S., we achieve this as one key advantage of our study to the maximum level possible, which is an improvement on earlier multi-industry and/or multi-country studies. As noted previously, siting decisions were not a direct factor in this study which rather focuses on emissions from established refinery sites, as discussed in Section 4.

4. Data and Method

It should be noted that the structure of the U.S. petroleum refining industry has changed significantly since the start of the 21st century (U.S. Energy Information Administration 2013 [52]). Out of 127 operable refineries in the U.S. in 2010, this study examined emissions from 118 (92%) of refineries in total. These were selected on the basis that they had been continuously operating from 1990 to 2010, and that it was possible to identify each refinery by name and location over the entire period of the study. While the location of the refineries considered in this study has remained unchanged, due to various mergers, acquisitions, sales and transfers of refineries, changes of name by a small number of U.S. refiners, and refinery closures, it was not possible to include every U.S. refinery in the study (U.S. Energy Information Administration 2013 [52]). Figure 1 provides an illustration of the location of petroleum refineries in the U.S. in 2012, together with their capacity volumes.

Based on the identified refinery sample, emissions to air from petroleum refineries in the U.S. in terms of benzene and toluene (measured in kilogrammes) were gathered using publicly available data on refinery emissions from the U.S. TRI for the period 1990 to 2007. Benzene is classified as a human carcinogen, and is widely monitored and intensely regulated around the world (Bulka et al., 2013 [53]). Toluene, which is often used as a solvent, also poses hazards to human health and has, for example, been shown to cause significantly significant physiological changes in workers exposed to that substance (Abbate et al., 1993 [54]).

Emissions data was combined with data on refining capacity (measured as barrels per day) and refinery complexity (which was gauged in an ordinal manner at three levels, with level 1 corresponding to low complexity and level 3 to high complexity) from the Oil and Gas Journal[4]. This also allowed us to control for refineries belonging to the same parent company, thus being aligned to a specific corporate strategy, and also for the effect of refinery complexity on refinery performance. We furthermore include the refinery age (measured in years) to

[4] Benzene and toluene emissions have been identified as major pollutants in the oil and gas industry (Tomorrow Web (1998) see: http://www.tomorrow-web.com/natural.html, accessed 8 October 2017).

account for possible effects of technological progress, and since the literature suggests that size and age are important factors influencing firm performance (Wagner, 2011 [55]).

The data was further combined with publicly available information on voter turnout (in terms of the share of Republican votes at the county level) and voter participation, and this was obtained from the websites of each U.S. state in which refineries are located[5]. All these explanatory variables are measured as percentage figures. Information on state and county level per capita income (all measured in U.S. dollars) was obtained from the U.S. Bureau of Economic Analysis Regional Economic Accounts[6]. State and county level unemployment data (all measured as a percentage figure) was obtained from the U.S. Bureau of Labor Statistics[7]. U.S. Census Bureau data[8] was used to produce annually estimated values of state and county level populations (measured as the number of inhabitants). Population densities were calculated by dividing population figures by the total land area (i.e. excluding areas covered by water) for each state and county (measured in square miles).

We test hypotheses 1 and 2 based on the above-defined variables for average county per-capita income and county unemployment rate. We further involve two variants of our main explanatory variables in hypotheses 3 and 4 that are derived from the former. These are the county per-capita income as a percentage of state per-capita income, and the difference between the county and state unemployment rates (both measured as percentage figures). Both of these derived variables control, to a larger extent than average county per-capita income and county unemployment rates, for distributional differences among counties. As well this, sensitivity analysis allows us to better evaluate the degree to which results depend on changes in the specification of our main explanatory variables.

Given that correlation between the independent variables may be of concern, as the matrices in tables 1 (for the main explanatory variables of hypotheses 1 and 2, respectively) and 2 (for main explanatory variables of hypotheses 3 and 4) show, this is always clearly less than 0.65. Multi-collinearity is therefore not an issue (Ramanathan, 2002 [56]). Also, the mean variance inflation factors (VIF) of the explanatory variable are all well below the value of 5 advocated in the literature to indicate the absence of multi-collinearity (Judge et al., 1985 [57]). Therefore it is considered safe to proceed with a multivariate analysis of the panel data at hand.[9]

[table 1 here]

[5] See for example http://sos.georgia.gov/elections/election_results/default.htm for the State of Georgia and http://www.sos.ca.gov/elections/elections_elections.htm for the State of California.

[6] U.S. Bureau of Economic Analysis Regional Economic Accounts data is available online at: http://www.bea.gov

[7] U.S. Bureau of Labor – Bureau of Labor Statistics data is available online at: http://www.bls.gov

[8] U.S. Census Bureau data is available online at: http://www.census.gov/index.html

[9] Summary statistics are also available on a more detailed, yearly level upon request from the authors.

[table 2 here]

To analyse panel data, two well-established models exist, namely random and fixed effects (Wooldridge, 2002 [57]). The difference between the fixed effects and the random effects model is based on whether the time-invariant effects are correlated with the regressors (which is the case for fixed effects) or (in case of the random effects model) not. For the models, the specification is: $u_{it} = c_i + e_{it}$ (1)

and $$y_{it+1} = \alpha + \beta' \mathbf{X}_{it} + c_i + e_{it} \quad (2)$$

where i = 1, …, N are the units under observation, and t = 1,…, T the time periods for which data were collected. y_{it+1} denotes an emission-related dependent variable for firm i in period t+1, $\mathbf{X}_{it}$ represents a set of lagged independent variables for firm i in period t, β' a vector of coefficients, c_i unobserved individual heterogeneity for firm i and e_{it} an idiosyncratic error that satisfies $E[e_{it}|\mathbf{X}_{it}, c_i] = 0$.

Whilst the random effects model is estimated assuming no correlation between e_{it} and c_i, for the fixed effects model the assumption is that the individual effect c_i is correlated with the time-variant independent variables $\mathbf{X}_{it}$. This means that, although the basic specification given in (1) and (2) remains, the interpretation differs, in that the disturbance c_i is a constant (and thus represented by a dummy variable) for each unit of analysis, i.e. here for each specific firm. The fact that the disturbance is a constant in the fixed effects model implies that all time-invariant variables are in this case dropped in the estimation.

To decide which of the two models is more appropriate, the Hausman test has been used. If the Hausman test is significant, then the fixed effects model is more appropriate. If it is insignificant, then the results of the random effects model are reported. Models are reported according to this criterion in tables 2 and 4. The dependent variables as well as population density and refinery capacity are included as logarithms in the estimations as is usually done in the literature (e.g. Helland and Whitford, 2003 [27]; Earnhart, 2004 [58]), and due to the skewedness of the emission data. We also control for refinery-specific influences and year fixed effects in all of the models.[10]

5. Results

As can be seen from table 3, the baseline models for both toluene and benzene emissions are, overall, significant. For benzene emissions as the dependent variable, the association with average county personal income is negative and significant, which supports H1. Furthermore, the county per-capita income as a percentage of state per-capita income is significantly

[10] Whilst for reasons of parsimony we only include the results of an omnibus test for the joint significance of year effects in our tables below, estimated coefficients for individual years are available upon request from the authors.

negatively associated with toluene emissions, which supports H3, while the difference of country and state unemployment is significantly associated with benzene emissions which supports H4. We note that, in this latter case, a positive effect is expected, since the larger the difference between county and state unemployment, the higher a county's unemployment relative to its context, i.e. the more pronounced is the relative inequality.

Refinery capacity is significantly positively associated with benzene emissions, which is as expected. This is, however, not the case for toluene emissions, indicating for the latter that larger refineries seem to have been better able to offset higher absolute emissions by means of lower specific emissions per unit of output. Finally, both very complex and very simple refinery structures are found to have lower emission levels compared to those of intermediate complexity in those cases where the random effects estimates are suggested to be more appropriate by the Hausman test.

[table 3 here]

In table 4 we provide an extended model that accounts for the fact, that 'political' variables such as voter turnout and the share of conservative versus non-conservative voters have been proposed as explanatory factors in prior literature (Earnhart, 2004 [51]). Furthermore, refinery age is included here as an additional organizational variable. This latter variable might be important, since research shows that age of refinery is correlated with technology improvements beyond retrofit, and hence the emission performance of a refinery (Xepapadeas and De Zeeuw [59], 1999; Feichtinger et al., 2005 [60]). Age therefore has a strong influence on the technology and processes adopted, which ultimately can significantly affect emission levels of a refinery. This extension of the list of explanatory variables comes, unfortunately, at a significant loss of observations in our data, due to more limited availability especially of the age data. Therefore, estimating this alternative extended model also functions as a sensitivity test for the results reported in table 3. What can be noted is that the significant lower number of observations in table 4 compared with table 3 (which as stated largely results from the much lower availability of data on the refinery age variable) does not affect the salient results. This provides additional assurance and suggests that selection issues are not a problem in the data.

As can further be seen from table 4, the models are again significant for both, toluene and benzene emissions. As concerns our hypothesized variables, as before for benzene emissions, the association with average county per-capita income is negative and significant, i.e. higher incomes correlate with lower absolute and relative emissions; this again supports H1. Furthermore, county per-capita income as percentage of state per-capita income is significantly negatively associated with toluene emissions, which supports H3. As before, refinery capacity is negatively associated with benzene emissions. This essentially confirms the results for the baseline model, except for H4, where the coefficient becomes insignificant. This is likely due to the additionally included variables and the reduction of the sample. H4 could, therefore, still hold in principle with the full dataset, but given the lack of information on the additional variables it was not possible to test for this.

[table 4 here]

As in the baseline model, refinery capacity is significantly positively associated with benzene emissions. Very complex and very simple refinery structures are again found to have lower emission levels compared to those of intermediate complexity in those estimations where, based on the Hausman test, the random effects estimates are suggested to be more appropriate.

As concerns the additionally included variables, we find refinery age to be additionally significant in the case of benzene. Furthermore, county voter turnout is significantly associated with both benzene and toluene emissions, as is the share of Republican votes in a county. In summary therefore, the basic results of the baseline specification in table 3 are confirmed and prove, as concerns the hypotheses, in all but one case to be insensitive against a substantial reduction in the number of cases included in the analysis as a result of adding more control variables in the extended model. This considerably increases the confidence that can be put in the estimates reported.

As concerns the economic significance of the hypothesized effects supported, a change of average per-capita income by 1,000 USD reduces benzene emissions by 10 percent (corresponding on average to a reduction of 1,077 kilogrammes) while an increase of per-capita country income by 1 percent relative to state income levels would reduce benzene emissions by 4.4 percent and toluene emissions by 2.3 percent. Compared to this, an increase in the percentage of Republican voters by 1 percent leads to an increase of benzene and toluene emissions in the range of 2.1 to 2.7 percent. Furthermore, for benzene, a 100 percent increase (i.e. a doubling) of refinery capacity would increase emissions by 63 percent, ceteris paribus. This again underscores the importance to control for refinery-related and other structural or institutional parameters in EJ studies.

6. Conclusions and Discussion

Stymne (2000 [47]) suggests that the issue of environmental inequality is complex, data for its empirical analysis is scarce, and that consequently more research is needed to understand links better. As previously noted, there are a wide range of empirical studies into the determinants of industrial or similar environmentally harmful activities, but there is potential for new insights from using TRI data that became available only recently. Our research addresses these issues by focusing on oil firms' environmental performance in relation to the socio-demographic characteristics around the refineries.

Overall, it finds that the hypotheses on per-capita income are strongly supported for hypothesis H3, proposing that relative income is negatively associated with absolute emissions of benzene and toluene, and partial supported for hypothesis H1, where absolute income is negatively associated with emissions of toluene, but not of benzene. In line with Earnhart (2004 [51]), we find inequality in that income correlates with emissions negatively, which is consistent with, and thus confirms, social justice theory and its ethical concerns. On the other hand, as concerns unemployment, we find only support for hypothesis H4. It thus appears that the effect of unemployment can conceptually work both ways and that it may be partly incorporated in per-capita income, which is somewhat correlated with unemployment. The association is likely also affected by the generally positive employment effect of a refinery commencing operations in a region.

Furthermore, whereas our analysis finds few significant positive effects of voter participation, Earnhart (2004 [51]) finds only positive associations for this variable. Yet this is likely due to the fact that Earnhart's study [51] looks at wastewater plants and only analyses Biochemical Oxygen Demand (BOD; a measure of organic pollution in a wastewater sample) emissions as its dependent variable, and has far fewer control variables, especially as concerns plant characteristics. This indicates the relevance of a rich set of technology-related control variables in studies on environmental justice (EJ) to avoid omitted variable biases. In general the findings therefore suggest that oil refineries pursue an instrumental approach to corporate social responsibility (CSR) that would make it attractive for them, from a cost perspective, to site refineries in poorer counties (Garcia-Castro et al., 2009 [2]).

It appears that refinery operators would do this even at the risk of losing reputation in the longer term. Thus, returning to the literature discussed in Section 2, the notion that siting a plant in a high-income area is an initially more costly project (in terms of the need to invest more effort to convince residents to accept the siting choice and the emission exposure associated with this, as compared to low-income areas) may weigh more than the long-term benefits from doing so. Long-term benefits would include capitalizing on a positive CSR image of the firm in recruiting activities such as attracting more motivated employees, or more generally in risk reduction that could be derived from prudent action (Albinger and Freeman, 2000 [61]). Through our study we not only shed light on this prisoner dilemma type situation, but also on the potential negative effects of inequality in a broader social context and paradoxical situations as concerns the link between a firm's performance and CSR (Greenberg, 2010 [62]). In doing so, we can also shed light on the general link between environmental performance and inequality more generally.

An important question for future research in the context of our research topic is whether the links identified are generic or contingent? For example, following Husted and Allen (2006 [63]), there might be a possibility that the type of global strategy a firm is pursuing (e.g., multinational versus transnational firms) is related to their local behaviour in a systematic manner. Given their size, globally active firms are over-proportionately important and can play a major role in alleviating inequality. It thus might be worthwhile to clarify any links between their strategy type and emissions. Several of the firms in the sample are such multinational firms, whereas others only have U.S. operations. However, at the moment, a classification of the former firms into different types is not feasible, since no agreed measures of strategy type exist over time, and since surveys to gauge the type are likely to suffer from hindsight bias. At the same time, given our focus on U.S. refineries (and refinery emissions) only, the international strategy aspects surrounding siting choices can anyway not be detected comprehensively in our data.

Since environmental injustice resulting from economic inequality and its correlates and consequences has become a focus for (business) ethics researchers and policy makers alike, we also identify a related need to orient ethics-related research towards policy interventions (Patten, 1998 [64]). In this respect, our analysis finds evidence of environmental injustice, but also of some effects of voter participation and voting preferences, which seem partly related to information-based policy instruments such as the U.S. Toxic Release Inventory.

Edwards and Darnall (2010 [65]) suggest that, at least in relation to manufacturing facilities, the use of voluntary instruments, especially environmental management systems (EMS), can help organizations achieve societal legitimacy. This is particularly important for emissions of facilities in areas where low-income groups or ethnic minorities form a high proportion of the local population. At the same time, the logic of EMS (as a prime example of voluntary instruments) suggests a potential for private firms to substitute direct public intervention by means of command and control legislation, but for such a substitution to succeed, appropriate motivations are pivotal (Edwards and Darnall, 2010 [65]). This also relates to other alternatives such as economic instruments, where a possible trade-off between reducing local and global pollutants has been suggested (Anguelovski and Martinez-Alier, 2014 [8]).

Our analysis shows that our hypotheses are more strongly supported in the case of benzene, and less so for toluene. At the same time, in some cases the relative and in some the absolute measures for income have an effect. These findings contribute to highlighting potentially differential effects depending on the pollutants considered, as well as the explanatory measures chosen.

As a further contribution, our findings also reveal the importance of controlling for voting behaviour and process characteristics (such as age, capacity or complexity of the processes and equipment operated) in EJ studies more generally.

As a limitation, we need to acknowledge that we are not measuring the intersectionality of different justice aspects, such as distributive and procedural justice; nor could we examine environmental racism. We therefore suggest these as areas which would benefit from further research.

Funding Sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

We would like to thank Andy Gouldson for providing access to the data used in this paper as well as for feedback during the early phases of carrying out the analysis. We would also like to thank participants at the 2015 International Public Management Network conference in Budapest, especially Nancy Roberts, Guyla Vastag and Clay Whybark, for their valuable comments.

References

[1] Piketty, T., 2014. Capital in the 21st century. Cambridge, MA: Belknap Press.

[2] Garcia-Castro, R., Arino, M.A., Canela, M.A., 2009. Does social performance really lead to financial performance? Accounting for endogeneity. Journal of Business Ethics, 92, 107–126. DOI: https://doi.org/10.1007/s10551-009-0143-8

[3] Becker, R.A., 2004. Pollution Abatement Expenditure by U.S. Manufacturing Plants: Do Community Characteristics Matter? BE Journal of Economic Analysis and Policy, 3(2), 1–23. DOI: https://doi.org/10.2202/1538-0645.1231

[4] Schlosberg, D., 2007. Defining Environmental Justice: Theories, Movements and Nature. Oxford University Press, Oxford, UK.

[5] U.S. Environmental Protection Agency (2017). Learn about Environmental Justice. January 19, 2017 Web Snapshot. Available at: https://www.epa.gov/environmentaljustice/learn-about-environmental-justice

[6] Cory, D.C., Rahman, T., 2009. Environmental justice and enforcement of the safe drinking water act: The Arizona arsenic experience. Ecological Economics, 68(6), 1825–1837. DOI: https://doi.org/10.1016/j.ecolecon.2008.12.010

[7] Martinez-Alier, J., 1995. The environment as a luxury good or "too poor to be green"?. Ecological Economics, 13(1), 1–10. DOI: https://doi.org/10.1016/0921-8009(94)00062-Z

[8] Anguelovski, I., Martinez-Alier, J., 2014. The 'Environmentalism of the Poor' revisited: Territory and place in disconnected glocal struggles. Ecological Economics, 102, 167-176. DOI: http://dx.doi.org/10.1016/j.ecolecon.2014.04.005

[9] Gouldson, A., Carpenter, A., Afionis, S., 2014. An international comparison of the outcomes of environmental regulation. Environmental Research Letters, 9, 1–9. http://iopscience.iop.org/article/10.1088/1748-9326/9/7/074019/pdf (accessed 18 April 2018)

[10] Gouldson, A., Carpenter, A., Afionis, S., 2015. Environmental leadership? Comparing regulatory outcomes and industrial performance in the United States and the European Union. Journal of Cleaner Production, 100, 278–285. DOI: https://doi.org/10.1016/j.jclepro.2015.03.029

[11] Kalnins, A., Dowell, G., 2017. Community characteristics and changes in toxic chemical releases: Does information disclosure affect environmental injustice? Journal of Business Ethics, 145(2), 277–292. DOI: https://doi.org/10.1007/s10551-015-2836-5

[12] Wheeler, D., Fabig, H., Boele, R., 2002. Paradoxes and dilemmas for stakeholder responsive firms in the extractive sector: Lessons from the case of Shell and the Ogoni. Journal of Business Ethics, 39(3), 297–318. DOI: https://doi.org/10.1023/A:1016542207069

[13] Hamilton, J.D., 1983. Oil and the macroeconomy since World War II. Journal of Political Economy, 91(2) (Apr., 1983), 228–248. DOI: https://doi.org/10.1086/261140

[14] Arouri, M.E.H., Jouini, J., Nguyen, D.K., 2012. On the impacts of oil price fluctuations on European equity markets: Volatility spillover and hedging effectiveness. Energy Economics, 34, 611–617. DOI: https://doi.org/10.1016/j.eneco.2011.08.009

[15] U.S. Energy Information Administration, 2016. What drives crude oil prices? An analysis of 7 factors that influence oil markets, with chart data updated monthly and quarterly. http://www.eia.gov/finance/markets/crudeoil/reports_presentations/crude.pdf (accessed 8 November 2016).

[16] Michieka, N.M., Gearhart, R., 2015. Oil price fluctuations and employment in Kern County: A vector error correction approach. Energy Policy, 87, 584–590. DOI: https://doi.org/10.1016/j.enpol.2015.09.043

[17] Analysis Group Inc. (2004). U.S. Energy Infrastructure: Demand, Supply and Facility Siting – Report to the National Commission on Energy Policy. Paul J. Hibbard Analysis Group, Inc., November 2004. Available at: http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/TA_C5.pdf

[18] Guenther, E., Hoppe, H., Poser, C., 2007. Environmental corporate social responsibility of firms in the mining and oil and gas industries: Current status quo of reporting following GRI guidelines. Greener Management International, 53, 7–25. http://www.jstor.org/stable/greemanainte.53.7 (accessed 8 October 2017)

[19] Godfrey, P.C., 2007. The dynamics of social responsibility: Processes, positions and paths in the oil and gas industry. Schmalenbach Business Review, 59, 208–224. DOI: https://doi.org/10.1007/BF03396748

[20] Bullard, R.D., Johnson, G.S., 1998. Environmental and economic justice: Implications for public policy. Journal of Public Management and Social Policy, 4(4), 137–148.

[21] Young, I.M., 1990. Justice and the politics of difference. Princeton University Press. Princeton, New Jersey.

[22] Taylor, D.E., 2000. The Rise of the Environmental Justice Paradigm: Injustice Framing and the Social Construction of Environmental Discourses. American Behavioral Scientist, 43(4), 508-580. DOI: https://doi.org/10.1177/0002764200043004003

[23] Walker, G., 2009. Beyond Distribution and Proximity: Exploring the Multiple Spatialities of Environmental Justice. Antipode, 41(4), 614-636. DOI: https://doi.org/10.1111/j.1467-8330.2009.00691.x

[24] Casey, J.F., Kahn, J.R., Rivas, A.A., 2008. Willingness to accept compensation for the environmental risks of oil transport on the Amazon: A choice modeling experiment. Ecological Economics, 67(4), 552–559. DOI: https://doi.org/10.1016/j.ecolecon.2008.01.006

[25] Farber, S., 1998. Undesirable facilities and property values: A summary of empirical studies. Ecological Economics, 24(1), 1–14. DOI: https://doi.org/10.1016/S0921-8009(97)00038-4

[26] Fry, M., Briggle, A., Kincaid, J., 2015. Fracking and environmental (in)justice in a Texas city. Ecological Economics, 117, 97–107. DOI: https://doi.org/10.1016/j.ecolecon.2015.06.012

[27] Helland, E., Whitford, A.B., 2003. Pollution incidence and political jurisdiction: evidence from the TRI. Journal of Environmental Economics and Management, 46(3), 403-424. DOI: https://doi.org/10.1016/S0095-0696(03)00033-0

[28] Kellogg, W.A., Mathur. A., 2003. Environmental justice and information technologies: Overcoming the information-access paradox in urban communities. Public Administration Review, 63(5), 573–585. DOI: https://doi.org/10.1111/1540-6210.00321

[29] Bowen, W.M., Wells, M.V., 2002. The politics and reality of environmental justice: A history and considerations for public administrators and policy makers. Public Administration Review, 62(6), 688–698. DOI: https://doi.org/10.1111/1540-6210.00251

[30] Arora, S., Cason, T., 1999. Do community characteristics influence environmental outcomes? Evidence from the Toxic Release Inventory. Southern Economic Journal, 65, 691–716. DOI: https://doi.org/10.2307/1061271

[31] Gray, W., Deily, M., 1996. Compliance and enforcement: Air pollution regulation in the U.S. steel industry. Journal of Environmental Economics and Management, 31, 96–111. DOI: https://doi.org/10.1006/jeem.1996.0034

[32] Murphy-Greene, C., Leip, L.A., 2002. Assessing the effectiveness of executive order 12898: Environmental justice for all? Public Administration Review, 62(6), 679–687. DOI: https://doi.org/10.1111/1540-6210.00250

[33] Konisky, D.M., 2009. Inequities in enforcement? Environmental justice and government performance. Journal for Public Policy Analysis and Management, 28(1), 102–121. DOI: https://doi.org/10.1002/pam.20404

[34] Boer, J.T., Pastor, M., Sadd, J.L., Snyder, L.D., 1997. Is there environmental racism? The demographics of hazardous waste in Los Angeles County. Social Science Quarterly, 78, 793–810. http://www.jstor.org/stable/42863732 (accessed 18 April 2018)

[35] Lynch, M.J., Stretsky, P.B., Burns, R.G., 2004. Determinants of environmental law violation fines against petroleum refineries: Race, ethnicity, income and aggregation effects. Society and Natural Resources, 17(4), 333–347. DOI: https://doi.org/10.1080/08941920490278782

[36] Cole, M.A., Elliott, R.J., Khemmarat, K., 2013. Local exposure to toxic releases: Examining the role of ethnic fractionalization and polarization. Ecological Economics, 93, 249–259. DOI: https://doi.org/10.1016/j.ecolecon.2013.05.011

[37] Bowen, W.M., Salling, M.J., Haynes, K.E., Cyran, E.J., 1995. Toward environmental justice: Spatial equity in Ohio and Cleveland. Annals of the Association of American Geographers, 84(4), 641–663. DOI: https://doi.org/10.1111/j.1467-8306.1995.tb01818.x

[38] Dolinoy, D.C., Miranda, M.L., 2004. GIS modeling of air toxic releases from TRI-reporting and non-TRI-reporting facilities: Impacts for environmental justice. Environmental Health Perspectives, 122(17), 1717–1724. DOI: https://doi.org/10.1289/ehp.7066

[39] Borghesi, S., 2000. Income inequality and the environmental Kuznets curve. Milano: Fondazione Eni Enrico Mattei.

[40] Ringquist, E.J., 2005. Assessing evidence of environmental inequities: A meta-analysis. Journal of Policy Analysis and Management, 24(2), 223–247. DOI: https://doi.org/10.1002/pam.20088

[41] Ness, K., Mirza, A., 1991. Corporate social disclosure – a note on a test of agency theory. British Accounting Review, 23, 211–217. DOI: https://doi.org/10.1016/0890-8389(91)90081-C

[42] Sharma, S., 2001. Different strokes: Regulatory styles and environmental strategy in the North-American oil and gas industry. Business Strategy and the Environment, 10, 344–364. DOI: https://doi.org/10.1002/bse.303

[43] Escobar, L.F., Vredenburg, H., 2011. Multinational oil companies and the adoption of sustainable development: A resource-based and institutional theory interpretation of adoption heterogeneity. Journal of Business Ethics, 98, 39–65. DOI: https://doi.org/10.1007/s10551-010-0534-x

[44] Berman, E., Bui, L.T., 2001. Environmental regulation and productivity: Evidence from oil refineries. The Review of Economics and Statistics, 83(3), 498–510. DOI: https://doi.org/10.1162/00346530152480144

[45] Porter, M., van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. Journal of Economic Perspectives, 9, 97–118. DOI: https://doi.org/10.1257/jep.9.4.97

[47] Wolverton, A., 2009. Effects of socio-economic and input-related factors on polluting plants' location decisions. BE Journal of Economic Analysis and Policy, 9(1), 1–30. DOI: https://doi.org/10.2202/1935-1682.2083

[47] Stymne, S., 2000. Measuring sustainable economic welfare. Surrey, UK: University of Surrey.

[48] Arndt, J., 1983. The political economy paradigm: Foundation for theory building in marketing. Journal of Marketing, 47(4), 44–54. DOI: https://doi.org/10.2307/1251398

[49] Dowling, J., Pfeffer, J., 1975. Organizational legitimacy: Social values and organizational behavior. Pacific Sociological Review, 18, 122–136. DOI: https://doi.org/10.2307/1388226

[50] Weersink, A., Raymond, M., 2007. Environmental regulations impact on agricultural spills and citizen complaint. Ecological Economics, 60(3), 654–660. DOI: https://doi.org/10.1016/j.ecolecon.2005.12.023

[51] U.S. Energy Information Administration (2013). Genealogy of major U.S. refiners. Available at: https://www.eia.gov/finance/genealogy/pdf/genealogy_refiners.pdf

[52] Bulka, C., Nastoupil, L.J., McClellan, W., Ambinder, A., Phillips, A., Ward, K., Bayakly, A.R., Switchenko, J.M., Walker, L., Flowers, C.R., 2013. Residence proximity to benzene release sites is associated with increased incidence of non-Hodgkin lymphoma. Cancer, 119(18), 3309-3317. DOI: https://doi.org/10.1002/cncr.28083

[53] Abbate, C., Giorgianni, C., Munaò, F., Brecciarolu, R., 1993. Neurotoxicity induced by exposure to toluene. International Archives of Occupational and Environmental Health. 64(6), 389-392.

[54] Wagner, M., 2011. Corporate performance implications of extended stakeholder management: New insights on mediation and moderation effects. Ecological Economics, 70(5), 942–950. DOI: https://doi.org/10.1016/j.ecolecon.2010.12.010

[55] Ramanathan, R., 2002. Introductory econometrics with applications. New York: Thomson Learning.

[56] Judge, G., Griffiths, W., Hill, R.C., Lutkepohl, H., Lee, T.C., 1985. The theory and practice of econometrics. New York: John Wiley & Sons.

[57] Wooldridge, J., 2002. Econometric analysis of cross-section and panel data. Boston, MA: MIT Press.

[58] Earnhart, D., 2004. The effects of community characteristics on polluter compliance levels. Land Economics, 80(3), 408–432. DOI: https://doi.org/10.2307/3654729

[59] Xepapadeas, A., De Zeeuw, A., 1999. Environmental policy and competitiveness: The Porter hypothesis and the composition of capital. Journal of Environmental Economics and Management, 37, 165–182. DOI: https://doi.org/10.1006/jeem.1998.1061

[60] Feichtinger, G., Hartl, R.F., Kort, P.M., Veliov, V.M., 2005. Environmental policy, the Porter hypothesis and the composition of capital: Effects of learning and technological progress. Journal of Environmental Economics and Management, 50, 434–446. DOI: https://doi.org/10.1016/j.jeem.2004.12.001

[61] Albinger, H., Freeman, S.J., 2000. Corporate social performance and attractiveness as an employer to different job seeking populations. Journal of Business Ethics, 28(3), 243–253. DOI: https://doi.org/10.1023/A:1006289817941

[62] Greenberg, J., 2010. Organizational injustice as an occupational health risk. Academy of Management Annals, 4(1), 205–243. DOI: https://doi.org/10.5465/19416520.2010.481174

[63] Husted, B.W., Allen, D.B., 2006. Corporate social responsibility in the multinational enterprise: Strategic and institutional approaches. Journal of International Business Studies, 37(6), 838–849. DOI: https://doi.org/10.1057/palgrave.jibs.8400227

[64] Patten, D.M., 1998. The impact of the EPA's TRI disclosure program on state environmental and natural resource expenditures. Journal of Accounting and Public Policy, 17(4–5), 367–382. DOI: https://doi.org/10.1016/S0278-4254(98)10011-X

[65] Edwards Jr., D., Darnall, N., 2010. Averting environmental justice claims? The role of environmental management systems. Public Administration Review, 70(3), 422–433. DOI: https://doi.org/10.1111/j.1540-6210.2010.02156.x

Table 1: Summary statistics and correlations for explanatory variables in hypotheses 1 and 2[a]

	Variables	Mean	Standard Deviation	Correlations 1	2	3	4	5	6	7	8	9
1	Per-capita income	23477.97	5866.72	1.00								
2	Population density	5.35	1.87	0.40***	1.00							
3	Unemployment rate	6.03	2.00	-0.32***	0.06*	1.00						
4	Refinery capacity	11.28	1.05	0.27***	0.30***	0.02	1.00					
5	Complexity level 1	0.26	0.44	-0.12***	-0.11***	0.04†	-0.64***	1.00				
6	Complexity level 3	0.36	0.48	0.07**	0.15***	0.05*	0.51***	-0.45***	1.00			
7	Voter participation	37.05	6.92	0.10**	-0.31***	-0.26***	-0.03	0.03	-0.18***	1.00		
8	Republican share	47.18	12.82	-0.03	-0.50***	-0.34***	-0.35***	0.22***	-0.22***	0.09**	1.00	
9	Refinery age	58.58	25.06	0.42***	0.36***	-0.19***	0.24***	-0.12**	0.29***	0.12*	-0.35***	1.00

[a] values > 0.2 are significantly correlated at p < 0.05

Table 2: Summary statistics and correlations for alternative specifications of income- and unemployment-related explanatory variables in hypotheses 3 and 4[a]

	Variables	Mean	Standard Deviation	Correlations 1	2	3	4	5	6	7	8	9
1	County as % of state per-capita income	98.28	14.55	1.00								
2	Population density	5.35	1.87	0.33***	1.00							
3	Difference county - state unemployment	0.29	1.41	-0.35***	0.06*	1.00						
4	Refinery capacity	11.28	1.05	0.21***	0.30***	0.00	1.00					
5	Complexity level 1	0.26	0.44	-0.07**	-0.11***	0.06**	-0.64***	1.00				
6	Complexity level 3	0.36	0.48	0.00	0.15***	-0.02	0.51***	-0.45***	1.00			
7	Voter participation	37.05	6.92	0.11**	-0.31***	-0.22***	-0.03	0.03	-0.18***	1.00		
8	Republican share	47.18	12.82	-0.17***	-0.50***	-0.14***	-0.35***	0.22***	-0.22***	0.09**	1.00	
9	Refinery age	58.58	25.06	0.35***	0.36***	-0.13**	0.24***	-0.12**	0.29***	0.12*	-0.35***	1.00

[a] values > 0.2 are significantly correlated at p < 0.05

Table 3: Regression results: baseline model

Dependent variable **Independ. variables**	**Log of absolute benzene emissions**	**Log of absolute benzene emissions**	**Log of absolute toluene emissions**	**Log of absolute toluene emissions**
Per-capita income	-0.00004 (0.00002)*	-	-0.00002 (0.00002)	-
County as % of state per-capita income	-	-0.007 (0.009)	-	-0.023 (0.011)*
Unemployment rate	0.049 (0.030)	-	-0.093 (0.034)**	-
Difference county - state unemployment	-	0.081 (0.039)*		0.0009 (0.044)
Population density	0.038 (0.075)	0.101 (0.209)	0.109 (0.091)	-0.067 (0.236)
Refinery capacity	0.650 (0.134)***	0.527 (0.200)**	0.061 (0.158)	-0.406 (0.225)†
Complexity level 1	-1.306 (0.374)***	(dropped)	-0.859 (0.454)†	(dropped)
Complexity level 3	-0.597 (0.316)†	(dropped)	0.245 (0.387)	(dropped)
Constant	1.979 (1.597)	2.194 (2.751)	9.532 (1.890)***	15.957 (3.105)***
16 year dummies	5.51	79.91***	11.74	53.06***
28 state dummies	28.40	27.79	55.77**	55.55**
R^2 within	0.056	0.052	0.041	0.040
R^2 between	0.521	0.253	0.428	0.078
R^2 overall	0.369	0.186	0.300	0.029
Rho	0.543	0.601	0.585	0.730
Hausman test	6.42	21.85**	5.82	28.98***
No. of obs. (firms)	1726 (116)	1726 (116)	1726 (116)	1726 (116)
Wald Chi^2 / F	190.08***	4.87***	134.32***	3.71***

Significance levels: † p<0.1; * p<0.05; ** p<0.01; *** p < 0.001; 28 included state dummies tested for joint significance; omitted reference category: Complexity level 2

Table 4: Regression results: model with refinery age, voter participation and republican share

Dependent variable **Independ. variables**	**Log of absolute benzene emissions**	**Log of absolute benzene emissions**	**Log of absolute toluene emissions**	**Log of absolute toluene emissions**
Per-capita income	-0.0001 (0.00002)***	-	0.00002 (0.00003)	-
County as % of state per-capita income	-	-0.044 (0.014)**	-	0.004 (0.012)
Unemployment rate	-0.113 (0.046)*	-	-0.112 (0.045)*	-
Difference county - state unemployment		-0.073 (0.060)		-0.077 (0.055)
Population density	-0.110 (0.089)	-0.157 (0.478)	0.019 (0.437)	-0.037 (0.438)
Refinery capacity	0.631 (0.172)***	-0.146 (0.272)	-0.260 (0.246)	-0.289 (0.250)
Refinery age	0.052 (0.008)***	-0.095 (0.023)***	-0.051 (0.040)	-0.005 (0.021)
Voter participation	-0.058 (0.028)*	-0.025 (0.038)	0.071 (0.035)*	0.076 (0.035)*
Republican share	0.021 (0.011)†	0.027 (0.012)*	-0.017 (0.012)	-0.024 (0.011)*
Complexity level 1	-3.664 (0.657)***	(dropped)	(dropped)	(dropped)
Complexity level 3	-1.230 (0.389)**	(dropped)	(dropped)	(dropped)
Constant	4.456 (2.419)†	21.262 (4.650)***	13.313 (4.427)**	10.452 (4.264)*
16 year dummies	24.67**	51.67	16.29	25.53**
28 state dummies	54.21***	51.80***	70.85***	66.55***
R^2 within	0.142	0.135	0.241	0.229
R^2 between	0.893	0.111	0.223	0.071
R^2 overall	0.776	0.030	0.061	0.005
Rho	0.393	0.974	0.948	0.924
Hausman test	9.87	34.84**	79.09***	34.26*
No. of obs. (firms)	328 (36)	328 (36)	328 (36)	328 (36)
F / Wald Chi^2	367.08***	2.37**	4.84***	4.52***

Significance levels: † p<0.1; * p<0.05; ** p<0.01; *** p < 0.001; 28 included state dummies tested for joint significance; omitted reference category: Complexity level 2